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SPREAD OF *PROSOPIS JULIFLORA* ON THE COASTAL WILD LIFE SANCTUARY, SANDSPIT / HAWKESBAY, KARACHI

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ABSTRACT

Coastal areas of Pakistan are dry round the year, seasonally wet and generally meagre in species. Forty seven (47) halophytic, xeropytic, psammopytes were found collectively belonging to 19 families in this area. Approximately half of them were halophytes and a quarter belonged to psammophytes. Dominant life forms were herbaceous perennials, perennial grasses and shrubs. Suaeda fruticosa, Arthrocnemum macrostachyum and Halopyrum mucronatum were the most common and dominant species of the Sandspit / Hawkesbay, coastal line. Arthrocnemum macrostachyum, S. fruticosa and Cressa cretica were most abundant in the region of frequent tidal inundation; this region has correspondingly lower soil salinity and pH. Areas with infrequent inundation were dominated by Zygophyllum simplex and Salsola imbricata. Coastal dunes were dominated by Halopyrum mucronatum.

Key words: Sandspit / Hawkesbay, vegetation, halophytes, Invasive plant, *Prosopis juliflora*.

INTRODUCTION

Karachi is the biggest city of Pakistan. The city has a population of more than 12 millions and ranked 10th amongst the biggest cities of the world. Increasing population pressure, expansion in industrial and residential areas, construction of roads, flyovers and invasion of non native species affected nature, structure and composition of the plant communities. Coastal areas of Pakistan have long been the subject of a range of human activities causing habitat loss. Almost each and every area of Karachi can be presented as the classical example of disturbance and pollution impact on plant communities. The city atmosphere is being polluted by almost every type of environmental pollution. The natural vegetation of the region is either being replaced by invasive species or is being removed by man for the construction of roads, flyovers, building and industries. Dumping of domestic and industrial trash in Malir, Lyari and Hub rivers is also a common practice

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in the city, which has also affected the indigenous biodiversity of these wetlands. Salt marshes are important for a range of interests as they support a range of specialist plant communities and associated animals (especially breeding and wintering birds) and often have a high nature conservation interest. They rarely exist in isolation and form an integral part of many estuaries, other tidal inlets and bays.

Ecological surveys are necessary for an adequate characterization of a plant community. Disturbed areas are considered those where the integrity of the natural setting and natural system processes has been directly or indirectly affected by human activities. These activities could be for resource extraction, visitor use, development of maintenance or invasion of non native species etc. The vegetation in the disturbed areas does not reflect a naturally evolved species composition but rather a mixture of small remnant patches dominated by native plants patches of largely invasive weedy alien plants and areas of mixed native and non native plants. All over the world natural habitats are being degraded. There is evidence of contamination in the most remote parts of the world. The human population is getting larger, spreading and producing more complex and interactive disturbance on plant communities. There are few undisturbed habitats left in some parts of the world. Nevertheless, there is also a general desire to maintain natural habitat for our enjoyment and for the continuous well-being of nature.

The objectives of this study are flora and vegetation of salt marshes and coastal wetland which is an important nesting site for Green turtles. The flora of coastal salt marshes was differentiated into levels according to the plants individual tolerance of salinity and water table levels. Coastal salt marshes of Sandspit are offered a number of forty seven (47) taxa, extended in nineteen (19) diverse families. The most presented families are Chenopodiaceae followed by Poaceae and Convolvulaceae with dominating genera like: *Arthrocnemum, Limonium, Salsola* and *Halystachys*. The representative species recorded were *Arthrocnemum fruticosum*, the most common salt marsh plant.

The response of plant communities to environmental change is often studied by analysing the composition of plant traits across communities. A lot of work has been done in ordinating the tropical, temperate, deciduous, desert and calcareous types of vegetation, whereas little work has been reported from disturbed vegetation. The ecological survey of such disturbed areas conducted by few researchers, in order to know the damage done to ecology of the area and also to know the diversity and dispersion status of species in the area. In Pakistan, phyto-sociological studies on plant communities of different areas have been conducted (Akbar and Ahmed, 1991; Dasti

and Agnew, 1994; Iqbal, 1998; Arshad *et al*., 2002). Ahmed and Khattak (2001) in quantitative studies on the vegetation of Islamabad concluded that due to large scale artificial addition the original vegetation is vanishing at certain places. Khan *et al*. (1999) have described structure, composition and above ground standing phytomass for the summer aspect of some grass dominated communities of Karachi. Khan and Shaukat (2005) described above ground standing phytomass of some grass-dominated communities of Karachi for winter aspect. In past, few ecological studies have been made on the plant communities of different areas of Karachi (Shafiq *et al*., 1992; Khan, 1993; Iqbal and Hussain, 1994; Iqbal *et al*., 1998; Khan and Shaukat, 2005). The aim of present investigation was to provide quantitative description of the vegetation on the disturbed areas of the Karachi city. The vegetation is changing from natural to semi-natural form due to anthropogenic disturbances and is still in progress.

MATERIALS AND METHODS

A. Description of the area

The average rainfall in Karachi is below 200 mm in summer and in winter the precipitation rate is very low. Karachi possesses very hot summer and mild winter. The Siberian winds keep the mean monthly minimum temperature of January around 10-12.5^{0}C. The insulation is intense with global solar radiation varying from 3580 Kcal m^{-2} day^{-1} for December to 5609 Kcal M^{-2} day^{-1} for May. The diffused radiation is 20-30% of the global radiation (Ahmed *et al.,* 1991).

Sandspit lies about 18 km southwest of Karachi. It is one of the prime recreational sites for the citizens of Karachi. The area contains shallow tidal lagoons, intertidal mudflats, saltpans and about 400 ha of mangrove swamps. The western part is open sandy beach extending for about 10 km. The climate is arid subtropical with temperatures remaining moderate throughout the year. The average annual rainfall is 125 mm and the mean annual temperature is 32 ^{0}C. The Karachi Port Trust (KPT) and Manora Cantonment Board own the major portion of the area. The Karachi City District Government also manages some part of the beach. It is also a prime recreational site for citizens of Karachi. A large number of visitors (estimated as 150,000) come to the area annually.

Social Setup

The main village in Sandspit is known as Kakapir. About 85% of the population is engaged in fishing activities.

Mangrove forest

The Mangrove forest harbors a unique biodiversity. It is an important spawning and nursery ground of many species of fish and shrimps. There are a number of marine invertebrates including

coelenterates, annelids, crustaceans and mollusks available in mangroves which play significant role in the food chain and are thus important in maintaining estuarine fisheries. Mangrove also serves as roosting habitat for birds.

Marine Turtle

Sandspit/Hawkesbay is a globally important site for marine turtle nesting. Two species, the Green turtle *(Chelonia mydas)* and the Olive Ridley *(Lepidochelys olivacea)* nest along the Sandspit-Hawkesbay beach. Globally they are classified as 'endangered'.

B: Vegetation survey

A reconnaissance survey of Sandspit/Hawkesbay was carried out in March to April, 2010. The study area is comprised of 10 kilometer square i.e. 2471 acre (Fig. 1).

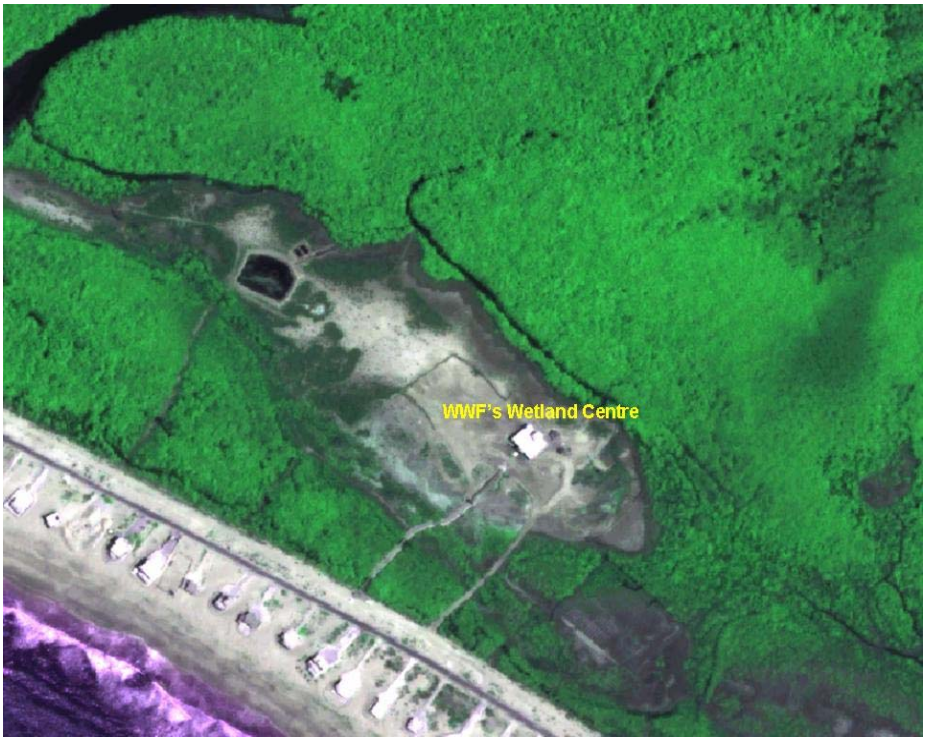

Figure 1. Map of Sandspit/Hawksbay, wild life sanctuary, Karachi.

RESULTS AND DISCUSSION

The diversity of flora in this area was low. The vegetation of the studied areas showed the dominance of *Avicenna marina* (a mangrove plant), *Prosopis juliflora* (an invasive species), halophytes and

xerophytes and disturbed type of vegetation. A list of all the halophytes and xerophytes are summarized in (Table-1). Among all the listed thirty nine plant species, *Avicenna marina* was found leading dominant in most of the stands and *P. juliflora* was the second dominant plant in the area. The stands dominated by *Prosopis* formed an association with halophytes (*Halotropium bacciferum, Salsola imbricata, Halostachys belangerana*, *Suaeda fruiticosa*, *Limonium stoksii*) and xerophytes (*Calotrpis procera*, *Indigofera oblongifolia*, *Tribulus terrestris*, *Fagonia indica*) species. *Avicennia marina* as a leading dominant formed an association with halophytes (*C. cretica*, *Salsola imbricate*, *Suaeda fruiticosa, Arthrocnemnum macrostachyum*). It was observed that although the *P. juliflora* was quite dominant in the area but in the pure stands of *Avicennia marina* it was absent. While, *Aizoon canariencse, Trianthema portulacastrum, Aerva javanica*, *Amaranthus viridis, Alternanthera sessilis* and *Chenopodium murale* were found at the place of sea rise. The stands dominated by *P. juliflora* also showed an association with *Limonium stocksii* and grass species *Aleuropus lagopoides, Halopyrum mucronatum, Sporobolus arabicus, Urochondra setulosa* in different stands.

Plant diversity serves as good indicator of the ecological condition of a system (Morgenthal *et al*., 2001a). With the introduction of Invasive species like *Prosopis juliflora* the natural vegetation tended to convert into the invaded semi natural vegetation. This process may lead to the change in the functions of the ecosystem. Common invasive species traits include the ability to reproduce both asexually and sexually, fast growth, rapid reproduction, high dispersal ability, phenotypic plasticity (the ability to alter one's growth form to suit current conditions), tolerance of a wide range of environmental conditions (generalist), ability to live off of a wide range of food types (generalist), association with humans and other successful invasions.

Major plant communities

Prosopis-Suaeda-Calotropis
Prosopis- Ipomea- Halopyrum
Calotropis-Tribulus-Prosopis
Limonium-Prosopis-Aleuropus
Avicenia-Cressa-Suaeda
Avicenia-Cressa-Salsola
Halopyrum-Convolvolus-Suaeda
Ipomea-Halopyrum-Convolvolus
Calotropis-Aerva-Senna

***Prosopis* community:** *Prosopis* community formed six different types of association with halophytic and xerophytic species, such as *H. bacciferum, C. cretica, S. fruticosa* and *Salsola imbricata.* The soil characteristics of *Prosopis* community showed variation in the nutritional value of soil characteristics. This community in association with *C. procera, S. persica, C. barbata, C. cretica, S. fruticosa, F. indica* and *H. mucronatum* preferred to grow on high percentage of sand, low amount of silt and clay particles.

***Avicennia* community:** This community is dominated by halophytes. The community formed an association with other halophytes *C. cretica, S. fruticosa* and *C. certica*. The community in association with *C. cretica and S. fruticosa* preferred to grow on high percentage of total sand, better percentage of silt and low clay particles. This community prefers to grow on sandy loam to loamy sand soil type. The soil of the community had slightly alkaline pH (7.56).

Limonium community: *Limonium* community formed main association with disturbed species i.e. *P. juliflora*, *A. lagopoides* and *C. conglomerates*. The community was found on soil having low percentage of total sand with high percentage of clay. However, the amount of silt was moderate.

***Ipomea* community:** *Ipomea* community formed main association with halophytes (*H. mucronatum*) and creeping *C. arvensis*. The soil of the community had a high percentage of total sand with better percentage of silt and clay particles. The soil was sandy loam and loamy sand with slightly alkaline pH (7.53).

***Halopyrum* community:** *Halopyrum* community formed main association with halophytes *S. fruticosa* and creeping plant species *C. arvensis*. The community was found on soil having high percentage of total sand with lowest percentage of clay particles. However, the amount of silt was moderate. This community prefers to grow on sandy loam to loamy sand.

Calotropis community: *Calotropis* community formed main association with xerophytes species likewise *A. javanica* and *S. holosericea*. This community preferred to grow on loamy sand soil type. The community was found on soil having high percentage of total sand with lowest percentage of silt and clay particles.

A Survey of different habitat around the mangroves forest was carried out to estimate the ecological knowledge of the native flora of Sandspit-Karachi. Importance value index (IVI) for each plant species was determined to enumerate the importance of each species. The vegetation of the studied sites is composed of halophytic, xerophytic and disturbed species. Sandspit is surrounded by five villages and also it is an important recreation site for the citizens of Karachi. This human influence has caused a disturbance in the vegetative regime.

Table-1. List of all the plants collected and identified.

S.No.	Family	Species
1.	Aizoaceae	*Aizoon craniensis*
		Trianthema portulacastrum
		Trianthema triquetra
2.	Amaranthaceae	*Amaranthus viridis*
		Alternenthera sessilis
		Digera muricata
		Aerva javanica
3.	Asclapiadaceae	*Calotrpis procera*
4.	Asteraceae	*Launaea procumbens*
		Launaea residifolia
5.	Avicenniaceae	*Avicennia marina*
6.	Boraginaceae	*Heliotropium crispum*
		Heliotropium ramosasimum
7.	Caryophyllaceae	*Polycarpaea spicata*
8.	Caesalpiniaceae	*Senna holoceracea*
9.	Capparidaceae	*Cleome brachycarpa*
10.	Chenopodiaceae	*Atriplex stocksii*
		Chenopodium murale
		Salsola imbricate
		Halostachys belangerana
11.	Convolvulaceae	*Arthrocnemnum macroshtachyum*
		Convolvulus prostrates
		Cressa cretica
12.	Cyperaceae	*Ipomoea pass-caprae*
		Cyperus arvensis
13.	Euphorbiaceae	*Cyperus bulbosus*
14.	Fabaceae	*Euphorbia granulata*
		Indigofera oblongifolia
		Indigofera argentea
15.	Mimosaceae	*Tephrosis purpuraea*
16.	Poaceae	*Prosopis juliflora*
		Dactyloctenium aegyptium
		Dactyloctenium aristatum
		Halopyrum mucronatum
		Sporobolus arabicus
		Aeluropus lagopoides
		Setaria verticellata
17.	Plumbaginaceae	*Urochondra setulosa*
18.	Portulacaceae	*Limonium stocksii*
19.	Zygophyllaceae	*Portulaca oleracea*
		Zygophyllum simplex

The disturbance is mainly due to the construction of roads, summer visitors, salinity and discharge of pollutant in the back waters and animal grazing. These human activities has malformed the natural vegetation into the semi natural vegetation.

Species also serves as good indicators of the ecological condition of a system (Morgenthal *et al.,* 2001b). A list of all species collected during the study was compiled. The species composition of the 24 stands (10 x 10 m^2) was different, but most of the area is dominate by only two to three species. Halophytes were more abundant on the soil having high salt content in the area. Vegetation analysis gives the information necessary to determine the name of community and provide data that can be used to compare it with other communities.

The plant communities like *Prosopis, Avicennia, Suaeda, Ipomea, Limonium, Calotropis, Halopyrum* were observed as dominant. The leading dominants of one stands were also found co-dominant in other stands. The communities in the study area were heterogeneous. The absence of certain frequencies classes in the communities reflected the heterogeneity of the vegetation i.e. due to biotic disturbance or the floral poverty.

Prosopis juliflora was found constantly having strong dominance values in both disturbed and halophyte community type. Establishment by the co-dominant, *S. fruticosa* suggests an increasing importance of this species. However, *P. juliflora* in association *with F. Indica* and *C. procera* appeared to be particularly adapted to the xeric conditions of soil. Plant growth and development are the result of many physiological processes, which are influenced by soil moisture (Begum and Paul, 1993). Distribution of plant communities mostly depends upon the edaphic factors i.e. soil texture, structure, pH, moisture and mineral composition. Soil salinity alone and in combination with water logging play an important role in distribution of halophytes. Variation in total salinity, depth of soil horizon and extent of water logging can greatly influence the vegetation of an area including halophytes (Maryam *et al.,* 1995). *Prosopis* community preferred to grow on wide range of water holding capacity of soil 19-48%, resulting in the formation of six different types of plant association.

One of the main factors which influence plant distribution is the type of soil. Most plants are specially adapted to more or less specific soil types. The distribution and composition of plant communities seems to be affected by climatic and underlying edaphic factors. The soil of the study area was alkaline in nature with sandy loam, loamy sand, loamy silt, sandy and silty combine with an appreciable amount of calcium carbonate. Soil of the communities showed significant

variation in their characteristics. The soil characteristics along water channels showed a significant correlation with vegetation type. *P. Juliflora* had wide ecological amplitude and was found as a first dominant in different stand with a range (7.10-7.85) of soil pH. A change in pH values caused change in association between species. Calcium carbonate is widely distributed in soil occurring separately or they may be associated with other salts.

Sandspit/Hawksbay area soil has better concentration of calcium carbonate. High percentage of calcium carbonate made the biological activity high and make the soil fertile. A variation in calcium carbonate concentration had also showed relationships with vegetation types. *P. juliflora* had wide ecological amplitude and was found as a first dominant in different stand with a range (7.10-7.85) of soil pH. A change in pH values caused changed in association between species (Iqbal *et al.,* 1998).

It has been observed and reported that *P. juliflora* has been well established in the Wild life Sanctuary of Sandspit/Hawkesbay and many other areas of Sindh and Punjab. This plant was introduced in Pakistan to fulfill the need of fodder to the livestock in the dry areas of Sindh, but with the passage of time it has spread in many areas of Pakistan. In Kenya, a complain was filed by community Museum of Kenya Ltd. against Kenya forest Research Institute that Mesquite has spread and chocked up natural vegetation, rivers and pathways resulting in the loss of pasture land, loss of livestock etc. According to them the thorns of Mesquite are poisonous not only to humans but to livestock as well. The animals that feed on this plant loose their teeth early and starve to death (Republic of Kenya in the Higher court at Nairobi, Petition # 466, 2006).

The negative impacts of *Prosopis* reported are:

- *Prosopis* is easily spread usually by vehicles, water and animals.
- In some animals it can take a week for the seed to pass through the gut, little is known about seed survival in wildlife.
- Quickly dominate disturbed habitat and reduce biodiversity.
- Having one of the most extensive root systems in the world and out competing native vegetation by monopolizing soil moisture.
- Dense canopy inhibits under canopy growth by blocking sunlight.
- One mature tree can produce up to a million seeds per year under favorable conditions.
- These seeds can remain viable in the soil for at least 10 years.
- Massive carbohydrate stores in the root system, *Prosopis* can survive the trunk being repeatedly cut. All of which makes *Prosopis* difficult to eradicate. (Awash National Park Ethiopia , Newsletter No 2 - April 2010)

Assessment of the floral composition support in the psychoanalysis of the affected area because this is the fundamental aspect for the conservation of important and endangered flora and fauna of any region. Protection of the natural flora from urbanization, disturbances and over grazing is obligatory. Healthy ecosystem resists from the invasion of different plant species. Introduction and establishment of unwanted aliens only occurs when natural vegetation is under stress. To support this statement data should continuously be collected to make a list of endangered plant species. The alien species like *Prosopis* will lead to desertification and then developing into the monocultures of specific plants. Invasive species often compete so successfully in new ecosystems that they displace native species and disrupt important ecosystem processes. These Alien species have the aggressive approach to:

- Displace native species
- Reduce native wildlife habitat
- Reduce forest health and productivity
- Alter ecosystem processes
- Degrade recreational areas

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