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MONITORING THE PLANT SPECIES THROUGH GEO-INFORMATICS: A CASE STUDY OF KARACHI UNIVERSITY CAMPUS, KARACHI

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ABSTRACT

Geo-informatics is a useful tool for the environmental applications that comprises of Remote Sensing (RS), Global Positioning Systems (GPS) and Geographic Information Systems (GIS). In recent times large amount of geospatial datasets have been efficiently manipulated and analyzed with the help of these technologies which allow the combination of real-time data with the information of their precise positions.

Data from GPS survey, Satellite Imageries of different resolutions, photographs and secondary sources. These data area analyzed by different GIS and Statistical Techniques. Results include the frequency, density, diversity and spatial distribution of flora within study area. Simpson's Diversity Index for the Site 1 is 0.096774 and for the Site 2 is 0.068263. Similarity Index for both sites is, 30%. With the help of the resulting maps and inventory most precious plants will be preserved and could be helpful for many researchers and planners.

Keywords: Geo-informatics, Plant Diversity, Satellite Remote Sensing

INTRODUCTION

Geo-informatics is a very popular discipline for the studies and management of flora in developed countries. Geo-informatics is the combination of different disciplines dealing with spatial information, including Cartography, Geodesy, Geographic Information Systems, Global Navigation Satellite Systems, Photogrammetry, Remote Sensing and Web Mapping. In recent times large amount of geospatial datasets have been efficiently manipulated and analyzed with the help of these technologies which allow the combination of real-time data with the information of their precise positions (Goswami *et.al*, 2012).

Remote sensing data and techniques fulfill the requirements of variety of ecological application that require data that comprises of broader spatial extent and cannot be obtaining by field-based methods. These applications include identifying and detailing the biophysical characteristics of species' habitats, predicting the distribution of species and spatial variability in species richness, and detecting natural and human-caused change; at scales ranging from individual landscapes to the worldwide (Kerr and Ostrovsky, 2003).

Plants comprise key life sustaining system. They form earth's soft green security coverlet. This regulates the atmosphere, maintains hydrological cycle, feed the mankind and provide raw material for pharmaceutical and scientific purposes. The subject of vegetation description, classification and spatial distribution is very diverse and complex. Vegetation may be regarded as being composed of all different types of plant communities within the region. The word "flora" refers to the plants abounding within a particular area. The vegetation of Karachi University Campus primarily consists of xerophytes, halophytes and disturbed vegetation. The disturbances include construction of buildings, biotic disturbances, and cattle grazing etc.. There is no comprehensive map available showing spatial distribution of flora at Karachi University Campus for current and as well as future research and planning

The province of Sindh is mostly arid with scant vegetation except for the irrigated Indus Valley. 35 % of the species mentioned in Flora of Karachi (Jafri, 1966) can now be included in the Red Data book for threatened species (Hussain *et. al*, 2010). Once Karachi University Campus showed the best representation of Karachi as 300 floral species reported from here alone but most of the species have eliminated from the campus. At present some of the indigenous plants of Karachi can be observed in the protected and enclosed areas of Malir cantonment, Shah Faisal cantonment, Masroor Airport area and Korangi, PAF base area. According to Hussain *et. al.* (2010) in Karachi 135 species are the threatened (Hussain *et. al*, 2010).

OBJECTIVES

Following are the objectives of the study:

1. To prepare the inventory of flora at Karachi University Campus based on taxonomic classification.
2. To explore GPS potential for geo-encoding of plants.
3. To develop a base map specific for Plant Distribution.

4. To explore the causes of changes in frequency and density of flora of the study area.
5. To explore the various source of satellite imageries potential for the study of flora.
6. To develop e-flora of specific plant species

STUDY AREA

The University of Karachi was established by an act of Pakistan parliament in June, 1951. The present campus, to which the University shifted in 1959, is spread over 1279 acres of land, then situated 20 Km away from the city center but now within active city limits (Fig. 1). The climatic conditions of the campus are not different from those of Karachi but little moderate both in summer and winter. The Karachi University campus lies in a broad valley which is filled by alluvium, slope wash and small area of windblown sand. The area as a whole is gently sloping towards north. The vegetation of the campus is rich in bio diversity, which was actually the product of diverse edaphic and physiographic features found in the environs of Karachi (Qadir *et al.*, 1966).

Initially only two study sites within Karachi University Campus have been selected for the present study (Fig. 2), named Site 1 and Site 2 respectively. Site 1 covers the vicinity area around Department of Geography and office of the Dean Faculty of Science and Site 2 covers the area around Central Mosque (*Masjid-e-Ibrahim*). Both study sites comprise a variety of plant species there.

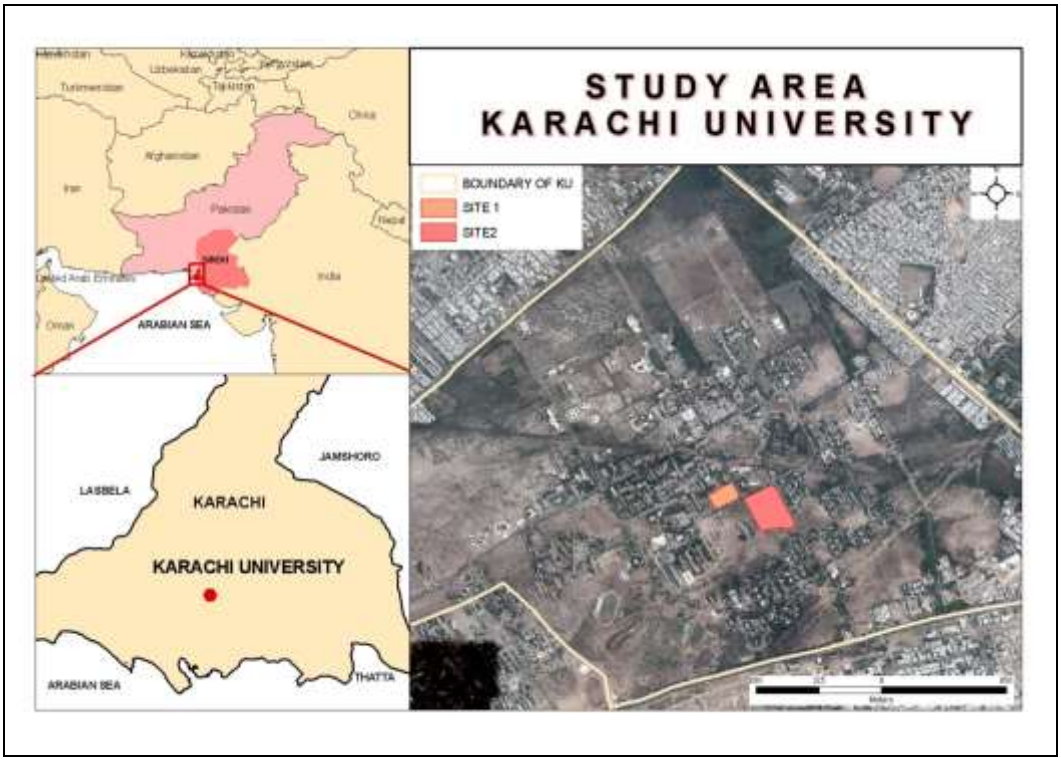

Fig. 1. STUDY AREA.

MATERIAL AND METHODS

1. Data Collection

Data have been collected by different primary and secondary means primary means includes the geographic coordinates of the individual plant stand through GPS, Sample of the different parts of plants like leaf, flower, fruit etc., field photographs for identification of plant species.

Secondary means includes the published research materials, books, different web pages, satellite remote sensing images of high spatial resolution like Quick Bird and Geo-Eye.

2. Data Processing

First step of processing is the scanning of available maps of Karachi University then mosaicing using Adobe Photoshop and geo-referencing of maps and satellite imageries extracted from Google Earth and then digitization of

maps and satellite imageries to create the vector data. Next step is to enter surveyed data in Microsoft excel and create necessary graphs from it and Geo-coding it for further GIS analysis using Arc Map 10.1.

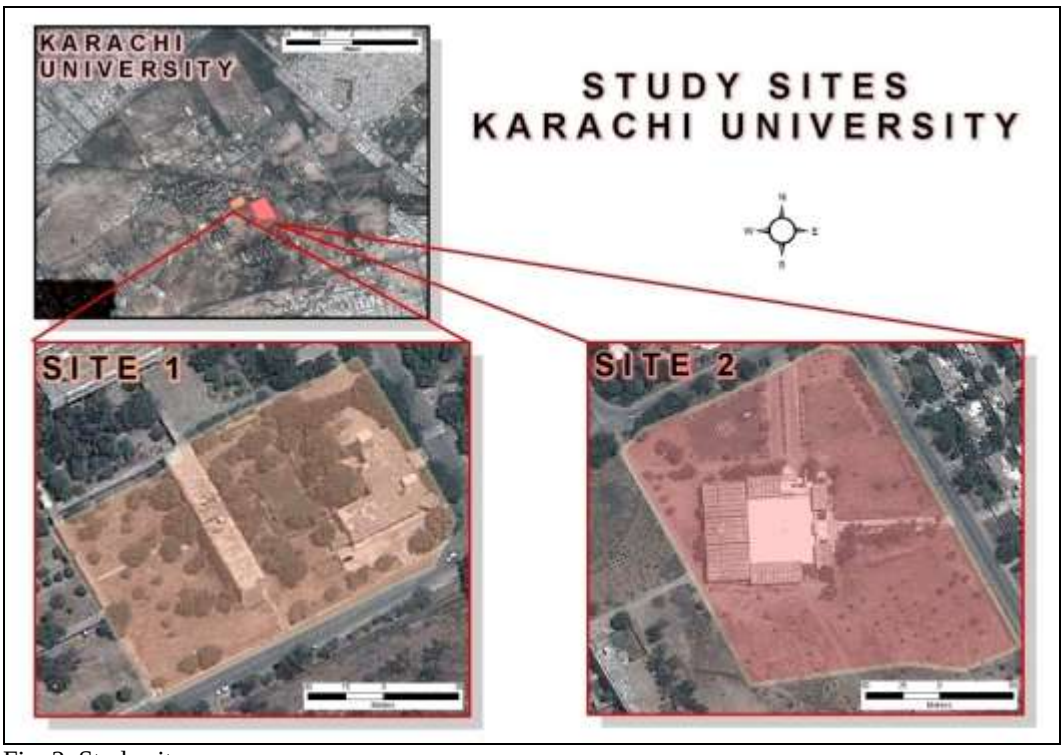

Fig. 2. Study sites.

3. Data Analysis

Digital Image Processing have been done by using Eradas Imagine 9.2 including the pixel based Image Classification (Unsupervised Classification), GIS Integration of Data sets using ArcMap 10.1 and some Statistical Analysis like by using Microsoft Excel 2007 describe below.

- **Species diversity**

Species diversity has been determined by the following formulae of Simpson's Index (Whittaker, 1972):

Simpson's Diversity index = $\sum\{n\ (n-1)\} / N\ (N-1)\}$

N = Total number of individual plants

n = number of individuals of single species

Σ = Sum of all individuals of a species.

- **Similarity Index**

Species similarity has been determined by the following formulae of Similarity Index (Wolda, 1981):

Similarity index = $2\sum n_c / (\sum n_a + \sum n_b)$

n_c = the number of species in common between sites

n_a= the number of species of site 1

n_b = the number of species of site 2

- **Plant Species Frequency**

Total number of plants of individual species within the sites had mentioned in term of plant species frequencies.

- **Plant Species Density**

Density has been calculated by dividing the number of plants of single species by the area of site i.e. in the square kilometer.

4. Data Presentation

Finally the results have been presented by different means; tables showing the frequency and density of different plant species, charts extracted from table also presented the frequency of different plant species present in study sites 1 and 2 and in the end extracted results from all the techniques which were applied and presented in the maps.

RESULTS AND DISCUSSION

Land Use and Land Cover (LULC) Classification:

Unsupervised pixel based raster clssification shows the variation between the vegetetion and the buildup areas of both study sites 1 and 2 extracted from the Geo-eye data (Fig. 3 and 4) and Areas (sq.m) of LULC has shown in Table 1.

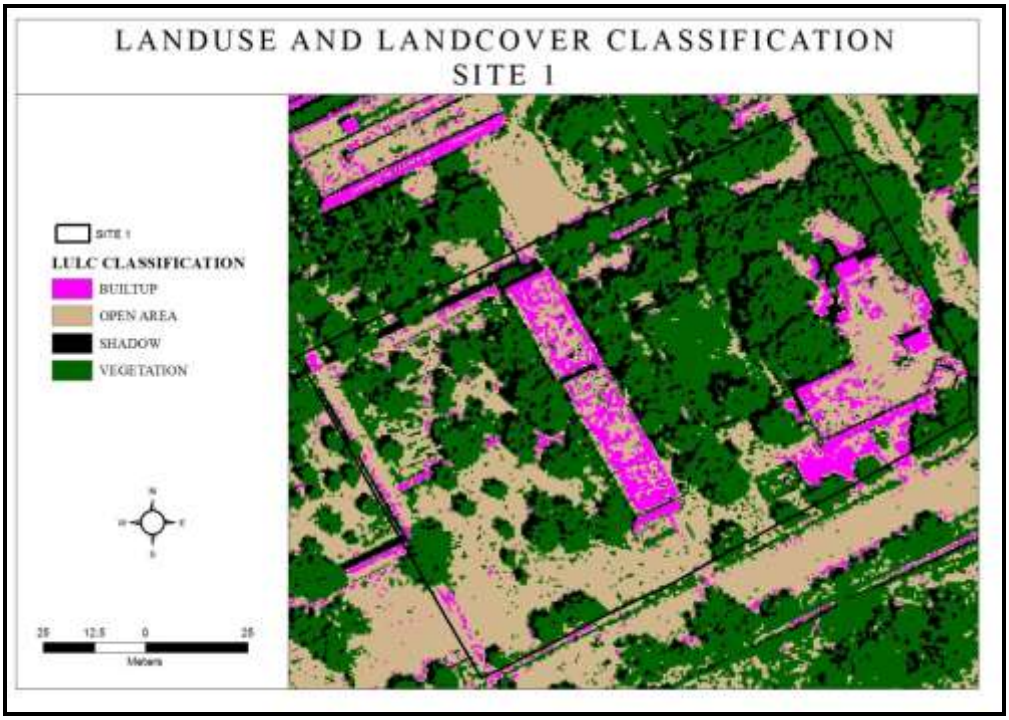

Fig. 3. LULC classification of site 1.

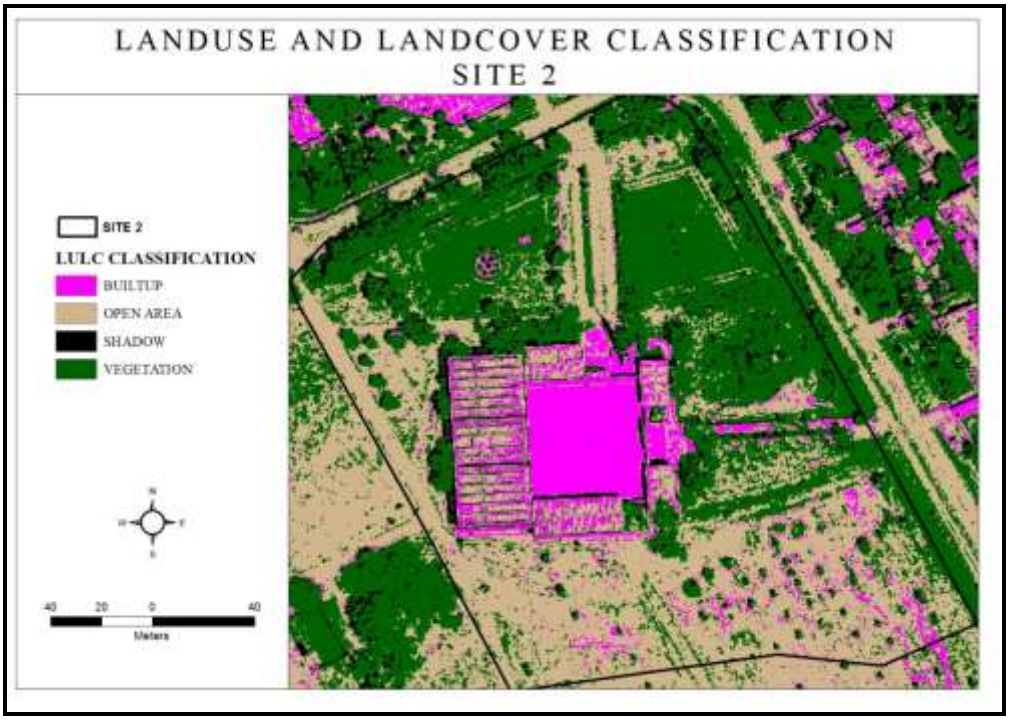

Fig. 4. LULC classification of site 2.

Table 1. LULC Area (sq.m) of Site 1 and Site 2

LULC CLASS	*SITE 1*	*SITE 2*
Shadow	3248.508	4012.255
Vegetation	11615.78	25748.31
Open Area	8091.009	24486.78
Built Area	1426.251	5587.257

Plants Distribution:

Figure 5 shows the plant distribution of site 1. Figure 6 and Table 2 shows the plant frequecy and density in the site 1.

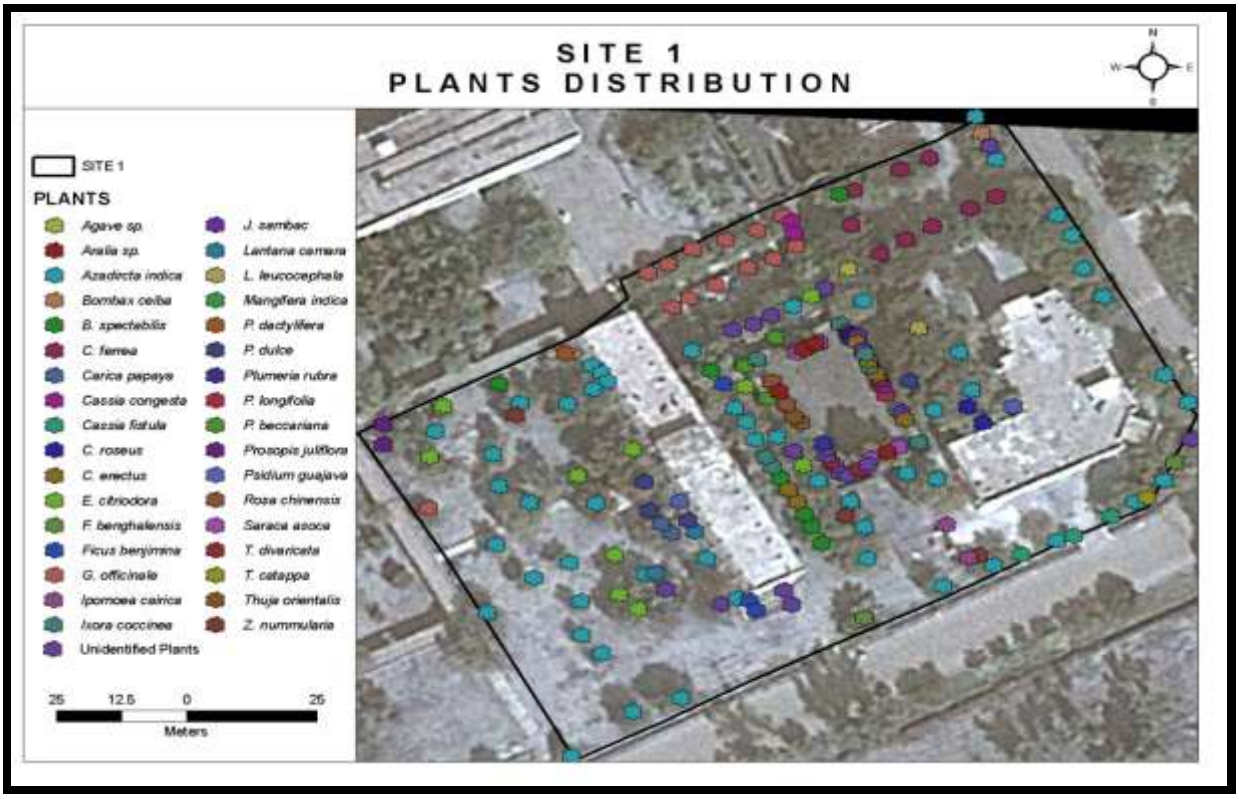

Fig. 5. Site 1 plants distribution.

Table 2. Site 1, Frequency and Density.

	NAME		**FREQUENCY**	**DENSITY(/SQ.KM)**
S.NO.	**Scientific Name**	**Common Name**	**181**	**5337.658508**
1	*Agave sp.*	Agave	1	92.48982612
2	*Jasminum sambac*	Arabic Jasmine	4	369.9593045
3	*Aralia sp.*	Aralia	5	462.4491306
4	*Bougainvillea spectabilis*	-	7	647.4287828

5	*Bombax ceiba*	Cotton tree	1	92.48982612
6	*Pritchardia beccariana*	Bottle Palm	3	277.4694784
7	*Cassia congesta*	Kokrondy	2	184.9796522
8	*Cassia fistula*	Golden Shower, Amaltas	3	277.4694784
9	*Rosa chinensis*	China Rose	3	277.4694784
10	*Conocarpus erectus*	Botton Wood	6	554.9389567
11	*Phoenix dactylifera*	Date Palm	1	92.48982612
12	*Eucalyptus citriodora*	Safeda	10	924.8982612
13	*F. benghalensis*	Banyan Tree	2	184.9796522
14	*F. benjimina*	Ficus Tree	3	277.4694784
15	*Psidium guajava*	Guava Tree	2	184.9796522
16	*Ipomoea cairica*	Cairo Morning Glory	2	184.9796522
17	*Ixora coccinea*	Ixora Red	8	739.918609
18	*Tabernaemontana divaricata*	Crape Jasmine	2	184.9796522
19	*Prosopis juliflora*	Kikar	2	184.9796522
20	*Pithecellobiun dulce*	Jungle Jalebi	4	369.9593045
21	*Terminalia catappa*	Jungli Badam	1	92.48982612
22	*Lantana camara*	Lantana	2	184.9796522
23	*Caesalpinia ferrea*	Leopard Tree	9	832.4084351
24	*Guaicum officinale*	Lignium Tree	13	1202.36774
25	*Mangifera indica*	Mango	1	92.48982612
26	*Azadircta indica*	Neem Tree	53	4901.960784
27	*Plumeria rubra*	Pagoda Tree	1	92.48982612
28	*Carica papaya*	Papaya	2	184.9796522
29	*Saraca asoca*	Sita Ashok	4	369.9593045
30	*Senna siamea*	Kassod Tree	1	92.48982612
31	*Thuja orientalis*	Mor Pankh	2	184.9796522
32	*Polyathia longifolia*	Ulta Ashok	2	184.9796522
33	*Catharanthus roseus*	Vinca Rosea	5	462.4491306
34	*Leucaena leucocephala*	White Babool	1	92.48982612
35	*Zizyphus nummularia*	Ber	3	277.4694784
36	*Mimusops elengi*	Maulsuri	4	369.9593045
37	Unidentified Plants	-	12	1109.877913

Table 3. Site 2, frequency and density.

	NAME		FREQUENCY	DENSITY(/SQ.KM)
S.NO.	Scientific Name	Common Name	181	5337.658508
1	*Abutilon sp.*	Abutilon	1	29.48982601
2	*Acacia nilotica*	Babool	1	29.48982601
3	*Albizia lebbeck*	Siris, Arni	1	29.48982601
4	*Alstonia scholaris*	Devil tree	4	117.959304

5	*Bauhinia racemosa*	Bidi Leaf Tree	7	206.4287821
6	*Bougainvillea spectabilis*	-	3	88.46947803
7	*Caesalpinia pulcherrim*	Chota Gulmohar	2	58.97965202
8	*Conocarpus erectus*	Botton Wood	6	176.9389561
9	*Tabernaemontana divaricata*	Crape Jasmine	12	353.8779121
10	*Cycas revoluta*	Sago Palm	2	58.97965202
11	*Phoenix dactylifera*	Date Palm	22	648.7761722
12	*Duranta erecta*	Golden Dewdrop	3	88.46947803
13	*Eucalyptus citriodora*	Safeda	20	589.7965202
14	*Lantana camara*	Lantana	4	117.959304
15	*Cordia dichotoma*	Lasura	2	58.97965202
16	*Caesalpinia ferrea*	Leopard Tree	2	58.97965202
17	*Thuja orientalis*	Mor Pankh	13	383.3677381
18	*Millingtonia hortensis*	Neem Chambeli	1	29.48982601
19	*Azadircta indica*	Neem Tree	25	737.2456503
20	*Nerium oleander Linn.,*	Ganira, Kunair	16	471.8372162
21	*Pentus Lanceolata*	Star Cluster	13	383.3677381
22	*Phragmitus karka*	Karka	1	29.48982601
23	*Saraca asoca*	Sita Ashok	1	29.48982601
24	*Tamaria gallica*	Jhao	1	29.48982601
25	*Typha domingensis*	Typha	2	58.97965202
26	*Polyathia longifolia*	Ulta Ashok	2	58.97965202
27	*Catharanthus roseus*	Vinca Rosea	1	29.48982601
28	*Zizyphus nummularia*	Ber	9	265.4084341
29	Unidentified Plants	-	4	117.959304

Table 4. Common Plant Species; Site 1 and Site 2.

S. No.	NAME		SITE 1		SITE 2	
	Scientific Name	Common Name	FREQUENCY	RANK	FREQUENCY	RANK
1	*Azadirachta indica*	Neem Tree	53	1	25	1
2	*E. citriodora*	Safeda	10	2	20	3
3	*Caesalpinia ferrea*	Leopard Tree	9	3	2	9
4	*B. spectabilis*	-	7	4	3	8
5	*C. erectus*	Botton Wood	6	5	6	5
6	*C. roseus*	Vinca Rosea	5	6	1	11

7	*Saraca asoca*	Sita Ashok	4	7	1	11
8	*Z. nummularia*	Ber	3	8	9	4
9	*T. divaricata*	Crape Jasmine	2	9	5	6
10	*Lantana camara*	Lantana	2	9	4	7
11	*P. longifolia*	Ulta Ashok	2	9	2	9
12	*P. dactylifera*	Date Palm	1	12	22	2

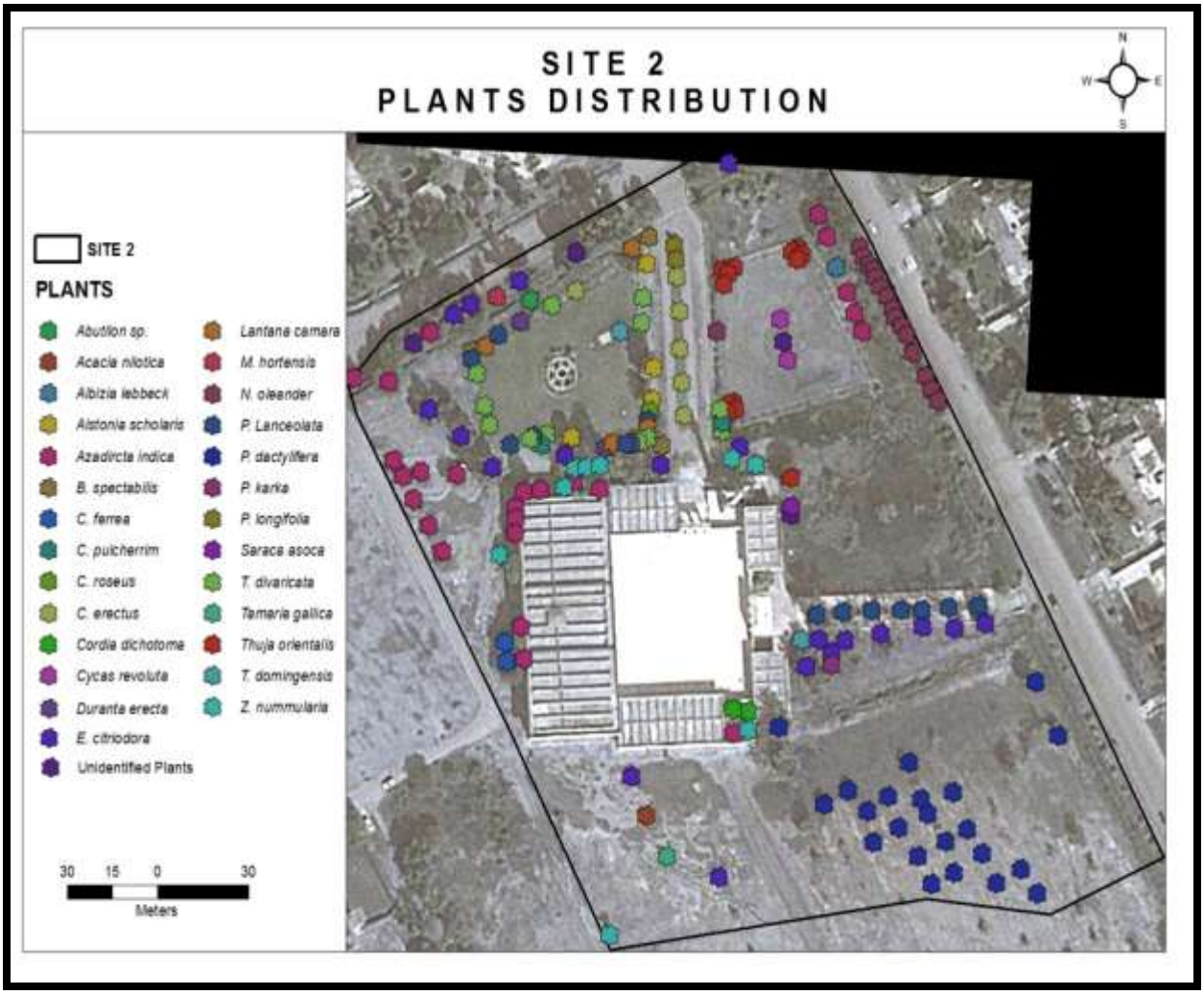

Fig. 6. Site 2 Plant distribution.

Figure 6 shows the plant distribution of site 2. Figure 8 and Table 3 shows the plant frequecy and density in the site 2.

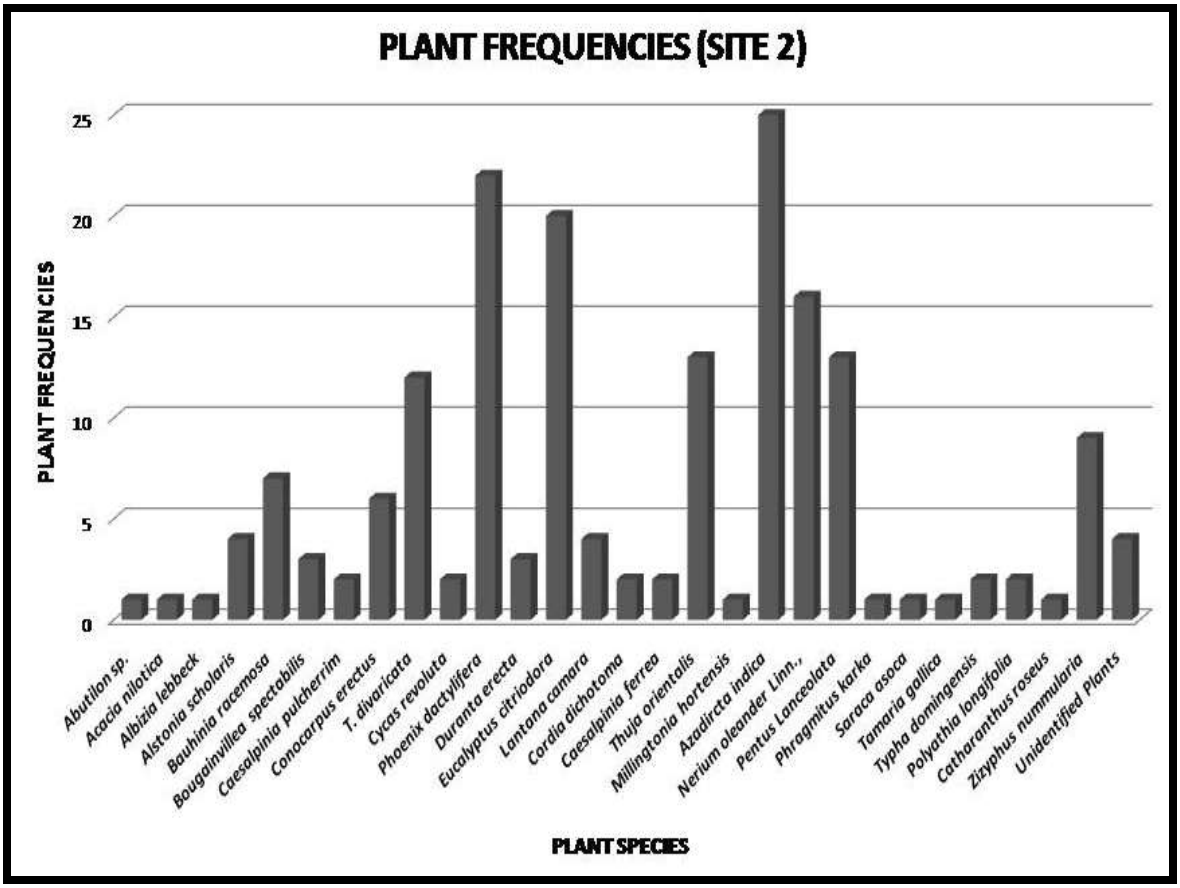

Fig. 7. Site 2 Plant frequencies.

Table 4 and figure 7 show the frequency common plant species of site 1 and site 2. Figures; 8, 9, and 10 show the flora sheets of Neem Tree (*Azadirachta indica*), Eucalyptus Tree (*Eucalyptus citriodora)* and Date Palm (*Phoenix dactylifera*) respectively. These flora sheets describe the basic characteristics and spatial distribution within study area and worldwide as well through both tabular and graphics means. Basic characteristics include the flower, leave, fruit, height of tree and crown diameter of these floral species. The locations of plants within study area taken through GPS in form of geographic coordinates, these coordinates converted into vector layers which have present over raster data. These three Plant species viz. Neem Tree (*Azadirachta indica*), Eucalyptus Tree (*Eucalyptus citriodora)* and Date Palm (*Phoenix dactylifera*) have been selected for detail description due to higher frequency with respect to the other plants within the both study sites.

Species Diversity Index:

Result of Simpson's Diversity Index for the Study Site 1 is, D = 0.096774 and for the Study Site 2 is, D = 0.068263. The range of values is 0 to 1 and lower value has indicates the greater diversity. But between the comparisons of two Study Sites the lower value of Study Site 2 indicates the greater diversity as compare to the Study Site 1.

Species Similarity Index:

Result of Similarity Index for the two study sites is, SI = 0.303797. Values range from 0 to 1 with the value suggesting more or less moderate indicating similarity almost 30% within the two Study Sites.

Figures 11, 12, 13 and 14 show the field photographs of some wild plants, ornamental plants, halophytes and palm trees located within the study sites respectively.

Fig. 8. Flora sheet of Neem Tree.

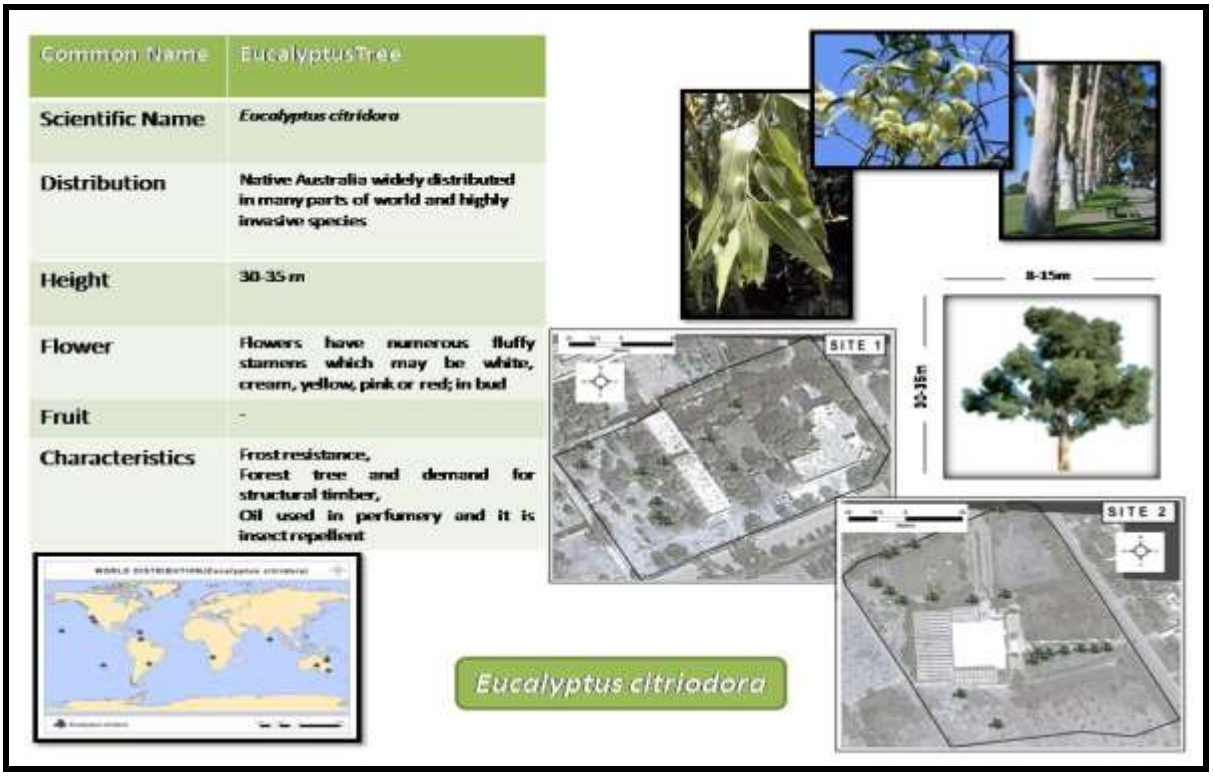

Fig. 9. Flora sheet of *Eucalyptus* Tree.

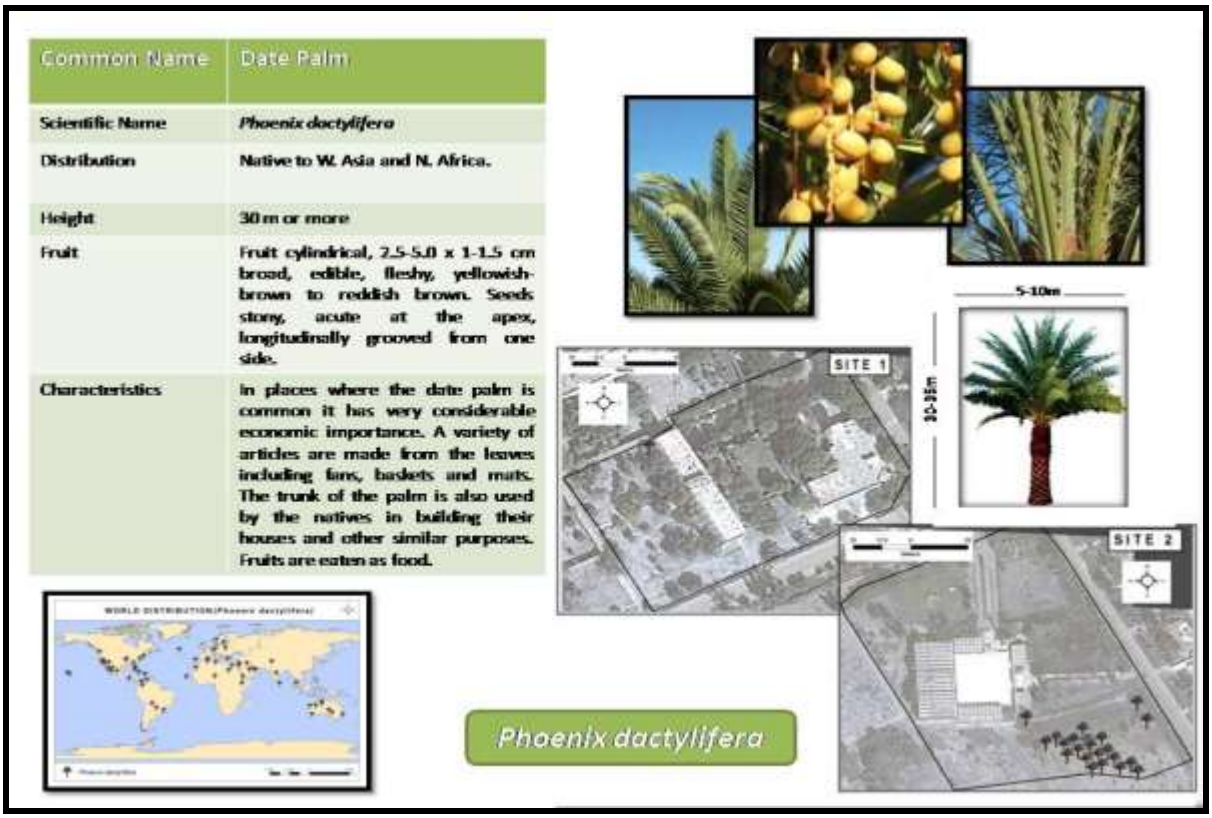

Fig. 10. Flora sheet of Date Palm.


Fig. 11. Some Wild Plants of Study Area.

Fig. 12. Some Ornamental Plants of Study Area.

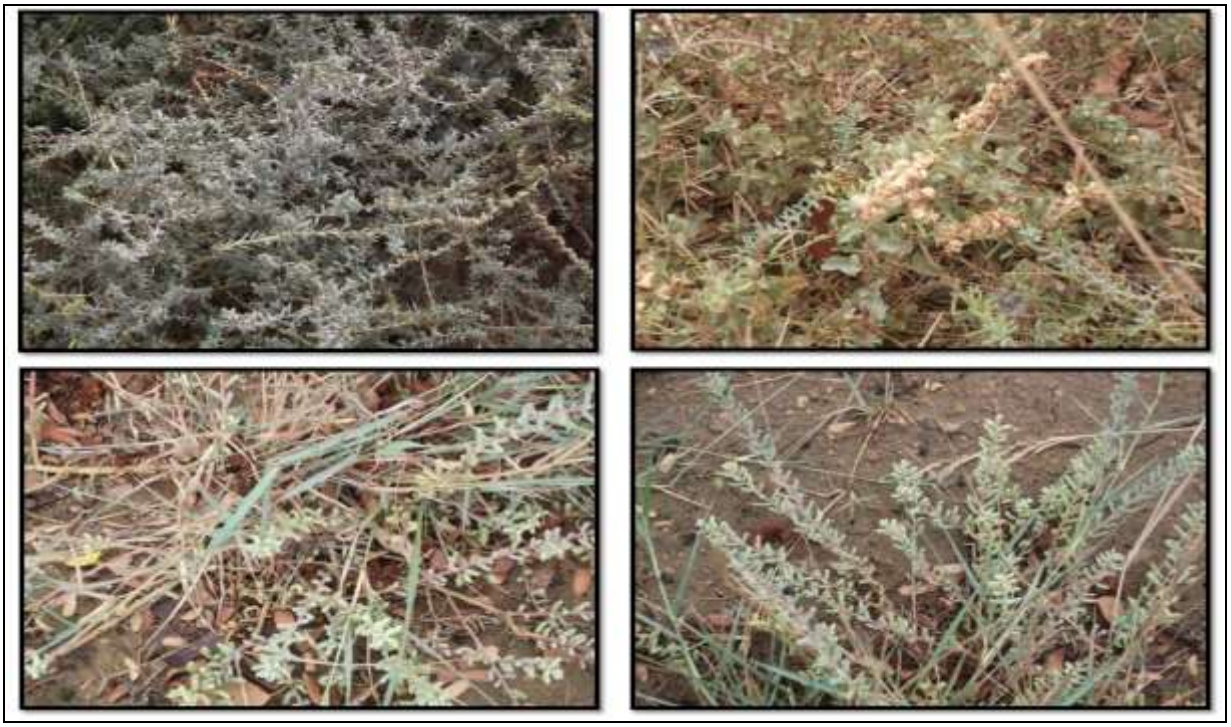

Fig. 13. Some Halophytes Species of Study Area.

Fig. 14. Palm Trees within Study Area.

CONCLUSION

The Plants of the Karachi University Campus mainly consists of xerophytes, halophytes, and disturbed species. The major reasons of disturbance are mainly the construction of new structures, cattle grazing etc. Due to such activities, the natural vegetation is converted to semi-natural vegetation. With the help of the modern techniques the status of plants species can be analyzed in relatively short time and many valuable plant can be preserved. Both Site 1 and Site 2 comprised of a variety of plants like ornamentals and many common and rare wild tree species.

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