STRUCTURE AND COMPOSITION OF URBAN GREENERIES IN DHAKA SOUTH CITY CORPORATION

A THESIS

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CERTIFICATE

*This is to certify that the thesis entitled **"STRUCTURE AND COMPOSTITION OF URBAN GREENERIES IN DHAKA SOUTH CITY CORPORATION"** submitted to the **Faculty of Agriculture,** Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) IN AGROFORESTRY & ENVIRONMENTAL SCIENCE**, embodies the results of a piece of bonafide research work carried out by I**SHRAT JAHAN Registration no. 10-04176** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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ABSTRACT

Plants are the important feature of urban ecosystems and provide different environmental and socio-economic benefits. Different habitats like roadsides, parks, gardens and playgrounds in Dhaka South City Corporation were surveyed for the assessment of structure and composition of urban plants. Stratified random sampling method was used in this study. A total of 347 plant species (Tree=144, Shrub=77 & Herb=126) belonging to 113 families were recorded. Among trees and shrubs, *Swietenia macrophylla, Polyalthia longifoli*a, *Cocos nucifera, Combrectum indicum* and *Tabernaemonlana divaricata* were recorded as the most dominant plant species. In case of tree and shrub, Fabaceae family (species % = 16.62) and in case of herbs, Poaceae family (species% = 13.49) were found dominant. Distribution of plants is highly uneven as only six species showed >40% frequency and eight species had greater than 25% frequency. Among all the study areas, highest tree and shrub population were represented by parks (44%) followed by gardens (26%), roadsides (26%) and playgrounds (4%), respectively. Majority of herb species was represented by parks (74.6%), followed by gardens (46.83%), roadsides (18.25%) and playgrounds (4.76%), respectively. Most of the tree populations were found in between 6-9 m height class whereas majority of shrub population were found in between 1-3 m height class. In case of DBH, maximum numbers of tree and shrub population were found in between 10-15 cm DBH class. Highest IVI value was found for *Polyalthia longifolia* (IVI= 103.39%) followed by *Swietenia macrophylla* (IVI= 85.61%) *Samanea saman* (IVI= 83.44%) and *Combrectum indicum* (IVI= 25.29%). Average density, mean DBH, mean basal area were 1785.62 (tree/ha), 458.59 (cm/ha), 182.79 (m^2/ha), respectively. This study reveals that species composition in Dhaka South City Corporation is significant whereas the structural attributes of plant population represent quite young and still developing vegetation. Findings of this research will help to manage and plan for future green infrastructure which will maintain ecosystem function, therefore, providing long term benefits for the city dwellers.

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LIST OF ABBREVIATION AND ACRONYMS

DBH	: Diameter at breast height (over bark)
Ha	: Hectare
Km	: Kilometer
Mm	: Millimeter
cm	: Centimeter
m^2	: meter square
m^3	: meter cube
$\geq$	: Greater than or equal to
ºC	: Degree Celsius
%	: Percentage
e.g.	: For example
et al.	: And others
IVI	: Important value index
DSCC	: Dhaka South City Corporation
DCC	: Dhaka City Corporation
UNPD	: United Nations Population Division
UN- Habitat	: United Nations Human Settlements Programme
AEZ	: Agro-Ecological Zone
FAO	: Food and Agricultural Organization

CHAPTER I

INTRODUCTION

Population pressure has increased globally in urban areas with people thronging the cities in quest of a better life (Rahman and Ahmed, 2012). About 44% of the total populations in developing countries are living in urban areas (UNPD, 2015). Dhaka is the capital of Bangladesh and also the 11th largest megacity of the world covering an area of 269.96 square kilometer with more than 18 million populations (Current affairs, June 2016). Dhaka would become the third largest mega city with an annual population growth rate of 4.4% by 2020 (UN-Habitat, 2013). The reduction of green space in Dhaka has gradually increased with the construction of building to meet up the housing demand by overlooking environmental protection (Mazumder, 2014). It is certain that, urbanization has a huge impact in the urban green spaces including parks, playgrounds, residential gardens and roadsides (Islam *et al*., 2015). In Dhaka, park area covers only 14.5% of the total land area (17% in north and central part and 12% in old part) whereas any city requires 25% greenery area for livable environment and to maintain a sustainable land ecosystem (Neema *et al.*,2014). It is alarming that only 8% vegetation currently present in Dhaka city whereas an ideal city needs about 20% green coverage (DCC, 2003). At present, almost 18 million dwellers of Dhaka city enjoy limited ecological services from several greenery areas like Ramna Park, Sohrawardy Udyan, Dhaka University campus, National Parliament Bhaban complex, Osmani Udyan, Botanical Garden and National Zoo etc. (Abid, 2013). Currently, the urban planning experts suggested that for all the cities of Bangladesh, there should be at least 1 acre of green spaces per 1000 population to maintain healthy living and to adopt this standard in Dhaka; the city needs approximately 6 square miles of area for recreation purpose (Chowdhury, 2004). Unfortunately few researches (Siddiqui, 1990; Islam *et al.*, 2002; Chowdhury, 2004; Nehrin *et al.*, 2004) have been conducted earlier about urban vegetation on parks and open spaces of cities in Bangladesh which are not adequate to evaluate urban forest structure and composition.

Urban forestry can be defined as the planting of trees on public lands such as roadsides, footpaths, parks, and residential gardens (Forrest and Konijnendijk, 1999). Urban forest is highly beneficial and also has established relationships between different urban forest structures through several benefits like visual quality (Schroeder, 1986), energy savings (McPherson, 1993), carbon sequestration (Rowntree and Nowak, 1991), urban heat island mitigation (Huang *et al.*, 1987), sound reduction (Cook and Van, 1977), wildlife habitat (DeGraaf *et al.*,1986), and personal safety (Schroeder *et al.*,1984). An urban forest can be characterized in terms of composition, structure and function and these factors also enhance the environmental quality and ecological processes within urban areas (Rowntree, 1984; Chen *et al.*, 2003). Urban forest structure means the spatial arrangement and characteristics of vegetation in relation to other objects (e.g., buildings, parks etc.) within urban areas and it also indicates the distribution of vegetation, both horizontally and vertically, in a given area (Nowak, 1994; Shawn *et al.*, 2013). Basic informations necessary to describe urban forest structure includes species composition, frequency, density, diameter class and height class distribution and this information is usually collected during field data collection (Nowak *et al.*, 2008; McPherson *et al.*, 1999). Species composition can be defined as the number of plant species found in a landscape, including trees, shrubs, and herbs and it reflects different patterns of urban vegetation and modern land use system (Rowntree, 1986; Fahey *et al.*, 2012). Additionally, different urban sites such as private gardens, parks or road networks may have different types of species composition (Godefroid *et a*l., 2007; Kendal *et al.*, 2012). Therefore, in this research an attempt has been taken to evaluate the structure and composition of plant species in Dhaka South City Corporation with following objectives.

Objectives:

1. To identify the vegetation status of DSCC

2. To find out the structure and composition of plant species in DSCC

CHAPTER II

REVIEW OF LITERATURE

2.1 Definition of Urban forest

Urban forestry is a recent and still developing research field but already the practice of urban forestry has started in Bangladesh. Many urban forest planners defined urban forestry for the purpose of improving the urban environment.

Grey and Deneke (1986) defined that "Urban forestry is the management of trees for their contribution to the physiological, sociological, and economic welfare of urban residents."

According to Miller (1988), "Urban forestry is an integrated approach to the planting, and management of tree populations in the urban areas to secure multiple environmental and social benefits for urban inhabitants."

Carter (1993) stated that "Different components of urban forest such as roadside trees, park trees, gardens, woodlands, riparian areas, manicured lawns the urban-rural interface and others makes up urban forest."

Konijnendijk *et al.*(2005) defined that "urban forestry is the art, science and technology of managing trees and forest resources around urban ecosystems for the sociological, economic, and aesthetic benefits trees provide to the urban society."

2.2 Importance of urban forest in Dhaka

Till now, large parts of the urban population are heavily dependent upon fuel wood in many developing countries for their domestic activities. Various kind of wood and non-wood forest products such as mushrooms, berries, medicinal herbs, rattan etc. can be provided by Urban and peri-urban plantations and green areas (Kuchelmeister, 1999).

McPherson *et al.* (1997) stated that particles and gaseous pollutants are usually absorbed by Trees and other plant species of urban area.

Kuchelmeister (1998) stated that urban green areas, like urban parks, vegetated areas, woodlands, even forest in most cities of the developed countries have recreational amenities. In poorer and developing countries urban forestry must pay attention to fulfill basic necessities.

El Lakany (1999) stated that urban vegetation reduces storm water runoff and can assist with processing wastewater, where other wastewater facilities are insufficient.

McPherson and Simpson (1999) reported that urban trees have contributions carbon sequester that help to mitigate global warming.

Elmqvist *et al.* (2003) stated that urban forest, which shows a great deal of variety, will likely be able to cope with the wide range of environmental conditions which exist in urban areas now, and the wider range that may occur in the future.

Fuller *et al.* (2007) stated that function and services of urban ecosystem also highly affected by the composition of urban forest (i.e. plant diversity).

Ansari (2008) stated that soils and moderately harsh urban climates are protected by urban greeneries through cooling air, reducing wind speeds, and shading.

Finally, it can be said that the wide range of benefits that urban green habitat provides is both practical and extensive and addresses many of the social, environmental and economic problems most urban and peri-urban localities face. In spite of that, urban greening can significantly treat many of them and create a much more adjuvant and desirable environment in which to live.

2.3 Urban greeneries condition in DSCC

Large scale plantations of trees were held in the country especially in Dhaka including the roadsides, avenues, highways, railways and other places during the last two decades. According to an estimate of the Arboriculture Division of the Works Ministry, approximately 310 hectares of total area of Dhaka city accommodate parks and gardens (Holiday, March 7, 2003).There are 27 enlisted parks/gardens in DSCC of which Osmani Uddyan, Bahadur Shah Park, Baldha Garden, Suhrawardi Uddyan, Ramna Park etc are mentionable.

Rahman *et al.*(2005) stated that the establishment of Baldha Garden by a private endeavor and Sohrawardi Uddyan at the old Race Course ground in DSCC was a highly praise worthy effort and these helped to enlarge vegetation area in this city corporation.

Nasir (2006) reported that only Ramna thana is considered to have a good no. of trees where Ramna park, Shishu Park, Suhrawardy Udyan and Dhaka University campus, all planned in the British era are the most essential green coverage considering the tree density in DSCC.

Hasan (2012) stated that at present, many new unauthorized housing projects are being developed in the old part of Dhaka. These will deteriorate and cut down the green coverage and will create unbearable pressure on the overburdened public utility. If the prevailing conditions remain unchanged then this city will definitely perish.

Farhan *et al.* (2013) stated that the limited numbers of parks are not capable to meet the demand of the urban dwellers in southern part of Dhaka city.

Neema *et al.* (2014) reported that many of the parks or open spaces have converted into garages, shopping malls or mosques and authorities of DSCC have failed to continue their responsibility to maintain the greenery of this city corporation.

Lindgren (2014) stated that Protecting and maintaining vegetative spaces in urban habitats is now considered a crucial aspect for the fulfillment of environmental quality and attaining a live-able city.

2.4 Structure and composition of plant species in Bangladesh context

Salim *et al.* (2009) reported 14 species under eight families in Juri forest range where *Tectona grandis* showed average number of stem/ha was 624 and basal area/ha was (10.36 m^2/ha) followed by *Acacia auriculiformis* (0.2 m^2/ha and 637 stem/ha).*Acacia auriculiformis* (0.2 m^2/ha and 637 stem/ha), *Gmelina arbore*a (0.2 m^2/ha and 600 stem/ha).

Sakera (2011) reported that Dulahazara Safari park had the highest average vegetation coverage (72 %), Chunati wildlife sanctuary and Sitakunda eco-park had more or less the same average vegetation coverage with 65% and 63%, respectively. *Dipterocarpus turbinatus, Acacia auricoliformis* and *Lagerstroemia speciosa etc.* occurring at all three study sites, showed highest IVI values and considered as the most dominant species.

Deb *et al.* (2013) reported 82 tree species in the street of Sylhet Metropolitan city. Here, they identified the most dominant species *Swietenia macrophylla* constituted about 40% of the total population. Average DBH of trees was 30.48 cm and the average height was 9.60 m. They found a considerable number of treeless wards and transects during the research.

Zaman and Salah (2014) studied about the composition, structure in the deciduous forestof Thakurgaon. They were enlisted A total of 126 tree species, 1,991 stems (663/ha) of ≥10-cm girth. Tree stand density varied from 651 to 685/ha, respectively. Meliaceae, Myrtaceae, and Rubiaceae were the most abundant families within the three plot area.

Akhter *et al.* (2015) stated that plant diversity and community structure are required to take necessary actions for conservation management. Total 107 tree species (Family=37& genera=72) were recorded during the study. Density and Basal area were

(418±20.09) stem/ha and (21.10±2.62) m²/ha, respectively. *Artocarpus chama* was found dominant showing maximum IVI followed by *Schima wallichii*, *Aporosa wallichii,* and *Lithocarpus acuminate.*

Deb *et al.* (2015) demonstrated that the species diversity of treelets (2 cm≤ DBH <10 cm) is much lower than that of trees (DBH ≥10 cm) in Lawachara national park, Bangladesh. Total 347 individual trees (69 species=69, &family= 29), and 311 individual non woody plant (species=61, &family=27) were found in this study.

Mamun and Akhter (2015) stated that the highest IVI of *Acacia auriculiformis* from Chunati forest was found 40.11 followed by *Tectona grandis* (16.46). Total 993 individual trees having ≥5 cm dbh (671trees ha) of 99 species belonging to 73 genera and 36 families were recorded from the forests of Chunati. *Dipterocarpus turbinate had shown* highest basal area (2.62 m²/ha) followed by *Acacia auriculiformis* (1.39 m²/ha).

Asaduzzaman *et al.* (2016) reported that in the forest of Chittagong, almost 64% trees were not getting favorable conditions to regenerate. The tree stem density, basal area, and wood volume were 0.49m²/ha, 1425 stem/ha, and 189.9m³/ha, respectively. Mean regeneration was significantly higher in bottom hill (14374 seedlings/ha) compared to top hill (9671 seedlings/ha).

Hossain (2016) examined a total of 2,338 individual tree stems of ≥10 cm dbh (468 stem/ha) of 183 tree species in Dudhpukuria-Dhopachori Sanctuary of Chittagong. Tree species richness varied from 107 to 158 species, stem density from 418 stem/ha to 540 stem/ha and basal area from 21.10 m^2 to 33.92 m^2 in all the study area.

2.5 Structure and composition of plant species in global context

McPhearson *et al.* (1997) stated that for the development of urban forests historical data can be used with information on current forest structure to better understand continuous change, current management needs, and future trends in forest health and productivity.

Annaselvam and Parthasarathy (1999) reported that species diversity of understory plants is nearly equal to the tree diversity at Western Ghats in India. Here, the most abundant species were Nilgiriunthus barbatus (IVI 29%) followed by Pellionia heyneana (12%) and most dominant family were Acanthaceae (15 species).

Shin-ichiro (1999) stated that forest structure and tree species diversity (both ≥ 4.8 cm and ≥ 10 cm diameter at breast height) decreased with altitude. The two forests on the different substrate series were similar at 700 m in structure, generic and familial composition and tree species diversity, but became dissimilar with increasing altitude. Tree species diversity was generally lower on ultra basic substrates than on non-ultra basic substrates at ≥ 1700 m.

Richardo and Vania (2002) reported trees with diameter at breast height (dbh) ≥ 15.9 cm in 1992 and trees with dbh ≥ 10 cm in 1997 in urban area of Brazil. During the research, very high growth and recruitment rates were found for *A. cunninghamiana.*

Burton (2006) stated that species richness was positively correlated to rural landscape characteristics and negatively related to urban characteristics in Georgia, USA. Urban sites were dominated by the non-native shrub, *Ligustrum sinense*, and several native overstory trees, mainly *Acer negundo.* Results from this study highlight the impact of urbanization on riparian forest plant biodiversity and structure.

Ramadhanil *et al*. (2008) reported about 376 plant species (tree seedlings=140, herbs and shrubs=162, ferns=29 and climbers=45) in Lore Lindu National Park, Indonesia. Urticaceae and Araceae were predominant in the study area. The study also recorded several invasive plant species such as *Piper aduncum L., Bidens pilosa L., Ageratum conyzoides* L. and*Sclerea purpuriens.*

Zhu *et al.* (2008) stated that most trees in the urban area are relatively short, with 65% less than 10 m in Shenyang city, China. There are a total of 1,234,132 trees of 87 species in the urban area with *Populus spp., Ulmus pumila, and Salix spp.* as the three most common species and most trees in the urban area are relatively small with an average dbh of 20.55 cm.

Michael *et al.* (2009) used the Urban Forest Effects (UFORE) model in the city of Tampa to calculate tree density; size distribution; tree, shrub and surface covers. Over 80% of the trees in Tampa are smaller than 6 inches in diameter. 73% of the 1- to 3 inch diameter trees are mangroves and Brazilian pepper (*Schinus terebinthifolius)*. In this study, they identified almost 93 different tree species in Tampa.

Escobedo *et al.* (2009) evaluated high diversity of native trees in the Gainesville city but this area represents with large percentage of smaller trees which indicating in most cases a younger urban forest.

Nowak *et al.* (2009) analyzed trees in Chicago which reveals that this city has about 3,585,000 trees with canopies that cover 17.2 percent of the area. Highest IVI was represented by Silver maple (17.1%) followed by Norway maple (15/4%) and Boxelder (4.8%) in the study area.

Rafael and Florian (2010) reported forest structure of understory trees (≥1 m height, <10 cm diameter at breast height) in two late-successional várzea forests in Brazil. Total1486 individuals and 116 species were recorded in study area. Approximately one third of the recorded species with densities ≥8 individuals' showed regular or random spatial distribution patterns, which suggests act on dispersal strategies and species establishment.

Trammell and Margeret (2011) stated that woody vegetation composition and structure of forests near urban interstates is an important determinant of their ability to provide these services. Plots in the city center had 81% lower stem density, 96% higher tree seedling regeneration, and 51% greater woody plant species richness. *Robinia pseudoacacia* showed highest IVI value (22.3%) followed by *Celtis accodentalis* (20.6%).

Zhao (2013) analyzed structure and composition of woody vegetation across subtropical, peri-urban Chongming where a total of 2,251 woody plants were measured comprising 42 species in 37 genera.

Akber *et al.* (2014) stated that most of the trees were ornamental type followed by shading trees in Sahiwal city of Pakistan. 45species belonging to 29 families were recorded in study area. *Azadirachata indica*, *Morus alba*, *Eugenia jambolana* and D*albergia sissoo* had sown highest frequency among all species.

Diogo *et al*. (2014) stated the structure and floristic composition of a remnant forest into the Fortaleza city. 200 trees and shrubs belonging to 27 species, 26 genera and 18 families were recorded in study area. The average distance and the total density of the study area were 3.27m ± 0.23 and 980 individuals /ha respectively and for the diameter, they found an average value of 14.53cm ± 5.6, respectively.

Rogers *et al.* (2015) enlisted about 126 species and Trees with diameter less than 15cm constitute35% percent of the population (42%=Inner London & 34%=Outer London) in UK. This study revealed that tree density is 53trees/ha, this is lower than densities of other cities of UK.

Maradana (2016) reported structure of trees with GBH≥ 15cm in Andhra Pradesh, India. A total of 2,227 individuals (family=44 & species=129) were recorded in study area. Combretaceae, and Euphorbiaceae, showed the greatest importance value index. Most species were contributed by Euphorbiaceae and the tree density varied from 435/ha to 767/ha with an average basal area of 25.82 m^2/ha.

Aladesanmi *et al.* (2016) reported fifty four tree species in Ibadan city of Nigeria where *Delonix regia* of Fabaceae family had shown the highest number of population with a frequency of eighteen, and highest IVI value (9.39%) followed by *Azadirachta indica* with IVI of 8.28.

Gunwoo (2016) examined the urban area of Roanoke city of Virginia where vacant land represents tree canopy covers about 30.6% with most three dominant tree species in terms of leaf area were American elm, black walnut, and sycamore spp.

CHAPTER III

MATERIALS AND METHODS

3.1 Study area

3.1.1 Geographical location and other factors of study area

The study was carried out in the Dhaka South City Corporation (DSCC) and it has located between 23º77'N latitude and 90º43'E longitudes, respectively (Wikipedia, 2011). Dhaka South City Corporation (DSCC) is one of the two municipal corporations in Dhaka created when the former Dhaka City Corporation was divided. Dhaka South City Corporation is a densely populated area. It covered 109.19 square kilometer area with 7.56 million populations (Current affairs, June 2016). Dhaka South City Corporation consists of 57 wards covering the thanas of Azimpur, Maghbazar, Malibagh, Motijheel, Jatrabari, Kotwali, Sutrapur, Bangsal, Wari, Gendaria, Lalbagh, Hazaribagh, Dhanmondi, Shahbagh, New Market, Khilgaon, Kamrangirchar & some others (DSCC, Wikipedia). It has 27 parks, 10 playgrounds, 3 gardens and 2 cemeteries respectively which have the major contribution to cover the urban vegetation of this city (DSCC, website). It has also consists of 781.83 km roads and 217.38 km footpath which also help to make a urban forest structure through street tree species (Ibrahim, 2014).The other basic information about DSCC have been presented in Appendix 2.

3.2 Climatic & soil condition of study area

3.2.1 Climate

Dhaka city represents tropical and humid climatic condition (Dhaka, Wikipedia). This city can be characterized by cool and short winters, long and wet hot summers with heavy rainfall. This area is divided by three distinct meteorological seasons such as 1) summer, 2) monsoon and 3) winter (Banglapedia, 2006). At present, Dhaka experiences a tropical wet and dry climate at present according to the Köppen climate classification (DCC, Wikipedia).The city has a specific monsoon season with an annual average temperature of 25 °C and monthly means varying between 18°C in January and 29°C in August. Nearly 1,854 millimeter rainfall occurs during monsoon which represents almost 80% annual average rainfall occurs from May until the end of September (Dhaka, Wikipedia). The city also experiences tornado, thunderstorms, cyclone and other natural calamities during the pre-monsoon season. The climatic data were collected from secondary sources (http://www.weatherbase.com) and weather averages & extremes have been presented in Appendix 1.

3.2.2 Water management

Dhaka city lies at the elevation of 6 to 8 m above sea level which is flat and level (Tawhid, 2004). Most of the part of Dhaka South City Corporation is surrounded by the river Burigonga which acted as the main drainage channel in this part of Dhaka city. The natural drainage system in the greater Dhaka city comprises of several retention areas and khals (channels), which are linked to the surrounding rivers (Mowla & Islam, 2013). In DSCC the quantity of open drainage channel is 466.43 km and 495.43 km pipe which are made for proper drainage (Ibraheem, 2014). But at present, natural drainage canals and open water bodies are filled up for development works which badly affect the drainage system.

3.2.3 Soil

According to the geological origin of soils; Dhaka city is under the category of Modhupur soil tract (AEZ 28) which consists mainly of silt and clay. Soil of the experimental site mainly belongs to the medium high land and its texture contains silty loam, olive-gray with common fine to medium distinct dark yellowish brown mottles with a pH of 5.6 (UNDP & FAO, 1998).

3.3 Vegetation characteristics of the study area

3.3.1 Trees and shrubs

According to the field data collection, the total numbers of trees are found at Dhaka south city corporation belongs to 34 families under 109 genera and 135 species, respectively. The total number of shrub belongs to 29 families under 69 genera and 86 species, respectively. Out of all trees and shrubs, 64 timber species (including 56 genera and 28 families), 42 fruit species (33 genera and 23 families), 18 medicinal plant species (18 genera and 15 families), 26 ornamental plant species (23 genera and 19 families), 54 flower plant species (47 genera and 26 families), 7 ficus plant species (1 genus and 1 family), 14 palm plants (14 genera and 2 families), 2 rubber plants (1 genus and 1 family), 1 spice plant (1 genus and 1family) are found.

3.3.2 Herbaceous plants

Among all the experimental plots at DSCC, the total number of herbaceous plants belongs to 50 families under 114 genera and 126 species. Out of all plant species, 27 flowering herbs (including 24 genera and 21 families), 21 grass species (18 genera and 4 families), 13 medicinal species (13 genera and 9 families), 38 weed species (34 genera and 24 families), 13 ornamental species (13 genera and 9 families),8 climbers (13 genera and 8 families) 1 fern plant (1genus and 1 family), 3 bamboo species (1genera and 1 family), 1spice and 1 fruit plant (1 genus and 1 family) are found.

(a) (b) (c) (d)

Plate 1: Photograph shows the study areas of Dhaka south city corporation; (a) =Playground (Dhanmondi club field), (b) = Park (Dhanmondi lake park), (c) =Garden (Sohrawardi uddan) & (d) =Roadside (Fuller road)}.

(a)

(b)

(c)

(d)

Plate 2: Photograph shows working procedures; (a) = measuring DBH in study area; (b) = measuring plot in study area; (c) = measuring height study area; (d) = Preparing list of plant species in study site.

(a) (b)

Plate 3: Photograph shows the instruments used for the experiment; (a) Diameter tape and (b) Haga altimeter.

3.4 Data collection

3.4.1 Selection of sampling area

Reconnaissance survey was made to the study area in order to get general information about the vegetation, and accessibility to the parks and other green spaces and a list of all tree species was prepared for further data collection. For conducting the survey the whole city corporation was divided into four categories according to its vegetation characteristics named:

1. Parks
2. Playgrounds
3. Gardens &
4. Roadsides

The sampling areas were selected through random sampling method in these study areas. The selected areas for survey are mentioned in Table-1.

Table 1: Selected sampling areas for survey in DSCC

SL No.	**Parks**	**No of plot taken**	**Area (acre)** (approx.)
1.	Shamibag wonderland	05	1.00
2.	Bahadur Shah Park	07	1.00
3.	Sikkatuli sishu park	01	0.35
4.	Shirajuddoula park	02	0.61
5.	Gulistan park	05	0.24
6.	Hajaribagh Sishu park	01	0.98
7.	Dhanmondi 3 No park	05	0.33
8.	Ramna Park	26	88.50
9.	Central Shishu Park	08	14.5
10.	Kalabagan Lake circus Park	20	3.31
		Total:80	**Total:110.82**
SL No.	**Playgrounds**	**No of plot taken**	**Area (acre)** (approx.)
1.	Dhanmondi club field	03	2.00
2.	Bangladesh Field	02	0.33
3.	Kolabagan Play Ground	03	2.50

4.	Dhupkhola Play Ground	02	2.50
		Total: 10	**Total:7.33**
SL No.	**Gardens**	**No of plot taken**	**Area (acre)** (approx.)
01.	Sohrawardi Uddan	28	67.00
02.	Boldha Garden	11	3.15
03.	Osmani Uddan	10	23.14
		Total: 49	**Total: 93.29**
SL No.	**Roads**	**No of plot taken**	**Area (Km)** (approx.)
1.	Dhaka Nagar Bhaban- Sufia Kamal Hall.	03	0.66 km
2.	Dhanmondi Abahoni Playground – Dhanmondi 8/a.	05	0.84 km
3.	Doel Chottor- Bangladesh Police Headquarters.	05	1.16km
4.	Eden College-North Fuller road staff Quarter, Fuller road.	05	1.18 km
5.	Enginner's Institute - Ruposhi Bangla Hotel, Dhaka.	05	1.04
6.	Jagannath University - Bongshal bus stop.	04	1.08km
7.	Dhaka University Malchattar-Saheed Minar.	05	1.29km
8.	Matshya bhaban- Paltan bus stop	05	0.92km
9.	Polashir more, Azimpur - Buet central gate.	06	1.35 km
10	Tinnetar Majar-Shahbag Bus stop	05	1.39km
11.	TSC-Chankharpul	05	1.68km
		Total:53	**Total: 12.59**

(Source: DSSC Wikipedia, DSSC website & Google Earth)

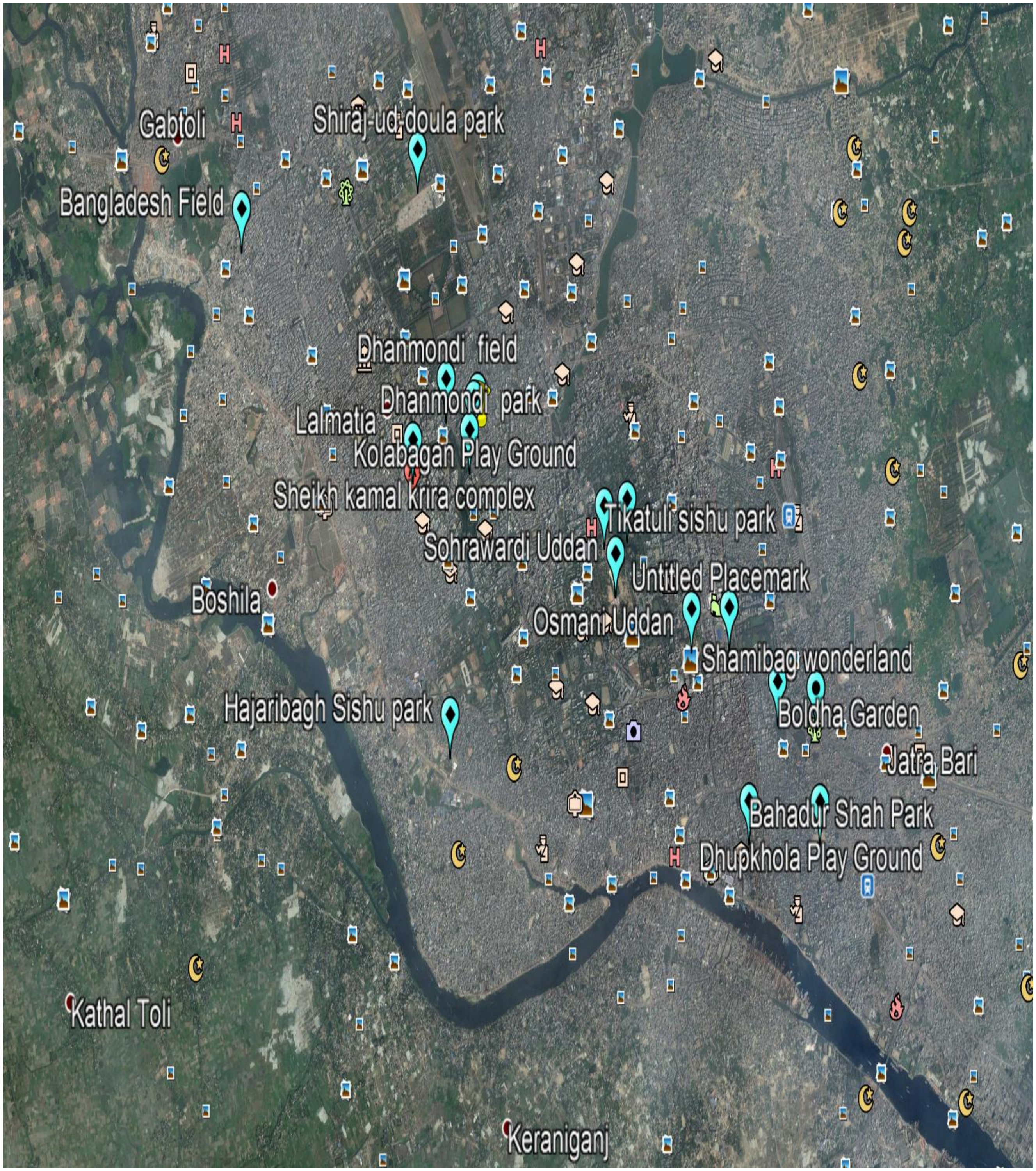

Plate 4: Photograph shows the satellitic view of study areas in DSCC. (Source: Google Earth)

3.4.2 Equipment used in the field study

SL No.	Name of the equipment	Function of the equipments
1.	Measuring tape	50 m metal tape for measuring plots.
2.	Pegs	Used to measure plot areas
3.	Dia tape	2 m tape for measuring diameter at breast height (1.37m).
4.	Haga altimeter	Height measuring instrument for calculating height of an individual trees and shrubs.
5.	Recordbook	Used to write down the information about plants.
6.	Data measurement sheet	To note the height and DBH of trees and shrubs.
7.	News paper and art paper	Used to wrap and convey the specimen

3.5 Field methods

3.5.1 Plot sampling

The quantitative assessment of structure and composition of tree covers was done by following stratified random sampling method during June 2016 to August 2016. A list of all tree species in DSCC was prepared and four habitat types (parks, gardens, roadsides and playgrounds) were selected. In these 4 habitat types, 25 sampling areas were selected for data collection. At each habitat types the quadrates were divided into four specific sizes. These are:

SL No.	Area	Plot size (m^2)
1.	Park	15×5
2.	Garden	15×5
3.	Playground	10×5
4.	Roadsides	20×5

In parks and gardens, 20 meter plot to plot distance was maintained but in playgrounds, 10 meter distance was adopted. In roadsides, plots were taken in a zigzag manner on both the sides of road (Fig.1) in order to maintain variation and 100 meter plot to plot distance was maintained.

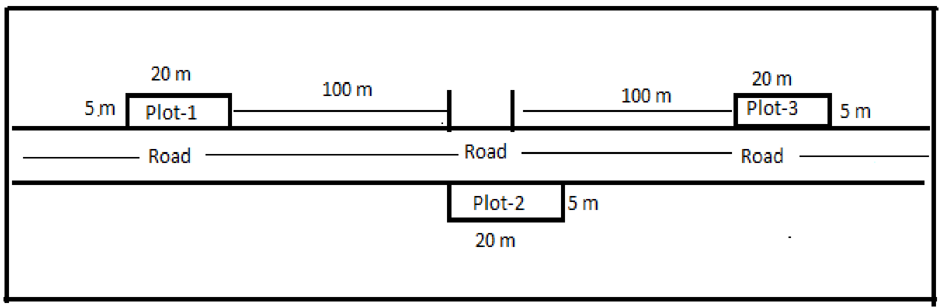

Fig 1: Schematic diagram of the zigzag plot layout along the roadside plantations in DSCC

3.5.2 Plant species sampling

A total of 192 sample plots (parks-80, playgrounds-10, gardens-49 & roadsides-53) were taken from the four categories of habitats. All plants in each quadrat were recorded and the number of each plant species was quantified. The common species were identified directly in the field. Local people and park officials also helped in identifying some species. A list of species was made with scientific name and family found in the sampling area.

3.5.3 Diameter and Height measurement

The diameters of all identified trees & shrubs were measured at breast height (1.3 m above ground) using a diameter tape and recorded. DBH of individual trees were recorded to calculate basal area and relative basal area per hectare to identify canopy coverage of plant species in study area. Height of all sampling trees and shrubs were measured by using Haga altimeter following the percentage scale formula:

Percentage scale: $$\frac{(TR+BR) \times H.D}{100}$$

Where, TR= Top reading; BR= Bottom reading and HD = Horizontal distance.

3.6 Data analysis

After finishing the collection of field data, all data was organized and analyzed by using MS Excel, and SPSS software. The density (stem/ha), frequency (%), relative frequency (%), basal area (m^2/ha), relative dominance and Importance Value Index (IVI) were calculated following the formulas of Moore and Chapman (1986), Shukla and Chandel (1980) and Dallmeier *et al.* (1992) for quantitative structure and composition for each trees and shrubs species.

1. Frequency

Frequency is the number of times a plant species occurs in a given number of quadrats. Frequency is usually expressed as a percentage. The concept of frequency indicates the probability of finding a species in a series of quadrats examined in an area of interest.

$$\textbf{Frequency} = \frac{\text{Total no. of plots in which the species occurs}}{\text{Total number of plot studied}} \times 100$$

2. Relative frequency

Relative frequency is the frequency of each species relative to all species expressed as a percent.

$$\textbf{Relative frequency} = \frac{\text{Frequency of one species}}{\text{Sum of frequency of all species}} \times 100$$

3. Density

Density is defined as the number of individuals of a given species that occurs within a given sample unit or study area and expressed in percent.

$$\textbf{Density (stem/ha)} = \frac{\text{Total no. of plots in which the species occurs}}{\text{Total no. of plots studied}} \times 100$$

4. Relative density

Relative density is the number of individuals per area as a percent of the number of individuals of all species.

$$\textbf{Relative density} = \frac{\text{Total no. of individuals of one species in all the plots}}{\text{Total no. of plots studied}} \times 100$$

5. Basal area (m^2/ha)

Tree basal area is the cross-sectional area (over the bark) at breast height (1.3m above the ground) measured in m^2. After that, sum of basal area of all the individuals of a species divided by total number and size of all plots in study area to find out the dominance of that species in that given area.

$$\textbf{Basal area (m}^2\textbf{/ha)} = \frac{\text{Total basal area of individual species}}{\text{Sample plot area (ha) x Total no. of plots studied}}$$

The basal area/ha is calculated according to the following formula

$$Ba/ha = \frac{\sum \frac{\Pi}{4} D^2}{\sum area \quad of \quad all \quad quadrats} X \quad 10000$$

Where, Ba = Basal area in m²

D = Diameter at breast height in meter

Π = 3.14

6. Relative Basal Area

It can be defined as the total basal area of species a as a percent of the total basal area of all species.

$$\textbf{Relative Basal Area} = \frac{\text{Total basal area of one species in all plots}}{\text{Total basal area of all species in all plots}} \text{ x } 100$$

7. Importance Value Index

Importance values are averages of two or more of the above parameters, each of which is expressed on a relative basis (ex: relative frequency, relative density and relative basal area) and can range from 0 to 300.

Importance value Index (%) = (Relative density + Relative frequency + Relative dominance)/3

CHAPTER IV
RESULTS AND DISCUSSION

Proper urban forest structure and composition assessment are the cornerstones of urban forest sustainability, because it has a strong influence on the urban forest function (McBride, 2008). Forest structure assessment includes the calculation of various physical features of the vegetation such as tree species composition, number of trees, family and genera, tree density, frequency, basal area, height class, DBH class etc (Nowak, 2009). Species composition of an area is usually calculated by identifying the species that are present and the number of individuals or percent of each species to the total plant population. This section aims to analize two or more above mentioned parameters to identify the structure and composition of DSCC.

4.1 Species composition of Dhaka South City Corporation (DSCC)

4.1.1 Number of plant species in different study area of DSCC

This study reveals that, the green sites of Dhaka South City Corporation express significant species composition. Among four types of study areas, maximum number of plant population were shown by parks (trees=118, shrubs= 60, herbs=94 & palms= 13), whereas the lowest number of species was shown in playgrounds (Table 2).

In total, 347 plant species consist of 144 tree and palm species, 77 shrubs and 126 herbs were observed in all 192 plots of four different types study area in DSCC. The number of species is quite lower compare to the 376 species (140 trees, 162 shrubs and 74 herbs) found in an urban forest, Lore lindu park of Indoneshia (Ramadhanil, 2008) and quite higher than 267 species (113 trees, 89 shrubs, 65 herbs) found in the Eastern Terai of India, (Pandey & Shukla, 2003). Diogo *et al.* 2014 enlisted only 116 species (27 trees and 89 shrubs) in the urban forest of Fortaleza, Brazil which is very low compared to the findings of this research followed by 126 species (87 trees and 39 shrubs) found in the Shenyang city of China (Zhu *et al.*, 2008).

4.1.2 Number of individual trees and shrubs according to the size of area in DSCC

The number of individuals (trees and shrubs) in four different study areas were estimated and presented in Fig.1. The figure indicates a linear relationship between the sizes of area (ha) and the number of individual plants. By comparing the number of species with the size of area it is clearly shows that with increase the area the number of plant species increases as well.

The graph also indicate that, park area (0.6 ha) showed the highest number of individual plant population (n= 1478) rather than gardens (0.37ha; n=858), roadsides (0.53 ha; n= 856) and playgrounds (0.05 ha; n= 134) (Fig 2).

Table 2: Number of Plant species observed in four types of study area in DSCC

SL No.	Area	No of plant species observed			
		Tree	Shrub	Herb	Palm
01	Parks	118	60	94	13
02	Gardens	97	42	59	11
03	Roadsides	65	20	23	8
04	Playgrounds	24	2	6	3

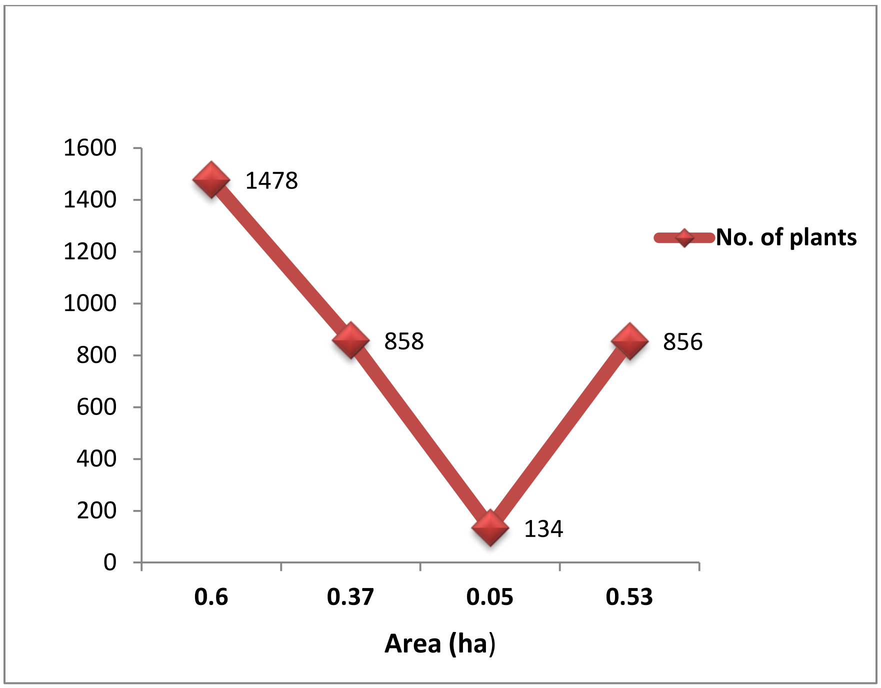

Fig 2: Number of individual plants according to the size of area (ha)

4.1.3 Composition of tree and shrub species according to family, genera and number of individuals in DSCC

A total of 221 species (trees and shrubs) distributed into 63 families and 177 genera were identified in the study area of DSCC (Table 5). The number of species, families and genera are higher in comparison to the species number (72 species, 30 families and 65 genera) found in the urban forest of Nigeria (Godwin, 2015).Whereas in Melbourne about 399 species and 52 families were found on public land (Cynnamon, 2013) which is higher than that of present study area. The tree species like; *Swietenia macrophylla*, *Polyalthia longifolia*, *Cocos nucifera*, *Samanea saman*, *Artocarpus heterophyllus, Mimusops elengi and Delonix regia* were more prevalent in the study area with maximum number of individuals and shrub species like *Combretum indicum*, *Tabernaemonlana divaricata, Codiaeum variegatum, Lagerstroemia lancasteri, Hibiscus rosa-sinensis and Caesalpinia pulcherrima* were represented maximum number of individuals among all the study area (Table 3 & 4). Among tree species *Swietenia macrophylla* and among shrub species *Combretum indicum* showed highest number of individuals (n=210 and 105), respectively. As shown in Table 5, families like; Fabaceae, Arecaceae, Moraceae Meliaceae, Annonaceae, Myrtaceae, Combrectaceae, Apocynaceae, Rubiaceae, Lythraceae and Sapotaceae represented as maximum number of plant population. Fabaceae is the richest family being represented by 28 species, 22 genera and 542 individuals followed by Arecaceae (14 species, 13 genera and 337 individuals) and Moraceae (13 species, 5 genera and 113 individuals). Fabaceae family also represented as the richest family with 18 species found in the urban forest of Brazil (Diogo *et al.*, 2014) and also in the urban area of Congo with 188 species (Felix *et al.*, 2015) which means in most of the urban areas maximum number of species belongs to the Fabaceae family.

Table 3: Most dominant tree species found in DSCC according to the individual number (>20)

SL No.	Common name	Scientific name	No. of Individuals
1.	Mahgoni	*Swietenia macrophylla*	210
2.	Debdaru	*Polyalthia longifolia*	150
3.	Coconut	*Cocos nucifera*	99
4.	Raintree	*Samanea saman*	98
5.	Kathal	*Artocarpus heterophyllus*	95
6.	Bokul	*Mimusops elengi*	95
7.	Krishnochura	*Delonix regia*	89
8.	Mango	*Mangifera indica*	85
9.	Bot	*Ficus bengalensis*	79
10.	Rajkoroi	*Albizia richardiana*	62
11.	Jarul	*Lagerstroemia speciosa*	56
12.	Areca palm	*Dypsis lutescens*	54
13.	Segun	*Tectona grandis*	53
14.	Eucalyptus	*Eucalyptus camaldulensis*	44
15.	Arjun	*Terminalia arjuna*	44
16.	Kodom	*Anthocephalus chinensis*	42
17.	Shissoo	*Dalbergia sissoo*	41
18.	Akashmoni	*Acacia auriculiformis*	40
19.	Nageshwar	*Mesua ferrea*	37
20.	Jam	*Syzygium cumini*	35
21.	Ipil-ipil	*Leucaena leucocephala*	33
22.	Thuja	*Thuja occidentalis*	32
23.	Tetul	*Tamarindus indica*	24
24.	Ghoraneem	*Melia azedarach*	23
25.	Sonalu	*Cassia fistula*	22

Table 4: Most dominant shrub species in DSCC according to the individual number (>10)

SL No.	Common name	Scientific name	No. of Individuals
1.	Rongon	*Combretum indicum*	105
2.	Togor	*Tabernaemonlana divaricata*	56
3.	Croton	*Codiaeum variegatum*	38
4.	Cherry	*Lagerstroemia lancasteri*	36
5.	Joba	*Hibiscus rosa-sinensis*	36
6.	Radhachura	*Caesalpinia pulcherrima*	34
7.	Musanda	*Mussaenda erythrophylla*	33
8.	Duranta	*Duranta erecta*	31
9.	Baganbilash	*Bougainvillea glabra*	22
10.	Gondhoraj	*Gardenia jasminoides*	21
11.	Beli	*Jasminum sambac*	20
12.	Red sister	*Cordyline fruticosa*	20
13.	Shet kanchon	*Bauhinia acuminata*	15
14.	Hasnahena	*Cestrum nocturnum*	14
15.	Shefali	*Nyctanthes arbor-tristis*	14

Table 5: Number of species, genera and individual plant population according to the family

SL No.	Family	No of species	% of species	No. of genera	No. of individuals
1.	Fabaceae	28	16.62	22	542
2.	Arecaceae	14	10.33	13	337
3.	Moraceae	13	6.47	5	211
4.	Malvaceae	11	2.27	11	74
5.	Apocynaceae	9	4.14	8	135
6.	Euphorbiaceae	8	2.64	7	86
7.	Rutaceae	8	1.44	4	47
8.	Bignoniaceae	7	0.49	7	23
9.	Rubiaceae	7	3.37	7	110
10.	Myrtaceae	7	4.39	5	143
11.	Combrectaceae	7	4.72	4	154
12.	Lythraceae	7	3.50	4	114
13.	Solanaceae	5	0.83	5	42
14.	Meliaceae	5	8.46	5	276
15.	Annonaceae	4	5.40	4	176
16.	Anacardiaceae	4	2.82	4	92
17.	Sapotaceae	4	3.28	3	107
18.	Oleaceae	4	1.17	2	38
19.	Magnoliaceae	4	0.31	2	10
20.	Lecythidaceae	3	1.38	3	45
21.	Lamiaceae	3	1.81	3	59
22.	Sapindaceae	3	0.34	2	26
23.	Caesalpiniaceae	3	0.55	2	33
24.	Asparagaceae	3	0.71	2	23
25.	Ebenaceae	3	0.52	1	17
26.	Asteraceae	2	0.12	2	19
27.	Verbenaceae	2	0.74	2	24
28.	Sterculiaceae	2	0.06	2	2
29.	Phyllanthaceae	2	0.40	2	13
30.	Arucariaceae	2	0.58	1	19
31.	Oxalidaceae	2	0.71	1	23
32.	Boraginaceae	2	0.15	1	5
33.	Malpighiaceae	2	0.21	1	7
34.	Araceae	2	0.06	1	2
35.	Araliaceae	1	0.12	1	4
36.	Nyctaginaceae	1	0.67	1	22
37.	Dipterocarpaceae	1	0.09	1	3
38.	Heliconiaceae	1	0.15	1	5
39.	Rhamnaceae	1	0.55	1	18
40.	Theaceae	1	0.09	1	3
41.	Dilleniaceae	1	0.95	1	31

42.	Cycadaceae	1	0.21	1	7
43.	Bixaceae	1	0.03	1	1
44.	Cactaceae	1	0.03	1	1
45.	Thymelaeceae	1	0.28	1	9
46.	Rosaceae	1	0.55	1	18
47.	Casuarinaceae	1	0.43	1	14
48.	Elaeocarpaceae	1	0.25	1	8
49.	Clusiaceae	1	0.03	1	1
50.	Pandanaceae	1	0.12	1	4
51.	Ochnaceae	1	0.18	1	6
52.	Lauraceae	1	0.06	1	2
53.	Zygophyllaceae	1	0.06	1	2
54.	Melastomataceae	1	0.06	1	2
55.	Ericaceae	1	0.06	1	2
56.	Calophyllaceae	1	1.13	1	37
57.	Berberidaceae	1	0.12	1	4
58.	caricaceae	1	0.43	1	14
59.	Cannaceae	1	0.03	1	1
60.	Liliaceae	1	0.61	1	20
61.	Moringaceae	1	0.58	1	19
62.	cupressaceae	1	0.98	1	32
63.	Zingiberaceae	1	0.06	1	2

4.1.4 Frequency and density of dominant tree and shrub species amongst different habitats in DSCC

Frequency and density of most dominant plant species in different study areas were shown in Table 6. From the findings, it can be clearly stated that, *Swietenia macrophylla* showed highest frequency (54.72%) followed by *Polyalthia longifolia* (50.12%), *Samanea saman* (47.77%), *Artocarpus heterophyllus* (42.56%) respectively. In case of density, maximum density (145.28%) was shown by *Swietenia macrophylla* followed by *Combrectum indicum* (96.67%), *Polyalthia longifolia* (96.23%), *and Mimusops elengi* (88.68%), respectively (Table 6). From this findings, we can say that distribution of plants are highly uneven in DSCC as only 6 species represent >40% frequency among all species whereas 8 species had shown >25% frequency. Similar types of findings were reported in Shahiwal city of Pakistan where only 4 species had >50% frequency and fourteen species had >5% frequency (Akber *et al.,* 2014).

4.2 Stand characteristics of study area

Stand characteristics of plants represent the overall structural features of a given area. From the findings of this study, the highest density (2475 trees/ha), DBH (572.98cm/ha) and the highest basal area (259.81m²/ha) were found in parks. However, the average density, DBH and basal area were 1785.58 trees/ ha, 452.59 cm/ha and 182.79m²/ha, respectively (Table 7). The average density (1785.58 tree/ha) was found higher in comparison to the 279 tree/ha from urban forest in Shenyang, China (Liu and Li, 2012), and 705 tree/ha in the urban roadsides of Taiwan (Wang, 2011). The finding of very high density in DSCC compared to other study due to the higher plant population in small amount of area (ex: parks, gardens and playgrounds). The average basal area (182.79 m²/ha) was found higher than basal area (16.88 m²/ha) in Chunati Wildlife Sanctuary (Rahman and Hossain, 2003) and 27.07 m²/ha in Dudpukuria Dhopachori Forest (Hossain *et al.,* 2013) but lower than the basal area (53.5 m²/ha) in Chittagong hill tracts (Nath *et al.,* 1998).

Table 6. Frequency (F) and density (D) of dominant trees and shrubs within different habitats in DSCC; (Frequency ≥5% and Density ≥13%)

No	Species name	Parks		Gardens		Playgrounds		Roadsides	
		F	D	F	D	F	D	F	D
1.	*Swietenia macrophylla*	37.5	68.33	20.41	59.86	53.42	46.8	54.72	145.28
2.	*Polyalthia longifolia*	26.25	88.33	20.65	43.54	50.12	61.45	39.62	96.23
3.	*Cocos nucifera*	25.47	56.67	32.65	81.63	42.11	52.09	28.3	54.72
4.	*Samanea saman*	27.5	53.33	20.41	43.54	47.77	68.9	41.51	58.49
5.	*Artocarpus heterophyllus*	42.56	90	24.49	45.52	15.43	40.11	26.42	43.40
6.	*Mimusops elengi*	22.5	48.33	22.44	46.26	21.32	46.78	35.82	88.68
7.	*Delonix regia*	28.75	70.14	26.47	44.13	30.09	45.23	33.96	53.94
8.	*Mangifera indica*	30.18	55	36.72	74.56	20.08	63.77	30.19	43.40
9.	*Ficus bengalensis*	23.75	38.39	12.24	21.77	41.17	60.05	11.32	13.21
10.	*Albizia richardiana*	27.5	53.63	16.33	32.65	11.67	41.64	30.19	43.40
11.	*Lagerstroemia speciosa*	6.25	8.34	24.49	84.35	10.96	20.26	13.41	26.42
12.	*Terminalia arjuna*	11.25	25.08	23.10	41.82	20.12	40.6	9.43	20.75
13.	*Combrectum indicum*	37.50	96.67	30.61	70.75	10.33	20.5	15.09	37.74
14.	*Bauhinia acuminata*	10.78	15.9	8.16	13.61	10	20.62	15.09	37.74
15.	*Tabernaemonlana divaricata*	20.48	50	26.53	46.26	10.7	20.38	7.55	13.21

Table 7: Density (tree/ha), DBH (cm/ha) and basal area (m²/ha) at different study area of DSCC

SL No.	Species parameter	Study Area				Average
		Park	Garden	Playground	Roadside	
1.	Density(tree/ha)	2475	2359.18	680	1628.30	1785.62
2.	DBH(cm)/ha	572.98	544.79	339.8	376.79	458.59
3.	Basal area(m²/ha)	259.81	194.59	137.32	139.44	182.79

4.3 Percent of plant species according to the study area of DSCC

The bar graph shows the percentage of plant population in four different types of study area (Fig 3). Among study areas, parks (trees=62.99%, shrubs=26.45%, palms=10.55%) and gardens (trees=68.18%, shrubs=22.72%, palms=9.09%) had shown significant proportion of trees, shrubs and palm species. Whereas, in playgrounds, tree species covers 90.29% of the study area but shrubs and palm species had shown lower percentage (shrub=1.49%, palm= 6.2%). That means, playgrounds of DSCC are shown poor shrub and palm species population. Roadsides had shown very higher percentage of tree population (75.35%) compared to the shrub (13.20%) and comparatively higher percentage of palm (11.42%) than parks and gardens.

From these findings it can be clearly stated that, Playgrounds and streets of the DSCC have a scarcity of shrubs compared to the garden and parks. Park contains the highest percentage of plant population (44%) whereas gardens and streets represent similar percentage of plants (26%). Playgrounds represent the lowest population percentage (4%) (Fig 4). From these findings we can say that, number of plant population is greatly related to the size of area. A similar study was conducted in Barcelona where parks have 43.10% and streets have 17.5% tree cover whereas parks contain 35% and streets contain only 3.2% shrub population (Lydia *et al.*, 2009) which is lower in comparison to this study.

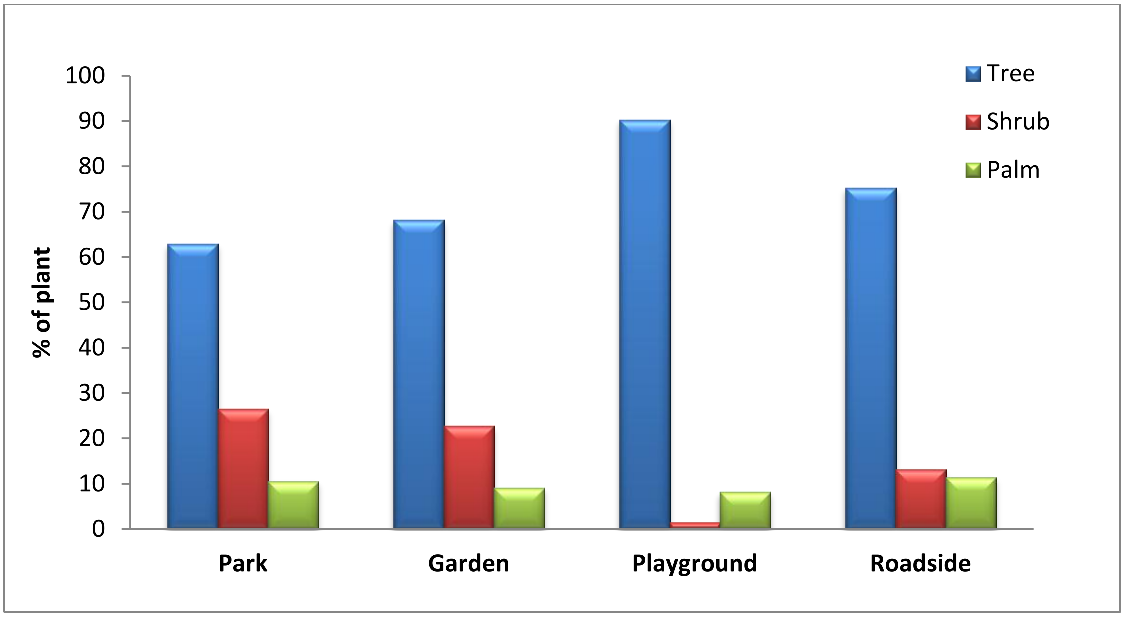

Fig 3: Percent distribution of plants according to tree, shrub and palm in different study areas

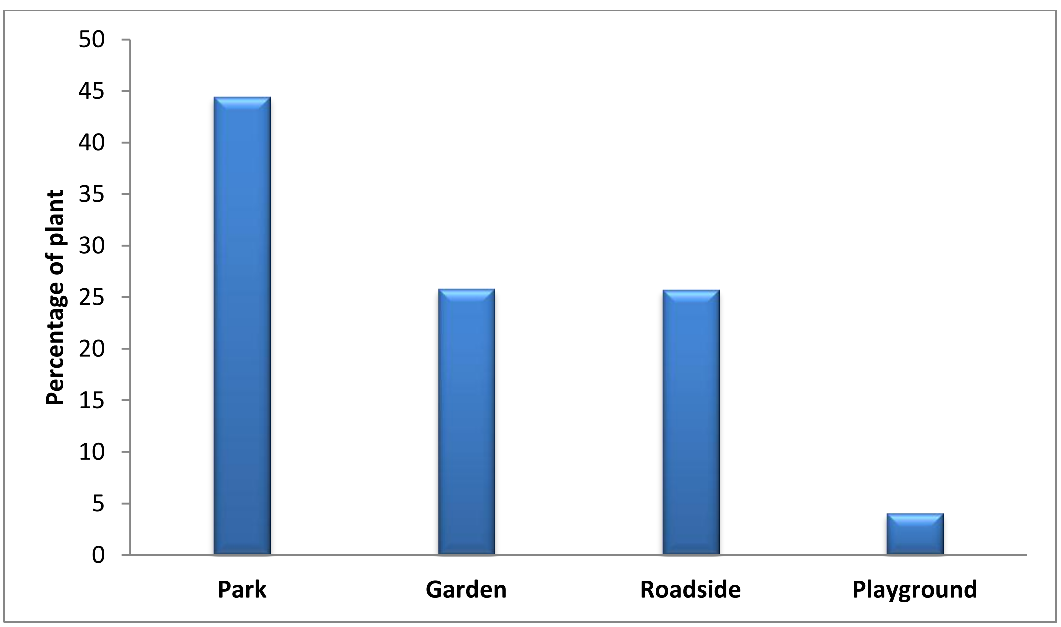

Fig 4: Percent distribution of plant population in different study areas of DSCC

4.4 Structure of urban area in DSCC

4.4.1 Height class distribution

For the height structure, the classes were defined at regular intervals of 3m and the height classes are categorized in comparison between areas. It was observed that the height differences between the four categories of study areas (parks, gardens, playgrounds and roadsides) were not statistically significant. In this section, the proportional distributions of different height classes of trees are presented.

In parks, maximum numbers of trees and palms (tree= 214 & palms= 47) were enlisted in between 6.1-9.1m height class with standard error value 8.27 for trees and 4.06 for palms where maximum numbers of shrubs (total 252) were found in between 3.1-6.1m height class with standard error value 9.00 (Fig 5). Park areas represent *Streblus asper*as the highest individual (32.1m) and *Araucaria columnaris* as the smallest (2.48m) among the tree species. In case of shrub species, *Caesalpinia pulcherrima* represented asthe highest individual (9.38m) and *Cordyline fruticosa* as the smallest (1.62m).

In gardens, maximum numbers of trees and palms (tree=156 & palms= 22) were enlisted in between 6.1-9.1m height class with standard error value 6.64 for trees and 2.52 for palms where maximum numbers of shrubs (total 128) were found in between 3.1-6.1m height class with standard error value 6.37 (Fig 6). Among all the tree species in the garden, *Swietenia macrophylla* represented as highest individual (28.54m) and *Mesua ferrea* as the smallest (3.09m). On the other hand among shrub species, *Lagerstroemia lancasteri* representedas the highest individual (3.05m) and *Lawsonia Inermis* as the smallest (1.71m).

In playgrounds, maximum numbers of trees (total 39) were found in between 6.1-9.1m height class with standard error value 3.59 where maximum number of palms and only 2 shrub species were found in betweem 1-3.1m height class with standard error value 0.86 for shrubs and 1.51 for palms (Fig 7). *Polyalthia longifolia* represented as the highest individual (17.77m) and *Terminalia arjuna* as the lowest (3.65m). Among the shrubs, *Combretum indicum* was the highest individual (5.61m) and *Bauhinia acuminate* was the smallest (4.12).

In roadsides, maximum numbers of trees (total 177) were enlisted in between 6.1-9.1m height class with standard error value 8.02 and maximum numbers of palms (total 29) were found in between 9.1-12.1m height class with standard error value 3.23. However, maximum numbers of shrubs (total 54) were found in between 1-3.1m height class having standard error value 4.53 (Fig 8). Roadsides represent *Albizia richardiana* as the highest individual (29.79m) and *Psidium guajava* as the smallest (3.09m) among the tree species. Among shrub species, *Combretum indicum* represented as the highest individual (3.05m) and *Cordyline fruticosa* as the smallest (1.71m).

From these findings, it is clear that almost all the study areas trees and palms were found in between 6-9 m height class which means most of the trees are quite smaller in height. Whereas, in case of shrub species, most of them are found in between 1-3.1 m height class which means the shrub species found in the study area, represents adequate height because of regular pruning and take care. The findings of this study are lower to the research conducted in the metropolitan areas of Sylhet where 48 percent of trees were found in between 9-12 m height class (Deb *et al.*, 2013). In the deforested area of Chittagong, the maximum tree and shrub population were found in between 3- 4.9m height class which is comparatively lower height of tree species found in present study area in DSCC (Amin, 2005). In urban parks of Sydney, majority of vegetation (including both trees and shrubs) found between 5-20m in height (City of Sydney, 2013). This is expected with the tree species of urban areas located under power lines, coupled with the City’s recent tree planting efforts, as the trees are still maturing.

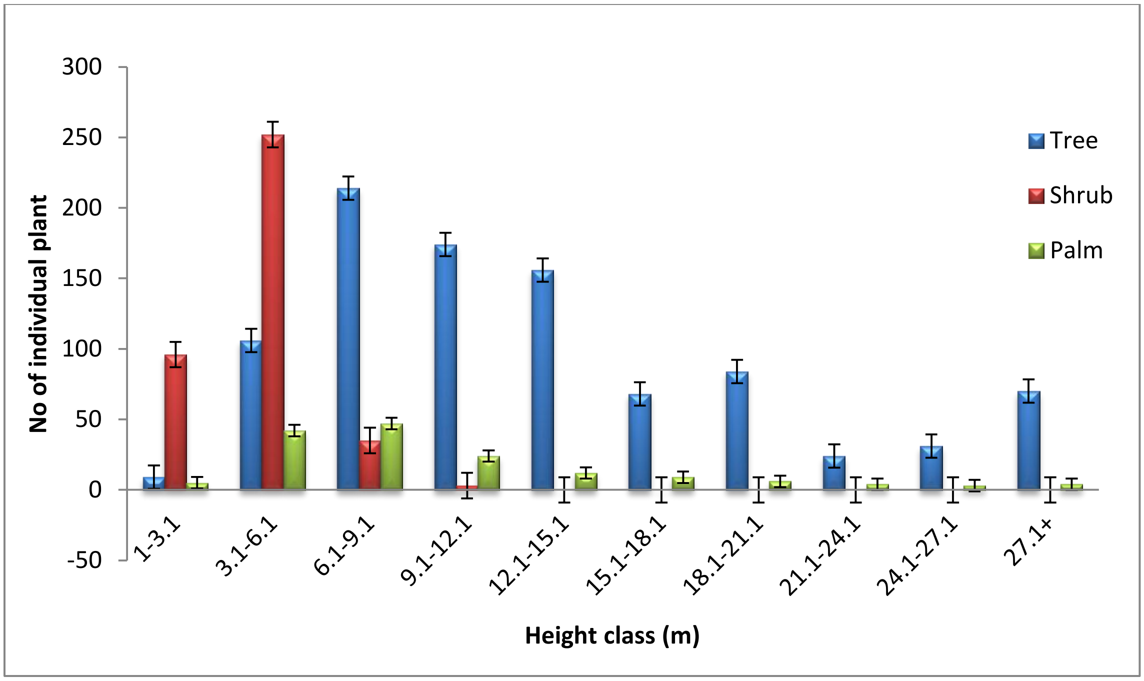

Fig 5: Height class distribution of trees and shrubs in parks of DSCC

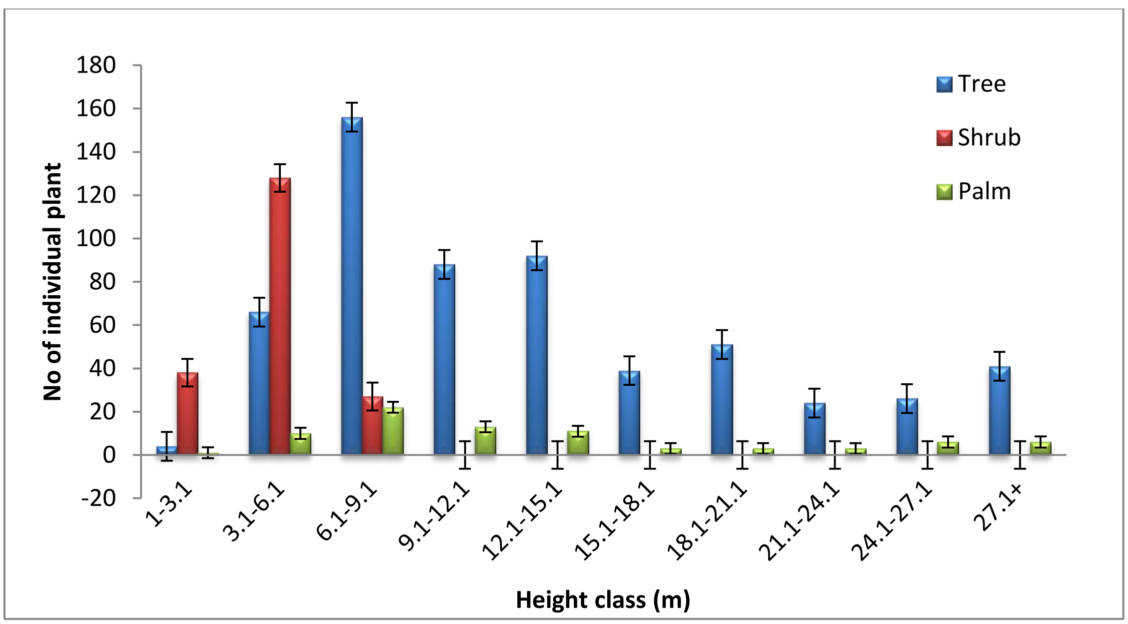

Fig 6: Height class distribution of trees and shrubs in gardens of DSCC

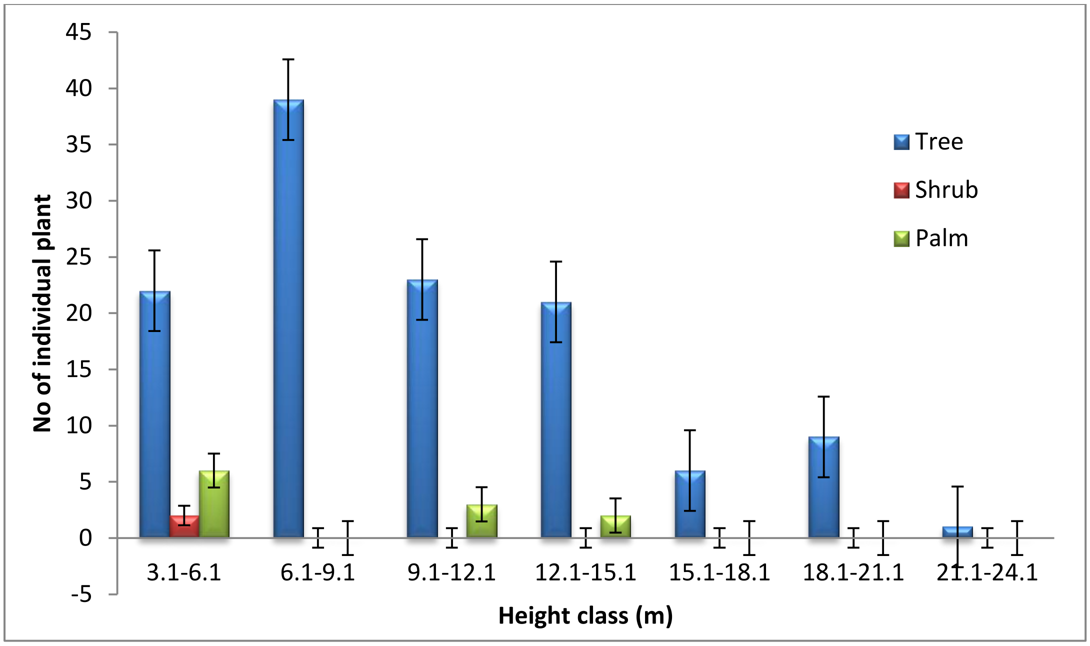

Fig 7: Height class distribution of trees and shrubs in playgrounds of DSCC

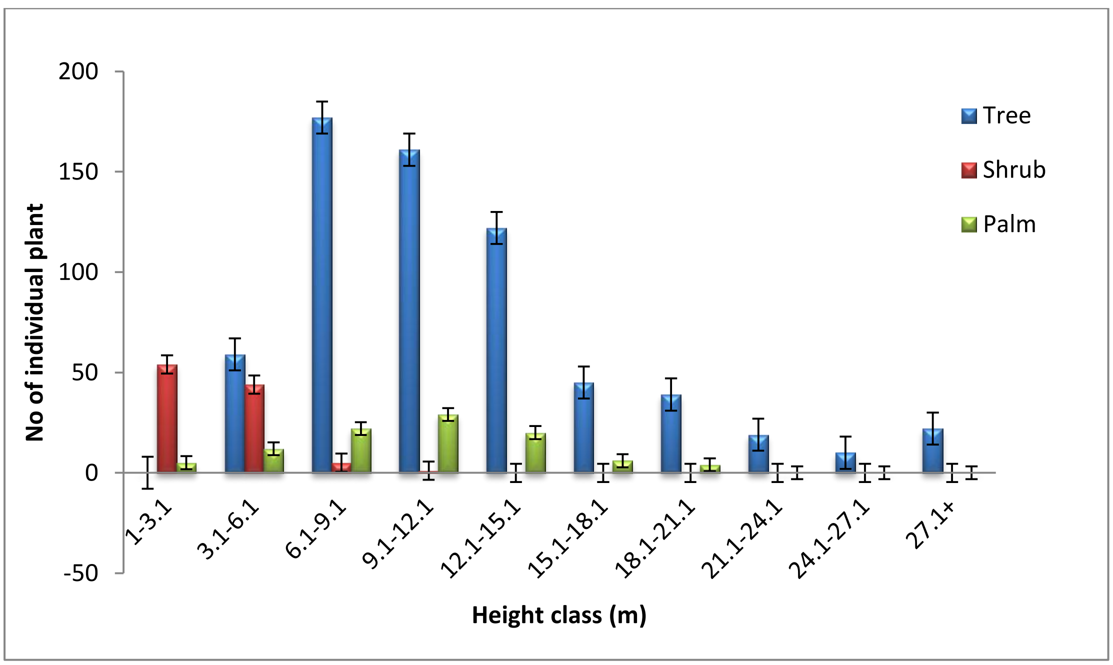

Fig 8: Height class distribution of trees and shrubs in roadsides of DSCC

4.4.2 DBH class distribution

In case of DBH, the classes were defined at regular intervals of 15cm to improve the comparison between areas. It was observed that the DBH differences between the four categories of study areas (parks, gardens, playgrounds and roadsides) were not statistically significant. In this section, the proportional distributions of different DBH classes of plants are presented.

In case of parks, maximum number of tree population (n= 270) were enlisted in between 15-30cm DBH class with standard error value 9.50 and maximum number of shrub and palm population (shrub=501 & palm= 49) were found in between 0-15cm DBH class with standard error value 14.30 for shrubs and 4.63 for palms (Fig 9). In parks, *Ficus virens* represent highest DBH (98.6cm) whereas, lowest DBH (4.5cm) was shown by the *Hibiscus rosa-sinensis.*

In case of gardens, maximum number of plant population (tree= 205; shrub= 209; palm= 25) were enlisted in between 0-15cm DBH class with standard error value 8.36 for trees, 9.23 for shrubs and 3.12 for palms (Fig 10). In gardens, *Ficus bengalensis* represent highest DBH (92.6cm) whereas lowest DBH (2.9cm) was shown by the *Jasminum sambac*.

In case of playgrounds, maximum number of plant population (tree=57; shrub=2; palm=8) were enlisted in between 0-15cm DBH class with standard error value 4.45 for trees, 0.90 for shrubs and 1.83 for palms (Fig 11). In playgrounds, *Samanea saman* represents highest DBH (95cm) whereas; lowest DBH was shown by the *Bauhinia acuminate* (4.2cm).

In roadsides, maximum number of plant population (tree= 283; shrub=110; palm=46) were found in between 0-15cm DBH class with standard error value 9.86 for trees, 6.69 for shrubs and 4.24 for palms (Fig 12). *Albizia richardiana* represent the highest DBH (110.6cm) whereas lowest DBH (3.9cm) was shown by the *Allamanda cathartica* in playgrounds.

From these findings, it is clear that maximum number of plant population belongs to the 0-15 cm DBH class in DSCC. Majority of plant population showed lower DBH and the number of individual plants decreased with the increase of diameter class in these study area. The DBH of plant species of present study area represented lower DBH class compared to the study conducted in the urban areas of Sao Paulo where maximum native trees (>25%) were found in the 22.5-27.5cm DBH class (Richardo, 2002). However, the findings of the study is quite higher in comparison to the urban parks and recreation places of Chicago, USA where maximum number of plant population including trees and shrubs are found in the 1-3 cm DBH class (Nowak *et al.*, 2009). Another study was conducted in vacant and commercial land at the Roanoke city of Virginia where maximum number of trees and shrubs were found in between 7.1-15.2 cm DBH class which is similar to the findings of this study (Kim, 2016). This means trees and shrubs which belong to the urban habitat are poor in diameter because of different environmental factors like pollutant sources, chemicals, and dust into the surrounding air, soil, and water. This biotic factor directly influence vegetation mortality and creates barriers to wildlife movement. Although the space to grow and maintain large trees on urban areas is limited, smaller trees collectively play an important role in improving commercial and industrial urban habitats.

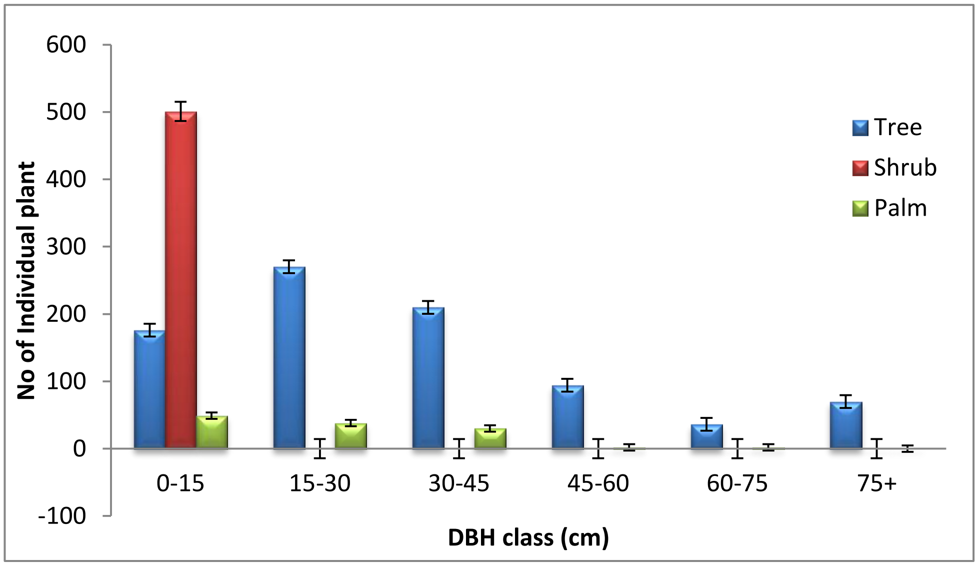

Fig 9: DBH class distribution of trees and shrubs in parks of DSCC

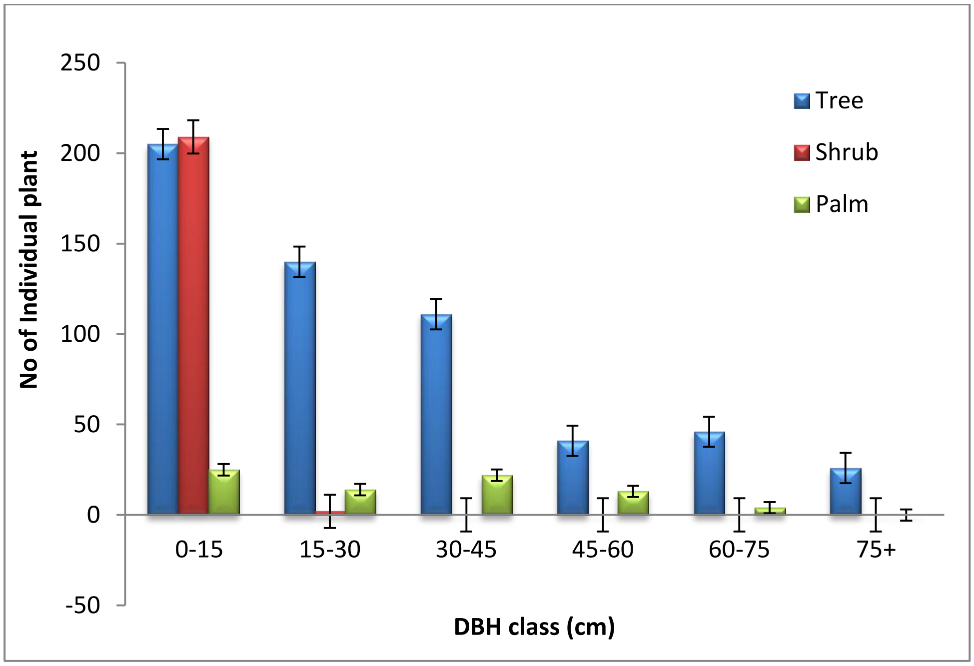

Fig 10: DBH class distribution of trees and shrubs in gardens of DSCC

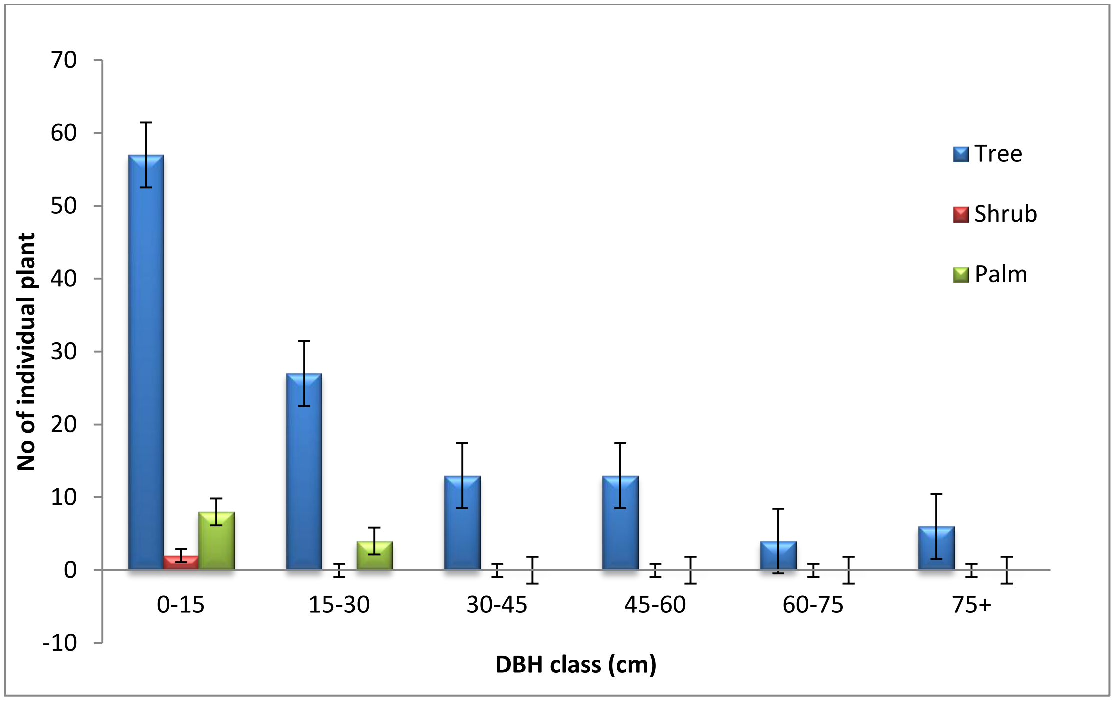

Fig 11: DBH class distribution of trees and shrubs in playgrounds of DSCC

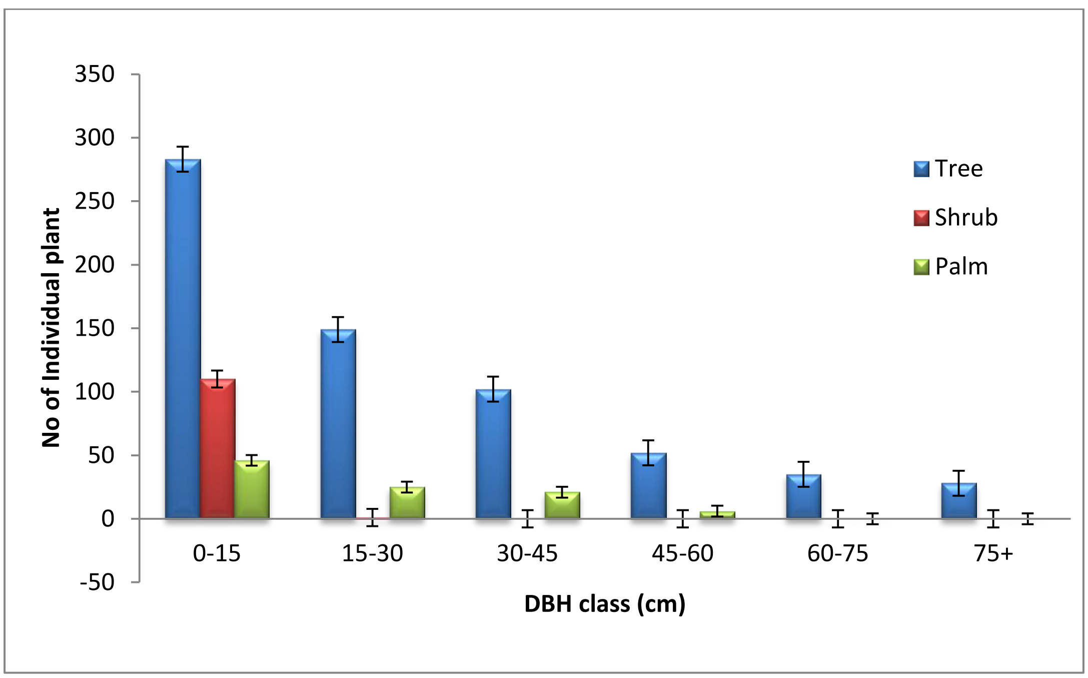

Fig 12: DBH class distribution of trees and shrubs in roadsides of DSCC

4.4.3 Average DBH and Height class of the plants

The comparison among the four study areas according to the average DBH and height of trees and shrubs were represented by figure 12 and 13. From the findings it can be clearly stated that, average height of trees are varied between 10m to 13m with standard error value 1.23 whereas in case of palms, average height was found in between 9-12m with standard error value 1.40 which is quite similar to the average height of trees. Again, in case of shrubs, average height was found in between 3-4m with standard error value 0.64 (Fig 13). The findings from this study indicated that plants in urban area are relatively short and young and in the stage of growth and development.

In case of average DBH, most of the trees are found in between 20-32cm diameter with standard error value 1.72 and palms are generally found within 16-30 cm having standard error value 2.50. However, shrubs are represented by 3-4cm average diameter with standard error value 0.56 in all study areas (Fig 14).

From these findings, it can be clearly stated that, many of the plants were planted very recently in the vegetative area of DSCC and for this reason trees and shrubs are more evenly aged and represent relatively even height and diameter (Fig 13) & (Fig 14). In the Shenyang city of China, most of the trees (about 65%) represent less than 10 m in case of height and 76% of trees represent less than 20 cm in diameter which is similar to the findings of this study (Zhu, 2008). In this research fewer number of individual tree were found with larger DBH values greater than 60 cm (DBH > 60 cm) because of their growth form which can go up to this diameters (Hartshorn, 1980).

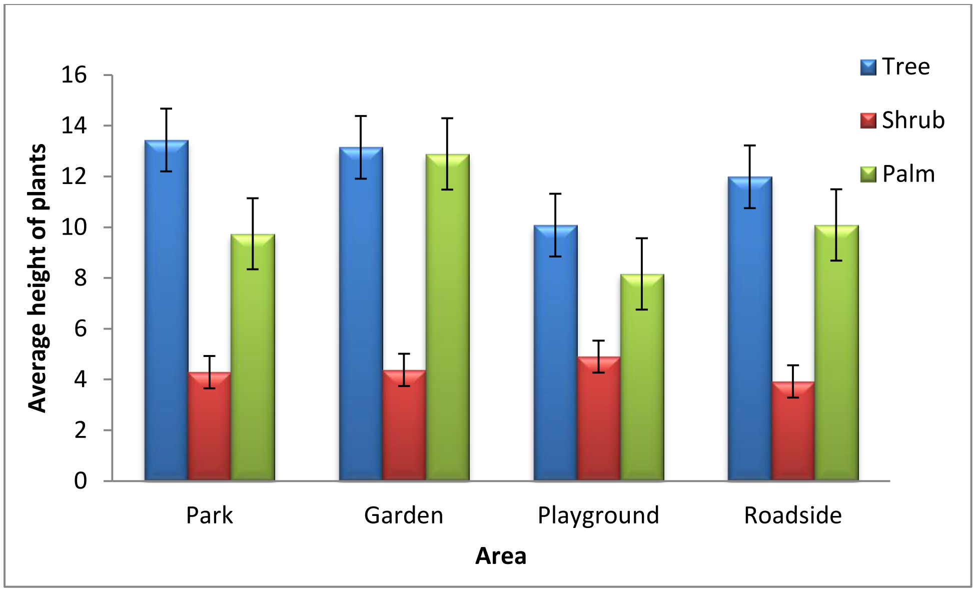

Fig 13: Average height of plant population according to study area

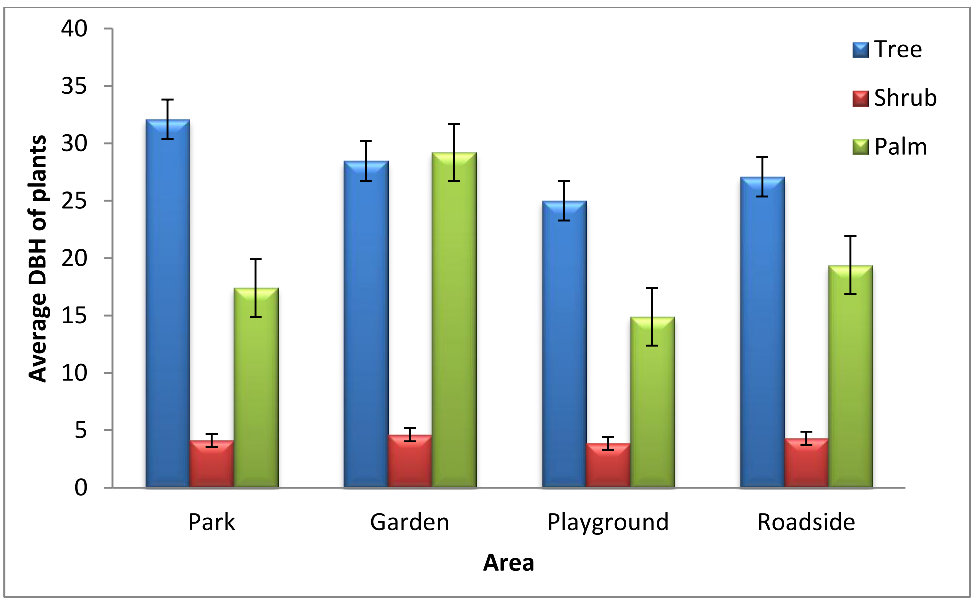

Fig 14: Average DBH of plant population according to study area

4.5 Relationship between area with frequency and density

The relationship of frequency and density with area (parks= 0.6 ha; gardens= 0.37 ha; roadsides= 0.53 ha & playgrounds= 0.05 ha) was shown in Figure 15. In case of frequency, the figure indicates a linear equation as: Y=-27.12x+22.21; (R^2=0.819), where R^2 value was positive and significant. In case of density, the figure indicates a linear equation as: Y=-146.0x+95.15; (R^2=0.857), where R^2 value was positive and significant. This study also indicates that, playground (0.05 ha) shows relatively higher frequency (22.41) and density (92.4) rather than gardens (F=7.7, D=15.56), parks (F=6.33, D=12.91) and roadsides (F=10.38, D=17.41) and the values are gradually decreased in the order of playground >roadsides >gardens >parks.

4.6 Relationship between area with relative frequency and relative density

The relationship of relative frequency and relative density of plants with the area (parks= 0.6 ha; gardens= 0.37 ha; roadsides= 0.53 ha & playgrounds= 0.05 ha) was shown in Figure 16. In case of relative frequency, the figure indicates a linear equation as: Y=-5.044x+3.384 (R^2=0.817), where R^2 value was positive and significant. In case of relative density, the figure indicates a linear equation as: Y=-62.53x+45.52 (R^2= 0.815), where R^2 value was positive and significant. This study also indicates that, playground (0.05 ha) shows relatively higher frequency (3.45) and density (46.21) rather than gardens (F=0.65, D=11.67), parks (F=0.55, D=9.68) and roadsides (F=1.07, D=17.59) and the values are gradually decreased in the order of playgrounds>roadsides > gardens > parks.

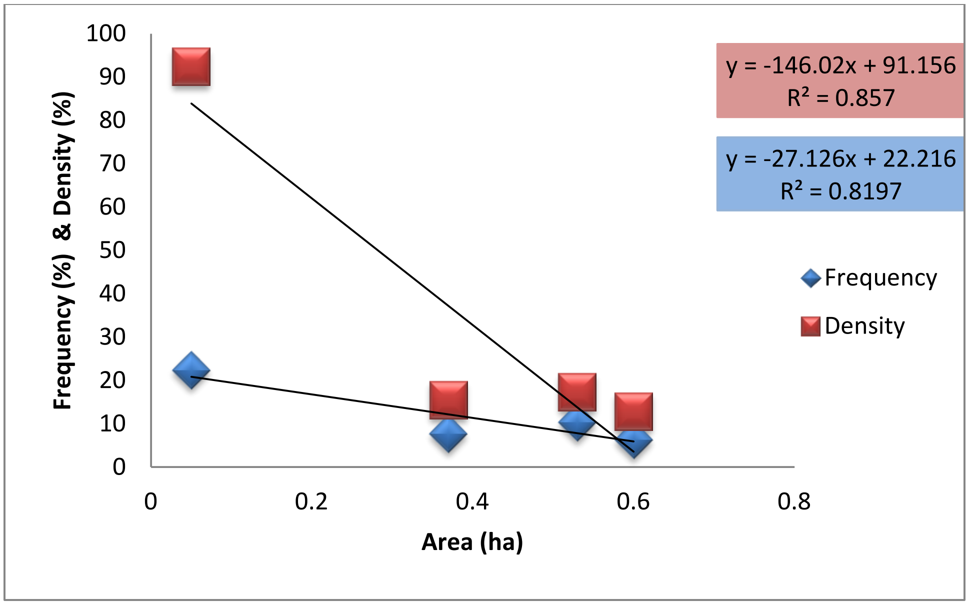

Fig 15: Relationship between area with frequency and density

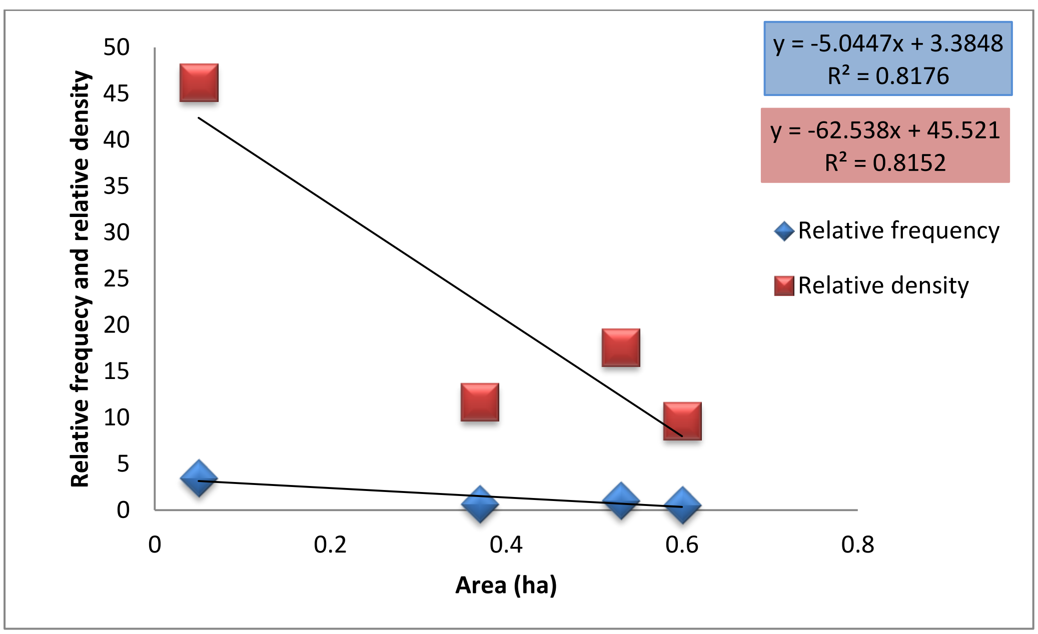

Fig 16: Relationship between area with relative frequency and relative density

4.7 Relationship between area and mean basal area (m^2/ha)

The relationship of mean basal area of plants with the area (parks= 0.6 ha; gardens= 0.37 ha; roadsides= 0.53 ha & playgrounds= 0.05 ha) was shown in Figure 17. In case of mean basal area (m^2/ha), the figure indicates a linear equation as: $Y=-12.69x+8.003$ ($R^2=0.835$), where R^2 value was positive and significant. This study also indicates that, playground (0.05 ha) shows relatively higher mean basal area (8.18 m^2/ha) rather than gardens (1.30m^2/ha), parks (1.36m^2/ha) and roadsides (1.5m^2/ha) and the values are gradually decreased in the order of playgrounds>roadsides > parks > gardens.

4.8 Relationship between area and mean DBH (cm)

The relationship of mean DBH (cm) of plants with the area (parks= 0.6 ha; gardens= 0.37 ha; roadsides= 0.53 ha & playgrounds= 0.05 ha) was shown in Figure 18. In case of mean DBH (cm), the figure indicates a linear equation as: $Y=-9.015x+ 16.75$ ($R^2=0.744$), where R^2 value was positive and significant. This study also indicates that, parks showed relatively higher mean DBH (23.18 cm) rather than gardens (20.99 cm), roadsides(19.76 cm) and playgrounds (17.05 cm) and the values are gradually decreased in the order of parks>gardens > roadsides > playgrounds.

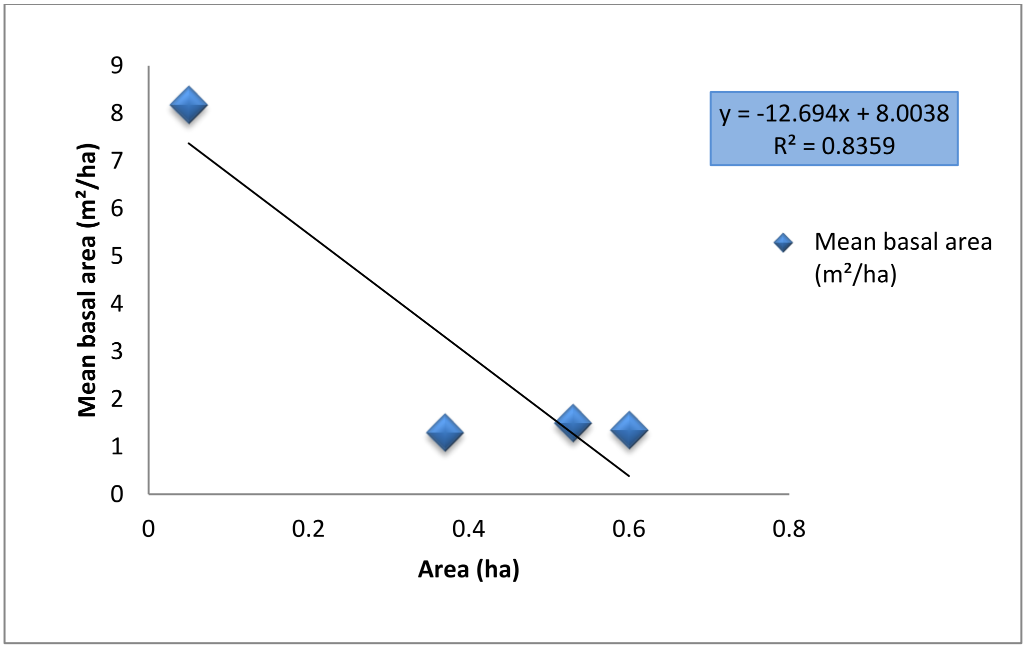

Fig 17: Relationship between area and mean basal area (m²/ha)

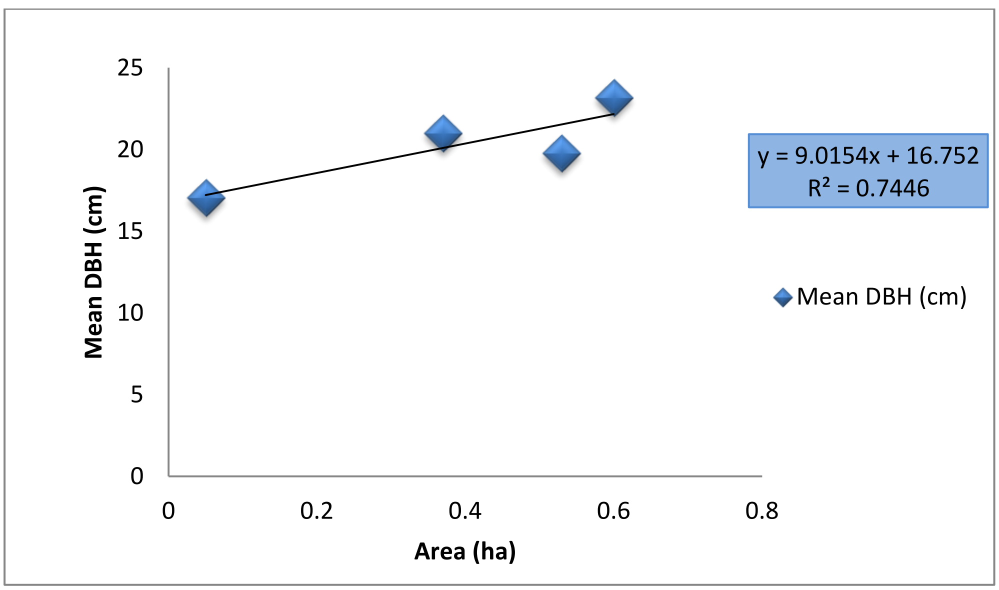

Fig 18: Relationship between area and mean DBH (cm)

4.9 Important value index of the plant species in DSCC

The importance value index (IVI) is an aggregate index that summarizes the density, abundance, and distribution of plant species (Okiror *et al.*, 2012). IVI reflects the degree of dominance and abundance of a given species in relation to other species in an area (Giliba *et al.*, 2011; Kent and Coker, 1992). Similarly, ecological significance of species can be identified in the study area through important value index (Muthuramkumar & Parthasarathy, 2000).

From the findings of this study it is clear that *Polyalthia longifolia* showed the highest IVI (103.39%) followed by *Swietenia macrophylla* (85.61%) and *Samanea saman* (83.44%) among all the species in 4 study area from 192 plots (Table 8, 9, 10 & 11). Similar study was conducted in the urban parks of Bangalore, India where IVI value for *Polyalthia longfolia* was quite lower (34.9%) (Nagendra & Gopal, 2010). The findings of this study also higher than IVI value (28.37%) for *Swietenia macrophylla* found in the metropolitan area of Chittagong (Uddin *et al.*, 2015) but quite similar with the IVI (77.1%) for *Swietenia macrophylla* in the urban forest of Shrilanka (Lilia *et al.*, 2012).

From four different types of study area, highest relative basal area (48%) and highest relative frequency (12.31%) was shown by *Samanea saman* whereas, highest relative density (300%) was shown by *Polyalthia longfolia*. In this section only those species were discussed which have ≥15% IVI value in all study area. The IVI value of all the plant species are represented in Appendix 3, 4, 5 & 6.

The Importance value Index (IVI) of any species depicts the dominance of it in a diverse population. So this study reveals that *Polyalthia longifolia, Swietenia macrophylla* and *Samanea saman* are the most dominant tree species in 4 categories of study site in DSCC. The high Importance Value Index (IVI) of these species in green areas of DSCC indicates their dominance and good power of regeneration, their growth habits and potential to tolerate diverse environmental condition of urban settlement.

4.9.1 Important value index of the plant species in Parks

The relative density (RD %), relative frequency (RF %), relative basal area (RBA %) and Importance Value Index (IVI) of plant species were recorded from the parks of DSCC. In parks, *Swietenia macrophylla* showed the maximum IVI (38%), followed by *Combretum indicum (*25.29%), *Polyalthia longifolia (*24.41%), *Artocarpus heterophyllus (*24.25%), *Delonix regia (*20.31%) and *Samanea saman (*18.53%), respectively.

Maximum basal area was shown by *Samanea saman* (13.18%); maximum relative density was shown by *Swietenia macrophylla (*103.75%) and maximum frequency was found in *Artocarpus heterophyllus (*3.72%), respectively (Table 8).

4.9.2 Important value index of the plant species in Gardens

The relative density (RD %), relative frequency (RF %), relative basal area (RBA %) and Importance Value Index (IVI) of plant species were recorded from the garden area of DSCC. In gardens, *Lagerstroemia speciosa* showed the maximum IVI (22.64%) followed by *Cocos nucifera* (21.34%), *Eucalyptus camaldulensis* (20.79%), *Mangifera indica* (20.19%), *Dalbergia sissoo* (19.97%), *Combretum indicum* (18.56%), *Mesua ferrea (17.56%)*, respectively.

Maximum basal area was shown by *Eucalyptus camaldulensis* (9.29%); maximum relative density was shown by *Lagerstroemia speciosa* (63.27%) and maximum relative density was found in *Mangifera indica* (3.08%), respectively (Table 9).

Table 8: Relative frequency, relative density, relative basal area & IVI of parks in DSCC (IVI value ≥ 15%)

SL No.	Species Name	Relative frequency (%)	Relative density (%)	Relative basal area (%)	IVI
1.	*Swietenia macrophylla*	3.28	103.75	6.96	38.00
2.	*Combretum indicum*	3.28	72.50	0.08	25.29
3.	*Polyalthia longifolia*	2.30	66.25	4.68	24.41
4.	*Artocarpus heterophyllus*	3.72	67.50	1.54	24.25
5.	*Delonix regia*	2.52	52.50	5.90	20.31
6.	*Samanea saman*	2.41	40.00	13.18	18.53
7.	*Cocos nucifera*	2.19	42.50	3.01	15.90
8.	*Mangifera indica*	2.63	41.25	2.31	15.40
9.	*Dypsis lutescens*	1.64	43.75	0.10	15.16

Table 9: Relative frequency, relative density, relative basal area & IVI of gardens in DSCC (IVI value ≥ 15%)

SL No.	Species Name	Relative frequency (%)	Relative density (%)	Relative basal area (%)	IVI
1.	*Lagerstroemia speciosa*	2.06	63.27	2.61	22.64
2.	*Cocos nucifera*	2.74	61.22	0.07	21.34
3.	*Eucalyptus camaldulensis*	2.06	51.02	9.29	20.79
4.	*Mangifera indica*	3.08	55.10	2.38	20.19
5.	*Dalbergia sissoo*	2.57	53.06	4.27	19.97
6.	*Combretum indicum*	2.57	53.06	0.06	18.56
7.	*Mesua ferrea*	2.23	48.98	1.49	17.56
8.	*Swietenia macrophylla*	1.71	44.90	3.30	16.64

4.9.3 Important value index of the plant species in Playgrounds

The relative density (RD %), relative frequency (RF %), relative basal area (RBA %) and Importance Value Index (IVI) of plant species were recorded from the playgrounds of DSCC. In playgrounds maximum IVI was shown by *Polyalthia longifolia* (103.39%) followed by *Swietenia macrophylla* (85.61%), *Samanea saman* (83.44%), *Dalbergia sissoo* (23.77%), *Cocos nucifera (*22.96%) and *Ficus bengalensis (*20.49%), respectively.

Maximum basal area was shown by *Samanea saman* (48%)*;* maximum relative density was shown by *Samanea saman* (12.31%) and maximum relative frequency was found in *Polyalthia longifolia* (300%) respectively (Table 10).

4.9.4 Important value index of the plant species in roadsides

The relative density (RD %), relative frequency (RF %), relative basal area (RBA %) and Importance Value Index (IVI) of plant species were recorded from the roadsides of DSCC. In streets, maximum IVI was shown by *Swietenia macrophylla* (52.97%) followed by *Polyalthia longifolia (*34.54%), *Mimusops elengi (*30.97%), *Samanea saman (*25.93%), *Tectona grandis* (20.81%) and *Delonix regia* (20.07%), respectively.

Maximum basal area was shown by *Samanea saman (15.03%);* maximum relative density was shown by *Swietenia macrophylla* (145.28%); maximum relative frequency was found in *Swietenia macrophylla* (5.62%), respectively (Table 11).

Table 10: Relative frequency, relative density, relative basal area & IVI of roadsides in DSCC (IVI value ≥ 15%)

SL No.	Species Name	Relative frequency (%)	Relative density (%)	Relative basal area (%)	IVI
1.	*Swietenia macrophylla*	5.62	145.28	7.99	52.97
2.	*Polyalthia longifolia*	4.07	96.23	3.32	34.54
3.	*Mimusops elengi*	3.68	88.68	0.54	30.97
4.	*Samanea saman*	4.26	58.49	15.03	25.93
5.	*Tectona grandis*	3.88	54.72	3.84	20.81
6.	*Delonix regia*	3.49	50.94	5.77	20.07
7.	*Cocos nucifera*	2.91	54.72	1.47	19.70
8.	*Albizia richardiana*	3.10	43.40	8.52	18.34
9.	*Mangifera indica*	3.10	43.40	3.25	16.58
10.	*Artocarpus heterophyllus*	2.71	43.40	0.98	15.70

Table 11: Relative frequency, relative density, relative basal area and IVI of playgrounds in DSCC (IVI value ≥ 15%)

SL No.	Species Name	Relative frequency (%)	Relative density (%)	Relative basal area (%)	IVI
1.	*Polyalthia longifolia*	7.69	300	2.47	103.39
2.	*Swietenia macrophylla*	10.77	230	16.05	85.61
3.	*Samanea saman*	12.31	190	48.00	83.44
4.	*Dalbergia sissoo*	6.15	60	5.14	23.77
5.	*Cocos nucifera*	7.69	60	1.19	22.96
6.	*Ficus bengalensis*	6.15	50	5.32	20.49
7.	*Anthocephalus sinensis*	4.62	50	6.68	20.43
8.	*Terminalia catappa*	3.08	50	2.14	18.41
9.	*Delonix regia*	4.62	40	1.31	15.31

4.10 Present status of herbaceous plant coverage in DSCC

4.10.1 Number of herb species according to family and genera

Number of herb species according to family and genera are presented in the Table 12. The findings from the table indicated that, maximum number of herb species belongs to the Poaeceae family (Sp=17& Gn=14) followed by Asteraceae (Sp=13& Gn=12), Lamiaceae (Sp=6& Gn=5), Amaranthaceae (Sp=6& Gn=4), Araceae (Sp=5& Gn=5), and Gramineae (Sp=5& Gn=5) (Table 12). This finding is coincident with the report of (Flávia, 2004) where 16% of herb communities were covered by Poaeceae family in the terra-firme Central Amazonian forest.

From these findings it can be stated that, the understorey vegetation of DSCC had shown significant number of herb species whereas maximum herbs were belongs to the Poacecae and Asteraceae family which means the understory vegetation of the urban area in DSCC are mostly dominant by weeds, grass, and small flowering herbs.

4.10. 2 Percent of available herb species

The herb community in this study includes only the real herbs, plants without woody tissue, and therefore seedlings of trees and shrubs are not considered. In all the study area, total 126 herb species under 50 families and 114 genera were found which is very lower than the number of herb species (n=155) found in the western ghat of India (Annaselvam, 1999) but comparatively higher than Singapore city where only 59 herb species were found (Turner *et al.*, 1996). Among the study areas, parks of DSCC represents the maximum percentage of herb species (total =74.6%) whereas playground shows minimum number of herb percentage (total= 4.76%) (Fig 19).The list of the herb species with their scientific name and family are represented in Appendix 7.

4.10.3 Percent of herbaceous plant species according to growth forms

In this section the percentage herbs according to their different growth form were mentioned (Fig 20). From the graph, it can be clearly stated that, maximum number of herbaceous plant species are weeds (29.37%), followed by flowering herbs (21.43%), grass (16.67%), ornamental (10.32%) and climber (7.14%). Only one fruit (*Musa acuminata colla*) and 3 bamboo species (*Bambusa balcooa*, *Bambusa tullda*&*Bambusa arundinacea*) were found in the study area.

Table 12: List of herb species according to family and genra

SL NO	Family	No. of Species	No. of Genera
1.	Poaceae	17	14
2.	Asteraceae	13	12
3.	Lamiaceae	6	5
4.	Amaranthaceae	6	4
5.	Araceae	5	5
6.	Gramineae	5	5
7.	Euphorbiaceae	4	4
8.	Fabaceae	4	4
9.	Solanaceae	4	4
10.	Cyperaceae	4	1
11.	Commelinaceae	3	3
12.	Asparagaceae	3	3
13.	Acanthaceae	3	3
14.	Liliaceae	3	2
15.	Convolvulaceae	3	2
16.	Zingiberaceae	2	2
17.	Musaceae	2	2
18.	Apocynaceae	2	2
19.	Verbenaceae	2	2
20.	Malvaceae	2	2
21.	Lythraceae	2	2
22.	Compositae	2	2
23.	Cucurbitaceae	2	2
24.	Balsaminaceae	1	1
25.	Nyctaginaceae	1	1
26.	Cannaceae	1	1
27.	Boraginaceae	1	1
28.	Malpighiaceae	1	1
29.	Passifloraceae	1	1
30.	Bignoniaceae	1	1
31.	Labiotae	1	1
32.	Apiaceae	1	1
33.	Rubiaceae	1	1
34.	Polygonaceae	1	1
35.	Oxalidaceae	1	1
36.	Papaveraceae	1	1
37.	Primulaceae	1	1
38.	Scrophulariaceae	1	1
39.	Dioscoreaceae	1	1
40.	Agavaceae	1	1
41.	Capparidaceae	1	1
42.	Caesalpiniaceae	1	1
43.	Brassicaceae	1	1
44.	Piperaceae	1	1
45.	Linderniaceae	1	1
46.	Dryopteridaceae	1	1

47.	Caryophyllaceae	1	1
48.	Portulacaceae	1	1
49.	Begoniaceae	1	1
50.	Marantaceae	1	1
		Total= 126	Total= 114

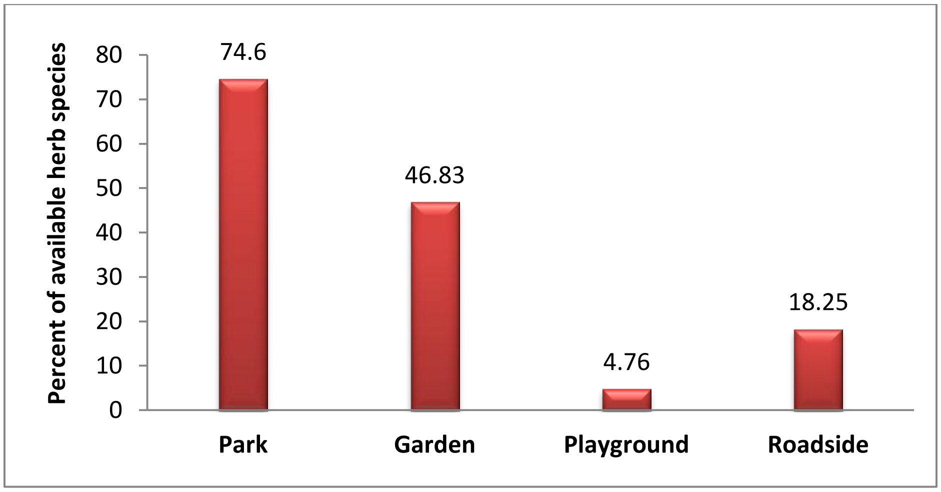

Fig 19: Percent of herb species according to study area

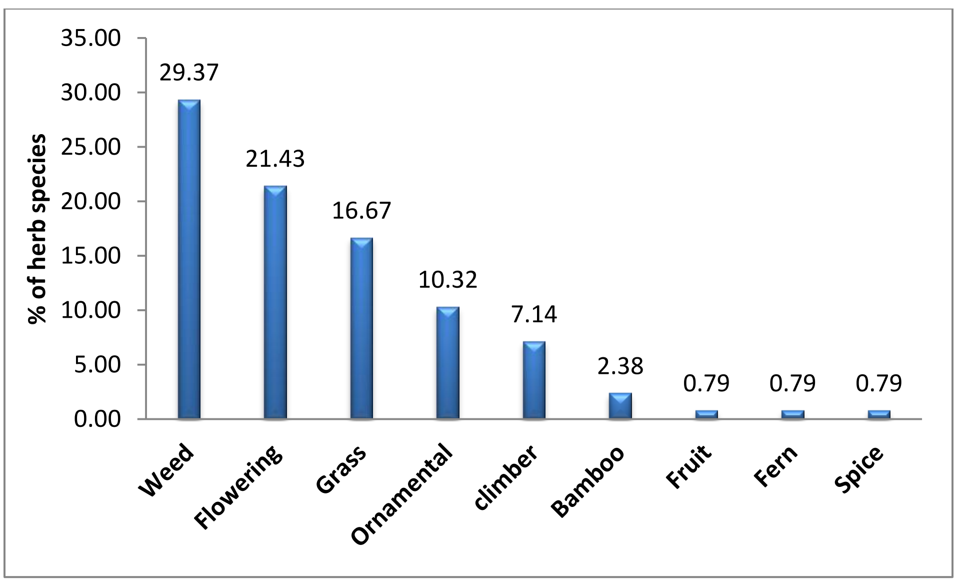

Fig 20: Percentage of herbs according to their growth form in DSCC

4.11 Dominancy of plant species and their primary uses

Selected study area of DSCC composed with different types of plant species with multipurpose use. Plant species with number of individual, percent of occurrence and their primary uses are collectively expressed in Table 13. Plant species in the urban areas are used for mainly aesthetic, ornamental and for fuel supply. Maximum plant species are mainly used for their flowering and ornamental purpose (Table 13). Among 221 tree and shrub species major six species found in dominancy than others and the highest percent of occurrence was found by *Swietenia macrophylla* (n=205, occurrence=6.05%) followed by *Polyalthia longifolia* (n=150, occurrence=4.42%) ,*Combretum indicum* (n=105, occurrence=3.10%) , *Samanea saman* (n=98, occurrence=2.89%) , *Mimusops elengi* (n=95, occurrence=2.80%)and *Delonix regia* (n=89, occurrence=2.62%) respectively (Table 12).

Table 13. Tree and shrub species identified in DSCC with their primary uses, number of individual and percent of total

Common Name	*Scientific name*	Family	Uses	No of Individuals	% of total
Agor	*Aquilaria agallocha*	Thymelaeceae	St, Md	9	0.27
Akashmoni	*Acacia auriculiformis*	Fabaceae	Ti	40	1.18
Akashneem	*Millingtonia hortensis*	Bignoniaceae	Ti, Om	1	0.03
Akondo	*Pimenta dioica*	Myrtaceae	Fr,Om	4	0.12
Allamonda	*Allamanda cathartica*	Apocynaceae	Fl	11	0.32
Amloki	*Emblica officinalis*	Phyllanthaceae	Fr	16	0.47
Amra	*Terminalia chebula*	Combrectaceae	Fr	11	0.32
Anjan	*Hardwickia binata*	Caesalpiniaceae	Ti, Om	1	0.03
Ankura	*Anogeissus acuminata*	Combrectaceae	Ti	1	0.03
Aralia	*Polyscias fruticosa*	Araliaceae	Om	14	0.41
Areca palm	*Dypsis lutescens*	Arecaceae	Om	54	1.59
Arjun	*Terminalia arjuna*	Combrectaceae	Ti, Md	44	1.30
Arucaria	*Araucaria araucana*	Arucariaceae	Ti	2	0.06
Arrow poison	*Antiaris toxicaria*	Moraceae	Md, St	1	0.03
Ashok	*Saraca asoca*	Fabaceae	Ti	6	0.18
Ashwatth	*Ficus religiosa*	Moraceae	Ti	3	0.09
Ata	*Annona squamosa*	Annonaceae	Fr	16	0.47
Babla	*Acacia nilotica*	Fabaceae	Ti	16	0.47
Baganbilash	*Bougainvillea glabra*	Nyctaginaceae	Fl, Om	22	0.65
Bailam	*Anisoptera scaphula*	Dipterocarpaceae	Ti,	3	0.09
Baobab	*Adansonia digitata*	Malvaceae	Ti,	2	0.06
Begun	*Solanum melongena*	solaneceae	Fr	1	0.03
Bel	*Aegle marmelos*	Rutaceae	Fr	9	0.27
Behula bot	*Ficus lyrtica*	Moraceae	Ti	1	0.03
Beli	*Jasminum sambac*	Oleaceae	Fl	20	0.59
Bichitro bokul	*Mimusop elengi L. veriegata*	Sapotaceae	Om	2	0.06
Bherenda	*Ricinus communis*	Euphorbiaceae	Md	3	0.09
Bilati gab	*Diospyros blancoi*	Ebenaceae	Fr, Ti	11	0.32
Bilati jarul	*Lagerstroemia thorelii*	Lythraceae	Fl, Ti	9	0.27
Bilimbi	*Averrhoa bilimbi*	Oxalidaceae	Fr	8	0.24
Bird of paradise	*Heliconia rostrata*	Heliconiaceae	Fl, Om	10	0.29
Bohera	*Terminalia bellerica*	Combretaceae	Md	6	0.18
Bokul	*Mimusops elengi*	Sapotaceae	Fl, Ti	95	2.80
Bon ashar	*zanthoxyllum rhesta*	Rutaceae	Ti	1	0.03
Bon parul	*Stereospermum kunthianum*	Bignoniaceae	Fl, Ti	2	0.06
Bonshupari	*Caryota urens*	Arecaceae	Ti	1	0.03
Boroi	*Ziziphus jujuba*	Rhamnaceae	Fr	23	0.68
Bot	*Ficus bengalensis*	Moraceae	Md	43	1.27
Botolbrush	*Callistemon citrinus*	Myrtaceae	Fl, Ti	14	0.41
Bottle palm	*Hyophorbe lagenicaulis*	Arecaceae	Om	3	0.09

Buddho narikel	*Pterygota alata*	Malvaceae	Md, Ti	1	0.03
Calliandra	*Calliandra haematocephala*	Fabaceae	Fl, Om	7	0.21
Camelia	*Camellia sasanqua*	Theaceae	Fl	3	0.09
Chaina komola	*Citrus aurantium*	Rutaceae	Fr	1	0.03
Chalta	*Dillenia indica*	Dilleniaceae	Fr	31	0.91
Chapalish	*Artocarpus chaplasha*	Moraceae	Fr, Ti	4	0.12
Chapa	*Magnolia champaca*	Magnoliaceae	Fl, Ti	2	0.06
Chatim	*Alstonia scholaris*	Apocynaceae	Md, Ti	30	0.88
Cherry	*Lagerstroemia lancasteri*	Lythraceae	Fl	36	1.06
Chikrashi	*Chukrasia tabularis*	Meliaceae	Om	9	0.27
Chinese bot	*Ficus microcarpa*	Moraceae	Md	1	0.03
Chitki	*Phyllanthus reticulatus*	Euphorbiaceae	Fr, Md, Ti	3	0.09
Chrismass tree	*Araucaria columnaris*	Arucariaceae	Om	17	0.50
Coconut	*Cocos nucifera*	Arecaceae	Fr, Md	99	2.92
Coffee	*Coffea arabica*	Rubiaceae	St, Md	2	0.06
Cordia	*Cordia myxa*	Boraginaceae	Fl	4	0.12
Croton	*Codiaeum variegatum*	Euphorbiaceae	Om	38	1.12
Cycus palm	*Cycas revoluta*	Cycadaceae	Om	7	0.21
Dadmordon	*Senna alata*	Fabaceae	Md	3	0.09
Dalim	*Punica granatum*	Lythraceae	Fr, Md	4	0.12
Debdaru	*Polyalthia longifolia*	Annonaceae	Ti	150	4.42
Debkanchon	*Phanera purpurea*	Fabaceae	Fl	1	0.03
Deshineeem	*Azadirachta indica*	Meliaceae	Fr, Md, Ti	37	1.09
Deua	*Artocarpus lakoocha*	Moraceae	Fr, Ti	10	0.29
Diabetic	*Gynura procumbens*	Asteraceae	Md	3	0.09
Doigota	*Bixa orellana*	Bixaceae	Md	1	0.03
Dracaena	*Dracaena aletriformis*	Asparagaceae	Om	17	0.50
Dragon fruit	*Hylocereus undatus*	Cactaceae	Fr	1	0.03
Dulichapa	*Magnolia pterocarpa*	Magnoliaceae	Fl	1	0.03
Dumbcane	*Dieffenbachia seguine*	Araceae	Om, Md	2	0.06
Dumur	*Ficus carica*	Moraceae	Fr, Ti, Md	9	0.27
Duranta	*Duranta erecta*	Verbenaceae	Om	31	0.91
Eucalyptus	*Eucalyptus camaldulensis*	Myrtaceae	Md, Ti	44	1.30
Falsha	*Grewia asiatica*	Malvaceae	Fr, Md	3	0.09
Faissa udal	*Sterculia villosa*	Sterculiaceae	Ti	1	0.03
Fanpalm	*Livistona chinensis*	Arecaceae	Om	29	0.86
Fishtail palm	*Caryota urens*	Arecaceae	Om	4	0.12
Forkoria	*Cordia sebestena*	Boraginaceae	Om	1	0.03
Gab	*Diospyros peregrina*	Ebenaceae	Fr, Ti	4	0.12
Ghoraneem	*Melia azedarach*	Meliaceae	Md	23	0.68
Giant yucca	*Yucca gigantea*	Asparagaceae	Om	2	0.06
Golap	*Rosa rubiginosa*	Rosaceae	Fl	18	0.53

Golapjam	*Syzygium Jambos*	Myrtaceae	Fr, Ti	16	0.47
Gondhoraj	*Gardenia jasminoides*	Rubiaceae	Fl, Md	21	0.62
Guava	*Psidium guajava*	Myrtaceae	Fr, Md	24	0.71
Gustavia	*Gustavia augusta.*	Lecythidaceae	Fl, Ti, Md	7	0.21
Hamelia	*Hamelia patens*	Rubiaceae	Fl	10	0.29
Hasnahena	*Cestrum nocturnum*	Solanaceae	Fl	14	0.41
Hijol	*Barringtonia acutangula*	Lecythidaceae	Ti , Om	20	0.59
Hortoki	*Terminalia chebula*	Combrectaceae	Fr	25	0.74
Ipil-ipil	*Leucaena leucocephala*	Fabaceae	Ti	15	0.44
Jam	*Syzygium cumini*	Myrtaceae	Fr, Ti	35	1.03
Jambura	*Citrus grandis*	Rutaceae	Fr	12	0.35
Jamrul	*Syzygium samarangense*	Myrtaceae	Fr	11	0.32
Jarul	*Lagerstroemia speciosa*	Lythraceae	Ti, Md	56	1.65
Jesmin	*Jasminum officinale*	Oleaceae	Fl, Md	2	0.06
Jhau	*Casuarinas equisetifolia*	Casuarinaceae	Om, Ti	16	0.47
Jiga gach	*Millingtonia hortensis*	Bignoniaceae	Ti	2	0.06
Joba	*Hibiscus rosa-sinensis*	Malvaceae	Fl, Md	22	0.65
Jog dumur	*Ficus racemosa*	Moraceae	Ti, Md	1	0.03
Jolpai	*Elaeocarpus serratus*	Elaeocarpaceae	Fr	8	0.24
Jonglibadam	*Sterculia foetida*	Malvaceae	Ti	4	0.12
kajubadam	*Anacardium occidentale*	Anacardiaceae	Fr, Ti, Md	5	0.15
Kalokoroi	*Albizia lebbek*	Fabaceae	Ti	17	0.50
Kamini	*Murraya paniculata*	Rutaceae	Fl	10	0.29
Kamranga	*Averrhoa carambola*	Oxalidaceae	Fr	15	0.44
Kananga	*Cananga odorata*	Annonaceae	Fl, Md	2	0.06
Karipata	*Murraya koenigii*	Rutaceae	Md	3	0.09
Kathal	*Artocarpus heterophyllus*	Moraceae	Fr, Md, Ti	95	2.80
Kathalichapa	*Artabotrys hexapetalus*	Annonaceae	Fl, Md	8	0.24
Kathbadam	*Terminalia catappa*	Combrectaceae	Fr, Ti	32	0.94
Kathgolap	*Plumeria obtusa*	Apocynaceae	Fl, Ti, Md	23	0.68
Kaufol	*Garcinia cowa*	Clusiaceae	Fr	1	0.03
Khapafol	*Nephelium longana*	Sapindaceae	Fr	1	0.03
Kentia palm	*Howea forsteriana*	Arecaceae	Om	14	0.41
Keya	*Pandanus fascicularis Lam*	Pandanaceae	Om, Md	4	0.12
Khejur	*Phoenix sylvestris*	Arecaceae	Fr, Om	17	0.50
Khoir	*Acacia catechu*	Fabaceae	St,Fr	1	0.03
Kodom	*Anthocephalus sinensis*	Rubiaceae	Fl, Ti, Md	42	1.24
konokchapa	*Ochna squarrosa*	Ochnaceae	Fl	6	0.18
Korobi	*Nerium indicum*	Apocynaceae	Fl	6	0.18
Koromcha	*Carissa carandas*	Apocynaceae	Fr, Md	6	0.18
Korpur	*Cinnamomum camphora*	Lauraceae	Md	2	0.06
Krishnochura	*Delonix regia*	Fabaceae	Fl, Ti, Md	89	2.62

Kurchi	*Holarrhena pubescens*	Apocynaceae	Md, Ti	2	0.06
Kusum	*Carthamus tinctorius*	Asteraceae	Ti, Fl	1	0.03
Ladies umbrella	*Holmskioldia sanguinea*	Lamiaceae	Om	3	0.09
Lal bichuti	*Tragia involucrata*	Euphorbiaceae	Md	1	0.03
Lal gulachin	*Plumeria rubra*	Apocynaceae	Fl, Md	2	0.06
Lal sonail	*Cassia javanica*	Fabaceae	Fl	4	0.12
Lanka joba	*Malvaviscus arboreus*	Malvaceae	Fl	6	0.18
Lebu	*Citrus limonum*	Rutaceae	Fr, Md	6	0.18
Life tree	*Guaiacum officinale*	Zygophyllaceae	Ti	2	0.06
Litchi	*Litchi chinensis*	Sapindaceae	Fr, Md, Ti	7	0.21
Lombu	*Khaya anthotheca*	Meliaceae	Ti	2	0.06
Lotki	*Melastoma malabathricum*	Melastomataceae	Fl, Md	2	0.06
Lohakath	*Xylia dolabriformis*	Fabaceae	Ti	6	0.18
Lotkon	*Baccaurea motleyana*	phyllanthaceae	Fr, Ti	2	0.06
Macurthur palm	*Ptychosperma macarthurii*	Arecaceae	Om	1	0.03
Machiful	*Malpighia coccigera*	Malpighiaceae	Fl, Om	3	0.09
Mahgoni	*Swietenia macrophylla*	Meliaceae	Ti, Md	205	6.05
Malta	*Citrus sinensis*	Rutaceae	Fr	1	0.03
Malpigia	*Malpighia emarginata*	Malpighiaceae	Fl ,Md	4	0.12
Mander	*Erythrina orientalis*	Fabaceae	Ti, Md	11	0.32
Mango	*Mangifera indica*	Anacardiaceae	Fr, Md,Ti	85	2.51
Mehedi	*Lawsonia Inermis*	Lythraceae	Md	12	0.35
Meleshia	*Millettia peguensis*	Fabaceae	Fl	4	0.12
May flower	*Epigaea repens*	Ericaceae	Fl, Om	2	0.06
Minjiri	*Cassia siamea*	Fabaceae	Ti	25	0.74
Morich	*Capsicum annuum*	solaneceae	Fr,Md	6	0.18
Modhumaloti	*Quisqualis indica.*	Combretaceae	Fl	5	0.15
Mohua	*Madhuca longifolia*	Sapotaceae	Fr, Md	5	0.15
Munesteria	*Mussaenda erythrophylla*	Rubiaceae	Fl	1	0.03
Muchkundo chapa	*Petrospermum acerifolium*	Sterculiaceae	Fl	1	0.03
Musanda	*Mussaenda erythrophylla*	Rubiaceae	Fl	33	0.97
Nageshwar	*Mesua ferrea*	Calophyllaceae	Md, Ti	37	1.09
Naglingom	*Couroupita guianensis*	Lecythidaceae	Fl,Om	18	0.53
Nandina	*Nandina domestica*	Berberidaceae	Om, Md	4	0.12
Neelini	*Indigofera tinctoria*	Fabaceae	Md	3	0.09
Neel parul	*Mansoa alliacea*	Bignoniaceae	Fl	8	0.24
Neel krishnochura	*Delonix aprevalia*	Fabaceae	Ti	1	0.03
Nishinda	*Vitex negundo*	Lamiaceae	Md	2	0.06
Nilkontho	*Jacaranda mimosifolia*	Bignoniaceae	Om	1	0.03
Oil palm	*Elaeis guineensis*	Arecaceae	Om,Md	9	0.27
Orboroi	*Phyllunthus acidus*	Euphorbiaceae	Fr, Md	3	0.09
Pakhiful	*Brownea coccinea*	Fabaceae	Om	2	0.06
Pakur	*Ficus virens*	Moraceae	Md	30	0.88

Palam	*Wrightia coccinea*	Apocynaceae	Ti	1	0.03
Palash	*Butea monosperma*	Fabaceae	Fl, Ti	3	0.09
Papaya	*Carica papaya*	caricaceae	Fr	14	0.41
Parijat	*Canna indica*	Cannaceae	Fl, Ti	1	0.03
Porosh pipul	*Thespesia populnea*	Malvaceae	Ti	1	0.03
Ponytail palm	*Beaucarnea recurvata*	Asparagaceae	Om	1	0.03
Putronjib	*Drypetes roxburghii*	Euphorbiaceae	Ti, Md	8	0.24
Queen palm	*Syagrus romanzoffiana*	Arecaceae	Om, Md	36	1.06
Radhachura	*Caesalpinia pulcherrima*	Fabaceae	Fl,Md	34	1.00
Raintree	*Samanea saman*	Fabaceae	Ti	98	2.89
Rambotam	*Nephelium lappaceum*	Sapindaceae	Ti	1	0.03
Rajghonta	*Brugmansia suaveolens*	Solanaceae	Ti	1	0.03
Raj ashok	*Amherstia nobilis*	Fabaceae	Ti	1	0.03
Rajkoroi	*Albizia richardiana*	Fabaceae	Ti	57	1.68
Red sister	*Cordyline fruticosa*	Liliaceae	Om, Md	20	0.59
Rongon	*Combretum indicum*	Combrectaceae	Fl, Md	105	3.10
Rokto kanchon	*Bauhinia variegata*	Casesalpinaceae	Fl, Md	3	0.09
Roktochondon	*Adenanthera pavonina*	Fabaceae	Fl, Md	6	0.18
Rokto joba	*Hibiscus rosa-sinensis*	Malvaceae	Fl, Md	14	0.41
Ronodeleshia	*Rondeletia odorata*	Rubiaceae	Fl	1	0.03
Royal palm	*Roystonea regia*	Arecaceae	Om, Md	42	1.24
Rubber bot	*Hevea brasiliensis*	Euphorbiaceae	Md, Om	35	1.03
Rudro palash	*Spathodea campanulata*	Bignoniaceae	Fl, Ti	1	0.03
Sajina	*Moringa oleifera*	Moringaceae	Md	19	0.56
Sadakoroi	*Albizia procera*	Fabaceae	Ti	3	0.09
Scarf lara	*Cuphea micropetala*	Lythraceae	Ti	1	0.03
Segun	*Tectona grandis*	Lamiaceae	Ti	54	1.59
Shaora	*Streblus asper*	Moraceae	Ti	8	0.24
Sharod mollika	*Jasminum angustifolium*	Oleaceae	Fl, Md	2	0.06
Shefali	*Nyctanthes arbor-tristis*	oleaceae	Fl, Md	14	0.41
Shet kanchon	*Bauhinia acuminata*	Casesalpinaceae	Fl, Om	15	0.44
Shet shimul	*Ceiba pentandra*	Malvaceae	Ti	2	0.06
Shimul	*Bombax ceiba*	Malvaceae	Ti	13	0.38
Shissoo	*Dalbergia sissoo*	Fabaceae	Ti	41	1.21
Shobeda	*Manilkara zapota*	Sapotaceae	Fr,Md	5	0.15
Shornochapa	*Michelia champaca*	Magnoliaceae	Fl, Ti	5	0.15
Shupari	*Areca catchu*	Arecaceae	St, Md, Fr	10	0.29
Sonalu	*Cassia fistula*	Fabaceae	Fl, Md	19	0.56
Spanish dagger	*Yucca gloriosa*	Asparagaceae	Om	3	0.09
Tabebuia	*Tabebuia cassinoides*	Bignoniaceae	Fl, Om	1	0.03
Tal palm	*Borassus flabellifer*	Arecaceae	Fr,Md	24	0.71
Tecoma	*Tecoma stans*	Bignoniaceae	Fl	2	0.06
Tetul	*Tamarindus indica*	Fabaceae	Fr, Md,Ti	24	0.71
Thuja	*Thuja occidentalis*	cupressaceae	Om	32	0.94

Tilokfota	*Lagerstroemia parviflora*	Lythraceae	Ti	1	0.03
Tomal	*Diospyros cordifolia*	Ebenaceae	Ti,Md	2	0.06
Tut	*Morus alba*	Moraceae	Md	5	0.15
Togor	*Tabernaemonlana divaricata*	Apocynaceae	Fl	54	1.59
Ulot kombol	*Abroma augusta*	Malvaceae	Md	3	0.09
Udoy podmo	*Magnolia grandiflora*	Magnoliaceae	Fl	8	0.24
Vadra	*Gmelina hystrix*	Verbenaceae	Md	1	0.03
Verenta	*Jatropha multifida*	Euphorbiaceae	Fl	3	0.09
Vuichapa	*Kaempferia rotunda*	Zingiberaceae	Fl	2	0.06
Yesterday ,today ,tomorrow	*Brunfelsia pauciflora*	solanaceae	Fl, Om	10	0.29

CHAPTER V

SUMMARY AND CONCLUSION

The analysis of the structure and composition provides the basis for long-term planning of the urban green infrastructure which will enhance ecosystem function, therefore providing longer term benefits for the human population (Benedictand & Mcmahon, 2002).

It was found that, all the study area of DSCC contained a total of 347 plant species (144 trees, 77 shrubs and 126 herbs) which is relatively significant in terms of species diversity. Among all the study area, parks had shown maximum number of plant species (n=285). *Swietenia macrophylla* were represented as the most dominant tree species (n=205, occurance= 6.05%) and *Combretum indicum* (n=105, occurance= 3.10%) as the most dominant shrub in DSCC because of their hardness and survival capacity in harsh condition of urban areas. Majority of tree and shrub population were represented by parks (44%) followed by gardens (26%), roadsides (36%) and playgrounds (4%). In case of understorey vegetation, parks had shown the highest percentage of herb coverage (74.6%) followed by gardens (46.83%) and majority of herb population are weeds (29.37%) which indicates the poor maintenance of urban vegetative areas as well as ground covers.

In case of trees and shrubs, maximum species belongs to the Fabaceae family followed by Arecaceae and Moraceae whereas maximum herbaceous plants belong to the Poaeceae family followed by Asteraceae and Lamiaceae family.

From the findings of the research, it was found that, only 6 species represent >40% frequency among all species whereas 8 species had shown >25% frequency in all the study area whereas, *Swietenia macrophylla* showed the highest frequency (54.72%) and density ((145.28%) among all the tree species and *Combretum indicum* represent the highest frequency (37.50%) and density (96.67%) among all the shrub species. In all the study area, comparatively high density/ ha (1785.62 trees/ ha), DBH (458.59 cm/ha), basal area/ ha (182.79 m^2/ha) were found because of higher plant population in small area which is a common feature of urban areas, where incondite and unplanned plantation of trees are occurred.

To understand structure of urban forest, height class and DBH class measurement is essential (Spencer 1986). From the findings of this study, it is revealed that majority of trees were found in between 6-9m height class whereas maximum shrubs were found in 1-3m height class. In case of DBH, maximum number of trees and shrubs were found in 0-15 cm DBH class. This findings indicates that maximum trees and shrubs represents comparatively lower height and DBH class which means, in urban area of DSCC, majority of tree and shrub population are in their young stage and still growing.

Importance value index express the dominance of a species in a given area among all the plant population (Pedlowski *et al.*, 2002). It was found that in four study area of DSCC, the dominant tree species was *Polyalthia longifolia* (IVI = 103.39 %) followed by *Swietenia macrophylla* (IVI= 85.61%) and *Samanea saman* (IVI= 83.44%), respectively. On the other hand, highest relative basal area (48%) and the highest relative frequency (12.31%) was shown by *Samanea saman* whereas, the highest relative density (300%) was shown by *Polyalthia longfolia*, respectively.

From the analysis of structure and composition of green resources around Dhaka South City Corporation, it can be easily explicable that the green resource is unorganized and promiscuous with different forms, pattern and performance. Only a few places (ex: Ramna park, Sohrawardi uddan, Osmani uddan, Boldha garden, & Dhanmondi lake) represent maximum amount of vegetation of this city corporation but they are not well planned and well managed.

CONCLUSION

Urban vegetation of Dhaka South City Corporation is not evenly distributed and not properly planned with very few exceptions. Based on the objective and findings of the research, the following conclusion can be drawn:

- This city corporation holds significant number of plant species but the quantity of individual plant is not adequate to enhance the urban environment. In this city corporation, among trees and shrubs *Swietenia macrophylla, Polyalthia longifolia, Cocos nucifera, Samanea saman, Artocarpus heterophyllus, Combrectum indicum, Tabernaemonlana divaricata,* are found dominant. Among four different habitats, maximum number of tree and shrub coverage were found in parks (44%) and minimum numbers of them were found in playgrounds (only 4%) whereas, gardens and roadsides were represented similar tree and shrub population (26%). In case of herb species, again parks represented highest percentage (74.6%) followed by gardens (46.83%), roadsides (18.25%) and playgrounds (4.76%). These findings indicated that, park areas represented maximum vegetation but it is very unfortunate that maximum parks are now under threat of over exploitation which in future may lose its tree density and diversity characteristics drastically.
- Structural attributes of an urban forest generally indicate the growth stage of the plant population. In DSCC, maximum trees are found in between 6-9 m height class and maximum shrubs were found in between 1-3 m height class whereas in case of DBH class, maximum tree and shrub population were found in between 0-15 cm. From the findings of the research area it can be clearly stated that majority of the tree and shrub populations are in their young age and poor in diameter. Different plantation programme may be helpful to enhance the urban vegetation of DSCC.

RECOMMENDATION

There are huge opportunities to enhance the urban plantation in Dhaka South City Corporation. Some recommendations related to urban greening are given below:

- From the findings of the study it can be clearly stated that the number of individual plant population in DSCC is not significant and maximum number of plant population are found in two or three areas (ex. Ramna park, Sohrawardi uddan, Dhanmondi lake etc.). For expanding the vegetation area in DSCC, governmental organization, forest department, local NGO's and other responsible organizations should implement tree plantation and city beautification programme in specific areas, roadsides and avenues.
- Existing parks and other green areas are the main component of urban green infrastructure of DSCC. Establishment of new small parks, play grounds, garden in expanding areas of the city and proper green structure Plan could be effective to increase urban greeneries and will be helpful to offer a healthy living for the city dwellers.

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APPENDICES

Appendix 1. Weather data of the experimental site during the period from June to August, 2016

Month	Air temperature			Humidity (%)	Rainfall (mm)	Evaporation (hrs.)
	Max.	Min.	Avg.			
June	30.8	25.43	28.13	84.27%	260.3	51.3
July	30.26	23.47	26.87	80.84%	598.3	109.2
August	30.80	21.90	25.75	86.90%	380.5	130.4

Source: Weatherbase.com

Appendix 2. Basic information of Dhaka South City Corporation

SL No.	Item	Quantity
1.	Area	109.19 Sq. Km.
2.	Population	7.56 millions
3.	Zone	5 nos.
4.	Ward	57 nos.
5.	Flyover	3 nos.
6.	Foot over bridge	40 nos.
7.	Educational institutions	2 nos.
8.	Hospital	2 nos.
9.	Maternity centre	1 nos.
10.	Community centre	35 nos.
11.	Parks	27 nos.
12.	Playgrounds	10 nos.
13.	Gardens	3nos.
14.	Graveyards	3 nos.
15.	Cemeteries	2 nos.
16.	Gymnasium	21 nos.
17.	Market	70 nos.
18.	Musice school	12 nos.
19.	Underpass	1 nos.
20.	Road	781.83 km
21.	Footpath	217.38 km
22.	Drain (open + pipe)	466.43+ 495.43 km
23.	Traffic signal	40 nos.
24.	Sodium light	7996 nos.

Appendix 3: Relative frequency, Relative density, Relative basal area & IVI for all the plant species in playgrounds of DSCC

SL No.	Species Name	RF (%)	RD (%)	RBA (%)	IVI
1.	*Polyalthia longifolia*	300	7.69	2.47	103.39
2.	*Swietenia macrophylla*	230	10.77	16.05	85.61
3.	*Samanea saman*	190	12.31	48.00	83.44
4.	*Dalbergia sissoo*	60	6.15	5.14	23.77
5.	*Cocos nucifera*	60	7.69	1.19	22.96
6.	*Ficus bengalensis*	50	6.15	5.32	20.49
7.	*Anthocephalus sinensis*	50	4.62	6.68	20.43
8.	*Terminalia catappa*	50	3.08	2.14	18.41
9.	*Delonix regia*	40	4.62	1.31	15.31
10.	*Syagrus romanzoffiana*	40	3.08	0.63	14.57
11.	*Terminalia arjuna*	20	3.08	5.93	9.67
12.	*Mangifera indica*	20	3.08	1.41	8.16
13.	*Tectona grandis*	20	1.54	1.73	7.75
14.	*Mimusops elengi*	20	3.08	0.02	7.70
15.	*Albizia richardiana*	20	1.54	0.23	7.26
16.	*Artocarpus heterophyllus*	20	1.54	0.19	7.24
17.	*Leucaena leucocephala*	20	1.54	0.14	7.23
18.	*Melia azedarach*	20	1.54	0.06	7.20
19.	*Callistemon citrinus*	10	1.54	0.87	4.14
20.	*Ziziphus jujuba*	10	1.54	0.16	3.90
21.	*Acacia auriculiformis*	10	1.54	0.14	3.89
22.	*Emblica officinalis*	10	1.54	0.03	3.86
23.	*Lagerstroemia speciosa*	10	1.54	0.05	3.86
24.	*Mesua ferrea*	10	1.54	0.03	3.86
25.	*Borassus flabellifer*	10.00	1.54	0.03	3.86
26.	*Combretum indicum*	10	1.54	0.01	3.85
27.	*Bauhinia acuminata*	10	1.54	0.01	3.85
28.	*Cassia fistula*	10	1.54	0.02	3.85
29.	*Plumeria obtusa*	10	1.54	0.02	3.85

Appendix 4. Relative frequency, Relative density, Relative basal area and IVI for all the plant species in parks of DSCC

SL No.	Species Name	RF (%)	RD (%)	RBA (%)	IVI
1.	*Swietenia macrophylla*	3.28	103.75	6.96	38.00
2.	*Combretum indicum*	3.28	72.50	0.08	25.29
3.	*Polyalthia longifolia*	2.30	66.25	4.68	24.41
4.	*Artocarpus heterophyllus*	3.72	67.50	1.54	24.25
5.	*Delonix regia*	2.52	52.50	5.90	20.31
6.	*Samanea saman*	2.41	40.00	13.18	18.53
7.	*Cocos nucifera*	2.19	42.50	3.01	15.90

8.	*Mangifera indica*	2.63	41.25	2.31	15.40
9.	*Dypsis lutescens*	1.64	43.75	0.10	15.16
10.	*Tabernaemonlana divaricata*	1.75	37.50	2.68	13.98
11.	*Thuja occidentalis*	1.42	40.00	0.08	13.83
12.	*Mimusops elengi*	1.97	36.25	1.11	13.11
13.	*Ficus bengalensis*	2.08	28.75	7.28	12.70
14.	*Acacia auriculiformis*	1.64	28.75	2.86	11.08
15.	*Albizia richardiana*	2.41	25.00	4.95	10.79
16.	*Codiaeum variegatum*	1.09	28.75	0.02	9.95
17.	*Eucalyptus camaldulensis*	1.20	21.25	3.00	8.49
18.	*Tectona grandis*	1.31	22.50	1.53	8.45
19.	*Psidium guajava*	1.53	21.25	0.20	7.66
20.	*Mussaenda erythrophylla*	1.20	21.25	0.02	7.49
21.	*Dillenia indica*	1.09	18.75	2.29	7.38
22.	*Caesalpinia pulcherrima*	0.77	21.25	0.02	7.35
23.	*Roystonea regia*	0.88	20.00	0.87	7.25
24.	*Terminalia arjuna*	0.98	18.75	1.03	6.92
25.	*Alstonia scholaris*	1.20	17.50	2.04	6.91
26.	*Dracaena aletriformis*	0.55	16.25	2.68	6.49
27.	*Acacia nilotica*	0.77	17.50	1.07	6.45
28.	*Rosa rubiginosa*	0.44	18.75	0.01	6.40
29.	*Terminalia catappa*	1.31	16.25	1.07	6.21
30.	*Syzygium cumini*	1.09	16.25	0.63	5.99
31.	*Anthocephalus sinensis*	1.20	15.00	1.57	5.92
32.	*Bougainvillea glabra*	0.98	16.25	0.02	5.75
33.	*Casuarinas equisetifolia*	0.77	15.00	1.03	5.60
34.	*Howea forsteriana*	0.44	16.25	0.10	5.60
35.	*Hevea brasiliensis*	0.98	13.75	2.00	5.58
36.	*Ficus virens*	0.88	11.25	4.56	5.56
37.	*Hibiscus rosa-sinensis*	1.20	15.00	0.01	5.41
38.	*Syagrus romanzoffiana*	0.55	15.00	0.17	5.24
39.	*Jasminum sambac*	0.66	15.00	0.01	5.22
40.	*Couroupita guianensis*	0.55	12.50	1.85	4.96
41.	*Azadirachta indica*	0.66	13.75	0.34	4.91
42.	*Brunfelsia pauciflora*	0.77	11.25	2.68	4.90
43.	*Duranta erecta*	0.66	13.75	0.01	4.81
44.	*Melia azedarach*	0.44	13.75	0.27	4.82
45.	*Leucaena leucocephala*	0.98	12.50	0.73	4.74
46.	*Lagerstroemia thorelii*	0.33	11.25	1.81	4.46
47.	*Lagerstroemia lancasteri*	0.88	12.50	0.01	4.46
48.	*Livistona chinensis*	0.66	12.50	0.00	4.39
49.	*Hibiscus rosa-sinensis*	0.66	12.50	0.01	4.39
50.	*Hamelia patens*	0.44	12.50	0.03	4.32
51.	*Diospyros blancoi*	0.44	11.25	0.73	4.14
52.	*Mesua ferrea*	0.55	11.25	0.42	4.07
53.	*Bauhinia acuminata*	0.88	11.25	0.14	4.06
54.	*Averrhoa carambola*	0.88	11.25	0.02	4.05
55.	*Araucaria columnaris*	0.66	11.25	0.16	4.02
56.	*Elaeis guineensis*	0.44	11.25	0.16	3.95

57.	*Annona squamosa*	0.88	10.00	0.13	3.67
58.	*Borassus flabellifer*	0.44	10.00	0.51	3.65
59.	*Gardenia jasminoides*	0.77	10.00	0.01	3.59
60.	*Tamarindus indica*	0.77	8.75	1.15	3.55
61.	*Nyctanthes arbor-tristis*	0.57	10.00	0.03	3.53
62.	*Cassia fistula*	0.66	8.75	0.94	3.45
63.	*Streblus asper*	0.44	8.75	0.71	3.30
64.	*Plumeria obtusa*	0.66	8.75	0.23	3.21
65.	*Syzygium samarangense*	0.66	8.75	0.10	3.17
66.	*Erythrina orientalis*	0.33	8.75	0.35	3.14
67.	*Cordyline fruticosa*	0.55	8.75	0.01	3.10
68.	*Allamanda cathartica*	0.44	8.75	0.01	3.06
69.	*Drypetes roxburghii*	0.55	7.50	0.49	2.85
70.	*Albizia lebbek*	0.55	6.25	1.75	2.85
71.	*Gustavia augusta*	0.33	7.50	0.58	2.80
72.	*Citrus grandis*	0.66	7.50	0.08	2.74
73.	*Ochna squarrosa*	0.55	7.50	0.01	2.69
74.	*Murraya paniculata*	0.33	7.50	0.01	2.61
75.	*Areca catchu*	0.22	7.50	0.09	2.60
76.	*Cassia siamea*	0.33	6.25	0.64	2.41
77.	*Syzygium Jambos*	0.44	6.25	0.35	2.34
78.	*Lagerstroemia speciosa*	0.55	6.25	0.14	2.31
79.	*Ziziphus jujuba*	0.55	6.25	0.07	2.29
80.	*Emblica officinalis*	0.55	6.25	0.04	2.28
81.	*Phoenix sylvestris*	0.33	6.25	0.26	2.28
82.	*Cestrum nocturnum*	0.55	6.25	0.01	2.27
83.	*jatropha multifida*	0.11	3.75	2.68	2.18
84.	*Polyscias fruticosa*	0.22	6.25	0.00	2.16
85.	*Heliconia rostrata*	0.22	6.25	0.01	2.16
86.	*Artabotrys hexapetalus*	3.83	2.50	0.01	2.11
87.	*Madhuca longifolia*	0.44	5.00	0.59	2.01
88.	*Litchi chinensis*	0.44	5.00	0.44	1.96
89.	*Aegle marmelos*	0.44	5.00	0.17	1.87
90.	*Elaeocarpus serratus*	0.44	5.00	0.14	1.86
91.	*Albizia procera*	0.33	3.75	1.51	1.86
92.	*Artocarpus chaplasha*	0.11	5.00	0.37	1.83
93.	*Phyllanthus emblica*	0.44	5.00	0.03	1.82
94.	*Terminalia chebula*	0.44	5.00	0.02	1.82
95.	*Nerium indicum*	0.44	5.00	0.00	1.81
96.	*Millettia peguensis*	0.22	5.00	0.20	1.81
97.	*Cycas revoluta*	0.44	5.00	0.00	1.81
98.	*Diospyros cordifolia*	0.22	2.50	2.68	1.80
99.	*Citrus limonum*	0.33	5.00	0.01	1.78
100.	*Lawsonia Inermis*	0.33	5.00	0.01	1.78
101.	*Chukrasia tabularis*	0.22	5.00	0.10	1.77
102.	*Morus alba*	0.11	2.50	2.68	1.76
103.	*Anisoptera scaphula*	0.11	3.75	1.35	1.74
104.	*Calliandra haematocephala*	0.22	5.00	0.01	1.74
105.	*Pandanus fascicularis Lam.*	0.22	5.00	0.00	1.74

106.	*Caryota urens*	0.11	5.00	0.06	1.72
107.	*Malpighia emarginata*	0.11	5.00	0.01	1.71
108.	*Dalbergia sissoo*	0.33	3.75	0.79	1.62
109.	*Adansonia digitata*	0.22	2.50	1.70	1.47
110.	*Artocarpus lakoocha*	0.33	3.75	0.35	1.47
111.	*Ficus carica*	0.33	3.75	0.32	1.47
112.	*Butea monosperma*	0.11	3.75	0.52	1.46
113.	*Grewia asiatica*	0.33	3.75	0.18	1.42
114.	*Holmskioldia sanguinea*	0.33	3.75	0.00	1.36
115.	*Malvaviscus arboreus*	0.22	3.75	0.00	1.32
116.	*Senna alata*	0.22	3.75	0.00	1.32
117.	*Gynura procumbens*	0.22	3.75	0.00	1.32
118.	*Yucca gloriosa*	0.11	3.75	0.00	1.29
119.	*Saraca asoca*	0.22	2.50	0.60	1.11
120.	*Ceiba pentandra*	0.22	2.50	0.51	1.08
121.	*Cassia javanica*	0.11	2.50	0.45	1.02
122.	*Cordia myxa*	0.11	2.50	0.43	1.01
123.	*Barringtonia acutangula*	0.22	2.50	0.27	1.00
124.	*Guaiacum officinale*	0.22	2.50	0.26	0.99
125.	*Michelia champaca*	0.22	2.50	0.24	0.99
126.	*Khaya anthotheca*	0.22	2.50	0.12	0.95
127.	*Holarrhena pubescens*	0.22	2.50	0.12	0.95
128.	*Sapindus saponaria*	0.22	2.50	0.10	0.94
129.	*Tecomella undulata*	0.11	1.25	2.68	0.93
130.	*Abroma augusta*	0.11	1.25	2.68	0.93
131.	*Gmelina hystrix*	0.11	1.25	2.68	0.93
132.	*Sterculia foetida*	0.22	2.50	0.06	0.93
133.	*Ficus religiosa*	0.11	2.50	0.16	0.92
134.	*Terminalia bellerica*	0.22	2.50	0.03	0.92
135.	*Cinnamomum camphora*	0.22	2.50	0.04	0.92
136.	*Carissa carandas*	0.22	2.50	0.01	0.91
137.	*Melastoma malabathricum*	0.22	2.50	0.00	0.91
138.	*Epigaea repens*	0.22	2.50	0.00	0.91
139.	*Phyllunthus acidus*	0.22	2.50	0.01	0.91
140.	*Brownea coccinea*	0.22	2.50	0.02	0.91
141.	*Carica papaya*	0.22	2.50	0.00	0.91
142.	*Coffea arabica*	0.11	2.50	0.00	0.87
143.	*Punica granatum*	0.11	2.50	0.00	0.87
144.	*Dieffenbachia seguine*	0.11	2.50	0.00	0.87
145.	*Yucca gigantea*	0.11	2.50	0.00	0.87
146.	*Jasminum officinale*	0.11	2.50	0.00	0.87
147.	*Quisqualis indica*	0.11	2.50	0.00	0.87
148.	*Capsicum annuum*	0.11	2.50	0.00	0.87
149.	*Moringa oleifera*	0.11	2.50	0.01	0.87
150.	*Tabebuia cassinoides*	0.11	1.25	0.43	0.59
151.	*Plumeria rubra*	0.11	1.25	0.27	0.54
152.	*Spathodea campanulata*	0.11	1.25	1.51	0.54
153.	*Aquilaria agallocha*	0.11	1.25	0.24	0.53
154.	*Phanera purpurea*	0.11	1.25	0.16	0.51

155.	*Wrightia coccinea*	0.11	1.25	0.13	0.50
156.	*Stereospermum kunthianum*	0.11	1.25	0.12	0.49
157.	*Baccaurea motleyana*	0.11	1.25	0.12	0.49
158.	*Canna indica*	0.11	1.25	0.05	0.47
159.	*Adenanthera pavonina*	0.11	1.25	0.04	0.47
160.	*Brugmansia suaveolens*	0.11	1.25	0.03	0.46
161.	*Magnolia pterocarpa*	0.11	1.25	0.01	0.46
162.	*Diospyros peregrina*	0.11	1.25	0.01	0.46
163.	*Solanum melongena*	0.11	1.25	0.00	0.45
164.	*Averrhoa bilimbi*	0.11	1.25	0.00	0.45
165.	*Citrus aurantium*	0.11	1.25	0.00	0.45
166.	*Ficus microcarpa*	0.11	1.25	0.00	0.45
167.	*Cordia sebestena*	0.11	1.25	0.00	0.45
168.	*Murraya koenigii*	0.11	1.25	0.00	0.45
169.	*Tragia involucrata*	0.11	1.25	0.00	0.45
170.	*Ptychosperma macarthurii*	0.11	1.25	0.00	0.45
171.	*Citrus sinensis*	0.11	1.25	0.00	0.45
172.	*Mansoa alliacea*	0.11	1.25	0.00	0.45
173.	*Vitex negundo*	0.11	1.25	0.00	0.45
174.	*Jacaranda mimosifolia*	0.11	1.25	0.00	0.45
175.	*Tecoma stans*	0.11	1.25	0.00	0.45
176.	*Thespesia populnea*	0.11	1.25	0.89	0.33
177.	*Pterygota alata*	0.11	1.25	0.43	0.18
178.	*Bauhinia variegata*	0.11	1.25	0.19	0.10
179.	*Carthamus tinctorius*	0.11	1.25	0.16	0.09
180.	*Hardwickia binata*	0.11	1.25	0.06	0.06
181.	*Delonix pumila*	0.11	1.25	0.08	0.06
182.	*Bombax ceiba*	0.11	1.25	0.07	0.06
183.	*zanthoxyllum rhesta*	0.11	1.25	0.06	0.05
184.	*Rondeletia odorata*	0.11	1.25	0.00	0.04
185.	*Albizzia julibrissin*	0.11	1.25	0.02	0.04
186.	*Manilkara zapota*	0.11	1.25	0.01	0.04
187.	*Mimusop elengi L. veriegata*	0.11	1.25	0.00	0.04
188.	*Callistemon citrinus*	0.11	1.25	0.01	0.04
189.	*Phyllanthus reticulatus*	0.11	1.25	0.00	0.04
190.	*Bixa orellana*	0.11	1.25	0.00	0.04
191.	*Munesteria Sp*	0.11	1.25	0.00	0.04

Appendix 5. Relative frequency, Relative density, Relative basal area and IVI for all the plant species in gardens of DSCC

SL No.	Species Name	RF (%)	RD (%)	RBA (%)	IVI
1.	*Lagerstroemia speciosa*	2.06	63.27	2.61	22.64
2.	*Cocos nucifera*	2.74	61.22	0.07	21.34
3.	*Eucalyptus camaldulensis*	2.06	51.02	9.29	20.79

4.	*Mangifera indica*	3.08	55.10	2.38	20.19
5.	*Dalbergia sissoo*	2.57	53.06	4.27	19.97
6.	*Combretum indicum*	2.57	53.06	0.06	18.56
7.	*Mesua ferrea*	2.23	48.98	1.49	17.56
8.	*Swietenia macrophylla*	1.71	44.90	3.30	16.64
9.	*Samanea saman*	1.71	32.65	6.83	13.73
10.	*Delonix regia*	1.71	32.65	3.31	12.58
11.	*Tabernaemonlana divaricata*	2.23	34.69	0.88	12.32
12.	*Mimusops elengi*	1.88	34.69	0.06	12.21
13.	*Polyalthia longifolia*	1.71	32.65	2.24	12.20
14.	*Artocarpus heterophyllus*	2.06	32.65	1.82	12.18
15.	*Terminalia arjuna*	2.06	32.65	1.56	12.09
16.	*Anthocephalus sinensis*	1.88	28.57	2.82	11.09
17.	*Acacia auriculiformis*	1.37	28.57	2.65	10.86
18.	*Caesalpinia pulcherrima*	1.37	28.57	0.12	10.02
19.	*Albizia richardiana*	1.37	24.49	4.18	10.02
20.	*Lagerstroemia lancasteri*	1.03	28.57	0.04	9.88
21.	*Syzygium cumini*	1.71	24.49	1.00	9.07
22.	*Azadirachta indica*	1.37	24.49	0.53	8.80
23.	*Roystonea regia*	0.51	22.45	2.99	8.65
24.	*Mussaenda erythrophylla*	0.86	24.49	0.04	8.46
25.	*Borassus flabellifer*	0.86	20.41	2.49	7.92
26.	*Cassia siamea*	1.03	18.37	3.38	7.59
27.	*Dypsis lutescens*	0.68	20.41	0.05	7.05
28.	*Ficus bengalensis*	1.03	16.33	3.36	6.91
29.	*Callistemon citrinus*	0.68	18.37	0.32	6.46
30.	*Gardenia jasminoides*	0.86	18.37	0.01	6.41
31.	*Hevea brasiliensis*	0.86	16.33	1.83	6.34
32.	*Cassia fistula*	0.86	16.33	0.86	6.02
33.	*Plumeria obtusa*	0.86	16.33	0.48	5.89
34.	*Tamarindus indica*	0.86	14.29	2.46	5.87
35.	*Jasminum sambac*	0.68	16.33	0.26	5.76
36.	*Lawsonia Inermis*	0.68	16.33	0.03	5.68
37.	*Hibiscus rosa-sinensis*	0.86	14.29	0.02	5.05
38.	*Mansoa alliacea*	0.68	14.29	0.02	5.00
39.	*Carica papaya*	0.68	14.29	0.03	5.00
40.	*Couroupita guianensis*	1.03	12.24	1.50	4.92
41.	*Ficus virens*	0.68	10.20	3.28	4.72
42.	*Artocarpus lakoocha*	0.86	10.20	2.68	4.58
43.	*Syzygium Jambos*	0.68	12.24	0.76	4.56
44.	*Albizia lebbek*	0.51	12.24	0.79	4.52
45.	*Livistona chinensis*	0.86	12.24	0.01	4.37
46.	*Nyctanthes arbor-tristis*	0.68	12.24	0.06	4.33
47.	*Artabotrys hexapetalus*	0.51	12.24	0.06	4.27
48.	*Adenanthera pavonina*	0.68	10.20	0.88	3.92
49.	*Tectona grandis*	0.34	10.20	1.01	3.85
50.	*Bombax ceiba*	0.68	10.20	0.51	3.80
51.	*Aquilaria agallocha*	0.68	10.20	0.31	3.73
52.	*Barringtonia acutangula*	0.51	10.20	0.19	3.64

53.	*Bauhinia acuminata*	0.68	10.20	0.04	3.64
54.	*Syzygium samarangense*	0.68	8.16	0.88	3.24
55.	*Saraca asoca*	0.51	8.16	0.94	3.21
56.	*Alstonia scholaris*	0.68	8.16	0.78	3.21
57.	*Terminalia catappa*	0.68	8.16	0.63	3.16
58.	*Aegle marmelos*	0.68	8.16	0.53	3.13
59.	*Spondias mombin*	0.68	8.16	0.29	3.05
60.	*Dillenia indica*	0.68	8.16	0.10	2.98
61.	*Xylia dolabriformis*	0.68	8.16	0.09	2.98
62.	*Manilkara zapota*	0.68	8.16	0.07	2.97
63.	*Morus alba*	0.34	6.12	2.45	2.97
64.	*Psidium guajava*	0.68	8.16	0.04	2.96
65.	*Murraya paniculata*	0.68	8.16	0.01	2.95
66.	*Pimenta dioica*	0.68	8.16	0.01	2.95
67.	*Dracaena aletriformis*	0.51	8.16	0.05	2.91
68.	*Cestrum nocturnum*	0.51	8.16	0.02	2.90
69.	*Elaeocarpus serratus*	0.51	8.16	0.02	2.90
70.	*Capsicum annuum*	0.34	8.16	0.00	2.84
71.	*Cordyline fruticosa*	0.34	8.16	0.01	2.84
72.	*Polyscias fruticosa*	0.17	8.16	0.01	2.78
73.	*Duranta erecta*	0.17	8.16	0.00	2.78
74.	*Nandina domestica*	0.17	8.16	0.01	2.78
75.	*Camellia sasanqua*	0.34	6.12	0.88	2.45
76.	*Leucaena leucocephala*	0.51	6.12	0.47	2.37
77.	*Phoenix sylvestris*	0.34	6.12	0.45	2.31
78.	*Melia azedarach*	0.51	6.12	0.24	2.29
79.	*Moringa oleifera*	0.51	6.12	0.09	2.24
80.	*Terminalia chebula*	0.51	6.12	0.07	2.23
81.	*Litchi chinensis*	0.51	6.12	0.05	2.23
82.	*Citrus grandis*	0.51	6.12	0.01	2.22
83.	*Averrhoa carambola*	0.51	6.12	0.02	2.22
84.	*Terminalia bellerica*	0.34	6.12	0.17	2.21
85.	*Ziziphus jujuba*	0.51	6.12	0.04	2.22
86.	*Calliandra haematocephala*	0.51	6.12	0.01	2.21
87.	*Feronia limonia*	0.17	6.12	0.31	2.20
88.	*Araucaria columnaris*	0.34	6.12	0.09	2.19
89.	*Ricinus communis*	0.34	6.12	0.06	2.18
90.	*Cycas revoluta*	0.34	6.12	0.00	2.16
91.	*Malpighia coccigera*	0.17	6.12	0.01	2.10
92.	*Indigofera tinctoria*	0.17	6.12	0.02	2.10
93.	*Hibiscus rosa-sinensis*	0.17	6.12	0.01	2.10
94.	*Magnolia champaca*	0.34	4.08	1.07	1.83
95.	*Sterculia foetida*	0.34	4.08	0.92	1.78
96.	*Hyophorbe lagenicaulis*	0.34	4.08	0.78	1.74
97.	*Araucaria araucana*	0.34	4.08	0.29	1.57
98.	*Cordia myxa*	0.17	4.08	0.45	1.57
99.	*Drypetes roxburghii*	0.34	4.08	0.29	1.57
100.	*Magnolia grandiflora*	0.34	4.08	0.19	1.54
101.	*Hedychium coronarium*	0.34	4.08	0.13	1.52

102.	*Diospyros peregrina*	0.34	4.08	0.14	1.52
103.	*Diospyros blancoi*	0.34	4.08	0.07	1.50
104.	*Emblica officinalis*	0.34	4.08	0.04	1.49
105.	*Acacia nilotica*	0.34	4.08	0.05	1.49
106.	*Averrhoa bilimbi*	0.34	4.08	0.03	1.49
107.	*Casuarinas equisetifolia*	0.34	4.08	0.04	1.49
108.	*Cananga odorata*	0.34	4.08	0.05	1.49
109.	*Punica granatum*	0.34	4.08	0.01	1.48
110.	*Murraya koenigii*	0.34	4.08	0.02	1.48
111.	*Carissa carandas*	0.34	4.08	0.00	1.48
112.	*Citrus limonum*	0.34	4.08	0.00	1.48
113.	*Abroma augusta*	0.34	4.08	0.00	1.48
114.	*Phyllanthus reticulatus*	0.17	4.08	0.11	1.42
115.	*Jasminum angustifolium*	0.17	4.08	0.01	1.42
116.	*Pterygota alata*	0.17	2.04	1.92	1.38
117.	*Plumeria rubra*	0.17	2.04	1.07	1.10
118.	*Amherstia nobilis*	0.17	2.04	0.76	0.99
119.	*Stereospermum kunthianum*	0.17	2.04	0.74	0.98
120.	*Sterculia villosa*	0.17	2.04	0.54	0.92
121.	*Ficus religiosa*	0.17	2.04	0.46	0.89
122.	*Mimusop elengi L. veriegata*	0.17	2.04	0.45	0.89
123.	*Ficus racemosa*	0.17	2.04	0.09	0.77
124.	*Anacardium occidentale*	0.17	2.04	0.10	0.77
125.	*Garcinia cowa*	0.17	2.04	0.09	0.77
126.	*Cuphea micropetala*	0.17	2.04	0.11	0.77
127.	*Anogeissus acuminata*	0.17	2.04	0.07	0.76
128.	*Howea forsteriana*	0.17	2.04	0.07	0.76
129.	*Petrospermum acerifolium*	0.17	2.04	0.06	0.76
130.	*Beaucarnea recurvata*	0.17	2.04	0.06	0.76
131.	*Bauhinia variegata*	0.17	2.04	0.05	0.76
132.	*Areca catchu*	0.17	2.04	0.07	0.76
133.	*Ficus carica*	0.17	2.04	0.04	0.75
134.	*Acacia catechu*	0.17	2.04	0.04	0.75
135.	*Allamanda cathartica*	0.17	2.04	0.00	0.74
136.	*Antiaris toxicaria*	0.17	2.04	0.00	0.74
137.	*Annona squamosa*	0.17	2.04	0.00	0.74
138.	*Ficus lyrtica*	0.17	2.04	0.01	0.74
139.	*Caryota urens*	0.17	2.04	0.00	0.74
140.	*Codiaeum variegatum*	0.17	2.04	0.00	0.74
141.	*Hylocereus undatus*	0.17	2.04	0.01	0.74
142.	*Gustavia augusta*	0.17	2.04	0.01	0.74
143.	*Nephelium longana*	0.17	2.04	0.00	0.74
144.	*Nerium indicum*	0.17	2.04	0.01	0.74
145.	*Baccaurea motleyana*	0.17	2.04	0.01	0.74
146.	*Erythrina orientalis*	0.17	2.04	0.02	0.74
147.	*Vitex negundo*	0.17	2.04	0.00	0.74
148.	*Phyllunthus acidus*	0.17	2.04	0.02	0.74
149.	*Nephelium lappaceum*	0.17	2.04	0.01	0.74
150.	*Brunfelsia pauciflora*	0.17	2.04	0.00	0.74

Appendix 6. Relative frequency, Relative density, Relative basal area and IVI for all the plant species in roadsides of DSCC

SL No.	Species Name	RF (%)	RD (%)	RBA (%)	IVI
1.	*Swietenia macrophylla*	5.62	145.28	7.99	52.97
2.	*Polyalthia longifolia*	4.07	96.23	3.32	34.54
3.	*Mimusops elengi*	3.68	88.68	0.54	30.97
4.	*Samanea saman*	4.26	58.49	15.03	25.93
5.	*Tectona grandis*	3.88	54.72	3.84	20.81
6.	*Delonix regia*	3.49	50.94	5.77	20.07
7.	*Cocos nucifera*	2.91	54.72	1.47	19.70
8.	*Albizia richardiana*	3.10	43.40	8.52	18.34
9.	*Mangifera indica*	3.10	43.40	3.25	16.58
10.	*Artocarpus heterophyllus*	2.71	43.40	0.98	15.70
11.	*Syagrus romanzoffiana*	1.55	37.74	2.21	13.83
12.	*Ficus virens*	2.52	30.19	7.73	13.48
13.	*Combretum indicum*	1.55	37.74	0.04	13.11
14.	*Leucaena leucocephala*	1.74	33.96	1.84	12.52
15.	*Roystonea regia*	1.16	28.30	1.62	10.36
16.	*Lagerstroemia speciosa*	1.36	26.42	3.20	10.32
17.	*Azadirachta indica*	2.33	26.42	0.54	9.76
18.	*Moringa oleifera*	1.74	26.42	0.33	9.49
19.	*Codiaeum variegatum*	0.58	26.42	0.02	9.01
20.	*Barringtonia acutangula*	1.16	24.53	1.10	8.93
21.	*Alstonia scholaris*	1.94	22.64	1.82	8.80
22.	*Livistona chinensis*	0.97	24.53	0.04	8.51
23.	*Dillenia indica*	1.74	22.64	0.93	8.44
24.	*Lagerstroemia lancasteri*	1.16	22.64	0.03	7.94
25.	*Anthocephalus sinensis*	1.55	20.75	0.73	7.68
26.	*Terminalia arjuna*	0.97	20.75	1.19	7.64
27.	*Tamarindus indica*	1.55	18.87	2.07	7.50
28.	*Terminalia catappa*	1.55	18.87	1.41	7.28
29.	*Syzygium cumini*	1.36	18.87	0.94	7.05
30.	*Hevea brasiliensis*	1.36	15.09	1.89	6.11
31.	*Bougainvillea glabra*	1.16	16.98	0.01	6.05
32.	*Ziziphus mauritiana*	1.16	16.98	0.01	6.05
33.	*Ficus bengalensis*	1.16	13.21	3.28	5.88
34.	*Dypsis lutescens*	0.58	16.98	0.01	5.86
35.	*Cordyline fruticosa*	0.39	16.98	0.01	5.79
36.	*Duranta erecta*	0.58	15.09	0.01	5.23
37.	*Plumeria obtusa*	1.16	13.21	0.20	4.86
38.	*Melia azedarach*	1.16	13.21	0.07	4.81
39.	*Annona squamosa*	1.16	13.21	0.03	4.80
40.	*Bombax ceiba*	0.58	13.21	0.45	4.75
41.	*Tabernaemonlana divaricata*	0.78	13.21	0.01	4.66
42.	*Cassia siamea*	0.56	11.32	1.53	4.47
43.	*Dalbergia sissoo*	0.97	11.32	0.59	4.29
44.	*Chukrasia tabularis*	0.97	9.43	0.77	3.72

45.	*Ficus carica*	0.78	9.43	0.58	3.60
46.	*Abroma augusta*	0.78	9.43	0.21	3.47
47.	*Borassus flabellifer*	0.58	9.43	0.29	3.44
48.	*Carica papaya*	0.58	9.43	0.03	3.35
49.	*Averrhoa bilimbi*	0.58	9.43	0.03	3.35
50.	*Araucaria columnaris*	0.39	9.43	0.02	3.28
51.	*Ficus blanceolata*	0.39	5.66	3.02	3.02
52.	*Anacardium occidentale*	0.39	7.55	0.77	2.90
53.	*Phoenix sylvestris*	0.78	7.55	0.18	2.83
54.	*Mussaenda erythrophylla*	0.39	7.55	0.01	2.65
55.	*Gardenia jasminoides*	0.39	7.55	0.01	2.65
56.	*Aquilaria agallocha*	0.58	5.66	1.24	2.49
57.	*Citrus grandis*	0.58	5.66	0.42	2.22
58.	*Couroupita guianensis*	0.39	5.66	0.62	2.22
59.	*Acacia auriculiformis*	0.39	5.66	0.58	2.21
60.	*Eucalyptus camaldulensis*	0.39	5.66	0.34	2.13
61.	*Casuarinas equisetifolia*	0.39	5.66	0.35	2.13
62.	*Michelia champaca*	0.58	5.66	0.15	2.13
63.	*Spondias mombin*	0.58	5.66	0.07	2.11
64.	*Erythrina orientalis*	0.58	5.66	0.04	2.10
65.	*Areca catchu*	0.58	5.66	0.05	2.10
66.	*Emblica officinalis*	0.58	5.66	0.01	2.09
67.	*Averrhoa carambola*	0.58	5.66	0.01	2.09
68.	*Mesua ferrea*	0.58	5.66	0.04	2.09
69.	*Caesalpinia pulcherrima*	0.58	5.66	0.01	2.08
70.	*Artocarpus lakoocha*	0.39	5.66	0.16	2.07
71.	*Xylia dolabriformis*	0.39	5.66	0.14	2.06
72.	*Cassia fistula*	0.39	5.66	0.06	2.04
73.	*Psidium guajava*	0.39	5.66	0.04	2.03
74.	*Lannea coromandelica*	0.39	5.66	0.04	2.03
75.	*Allamanda cathartica*	0.39	5.66	0.00	2.02
76.	*Hibiscus rosa-sinensis*	0.39	5.66	0.01	2.02
77.	*Carissa carandas*	0.39	5.66	0.01	2.02
78.	*Quisqualis indica*	0.39	5.66	0.00	2.02
79.	*Callistemon citrinus*	0.19	5.66	0.14	2.00
80.	*Rosa rubiginosa*	0.19	5.66	0.00	1.95
81.	*Terminalia bellerica*	0.58	1.89	0.02	0.83
82.	*Streblus asper*	0.19	1.89	0.19	0.76
83.	*Aegle marmelos*	0.19	1.89	0.04	0.71
84.	*Albizia lebbek*	0.19	1.89	0.06	0.71
85.	*Feronia limonia*	0.19	1.89	0.05	0.71
86.	*Millingtonia hortensis*	0.19	1.89	0.00	0.70
87.	*Diospyros peregrina*	0.19	1.89	0.01	0.70
88.	*Madhuca longifolia*	0.19	1.89	0.02	0.70
89.	*Bauhinia variegata*	0.19	1.89	0.01	0.70
90.	*Nerium indicum*	0.19	1.89	0.00	0.69
91.	*Malvaviscus arboreus*	0.19	1.89	0.00	0.69
92.	*Hibiscus rosa-sinensis*	0.19	1.89	0.00	0.69
93.	*Tecoma stans*	0.19	1.89	0.00	0.69

Appendix 7. List of 126 herb species with scientific name and family

SL No.	Local Name	Scientific name	Family
1.	Spider Lily	*Hymenocallis littoralis*	Liliaceae
2.	Purple Heart	*Tradescantia pallida*	Commelinaceae
3.	Elachi	*Elettaria cardamomum*	Zingiberaceae
4.	Money Plant	*Epipremnum aureum*	Araceae
5.	Snake Plant	*Sansevieria trifasciata*	Asparagaceae
6.	Day Lily	*Hemerocallis lilioasphodelus*	Liliaceae
7.	MorogJhuti	*Celosia argentea*	Amaranthaceae
8.	Morogful	*Celosia plumose*	Amaranthaceae
9.	Kalomegh	*Andrographis paniculata*	Acanthaceae
10.	salvia	*Salvia officinalis*	Lamiaceae
11.	Panthopadop	*Ravenala madagascariensis*	Musaceae
12.	Nayantara	*Catharanthus roseus*	Apocynaceae
13.	Botamful	*Gomphrena globosa*	Amaranthaceae
14.	Tulshi	*Ocimum tenuiflorum*	Lamiaceae
15.	Dopati	*Impatiens balsamina*	Balsaminaceae
16.	Fruit Salad	*Monstera deliciosa*	Araceae
17.	Lantana	*Lantana Camara*	Verbenaceae
18.	Sandhyamaloti	*Mirabilis jalapa*	Nyctaginaceae
19.	Kolaboti	*Canna indica*	Cannaceae
20.	Pink Swamp Mellow	*Abelmoschus moschatus*	Malvaceae
21.	Panika	*Cuphea hyssopifolia*	Lythraceae
22.	Cosmos	*Cosmos sulphureus*	Asteraceae
23.	Hatishur	*Heliotropium indicum*	Boraginaceae
24.	BoroHatishur	*Acalypha hispida Burm*	Euphorbiaceae
25.	Peacocok ginger	*Kaempferia elegans*	Zingiberaceae
26.	Goldenstar	*Chrysogonum virginianum*	Asteraceae
27.	Oporajita	*Clitoria ternatea*	Fabaceae
28.	Madhobilota	*Hiptage madablota*	Malpighiaceae
29.	Jhumkolota	*Passiflora laurifolia*	Passifloraceae
30.	Neelmoni lota	*Petrea volubilis*	Verbenaceae
31.	Konoklota	*Pyrostegia venusta*	Bignoniaceae
32.	Trumpet flower	*Solandra grandiflora*	Solanaceae
33.	Spider Plant	*Chlorophytum comosum*	Asparagaceae
34.	Aster	*Aster novi-belgii*	Compositae
35.	Coleus	*Coleus blumeri*	Labiotae
36.	Baharikocu	*Caladium bicolor*	Araceae
37.	Shotomuli	*Asparagus racemosus*	Asparagaceae
38.	Thankkuni	*Centella asiatica*	Apiaceae
39.	Bon Morich	*Ammannia baccifera*	Lythraceae
40.	Shorpogondha	*Rauvolfia serpentina*	Apocynaceae
41.	Shornolota	*Cuscuta Reflexa*	Convolvulaceae
42.	Cairo Morning Glory	*Ipomoea cairica*	Convolvulaceae
43.	Golden Garnia	*Gardenia carinata*	Rubiaceae
44.	Devil weed	*Chromolaena odorata*	Asteraceae
45.	Bathua	*Chenopodium album*	Amaranthaceae
46.	Bishkataly	*Polygonum hydropiper*	Polygonaceae
47.	Amrul shak	*Oxalis europea*	Oxalidaceae

48.	Girakata	*Spilanthes acmella*	Asteraceae
49.	Lazzabati	*Mimosa pudica*	Fabaceae
50.	Shialkata	*Argemone mexicana*	Papaveraceae
51.	Keshraj	*Eclipta alba Hessk.*	Compositae
52.	Potpoti	*Ruellia tuberosa*	Acanthaceae
53.	Gobura	*Anisomeles indica*	Lamiaceae
54.	bon okara	*Urena lobata*	Malvaceae
55.	JonakiFul	*Anagallis arvensis*	Primulaceae
56.	Patenga	*Trichosanthes cucumerina wild.*	Cucurbitaceae
57.	Shetdron	*Leucus cephalot*	Lamiaceae
58.	Hajarmoni	*Phyllanthus urinaria.*	Euphorbiaceae
59.	Bon dhonia	*Coparia dulcis*	Scrophulariaceae
60.	Chorakata	*Chrysopogon aciculatus*	Poaceae
61.	Grass pea,	*Lathyrus sativus*	Fabaceae
62.	Petunia	*Petunia hybrida*	Solanaceae
63.	Motimunda	*Taccachantrieri*	Dioscoreaceae
64.	Goldenwave	*Coreopsis tinctoria*	Asteraceae
65.	Rajanigondha	*Polianthes tuberosa*	Agavaceae
66.	Kunjolota	*Ipomoea quamoclit*	Convolvulaceae
67.	Tridhara	*Tridax procumbens*	Asteraceae
68.	Biralnokha	*CapparisSpinosa* /	Capparidaceae
69.	Telakucha	*Cephalandra indica*	Cucurbitaceae
70.	Boro shama	*Echinochloa crussgalli*	Poaceae
71.	Durba	*Cynodon dactylon*	Poaceae
72.	Chapra	*Elusine indica*	Poaceae
73.	Angulee ghas	*Digitaria sanguinalis*	Poaceae
74.	Khude angulee	*Digitaria ischaemum*	Poaceae
75.	Gitla ghas	*Paspalum distichum*	Poaceae
76.	Shial leja	*Setaria glauca*	Poaceae
77.	Kakpaya	*Dactyloctenium aegyptium*	Poaceae
78.	Carpet grass	*Axonopus compressus*	Poaceae
79.	Bon cheena	*Panicum repens*	Poaceae
80.	Chira ghash	*Eragrostis unioloides*	Poaceae
81.	Moyurleja	*Leptochola panicea*	Gramineae
82.	Busket grass	*Oplisma burmaniaii*	Poaceae
83.	Nol khagra	*Phragmites karka*	Poaceae
84.	Mutha ghas	*Cyperus rotundus*	Cyperaceae
85.	Umbrella ghas	*Cyperus difformis*	Cyperaceae
86.	Chatidhora	*Cyperus compressus*	Cyperaceae
87.	Nakfuli	*Cyperus michelianus*	Cyperaceae
88.	Keshuti	*Eclipta prostrata*	Asteraceae
89.	Bugra ghas	*Veronia patula*	Asteraceae
90.	Jirakata	*Spilanthes acmella*	Asteraceae
91.	Mikania lota	*Mikania cordata*	Asteraceae
92.	Boro dudhia	*Euphorbia hirta*	Euphorbiaceae
93.	Kanai bashi	*Commelina benghalensis*	Commelinaceae
94.	Kanainala	*Cyanotis axillaris*	Commelinaceae
95.	Arich	*Cassia tora*	Caesalpiniaceae
96.	Bonno shorisa	*Rorippa indica*	Brassicaceae
97.	Peperomia	*Peperomia caperata*	Piperaceae
98.	Tita begun	*Solanum nigrum*	Solanaceae

99.	Dhutura	*Datura metel*	Solanaceae
100.	Khetpapri	*Lindernia procumbens*	Linderniaceae
101.	Fern	*Dryoyteris filix-mas*	Dryopteridaceae
102.	Roktodron	*Leonurus sibiricus*	Lamiaceae
103.	Calendula	*Calendula officinalis*	Asteraceae
104.	Dianthus	*Dianthus caryophyllus*	Caryophyllaceae
105.	Portulaka	*Portulaca grandiflora*	Portulacaceae
106.	Shotomuli	*Asparagus officinalis*	Liliaceae
107.	Begonia	*Begonia bicolor*	Begoniaceae
108.	Anthurium	*Anthurium crystallinum*	Araceae
109.	Alocasia	*Alocasia portei*	Araceae
110.	Zebra plant	*Calathea zebrina*	Marantaceae
111.	Bicolor	*Excoecaria bicolor*	Euphorbiaceae
112.	Rye grass	*Lolium pratense*	Gramineae
113.	China grass	*Poa pratensis*	Gramineae
114.	Rybby grass	*Tricholaena rosea*	Gramineae
115.	Lemon grass	*Cymbpopgon citratus*	Gramineae
116.	Bokful	*Vigna unguiculata*	Fabaceae
117.	Katanotey	*Amaranthus Spinosus*	Amaranthaceae
118.	Notiyasag.	*Amaranthus Blitum*	Amaranthaceae
119.	Ban tulsi	*Salvia plebeja*	Lamiaceae
120.	Chondromollika	*Chrysanthemum coronarium*	Asteraceae
121.	Ghagra	*Xanthium indicum*	Asteraceae
122.	Bara bans	*Bambusa balcooa*	Poaceae
123.	Mitinga bans	*Bambusa tullda*	Poaceae
124.	Kata bans	*Bambusa arundinacea*	Poaceae
125.	Banana	*Musa acuminata colla*	Musaceae
126.	Bashok	*Adhatoda vasica*	Acanthaceae