Plant Species Composition and Structure
of Some Selected Area of Dhaka North City Corporation (DNCC)

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SHER-E-BANGLA AGRICULTURAL UNIVERSITY

Dhaka-1207

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CERTIFICATE

This is to certify that the thesis entitled' **Plant Species Composition and Structure of Some Selected Area of Dhaka North City Corporation (DNCC)** *'submitted to the Faculty of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of* ***Master of Science in Agroforestry and Environmental Science****, embodies the result of a piece of bona fide research work carried out by* ***Md. Rafiqul Islam****, Registration No.* ***15-06887*** *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 acknowledgement.

Dated: June 8, 2016

Place: Dhaka, Bangladesh

Prof. Dr. Md. Forhad Hossain
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Dedicated

To my

Beloved Family

&

The Department of Agroforestry and

Environmental Science

Sher-e-Bangla Agricultural University

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June 2017 ***The Author***

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Abstract

The present study was conducted to assess the composition and structure and to identify the vegetation status of different plant species in Dhaka North City Corporation (DNCC) of some selected areas. The study was conducted from 1 January 2017 to 31 March 2017. Data was collected from three habitat category (Parks, gardens and roads) in DNCC. The study areas were Chandrima, Uddan, Botanical Garden, Rokeya Sarani, Mirpur -2 Road and Zoo Road. In this study, tree species and total number were found at the Chandrima Uddan, Rokeya Sarani, Mirpur -2 Road, Zoo Road and Botanical Garden were 18 and 226, 12 and 85, 11 and 60, 2 and 276 and 13 and 621 respectively. Similarly, Shrub species and total number were found at the Chandrima Uddan, Rokeya Soroni, Mirpur -2 Road, Zoo Road and Botanical Garden were 11 and 214, 5 and 386, 7 and 758, 0 & 0 and 9 and 1165, respectively. Herb species and total number were found at the Chandrima Uddan, Rokeya Sarani, Mirpur -2 Road, Zoo Road and Botanical Garden were 3 and 370, 0 and 0, 0 and 0, 0 and 0 and 5 and 146 respectively. Results found that at Chandrima Uddan the highest number of plant was found in *Acacia auriculiformis* (44) followed by *Borassus flabellifer* (39) and the lowest number was found in *Samanea saman* (3) and *Delonix regia* (3), at Rokeya Sarani the highest number of plant was found in *Swietenia macrophylla* (40) and the lowest number was found in *Azadirachta indica* (1), at Mirpur-2 road the highest number of plant was found in *Mimusops elengi* (15) and the lowest number was found in *Dalbergia sissoo* (1), at the Zoo road the highest number of plant was found in *Swietenia macrophylla* (264) and the lowest number was found in *Arecaceae palmae* (12) and the highest number of plant was found in *Polyalthia longifolia* (165) and the lowest number was found in *Arecaceae palmae* (6) and *Pennisetum glaucum* (6) at Botanical Garden. In Height Class (in m) results found that the highest amount of tree individuals 117 was found at heights (8-16 m) and the lowest amount of tree individuals 40 was found at heights (16-24 m) at Chandrima Uddan, at Rokeya sarani the highest amount of tree individuals 47 was found at heights (1.6-8 m) and the lowest amount of tree individuals 1 was found at heights (16-24 m),at Mirpur-2 road the highest amount of tree individuals 46 was found at heights (1.6-8 m) and the lowest amount of tree individuals 14 was found at heights (8-16 m), at Zoo road the highest amount of tree individuals 184 was found at heights (8-16 m) and the lowest amount of tree individuals 0 was found at heights (<1.60 m) and the highest amount of tree individuals 202 was found at heights (8-16 m) and the lowest amount of tree individuals 40 was found at heights (1.6-40 m) at Botanical garden. For comparison among five study areas it was found that tree individual of Botanical garden had more height among all study areas. In DBH (cm) the highest amount of tree individuals 72 was found at heights (>100 cm) at Chandrima Uddan, at Rokeya Sarani the highest amount of tree individuals 13 was found in DBH class (31-40 cm), at Mirpur-2 road the highest amount of tree individuals 16 was found in DBH class (10-20 cm), at Zoo road the highest amount of tree individuals 31 was found in DBH class (61-70 cm) and the highest amount of tree individuals 503 was found in DBH class (>100 cm) at Botanical garden. For comparison among five study areas it was found that tree individual of Botanical garden had more diameter at breast height (dbh) among all study area.

CHAPTER I
INTRODUCTION

1.1 General Background

The global population pressure has increased 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 (UNDP 2015). It is certain that, urbanization not only shows impact on the ecology, economy, society at regional and global levels but also in the urban green spaces including urban forestry, parks, playgrounds, domestic gardens, roadside open spaces and urban vegetation (Islam *et al.* 2015). Dhaka is the capital of Bangladesh and also the 11th largest megacity of the world covering an area of 269.96 sq. kilometer with more than 18 million populations (Current affairs June 2016). Dhaka has been identified as the fastest growing mega city in the world in recent studies (World Bank 2007). It has been projected that by 2020 Dhaka would become the third largest mega city with an annual population growth rate of 4.4 percent (UN-Habitat 2013). Dhaka city is represented by 21.57% open space of which city parks occupy 0.89%, urban forestry 0.02%, gardens 0.90% and 12.12% by agriculture (Rahman and Ahmed 2012). Unplanned urbanization has deteriorated the ecological imbalances in the city day by day. 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). There are about 54 registered parks under Dhaka City Corporation (DCC). 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 area like Ramna Park, Sohrawardy Udyan, Chandrima Uddan, Dhaka University campus, National Parliament Bhaban complex, Usmani Udyan, Botanical Garden and National Zoo (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 sq. miles of area for recreation purpose (Chowdhury, 2004).Unfortunately, to improve the parks and other green spaces of Dhaka city, till now no initiatives have been taken yet (Alam 2012). Few researches have been conducted earlier on parks and open spaces of cities in Bangladesh which are not adequate to evaluate urban forest structure (Chowdhury 2004; Islam *et al.* 2002; Siddiqui 1990; Nehrin *et al.* 2004).

Urban forestry can be defined as the planting of trees, shrubs, herbs and some other species on public lands such as roadsides, footpahts, parks, city squares and residential gardens (Forrest& Konijnendijk 1999). Urban vegetation in an area is a highly altered ecosystem in which structure and composition of species is determined by human activities (Heynen and Lindsey 2003; Dobbs *et al.* 2011 Ramage *et al.* 2013). The ecological processes and functions which enhance the environmental quality within urban areas are highly influenced by Urban forest structure and composition (Chen and Jim 2003; Zhao *et al.* 2010).Urban forest is highly beneficial and also has established relationships between different urban forest structures and specific functions through several studies like visual quality (Schroeder 1986), energy savings (McPherson 1993), removal of atmospheric carbon dioxide (Rowntree and Nowak 1991), urban heat island mitigation (Huang *et al.* 1987), sound reduction (Cook and Van Haverbeke 1977), wildlife habitat (DeGraaf & Wentworth 1986), and personal safety (Schroeder and Anderson 1984). Variation in sizes and species of trees in an urban forest ensures the diversity of structures which support the variety of values the urban forest provides (Andreu *et al.* 2008).An urban forest can be characterized in terms of composition, structure, and function (Rowntree 1984). Urban forest structure means the spatial arrangement and characteristics of vegetation in relation to other objects (e.g., buildings, parks, roadsides etc) within urban areas (Nowak 1994). Forest structure also indicates the distribution of vegetation, both horizontally and vertically, in a given area (Shawn *et al.* 2013). Basic information that is necessary to describe urban forest structure includes tree numbers, species composition, density, basal area and growing conditions (Nowak *et al.* 2008). Traditionally, this information is collected during field data collection (McPherson and Simpson 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, green spaces or road networks may have different types of species composition (Jim and Liu 2001; Chen and Jim 2003; Godefroid and Koedam 2007; Zhao *et al.* 2010; Kendal *et al.* 2012).

In 04 December 2011, the Government of Bangladesh amended the Local Government City (City Corporation) Act 2009, and divided the Dhaka City Corporation into two parts namely, *Dhaka South City Corporation (DSCC)* and *Dhaka North City Corporation (DNCC)*. In this research an attempt has been taken to evaluate the structure and composition of tree species which will be helpful to increase the vegetation and establishment of urban forest in Dhaka North City Corporation because, no systematic study has been performed yet to analyze the structure and composition of vegetative covers of existing parks and green spaces in Dhaka city. Therefore, some selected area of Dhaka North City Corporation (DNCC) has been chosen for this research to evaluate the species composition and structure of tree covers of this surrounding area.

Objectives:

1. To assess the composition and structure of plant species in DNCC of some selected areas and
2. To identify the vegetation status of different plant species.

CHAPTER- II

REVIEW OF LITERATURE

2.1. Urban forestry concept

Urban forestry is not a new concept, but it is one which appears to have growing potential. This is particularly true in developing countries, where urbanization is increasing at a rapid rate and a demographic switch from a predominantly rural to a predominantly urban society is taking place. Although United Nations (UN) (1991) figures indicate that in 1990 only 37% of the total population of developing countries was urbanized, it is predicted that by the year 2025 the proportion will be 61%. Already rapid and uncontrolled urbanization in many developing countries is having fundamental social and environmental consequences. The role of urban trees in ameliorating this situation might, at first thought, appear to be small.

2.2. Definition of the term 'Urban'

Urban areas in developing and developed countries are often very different. Furthermore, although we know intuitively what is 'urban' and what is 'rural', there is actually no universally accepted criterion for distinguishing between such settlements. The usual mechanism, common in national censuses, is to take population thresholds. Once a nucleated settlement grows beyond a certain threshold, it becomes 'urban'. However, the threshold used varies widely from country to country, and may even change in successive censuses (Hardoy and Satterthwaite 1986). The United Nations has attempted to standardize data by defining settlements of over 20,000 people as 'urban', over 100,000 as 'cities', and over 5 million as 'big cities'. In contrast, Hardoy and Satterthwaite define any nucleated settlement of more than 5,000 as an urban centre, those having a population of less than 20,000 being 'small urban centres', and those having some 20,000 to 100,000 inhabitants being 'intermediate urban centres'. Whatever the figure used, generalizations are inevitably unsatisfactory. A small Pacific island whose total population is under 20,000 will obviously have a different perspective on urban settlements from a large, heavily populated country such as India. Different national perspectives may well reflect historical, cultural and political differences. This varied concept of an 'urban settlement' should be remembered throughout the ensuing discussion. It is also worth noting that the 'cut off point' on the ground for an urban centre is interpreted differently in different countries. An obvious example of this is in China, where cities often 'annex' a number of adjacent districts into their administrative areas in order to ensure control over the supply of essential urban services, such as reservoirs or power plants. The official population of many Chinese cities thus includes many rural dwellers (Drakakis-Smith, 1987).

2.3. Definitions of Urban Forestry

The definition of urban forestry given by Miller (1988) is of, "An integrated, city wide approach to the planting, care and management of trees in the city to secure multiple environmental and social benefits for urban dwellers." The definition of urban forestry given by Grey and Deneke (1986) is of, "Urban forestry is the management of trees for their contribution to the physiological, sociological, and economic well-being of urban society. Urban forestry deals with woodlands, groups of trees, and individual trees, where people live - it is multifaceted, for urban areas include a great variety of habitats (streets, parks, derelict corners, etc) where trees bestow a great variety of benefits and problems."

2.4. Peri-urban forestry as a separate concept

Peri-urban forestry is loosely defined as forestry on the fringe of urban settlements, but given the lack of conformity between countries as to what constitutes 'urban', a precise definition of 'peri-urban' is impossible. To use the simple definition of the area used by urban residents is inadequate, since this may extend far into rural areas; as theories such as that of Von Thunen have shown the sphere of influence of a city or town may be very wide. To define peri-urban solely in spatial terms is also unsatisfactory, since it can be so variable. Many urban foresters are unwilling to accept peri-urban forestry as a separate concept; they argue that the peri-urban area, or urban fringe, is simply one location for urban forestry. This argument has been accepted in the compilation of this document, so that all further mention of urban forestry may be assumed to include peri-urban locations, unless otherwise indicated. (Carter, 1993).

2.5 A new approach to the potential of urban forestry in developing countries

The potential of forestry in and around urban settlements may be approached from one of two broad perspectives. One is to focus upon the trees themselves; the potential benefits and problems that may be expected from their cultivation in an urban environment; how they may be managed to maximize the former; and what threats an urban environment pose to their survival. An alternative perspective, which this paper attempts, is to focus first on the residents of urban areas, their needs and the nature of their invariably diverse living conditions, and then to consider how trees might be of benefit to them To learn more about the urban dweller, especially in the developing world, it is necessary to consult geographical or other social science texts. These rarely devote much attention to peoples' use of and perceptions of trees, except, to a certain extent, in the case of fuel wood supplies from peri-urban areas (Carter, 1993)

2.6 Why Urban Forestry?

The need for urban forestry to be a planned, integrated, and systematic approach to urban tree management should be stressed. Planning is important because trees are very often considered as an afterthought once development has taken place, rather than being incorporated at the original design phase. An integrated approach implies the participation of many different organizations - local councils, municipal and national planning bodies, departments, etc. Systematic management entails regulated tree management; operations such as planting, pruning, and felling must all be conducted in an organized manner, at the appropriate time. In industrialized countries urban forestry is concerned primarily with environmental enhancement. Even in countries (e.g. Germany), where timber is harvested from peri-urban forests, the major management objective is providing recreation/education of the urban dweller, and timber harvesting operations are significantly modified accordingly (Carter, 1993).

2.7 Structure and composition of tree species in Bangladesh context

Mamun and Akhter (2015) have stated that the highest IVI of *Acacia auriculiformis* from Chunati forest was found 40.11 followed by *Tectona grandi* (16.46). 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 m^2/ha) followed by *Acacia auriculiformis* (1.39 m^2/ ha).

Jibon & Halim (2013) investigated 1,082 trees in the street trees 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.

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).

Akhter & Kamal (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) m^2/ha and respectively. Artocarp*us chama* was found dominant showing maximum IVI followed by *Schima wallichii*, *Aporosa wallichii*, and *Lithocarpus acuminate.*

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

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. Species (*Dipterocarpus turbinatus, Acacia auricoliformis* and *Lagerstroemia speciosa*,) occurring at all three study sites, showed highest IVI values and considered as the most dominant species.

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 m2/ha) followed by *Acacia auriculiformis* (0.2 m2/ha and 637 stem/ha).

Acacia auriculiformis (0.2 m2/ha and 637 stem/ha), Gmelina arborea (0.2 m2/ha and 600 stem/ha).

Hossain (2016) had stated a total of 2,338 individual tree stems of ≥10 cm dbh (468 stem ha-1) 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^{-1} to 540 stem ha^{-1} and basal area from 21.10 m^2 to 33.92 m^2 in all the study area.

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 nonwoody plant (species=61, &family=27) were found in this study.

2.8 Structure and composition of tree species in global context

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 andAraceae, 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.*

Akber (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.

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

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.

Shin-ichiro (1999) stated that, forest structure and tree species diversity (both ≥ 4.8 cm and ≥ 10 cm diameter at breast height [dbh]) 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 ultrabasic substrates than on non-ultrabasic substrates at ≥ 1700 m.

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–1 to 767 ha–1 with an average basal area of 25.82 m2/ha.

Zhao.M (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.

Michael & Melissa (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.

Trammell (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%).

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.

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.

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.

Aladesanmi *et. al.* (2016) reported fifty four tree species in Ibadan city of Nigeria where *Delonix regia* of Fabacea family had shown the highest number of population with a frequency of eighteen (18), 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.

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.

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.

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 was 3.27m ± 0.23 and 980 ind. /ha respectively and for the diameter, they found an average value of 14.53cm ± 5.6 respectively.

Urban forestry plays a vital role in the following ways-

2.9.1 Improving the aesthetic quality of urban areas

It is the aesthetic and recreational value of trees, forests and parks that is most directly identified by most urban dwellers, in developed and developing countries alike. Trees fulfill certain psychological, social and cultural needs of the urban dweller (Dwyer Schroeder and Gobster 1991). They play a very important social role in easing tensions and improving psychological health; people simply feel better living around trees. Parks provide easily accessible recreational opportunities for people.

2. 9. 2 Ecological maintenance

As a result of the predominance of concrete buildings, asphalt and metal as well as the concentration of transport systems and industrial activities in and around urban areas, the median temperature is higher (the "heat island" effect), the air is drier and often polluted, rainfall is less efficiently absorbed and the environment is generally noisier than in a rural setting (Kuchelmeister and Braatz ,1991)

2. 9. 3 Cleaning the air

One of the major problems in urban areas is poor air quality. Plants help remove pollutants from the air in three ways: absorption by the leaves or the soil surface; deposition of particulates and aerosols on leaf surfaces; and fallout of particulates on the leeward (downwind) side of the vegetation because of the slowing of air movement.

Research on the removal of airborne pollutants by vegetation shows that plants are effective sinks for pollution. Trees absorb sulphur dioxide very efficiently. Keller (1979) has quantified an 85 percent reduction in lead behind a shelter-belt of trees. Soil effectively absorbs gaseous pollutants, including carbon monoxide, sulphur dioxide, nitrogen oxides, ozone and hydrocarbons. Trees intercept dust: a belt of trees measuring 30 meters in width has been found to intercept almost all dust in the air.

2. 9. 4 Modifying temperature extremes

Trees, shrubs and other vegetation help to control temperature extremes in urban environments by modifying solar radiation. The shade of one large tree may reduce the temperature of a given building to the same extent as would 15 air conditioners at 4000 British thermal units (BTU), i.e. 4220 kJ, in a similar but unshaded building. Energy saving through tree-planting around houses ranges from 10 to 50 percent for cooling and from 4 to 22 percent for heating (NAA/ISA, 1991).

2. 9. 5 Noise reductions

Noise is often referred to as invisible pollution. Excessive noise levels in most major cities contribute to both physical and psychological damage. Trees can help both by absorbing and refracting or dissipating noise such as that produced by the heavy vehicular traffic which characterizes urban areas (Kuchelmeister and Braatz 1991).

2. 9. 6 Meeting resource-poor people's basic needs

Beyond their aesthetic and ecological value, trees can contribute to the satisfaction of energy requirements as well as the daily food requirements of urban dwellers, particularly in the case of the poorest elements of society (*Kuchelmeister* and Braatz, 1991).

2. 9. 7 Urban forestry provides Fuel wood

Although "high technology" sources of domestic and industrial energy are available in most cities (electricity and petroleum products such as diesel, kerosene, gas), their relatively high price puts them out of the reach of much of the urban population in the developing world. Therefore, people continue to depend on fuelwood and charcoal for their energy needs which are consequently satisfied by uncontrolled collection, often resulting in the extensive degradation of areas around many urban settlements in developing countries. When "free" wood energy supplies are exhausted or are too difficult for people to tap into, fuelwood markets develop. Even this energy source is relatively expensive; studies report expenditures of 30 to 40 percent of total income by low-income groups to meet domestic energy requirements. Wood-based building materials - poles, branches and leaves for thatching, for example - are also in high demand in many urban areas (Kuchelmeister, 1991; Ducchart, 1989).

2. 9. 8 Food Productions

Urban agriculture is common in many cities in Asia, Latin America and Africa (Yeung 1987; Sanyal 1985; Streiffeler 1987; Ninez 1985; Skinner 1981). Who and how many people practice it as well as what form it takes differ greatly from place to place. It is most often practiced in the urban fringe area by low-income families but, in places such as Africa and the Pacific Islands, urban agriculture is widespread within cities. Although in most places the emphasis is not on the production of staple foods, through the production of vegetables, fruits and condiments, urban agriculture can contribute to the improvement of the nutritional value and variety of city dwellers' diets.

2. 9. 9 Environmental benefits

Environmental benefits to be gained from urban trees in the developing world include landscape enhancement, recreation, education, and general well-being; a habitat for wildlife; climatic modification; the control of air and noise pollution; erosion control; the protection of catchments areas for urban water supplies; and the productive use or safe disposal of urban wastes. (Carter, 1993)

2.10 Potential problems from urban forestry

A number of the potential problems of trees in urban areas are discussed further in section six, with regard to species selection. However, a brief review is of use here, both of the problems and possible means of avoiding them.

2. 10. 1 Cost

Urban forestry initiatives conducted on a scale beyond small home gardens can cost a large amount of money to implement. This is particularly the case if instant results are wanted in amenity plantings, so large saplings are planted which require intensive after care in the first year or so of establishment. Maintenance costs, in particular irrigation, can be very high in such situations. Poorly run tree planting campaigns can also prove to be very costly, if mortalities are high as a result of inadequate or misdirected support. There are numerous ways in which costs can be minimized and benefits maximized through appropriate technology and careful planning but arrangement for regular maintenance is crucial. (Carter, 1993)

2.10.2. Threats to human safety

Poorly planted or inappropriate tree species can serve as a hazard to urban inhabitants, either directly (through falling branches or the falling over of the entire tree) or indirectly. The former may be particularly likely in countries where typhoons or hurricanes are regularly experienced. It is possible that they are also of increasing occurrence in former colonies where colonial tree plantings are now over-mature and in need of replacement. Whereas in many developed countries there is provision for ensuring the removal or treatment of dangerous trees, this may not exist, or fail to be implemented in some developing countries. The general result is that there is probably more cause for genuine concern about the safety of trees in cities of developing rather than developed countries. Onganga (1992) comments that in Kenya, for example, problems with "trees blocking highways and falling on roofs of houses are common in urban areas." Careful planting and choice of species, regular maintenance and a clear line of responsibility for dealing with dangerous trees would help to increase human safety.

2.10.3 Structural damage

The roots of street trees often cause the cracking of roads and pavements and sometimes water pipes. Urban trees can also cause structural damage to buildings, both at foundation level due to their roots, and through the falling of whole trees or branches. As with human safety, such problems can be minimized by careful species choice and maintenance (Biddle, 1987).

2.10.4 Vandalism and browsing

Damage may be inflicted on trees simply out of intent to destroy; out of casual disregard; as a consequence of harvesting tree products; and by browsing livestock. While many foresters and arboriculturalists would classify all these as vandalism, there are clear differences. Only deliberate and casual vandalism are generally a problem in the developed world, whereas all four occur in Third World cities. Apart from any other considerations, this probably renders them a more difficult environment in which to raise trees (Sunder, 1985).

The most important issue in combating all forms of human and animal-induced tree damage is gaining local people's support for and active involvement in tree cultivation, a matter discussed in section five. Apart from this, urban amenity plantings can be planned to minimize the likelihood of vandalism. Trees planted within cultivated ground tend to be less susceptible to deliberate or casual damage than ones surrounded by tarmac or concrete, as are ones planted in groups compared with lone trees. This is substantiated by observations of street trees in Bangalore, India. Here it was noted that, the position of tree stakes can also influence vandalism; trees with stakes that reach to breast height are more likely to be snapped off at this point than ones which have lower, less obvious stakes (Sunder, 1985).

2.10.5 Access to solar energy

In developing as well as developed countries which receive significant solar radiation, solar power is an increasingly utilized energy source. While trees may be valued for their cooling shade, if this reduces solar radiation falling onto a solar panel, it may be viewed as a nuisance. In many States of the USA, there are now laws regarding access to solar energy which effectively require trees blocking solar radiation to be pruned or removed (Miller 1988). Although such legal difficulties are unlikely to affect urban tree growers in developing countries, the issue of access to solar energy is one which may be of increasing future importance.

The extent of mutilation is clearly inversely proportional to the extent of tree cover in a locality. The fewer the trees, the more insidious the process of destruction, we have either very little, or almost total mutilation in any locality it seems as if there is a psychological threshold involved: once people get over the inhibitions and into the habit of hacking trees, they go and hack every one of them(Gadgil and Parthasarathy 1977).It is common in Kenya, during funerals of important people or when a home team wins a prestigious cup, for people to cut trees and carry branches as a sign of sorrow or victory. One day's riot can leave an entire park stripped of thousands of trees (Onganga, 1992).

2.10.6 Unorganized waste disposal

Rather than being a means of recycling urban waste, urban forests may be used as dumping grounds in manner that is wholly deleterious to the environment. Urban forests are considered by many people as the most ideal place to dump industrial waste. This is a major problem which is not easy to solve in Kenya because it involves very rich and influential people. Waste from tires, bottles, and other industrial by-products quite often covers several acres that otherwise could be used for tree planting. These waste products have also become a health hazard to the urban dwellers (Onganga 1992).

2.11 Changes in Urban Forests through Time

The structure of the urban forest changes through time in response to a wide range of powerful forces. These changes originate from diverse human and natural actions operating directly and indirectly on the urban forest and its management. The impacts of these forces for change vary over time and across and among urban systems; they contribute to different urban ecosystems and rates of change across urban areas. By understanding how human and natural forces interact within urban systems to create change, management can minimize negative forest changes and facilitate positive changes (Dwyer Nowak Noble and Sisinni, 2000).

Human forces for change in urban forests include

- Urban resident involvement in tree planting, maintenance, and management
- Plant community and species preferences or fads
- Influx of funds to plant trees and other vegetation
- Management of urban infrastructure
- Urban development and land use change
- Development of new urban forest management techniques and tools
- Increased interest in quality of the urban environment and urban life
- Changing character of the urban population (race, ethnicity, and age structure)
- Byproducts of urbanization (for example, air and water pollution)

Natural forces that can lead to changes in urban forest structure include

• Extreme precipitation or temperature events
• Storms and other natural disasters
• Fire
• Natural regeneration
• Aging of the existing forest
• Insect and disease outbreaks

(Dwyer Nowak Noble and Sisinni 2000)

What most distinguishes the urban forest from exurban forests is the dynamic influence of people. Human activities not only change urban forest structure to meet design and functional needs but also try to minimize and prevent detrimental changes due to natural forces (for example, controlling insects and diseases or altering structure to reduce the risk of wildfires) to sustain desired forest structure

A combination of human actions and natural forces will continue to shape the urban forests in the years ahead. These interacting forces highlight the need to coordinate urban forest resource management with many other urban activities (for example, land use planning, environmental protection, residential development, infrastructure development and maintenance, community empowerment and revitalization, and environmental education). Management of these complex, dynamic systems requires involvement of many disciplines, organizations, owners, users, and managers to sustain ecosystem health and desired functions.

A principal goal of urban forestry is to sustain forest structure, health, and benefits throughout the urban ecosystem over the long term. Comprehensive and adaptive management approaches are needed to do this. Expanding the management focus of urban forests to all trees, associated resources, and their benefits across the urban ecosystem will require nontraditional urban forest management techniques. The overall societal benefits of implementing such management are likely to be substantial (Dwyer Nowak Noble and Sisinni 2000).

Management also must be comprehensive in terms of its process, and it must be adaptive to allow for adjustments in management activities based on new situations and information. To attain comprehensive and adaptive management, urban forest managers should consider:

• The desires and needs of the community
• What urban forest structure is necessary to best address community needs?
• Periodically reassessing community needs and urban forest structure to ensure that management plans remain appropriate

To facilitate comprehensive and adaptive management to sustain the entire urban forest ecosystem, the following topic areas need to be emphasized:

• Improving inventory and assessment
• Improving dialogue among owners, managers, and users
• Fostering collaboration among agencies and groups

(Dwyer Nowak Noble and Sisinni 2000)

2.12 Opportunities for Improving Urban Forest Resource Management

• Improving the understanding of how forest configurations influence forest use and benefits
• Increasing knowledge about factors that influence urban forest health
• Improving the dissemination of information about urban forests and their management

With improvements in the above areas, urban forest resources can become a more highly valued component of large-scale and long-term environmental and community planning. Facilitating the effective management of urban forest ecosystems in the United States requires forging partnerships and collaborative efforts across resources, disciplines, organizations, and geographic areas. One continuing issue is to understand the relation between the management of urban and exurban resources, such that collaborative management efforts across these areas can be fostered. This assessment is the first step in developing a comprehensive understanding of the national urban forest resource and can assist in development of comprehensive adaptive management plans in both urban and exurban environments. As an increasingly urban population continues to play a key role in the social and political structure, understanding and managing of urban forest resources will be a critical mechanism for improving forest benefits and connecting people with ecosystems in the 21st century (Dwyer Nowak Noble and Sisinni 2000).

2.13 Attributes of the Urban Forestry

2.13.1 Diversity

Diversity is one of the most distinctive attributes of the urban forest. This feature is primarily a function of the many components of the urban forest, including trees and ground covers, soil types, microclimates, wildlife, people, buildings, infrastructure, and other developments. These elements are found in almost unlimited combinations in an intricate mosaic across the urban landscape. The elaborate mixture of natural and human-made resources in complex urban ecosystems broadens the scope of urban forestry beyond traditional forestry, arboriculture, and other natural resource disciplines. The diversity of urban forests is also a function of variations in land uses, land ownerships, residents and visitors, and management objectives across and between urban systems. Urban areas are characterized by multiple land uses and diverse populations; consequently, the management of activities by different individuals and groups creates a complex landscape pattern reflecting an area's unique combinations of physical, biological, and social attributes. With the diversity of land uses and owners in urban areas, the objectives and issues facing managers of the urban forest are wide ranging, extending from wildlife management to the mitigation of air pollution, enhancing aesthetic value, and providing recreation, flood control, fire prevention, and other benefits.

Several factors serve as catalysts for increased diversity in urban forest ecosystems. Shifts in population, changes in economic activity, improvements in transportation, and other developments increase the range of land uses, broaden the spectrum of people involved, and complicate the mixture of old and new, artificial and natural, and native and exotic natural resources in urban areas (Dwyer Nowak Noble and Sisinni 2000).

2.13.2 Connectedness

Connectedness among resource components, and with other resources, activities, and functions within and beyond the urban environment, is another key attribute of the urban forest. Other elements of urban environments include roads, homes, industrial parks, and downtown centers. Whether connected by the logistics of managing urban infrastructure (for example, coordinating maintenance of urban trees and power lines, sewers, sidewalks, and roads), or by contributing to the overall character of the area, urban forests link "landscape" with "architecture" and become an important component of urban planning.

The connectedness of urban forests is reflected in their contribution to a wide range of urban issues, programs, and initiatives. Urban forests and their management are connected to programs for improving air and water quality, flood control, energy conservation, microclimate control, aesthetic enjoyment, recreational opportunities, environmental education, and other goods and services in the urban environment. With the many benefits that urban vegetation can provide, the management of urban forests may be linked to an array of other urban initiatives, including urban renewal and community revitalization, economic development, community empowerment, and environmental education. Urban forests represent a critical link between people and forest resources. Ownership and use of residential holdings, as well as experience with public parks and forest preserves in urban areas, are how many citizens experience, appreciate, and learn about natural resources (Dwyer Nowak Noble and Sisinni 2000).

2.13.3 Dynamics

Like all forests, urban forests undergo significant change with the growth, development, and succession of their biological components over time. The growth and development of urban forest resources occur, however, in the context of much more powerful and swift human-induced factors. Coupled with the relatively slow rate of tree growth and plant succession, the swift human forces for change make the dynamics of the urban forest particularly challenging for managers and users. The expansion and development of urban areas bring important changes in urban vegetation and other urban resources. Alterations to the distribution of land uses, intensity of urbanization, and population characteristics in urban areas result in different combinations of ground cover, increased or decreased opportunities for tree establishment and growth, changing environmental conditions, different resource-use patterns, and altered management objectives. New developments in transportation technology or manufacturing and service industries can bring considerable change to the condition, function, and management of urban lands and associated resources. The introduction of exotic plants and animals into interstate and international trade centers can have a profound influence on the urban forest, as has been the case with Dutch elm disease, gypsy moth, and the Asian long horned beetle. Changes in the composition of neighborhoods can prompt different approaches to the management of forests in residential areas, parks, and other open spaces. Urban trees are becoming more widely appreciated for their ecological, economic, social, cultural, and historical value throughout the urban environment (Dwyer Nowak Noble and Sisinni, 2000).

2.14 Management of urban forestry in Bangladesh

The main objectives of managing urban forests in Bangladesh are- To Maintenance and sustenance of natural processes such as water, gaseous, nutrient cycles and support of flora and fauna, Provision of economic and social benefits, To get fuel wood and shade from urban forestry. Many of the general principles of arboriculture are applicable throughout the world, although specific management requirements will be dictated by such factors as the species and climatic regime in question. A poor choice of species can be ameliorated to a certain extent by appropriate arboricultural treatment; for example, a tree which has grown too tall for its surroundings can be pruned. However, this is undesirable for tree health, aesthetically unappealing, and wasteful in terms of maintenance costs. It would have been far better to select in the first place a tree that only reaches a low height on maturity. Important arboricultural principles of general application include site preparation, tree establishment and early maintenance, tree surgery and protection, and the removal of tree waste. Each is discussed briefly here, drawing attention to recent changes in thinking and practice. The extent to which these principles are currently followed in Bangladesh is generally uncertain, although mention is made if any information on this subject was available (Carter, 1993).

2.14.1 Site preparation

As noted above, urban soils are often poorly suited to tree growth. Common problems are low levels of available nutrients, and high compaction due to the impact of human and vehicular traffic. This is compounded by low soil organic matter levels. The 'traditional' response to this has been radical site amelioration prior to planting. Current thinking entails a more modified approach, depending on site conditions. In general, alleviation of soil compaction is seen as being more important than other soil treatments. This may be achieved in a number of ways, the most important being subsoil ripping of the planting site. Current arboricultural practice also places far more emphasis on choosing a species to fit the given site rather than modifying the site to fit the desired species (Carter, 1993).

2.14.2 Tree establishment and early maintenance

Plantation stock it is particularly crucial in urban settings to plant nursery stock of good form and quality, with a healthy root-to-shoot ratio. Saplings without this are unlikely to survive planting in compacted urban soils, but even if they do, they may become a hazard in later life, being more prone than trees with a well-developed root system to being blown over, or to other damage. Similarly, saplings which have damaged stems will grow into trees with an unbalanced branch system; this may not only look unsightly, but could be dangerous. The size of seedlings or saplings planted in urban situations is often considerably larger than those used in normal plantation forestry. However, the use of seedlings of no more than 60 cm height is now considered by many professionals to be sounder practice. They are often so much more vigorous than larger saplings that they catch up in size with the latter after a short period (Carter, 1993).

2.14.3 Planting techniques

Following site preparation, it is of course important to ensure that planting pits are dug to an adequate size, and preferable that they are prepared well in advance of, rather than at the moment of, planting. It may also be necessary to take into account the existence of underground utility services (water pipes, etc.) when planning where to plant. In professionally conducted urban plantings, particularly in the case of street trees, a variety of techniques may be employed to ensure good tree establishment and to guard against future problems (Webb, 1991).

2.14.4 Watering and mulching

Watering is often considered essential for the establishment of urban trees, but it may be very difficult to provide in some circumstances. One example is provided by tree growing in self-help housing areas where even drinking water is in short supply. Apart from taking the obvious precaution of timing planting to coincide with the beginning of the rains, and ensuring that the pit is at least well watered at the time of planting, various options may be considered. These include the use of drought-tolerant species, regular weeding, the application of mulch, irrigation (possibly using wastewater), and the incorporation at the time of planting of a pipe to facilitate water penetration (Carter, 1993).

2.14.5 Tree surgery and protection

Since the mid-1980s, arboricultural theory and practice in the Western world has been strongly influenced, if not "revolutionized", by the work of the American arboriculturalist, Alex Shigo. While his ideas are not universally accepted or even necessarily new, his practical recommendations are now quite widely implemented in North America, Europe, Australia and cities elsewhere with a strong urban forestry programme such as Hong Kong. In Bangladesh these practice need to be started. Possibly the most celebrated of Shigo's theories is that of CODIT, Compartmentalization of Decay in Trees. CODIT is a model that describes a tree's defense system - its response to wounding. It is used to explain why traditional pruning regimes using flush cuts are bad for tree health, and that 'Natural Target Pruning' (NTP), cutting off the branch at an angle (leaving the branch collar, if one exists, intact), is better practice. CODIT theory is also used as an argument against treating wounds with a seal to guard against pathogens. In place of sealants, a variety of gel formulations with systemic fungicidal properties are now more commonly recommended (Clifford and Gendle, 1987).

It is uncertain to what extent the ideas of Shigo are put into practice in developing countries, although it is unlikely that they are widely known or followed. In general, knowledge and skill in tree surgery varies widely by country. For example, Hill (1992) reports that in Quito, Ecuador, poor pruning practices were attributed to excessive demand for services and poor tools, rather than lack of experience and skill. In South China, Jim (1991) have noted that despite quite high standards of tree selection and planting design, pruning is conducted with very scant regard to tree health. Johnston added that this was certainly not merely a reflection of a lack of suitable equipment. Timely and efficient tree surgery is one of the most important means of preventing the spread of disease in trees once it occurs, but good arboricultural practice also implies minimizing the possibility of pest and disease attacks. Attention to this in the early years of tree establishment, including an appropriate choice of species/provenance/cultivar is clearly important, as is the prompt and complete removal of any infected tree material (which should be duly destroyed).

2.14.6 The removal of tree waste

Key issues in the removal of tree waste are public safety, utilization of removed material as appropriate, and (as mentioned above) limiting the spread of pests and diseases. In Bangladesh, many urban authorities make use of tree prunings by shredding it for compost or mulch, and such recycling is becoming an increasingly important feature of urban forest management. Inevitably urban trees grow old and must be removed, or parts of them removed, before they cause any damage. Technically, there are often complications in this due to the close proximity of buildings and other urban infrastructure. However, perhaps the most important issue for urban foresters is advance planning - ensuring that removal operations are timed to avoid any public hazard, rather than responding to one (Carter, 1993).

2.15 Management, structure, factors of urban forestry in Dhaka city

Urban forestry needs multi-management approach. It does necessitate appropriate planning before embarking upon an urban forestry programme. The goals based on the local needs have to be determined in the planning phase. A management plan should serve to sustain psychological health for human perception as well as to maintain whole some environment (Zabala, 1991).

The primary objective of urban forest management is to maintain the health and vigor of the vegetation without undue interference of the city dwellers. Apart from others, urban forest management has three fundamental needs, tree planting, maintenance and removal.

2.15.1 Species-site selection

The urban site is a complex environment where soil, temperature, moisture availability, pollutants etc. vary from one place to another. The species therefore, selected for planting at a given site must be adapted to it.

2.15.2 Species composition

Diversification of species is needed. As a general rule, the species composition promotes species diversification by restricting a species to not more than 15% of the population.

Spacing recommendation:

- Trees which attain bole dia greater than 30 cm when mature should be planted in space less than 1m
- Trees should not be planted within 10 m of an intersection
- Trees should not be planted within 3m of utility poles or fire hydrants.
- Large trees should be planted 12-18 m apart.
- Medium tree should be planted a minimum of 10 m apart
- Small trees should be planted a minimum of 8 m apart. (Zabala, 1991)

CHAPTER- III
MATERIALS AND METHODS

3.1 Description of Study Area

3.1.1 Climate of Dhaka

There is a hot, wet and humid tropical climate in Dhaka city as well as Dhaka North City Corporation. The city has a monsoonal season, with and annual average temperature of 26^0C and monthly mean varying between 19^0C in January and 29^0C in May (Weatherbase, 2008). The daily average maximum temperature in Dhaka city is 25^0C in January with the average of minimum 10^0C, while in the June the average maximum temperature is 32^0C with a minimum of 25^0C. The wettest month in Dhaka is July with an average rainfall of 367.9 mm while the driest month is December with 809 mm precipitation. The climate data were collected from secondary sources.

3.1.2 Geographical location and other factors of study area

The study was carried out in the Dhaka North City Corporation (DNCC) and it has located between 23º44-23º54 'N latitude and 90º20-90º28 'E longitudes respectively (Wikipedia, 2011). Dhaka North City Corporation (DNCC) is one of the two municipal corporations in Dhaka created when the former Dhaka City Corporation was divided. Dhaka North City Corporation is a populated area. It has covered 82.638 square kilometer area and consists of 36 number of wards covering the thanas Dhaka North City Corporation consists of 36 wards covering the thanas of Mirpur, Mohammadpur, Sher-E-Bangla Nagar, Pallabi, Adabor, Kafrul, Dhaka Cantonment, Tejgaon, Gulshan, Rampura, Banani, Khilkhet, Vatara, Turag, Badda, Uttara, Uttarkhan, Dakkshinkhan & some others. It has 28 parks, 15 playgrounds, 3 gardens graveyards 06 etc. It has also consists of 1337.913 km roads and 223.049 km footpath which also help to make a urban forest structure through street tree species (Ibrahim, 2014).

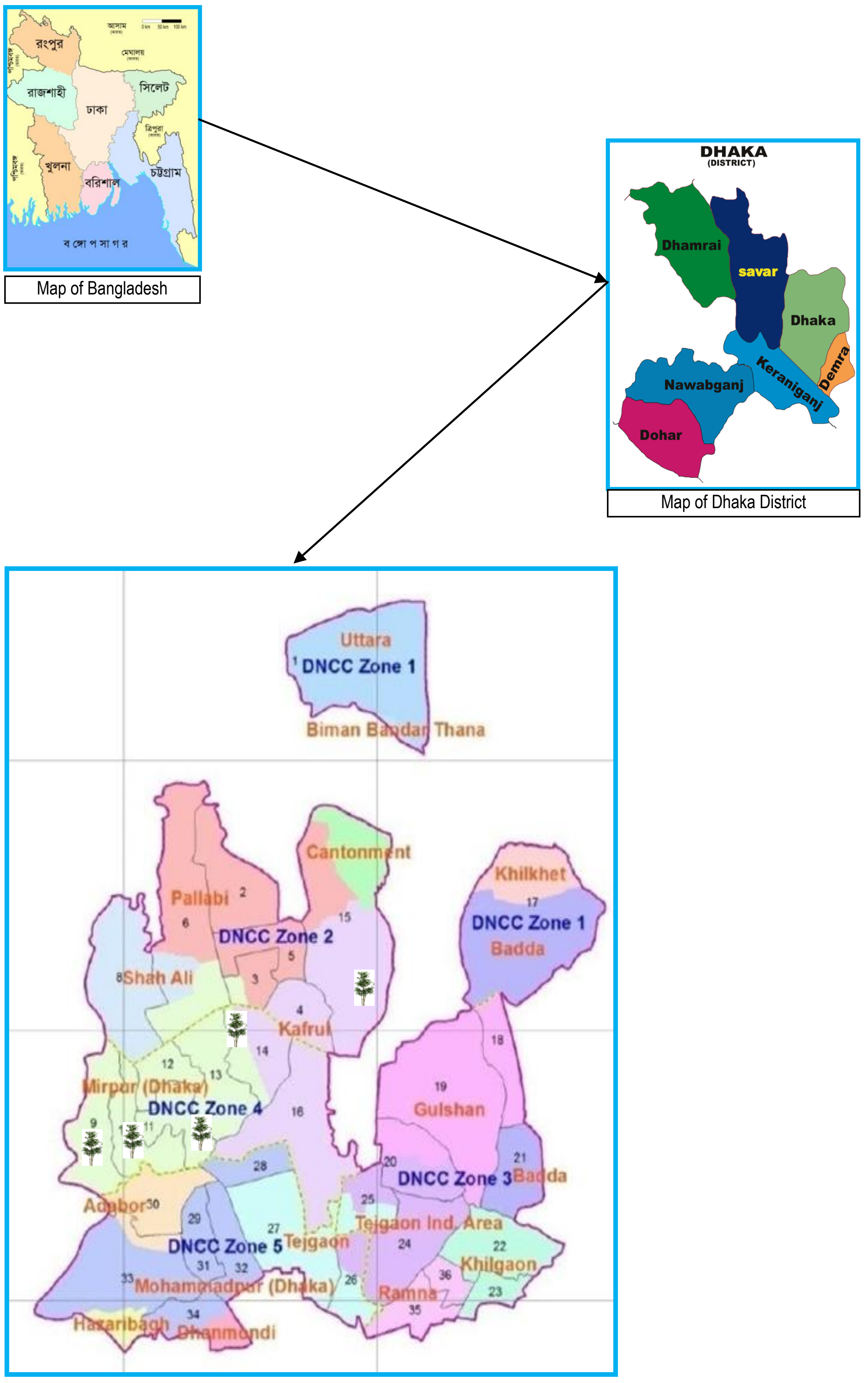
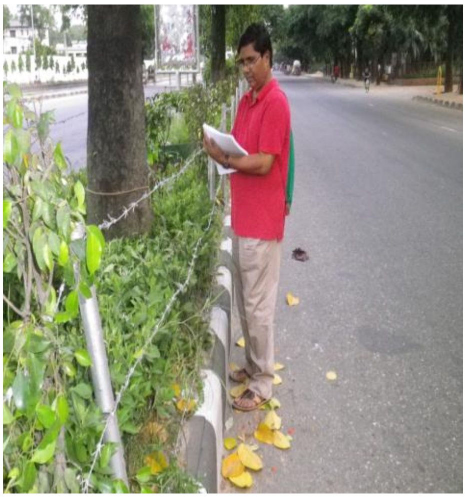


Figure 3.1: A map of DNCC mention with selected areas



a)

b)

c)

d)

a) Mirpur-2 Road
b) Rokeya Soroni
c) Zoo Road
d) Botanical Garden

Plate 1: Photographs shows the different study area

3.1.3 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 (FAO & UNDP, 1998). 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 5.6 (UNDP & FAO, 1998).

3.2 Data Collection

3.2.1 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 DNCC was divided into three categories according to its vegetation characteristics named:

1. Parks
2. Gardens and
3. Roadsides

In these 3 categories of habitat, the survey areas are selected through random sampling method. The selected areas for survey have been studied during the research:

Sl No	Name of Study Area	Location
1	Chandrima Uddan	Jatiyo Sangshad Bhaban
2	Botanical Garden	Mirpur
3	Rokeya Soroni	Mirpur Road
4	Mirpur -2 Road	Mirpur
5	Zoo Road	Mirpur

3.2.2 Equipment used in the field study

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

3.2.3 Secondary information Collection

The information's and relevant literature required for conducting this thesis paper were collected from various books, journals, articles, reports, publications, manuals, proceedings etc and related information's and literature were collected from internet sources.

3.3 Field Methods

3.3.1 Plot Sampling

The quantitative assessment of structure and composition of tree covers was done by following stratified random sampling method during March 2017. A list of all tree species in DNCC was prepared and five study areas (Chandrima Uddan, Botanical Garden, Rokeya Sarani, Mirpur -2 Road and Chiriakhana Road) were selected. In these 5 sampling areas were selected for data collection. These are:

SL No.	Study Area	Plot size (m^2)	No. of Sample Plot
1	Chandrima Uddan	30×20	10
2	Rokeya Sarani	30×5	5
3	Mirpur -2 Road	30×5	5
4	Zoo Road	30×5	5
5	Botanical Garden	30×20	15

In Chandrima Uddan, at least 30 meter plot to plot, Botanical Garden at least 100 meter plot to plot and in road side's 30 meter plot to plot distance was maintained.

3.3.2 Plant Species Sampling

A total of 40 sample plots (Chandrima Uddan, Botanical Garden, Rokeya Sarani, Mirpur-2 Road and Zoo Road) were taken from the three categories of habitats. All trees in each quadrate were recorded and the number of each tree species was quantified. The common species were identified directly in the field. A list of species was made with scientific name and family found in the sampling area. The species will be categorized into 3 categories. They are:

1) Tree layer: the tree species which are more than 1.5 meter in height.

2) Shrub layer: Tree species which are less than/equal to 1.5 meter in height.

3) Herb Layer: species which are less than/equal to 1 meter in height.

3.3.3 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:

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

Where, TR= Top reading

BR= Bottom reading and

HD= Horizontal distance

3.3.4 Data analysis

After finishing the collection of field data, all the 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. $$\text{Density of one species} = \frac{\text{Total No. of individuals of one species in all the quadrates}}{\text{Total No. of quadrates studied}} \times 100$$

2. $$\text{Relative density of one species} = \frac{\text{Total No. of individuals of one species in all the quadrates}}{\text{Total No. of individual of all species}} \times 100$$

3. $$\text{Frequency of one species} = \frac{\text{Total No. of quadrates in which the species occurs}}{\text{Total No. of quadrates studied}} \times 100$$

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

5. $$\text{Abundance of one species} = \frac{\text{Total No. of individuals of one species in all the quadrates}}{\text{Total No. of quadrates in which the species occurs}} \times 100$$

6. $$\text{Relative abundance of one species} = \frac{\text{Abundance of the species}}{\text{Total abundance of all the species}} \times 100$$

7. $$\text{Relative dominance of one species} = \frac{\text{Total basal area of one species in all quadrates}}{\text{Total basal area of all species in all quadrates}} \times 100$$

8. Importance Value Index = Relative density + Relative frequency + Relative dominance

The basal area/ha is calculated according to the following formula (Shukla and Chandel, 1980).

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

Basal area =$\pi\pi$ D^2/4.

Where, Ba = Basal area in m^2

D = Diameter at breast height in meter

Π = 3.14

CHAPTER-IV

RESULT AND DISCUSSION

This study aims to identify plant species composition and structure of some selected area of Dhaka North City Corporation (DNCC). Data obtained from the present study have been presented and results discussed in this chapter.

4.1 Composition of plant species

In this study 18 tree families were found at the Chandrima Uddan. Composition of plant species of Chandrima Uddan of all species are show in Table 4.1. Result found that the total number of plant was 226. The highest most dominant amount of tree individuals (44) was *Acacia auriculiformis* and it was 19.47% and the lowest amount of tree individuals 1.33% (number 3) was *Delonix regia* at Chandrima Uddan.

Table 4.1: Most dominant tree species found in Chandrima Uddan and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Akashmoni	*Acacia auriculiformis*	Fabaceae	44	19.47%
2	Tali Palm	*Borassus flabellifer*	Arecaceae	39	17.26%
3	Bottle Brush	*Callistemon lanceolatus*	Myrtaceae	23	10.18%
4	Katbadam	*Terminalia catappa*	Combrectaceae	21	9.29%
5	Asok	*Saraca asoca*	Fabaceae	18	7.96%
6	Rajkoroi	*Albizia richardiana*	Fabaceae	12	5.31%
7	Jackfruit	*Artocarpus heterophylus*	Moraceae	9	3.98%
8	Mango	*Mangifera indica*	Anacardiaceae	9	3.98%
9	Bokul	*Mimusops elengi*	Spotaceae	9	3.98%
10	Suli	*Astatotilapia calliptera*	Oleaceae	6	2.65%
11	Bel	*Aegle marmelos*	Rutaceae	6	2.65%
12	Amloki	*Emblica officinalis*	Phyllanthaceae	6	2.65%
13	Deshineem	*Azadirachta indica*	Meliaceae	6	2.65%
14	Mahua	*Madhuca talifolia*	Sapotaceae	4	1.77%
15	Badar Lati	*Cassia fistula*	Fabaceae	4	1.77%
16	Sissu	*Dalbergia sissoo*	Fabaceae	4	1.77%
17	Raintree	*Samanea saman*	Fabaceae	3	1.33%
18	Krishnachura	*Delonix regia*	Fabaceae	3	1.33%
				226	

In this study 11 shrub families were found at the Chandrima Uddan. Composition of shrub species of Chandrima Uddan of all species is show in Table 4.2. The total number of shrub was 214. The highest most dominant amount of herb individuals (50) was *Thuja orientalis* and it was 23.36% and the lowest amount of shrub individuals 4.21% (number 9) was *Ixora lutea* at Chandrima Uddan

Table 4.2: Most dominant Shrub species found in Chandrima Uddan and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Thuja	*Thuja orientalis*	Pinaceae	50	23.36%
2	Rongon white	*Ixora alba*	Rubiaceae	27	12.62%
3	Beli	*Jaeminum sambac*	Oleaceae	25	11.68%
4	Joba/China rose	*Hibiscus rosa sinensis*	Malvaceae	21	9.81%
5	Patabahar	*Codiaeum craigii*	Euphobiaceae	20	9.35%
6	Rongon golapi	*Ixora cinensis*	Rubiaceae	18	8.41%
7	Hasnahena -red	*Cestrum elegans*	Solanaceae	12	5.61%
8	Kamini	*Murraya exotica*	Rutaceae	12	5.61%
9	Cycus	*Cycus circunalis*	Cycadaceae	10	4.67%
10	Hasnahena -white	*Cestrum nocturnum*	Solanaceae	10	4.67%
11	Rongon yellow	*Ixora lutea*	Rubiaceae	9	4.21%
				214	

In this study 3 herb families were found at the Chandrima Uddan. Composition of herb species of Chandrima Uddan of all species is show in Table 4.3. The total number of herb was 370. The highestmost dominant amount of herb individuals (275) was *Combretum indicum* (Madhobilota*)* and it was 74.32% and the lowest amount of herb individuals 4.32% (number 16) was *Ixora lutea* at Chandrima Uddan.

Table 4.3: Most dominant herb species found in Chandrima Uddan and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Madobilota	*Combretum indicum*	Combretaceae	275	74.32%
2	Thuncuni	*Centella asiatica*	Umbelliferae	79	21.35%
3	Basok	*Adhtoda vasica*	Acanthaceae	16	4.32%
				370	

Composition of plant species of Rokeya Sarani of all species are show in Table 4.4. Result found that the total number of plant was 85. The highest dominant amount of tree individuals (40) was *Swietenia macrophylla* and it was 47.06% and the lowest amount of tree individuals 1.18% (number 1) was *Albizia lebbek* at Rokeya Sarani.

Table 4.4: Most dominant tree species found in Rokeya Sarani and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Mehagoni	*Swietenia macrophylla*	Meliaceae	40	47.06%
2	Bat	*Ficus bengalensis*	Moraceae	12	14.12%
3	Bokul	*Mimusops elengi*	Sapotaceae	11	12.94%
4	Debdaru	*Polyalthia longifolia*	Annonaceae	6	7.06%
5	Mango	*Mangifera indica*	Anacardiaceae	3	3.53%
6	Dumur	*Ficus carica*	Moraceae	3	3.53%
7	Jam	*Syzygium cumini*	Myrtaceae	3	3.53%
8	Mahua	*Madhuca talifolia*	Sapotaceae	2	2.35%
9	Chinease Bat	*Ficus microcarpa*	Moraceae	2	2.35%
10	Deshineem	*Azadirachta indica*	Meliaceae	1	1.18%
11	Kadam	*Neolamarckia cadamba*	Rubiaceae	1	1.18%
12	Kalkoroi	*Albizia lebbek*	Fabaceae	1	1.18%
				85	

Composition of shrub species of Rokeya Sarani of all species is show in Table 4.5. The total number of shrub was 386. The highest dominant amount of herb individuals (285) was *Bignonia indica* L.(Kanaidinga) and it was 73.83% and the lowest amount of shrub individuals 3.11% (number 12) was *Jaeminum sambac* at Rokeya Sarani.

Table 4.5: Most dominant Shrub species found in Rokeya Sarani and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Kanaidinga	*Bignonia indica* L.	Bignoniaceae	285	73.83%
2	Patabahar	*Codiaeum craigii*	Euphobiaceae	35	9.07%
3	Baganbilus			29	7.51%
4	Rongon golapi	*Ixora cinensis*	Rubiaceae	25	6.48%
5	Beli	*Jaeminum sambac*	Oleaceae	12	3.11%
				386	

Composition of plant species of Mirpur -2 Road of all species are show in Table 4.6. Result found that the total number of plant was 60. The highest dominant amount of tree individuals (15) was *Mimusops elengi* and it was 25.00% and the lowest amount of tree individuals 1.67% (number 1) was *Mangifera indica* at Mirpur -2 Road.

Table 4.6: Most dominant tree species found in Mirpur -2 Road and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Bokul	*Mimusops elengi*	Spotaceae	15	25.00%
2	Akashmoni	*Acacia auriculiformis*	Fabace	12	20.00%
3	Debdaru	*Polyalthia longifolia*	Annonaceae	10	16.67%
4	Mehagoni	*Swietenia macrophylla*	Meliaceae	6	10.00%
5	Katbadam	*Terminalia catappa*	Combrectaceae	4	6.67%
6	Bat	*Ficus bengalensis*	Moraceae	3	5.00%
7	Chinease Bat	*Ficus microcarpa*	Moraceae	3	5.00%
8	Jarul	*Lagerstroemia speciosa*	Lythraceae	3	5.00%
9	Jhau	*Casuarinas equisetifolia*	Casuarinaceae	2	3.33%
10	Sissu	*Dalbergia sissoo*	Fabaceae	1	1.67%
11	Mango	*Mangifera indica*	Anacardiaceae	1	1.67%
				60	

Composition of shrub species of Mirpur -2 Road of all species is show in Table 4.7. The total number of shrub was 758. The highest dominant amount of shrub individuals (355) was *Bignonia indica* L.(Kanaidinga) and it was 46.83% and the lowest amount of shrub individuals 1.72% (number 13) was *Ixora cinensis* at Mirpur -2 Road. Dominant herb species are not found in Mirpur-2 Road

Table 4.7: Most dominant Shrub species found in Mirpur-2 Road and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurance
1	Kanaidinga	*Bignonia indica* L.	Bignoniaceae	355	46.83%
2	Patabahar	Codiaeum craigii	Euphorbiaceae	225	29.68%
3	Baganbilus-yellow	Bellis perennis L.	Asteraceae	61	8.05%
4	Baganbilus-golapi	Bellis sp.	Asteraceae	46	6.07%
5	Beli	Jaeminum sambac	Oleaceae	33	4.35%
6	Thuja	Thuja orientalis	Pinaceae	25	3.30%
7	Rongon golapi	Ixora cinensis	Rubiaceae	13	1.72%
				758	

Composition of plant species of Chiriakhana Road of all species are show in Table 4.8. Result found that the total number of plant was 276. The highest dominant amount of tree individuals (264) was *Swietenia macrophylla* and it was 95.65% and the lowest amount of tree individuals 4.35% (number 12) was *Arecaceae palmae* at Chiriakhana Road. Dominant shrub & herb species are not found in Chiriakhana Road

Table 4.8: Most dominant tree species found in Chiriakhana Road and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Palm	*Arecaceae palmae*	Arecaceae	12	4.35%
2	Mehagoni	*Swietenia macrophylla*	Meliaceae	264	95.65%
				276	

Composition of plant species of Botanical Garden of all species are show in Table 4.9. Result found that the total number of plant was 621. The highest dominant amount of tree individuals (165) was *Polyalthia longifolia* and it was 26.57% and the lowest amount of tree individuals 0.97% (number 6) was *Pennisetum glaucum* at Botanical Garden.

Table 4.9: Most dominant tree species found in Botanical Garden and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Debdaru	*Polyalthia longifolia*	Annonaceae	165	26.57%
2	Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae	135	21.74%
3	Casia	*Cassia fistula*	Fabaceae	57	9.18%
4	Talia Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae	54	8.70%
5	Green Pine	*Pinus densiflora*	Pinaceae	51	8.21%
6	Eucalyptus	*Eucalyptus camaldulensis*	Myrtaceae	51	8.21%
7	Mehagoni	*Swietenia macrophylla*	Meliaceae	45	7.25%
8	Akashmoni	*Acacia auriculiformis*	Bignoniaceae	24	3.86%
9	Jackfruit	*Artocarpus heterophylus*	Moraceae	9	1.45%
10	Cordia	*Cordia eliodora*	Boraginaceae	9	1.45%
11	Hortoki	*Terminalia chebula*	Combrectaceae	9	1.45%
12	Palm	*Arecaceae palmae*	Arecaceae	6	0.97%
13	Bajra	*Pennisetum glaucum*	Poaceae	6	0.97%
				621	

Composition of shrub species of Botanical Garden of all species is show in Table 4.10. The total number of shrub was 1165. The highest dominant amount of shrub individuals (235) was *Codiaeum craigii* and it was 20.17% and the lowest amount of shrub individuals 2.58% (number 30) was *Hibiscus rosa sinensis* at Botanical Garden.

Table 4.10: Most dominant Shrub species found in Botanical Garden and their common name, scientific name, family and % of occurrence

Sl No	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Patabahar	*Codiaeum craigii*	Euphobiaceae	235	20.17%
2	Beli	*Jaeminum sambac*	Oleaceae	205	17.60%
3	Thuja	*Thuja orientalis*	Pinaceae	167	14.33%
4	Hasnahena -white	*Cestrum nocturnum*	Solanaceae	150	12.88%
5	Rongon yellow	*Ixora lutea*	Rubiaceae	133	11.42%
6	Rongon white	*Ixora alba*	Rubiaceae	115	9.87%
7	Rongon golapi	*Ixora cinensis*	Rubiaceae	99	8.50%
8	Cycus	*Cycus circunalis*	Cycadaceae	31	2.66%
9	Joba/China rose	*Hibiscus rosa sinensis*	Malvaceae	30	2.58%
				1165	

Composition of herb species of Botanical Garden of all species is show in Table 4.11. The total number of herb was 146. The highest dominant amount of herb individuals (55) was *Adhtoda vasica* and it was 37.67% and the lowest amount of herb individuals 10.27% (number 15) was *Kalanchae pinnata* at Botanical Garden.

Table 4.11: Most dominant herb species found in Botanical Garden and their common name, scientific name, family and % of occurrence

Sl No.	Common Name	Scientific Name	Family Name	Number	% of occurrence
1	Basok	*Adhtoda vasica*	Acanthaceae	55	37.67%
2	Thuncuni	*Centella asiatica*	Umbelliferae	28	19.18%
3	Fern	*Pteris sp.*	Polypodiaceae	25	17.12%
4	Zinnia -yellow	*Zinnia elegans*	Composite	23	15.75%
5	Patharcuchi	*Kalanchae pinnata*	Crassulaceae	15	10.27%
				146	

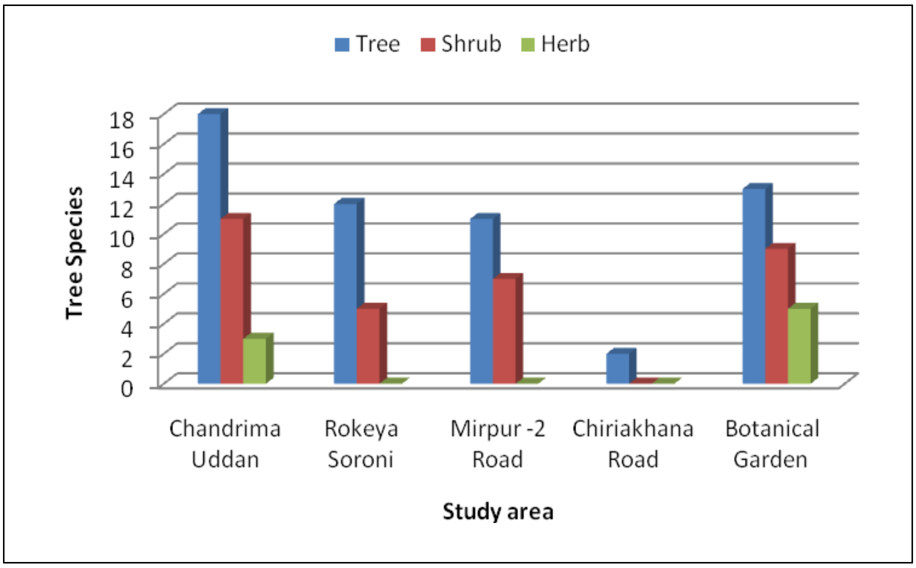


Fig 4.1 Showing Number of tree species in five study area

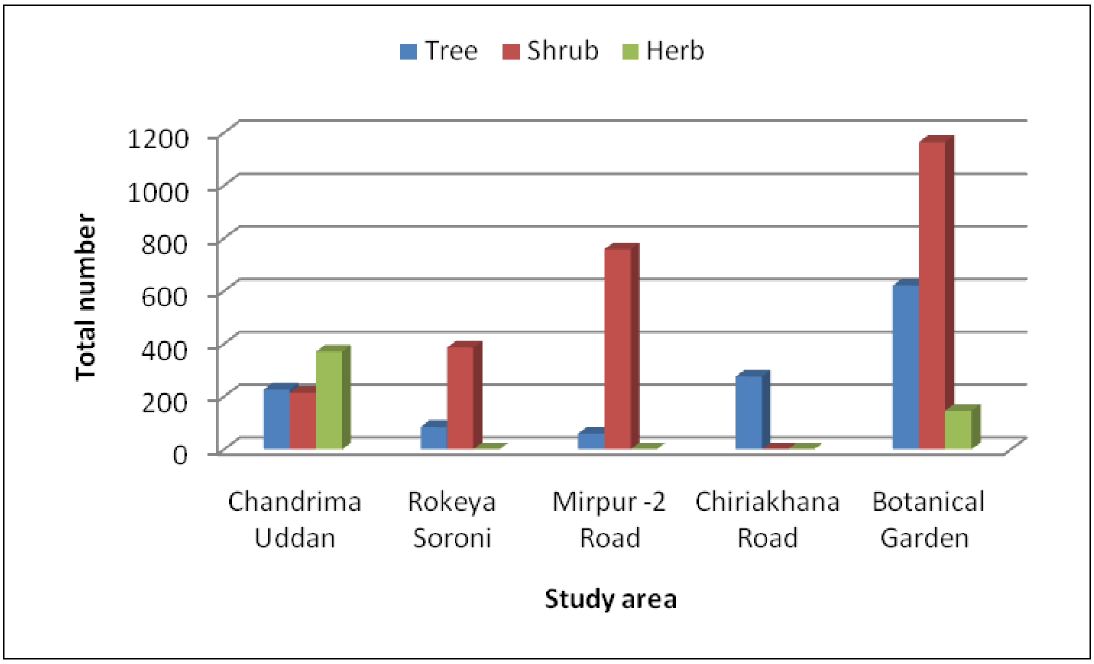


Fig 4.2 Showing total Number of tree, shrub and herb in five study area

4.2 Structural Diversity of Tree

4.2.1 Height Class (in m)

Structural diversity of all species are show in Table 4.12 of Chandrima Uddan, Rokeya Sarani, Mirpur-2 Road, Chiriakhana Road and Botanical Garden study area. In Chandrima Uddan the tree ranges from 3.5 – 23 m in height class with an average 9.76 m. Result found that the highest amount of tree individuals 117 was found at heights (8-16 m) and the lowest amount of tree individuals 40 was found at heights (16-24 m) at Chandrima Uddan.

In Rokeya Sarani the tree ranges from 1.20 – 18.00 m in height class with an average 6.52 m. Result found that the highest amount of tree individuals 47 was found at heights (1.6-8 m) and the lowest amount of tree individuals 1 was found at heights (16-24 m) at Rokeya Sarani.

In Mirpur -2 Road the tree ranges from 2.25 – 16.00 m in height class with an average 7.64 m. Result found that the highest amount of tree individuals 46 was found at heights (1.6-8 m) and the lowest amount of tree individuals 14 was found at heights (8-16 m) at Mirpur -2 Road.

In Zoo Road the tree ranges from 0.25 – 17.50 m in height class with an average 11.2 m. Result found that the highest amount of tree individuals 184 was found at heights (8-16 m) and the lowest amount of tree individuals 0 was found at heights (<1.60 m) at Chiriakhana Road.

In Botanical garden the tree ranges from 4.25-35.5 m in height class with an average 30.54 m. Result found that the highest amount of tree individuals 202 was found at heights (8-16 m) and the lowest amount of tree individuals 40 was found at heights (1.6-40 m) at Botanical garden.

For comparison among five studies area it was found that tree individual of Botanical garden had more height among all study areas.

Table 4.12: Tree individuals' distribution in different height classes (in m) at the five different study areas

Height class (in m)	Chandrima Uddan	Rokeya Sarani	Mirpur-2 Road	Zoo Road	Botanical garden
< 1.60 m	00	0	0	6	0
(1.6 - 8) m	75	47	46	75	40
(8 - 16) m	117	37	14	184	202
(16 - 24) m	34	1	0	11	137
(24 - 32) m	0	0	0	0	141
>32 m	0	0	0	0	101
Total tree (no.)	**226**	**85**	**60**	**276**	**621**
Average	9.76	6.52	7.64	11.2	30.54
Range (m)	3.50-23.00	1.20-18.00	2.25-16.00	0.25-17.50	4.25-35.50

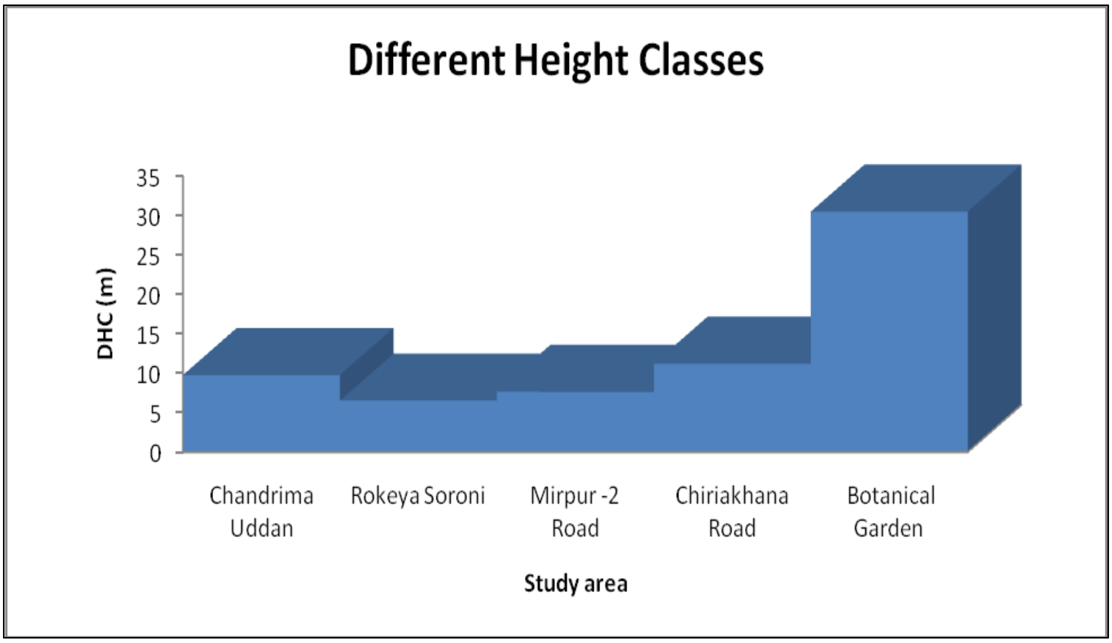


Fig. 4.3 Showing different height classes of trees at five different study areas

4.2.2 DBH (cm)

In Chandrima Uddan the tree ranges from 14 – 195 cm in diameter and with an average 112.4 cm at breast height (DBH) class. Result found that the highest amount of tree individuals 72 was found at heights (>100 cm) and the lowest amount of tree individuals 1 was found at heights (91-100 cm) at Chandrima Uddan.

In Rokeya Sarani the tree ranges from 15 – 250 cm and with an average 99.76 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 13 was found in DBH class (31-40 cm) and the lowest amount of tree individuals 4 was found in DBH class (10-20 cm and 91-100 cm) at Rokeya Sarani.

In Mirpur- 2 Road the tree ranges from 87 – 140 cm and with an average 87.54 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 16 was found in DBH class (10-20 cm) and the lowest amount of tree individuals 2 was found in DBH class (61-70 cm) at Mirpur -2 Road.

In Zoo Road the tree ranges from 53 – 150 cm and with an average 95.97 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 31 was found in DBH class (61-70 cm) and the lowest amount of tree individuals 67 was found in DBH class (91-100 cm) at Zoo Road.

In Botanical garden the tree ranges from 17-207 cm and with an average 154 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 503 was found in DBH class (>100 cm) and the lowest amount of tree individuals 6 was found in DBH class (10-20 cm and 20-30 cm) at Botanical garden.

For comparison among five studies area it was found that tree individual of Botanical garden had more diameter at breast height (dbh) among all study area.

Table 4.13: Tree individuals' distribution in different DBH (Diameter at breast height) in centimeter classes at the five study areas

DBH (cm) class	Chandrima Uddan	Rokeya Sarani	Mirpur-2 Road	Chiriakhana Road	Botanical garden
<10 cm	0	0	3	0	0
10-20 cm	7	4	16	0	6
21-30 cm	0	7	5	0	6
31-40 cm	31	13	5	0	0
41-50	51	6	7	0	0
51-60	20	5	3	35	8
61-70	15	6	2	31	13
71-80	17	5	6	41	17
81-90	12	9	5	40	40
91-100	1	4	5	67	28
>100	72	26	3	62	503
Total tree (no.)	**226**	**85**	**60**	**276**	**621**
Average	112.4	99.76	87.54	95.97	154.35
Range (cm)	14-195	15-250	87-140	53-150	17-207

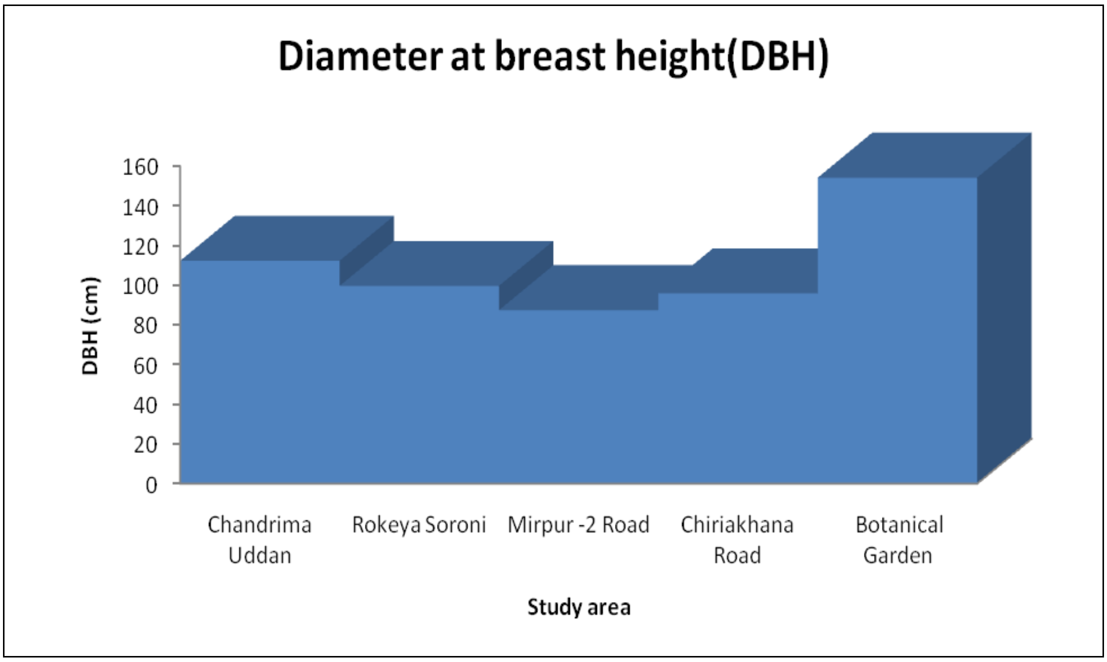


Fig. 4.4 Showing Diameter at Breast Height (DBH) of trees at five different study areas

4.3 Structural attributes of tree species found in five study areas

Table 4.14, 4.15, 4.16, 4.17 and 4.18 show the relative density, relative frequency, relative abundance, relative dominance and importance value index of dominant tree species of Chandrima Uddan, Rokeya Saroni, Mirpur-2 Road, Chiriakhana Road and Botanical garden study area.

From the Table 4.14 it was found that total 18 species and total number of 226 tree was found at Chandrima Uddan study area. It becomes evident that only six tree species *Acacia auriculiformis* (44), *Borassus flabellifer* (39), *Callistemon lanceolatus* (23), *Albizia richardiana* (12), *Saraca asoca* (18) and *Terminalia catappa* (21) are occurring at Chandrima Uddan within the dominant tree species. The highest number of plant was found in *Acacia auriculiformis* (44) followed by *Borassus flabellifer* (39) and the lowest number was found in *Samanea saman* (3) and *Delonix regia* (3) at Chandrima Uddan.

Table 4.14: Structural attributes of dominant tree species at Chandrima Uddan are listed

Botanical Name	Local/Common Name	No	Relative density (RD %)	Relative frequency (RF %)	Relative abundance (RA %)	Relative dominance (RDo %)	Importance value index (IVI)
Acacia auriculiformis	Akashmoni	44	19.47	12.28	9.39	27.33	59.08
Borassus flabellifer	Tali Palm	39	17.26	11.40	8.96	25.79	54.45
Madhuca talifolia	Mahua	4	1.77	4.39	2.39	1.804	7.96
Badar Lati	Badar Lati	4	1.77	4.39	2.39	0.842	7.00
Dalbergia sissoo	Sissu	4	1.77	4.39	2.39	2.485	8.64
Callistemon lanceolatus	Bottle Brush	23	10.18	10.53	5.73	6.453	27.16
Artocarpus heterophylus	Jackfruit	9	3.98	4.39	5.38	5.952	14.32
Astatotilapia calliptera	Suli	6	2.65	2.63	5.98	1.503	6.79
Aegle marmelos	Bel	6	2.65	2.63	5.98	1.172	6.46
Albizia richardiana	Rajkoroi	12	5.31	4.39	7.17	9.259	18.95
Saraca asoca	Asok	18	7.96	4.39	10.76	2.886	15.24
Emblica officinalis	Amloki	6	2.65	7.02	2.24	0.436	10.11
Mangifera indica	Mango	9	3.98	2.63	8.96	4.148	10.76
Mimusops elengi	Bokul	9	3.98	4.39	5.38	0.496	8.86
Samanea saman	Raintree	3	1.33	1.75	4.48	1.533	4.61
Delonix regia	Krishnachura	3	1.33	1.75	4.48	1.428	4.51
Terminalia catappa	Katbadam	21	9.29	9.65	5.70	4.945	23.89
Azadirachta indica	Deshineem	6	2.65	7.02	2.24	1.533	11.21

It was found that total 12 species and total number of 85 trees was found at Rokeya Sarani study area (Table 4.15). It becomes evident that only five tree species *Mimusops elengi* (11), *Swietenia macrophylla* (40), *Ficus bengalensis* (12) and *Polyalthia longifolia* (6) are occurring at Rokeya Sarani within the dominant tree species. The highest number of plant was found in *Swietenia macrophylla* (40) and the lowest number was found in *Azadirachta indica* (1), *Neolamarckia cadamba* (1) and *Albizia lebbek* (1) at Rokeya Sarani.

Table 4.15: Structural attributes of dominant tree species at Rokeya Sarani are listed

Botanical Name	Common/ Local Name	No	Relative density (RD %)	Relative frequency (RF %)	Relative abundance (RA %)	Relative dominance (RDo %)	Importance value index (IVI)
Madhuca talifolia	Mahua	2	2.35	6.06	4.33	3.211	11.62
Mangifera indica	Mango	3	3.53	6.06	6.49	0.564	10.15
Mimusops elengi	Bokul	11	12.94	15.15	9.52	12.59	40.68
Azadirachta indica	Deshineem	1	1.18	3.03	4.33	0.566	4.77
Swietenia macrophylla	Mehagoni	40	47.06	15.15	34.63	58.95	121.16
Polyalthia longifolia	Debdaru	6	7.06	12.12	6.49	7.342	26.52
Neolamarckia cadamba	Kadam	1	1.18	3.03	4.33	0.816	5.02
Albizia lebbek	Kalkoroi	1	1.18	3.03	4.33	1.882	6.09
Ficus bengalensis	Bat	12	14.12	15.15	10.39	6.632	35.90
Ficus microcarpa	Chinease Bat	2	2.35	6.06	4.33	0.974	9.39
Ficus carica	Dumur	3	3.53	9.09	4.33	1.461	14.08
Syzygium cumini	Jam	3	3.53	6.06	6.49	5.013	14.60

It was found that total 11 species and total number of 60 trees was found at Mirpur-2 Road study area (Table 4.16). It becomes evident that only five tree species *Acacia auriculiformis* (12), *Mimusops elengi* (15), *Swietenia macrophylla* (6) and *Polyalthia longifolia* (10) are occurring at Mirpur-2 Road within the dominant tree species. The highest number of plant was found in *Mimusops elengi* (15) and the lowest number was found in *Dalbergia sissoo* (1) at Mirpur-2 Road.

Table 4.16: Structural attributes of dominant tree species at Mirpur-2 Road are listed

Botanical name	Local/Common Name	No	Relative density (RD %)	Relative frequency (RF %)	Relative abundance (RA %)	Relative dominance (RDo %)	Importance value index (IVI)
Acacia auriculiformis	Akashmoni	12	26.09	13.89	8.44	29.85	69.82
Dalbergia sissoo	Sissu	1	2.17	2.78	3.52	1.595	6.55
Mimusops elengi	Bokul	15	32.61	2.78	52.76	4.96	40.35
Mangifera indica	Mango	1	2.17	2.78	3.52	2.47	7.42
Terminalia catappa	Katbadam	4	8.70	8.33	4.69	2.101	19.13
Swietenia macrophylla	Mehagoni	6	13.04	13.89	4.22	12.84	39.77
Polyalthia longifolia	Debdaru	10	21.74	13.89	7.03	14.59	50.22
Ficus bengalensis	Bat	3	6.52	8.33	3.52	2.859	17.71
Ficus microcarpa	Chinease Bat	3	6.52	5.56	5.28	2.159	14.24
Lagerstroemia speciosa	Jarul	3	6.52	8.33	3.52	5.485	20.34
Casuarinas equisetifolia	Jhau	2	4.35	5.56	3.52	4.707	14.61

From the Tabe 4.17 it was found that total 2 species and total number of 276 tree was found at Chiriakhana Road study area. It becomes evident that only five tree species *Arecaceae palmae* (12) and *Swietenia macrophylla* (264) are occurring at Chiriakhana Road within the dominant tree species. The highest number of plant was found in *Swietenia macrophylla* (264) and the lowest number was found in *Arecaceae palmae* (12) at Chiriakhana Road.

Table 4.17: Structural attributes of dominant tree species at Chiriakhana Road are listed

Botanical Name	Local/Common Name	No	Relative density (RD %)	Relative frequency (RF %)	Relative abundance (RA %)	Relative dominance (RDo %)	Importance value index (IVI)
Arecaceae palmae	Palm	12	4.35	47.37	4.81	5.198	56.91
Swietenia macrophylla	Mehagoni	264	95.65	52.63	95.20	94.8	243.09

It was found that total 13 species and total number of 621 tree was found at Botanical Garden stady area (Table 4.18). It becomes evident that only five tree species *Acacia auriculiformis* (24), *Swietenia macrophylla* (45), *Polyalthia longifolia* (165), *Dipterocarpus turbinatus* (Garjan 135), *Dipterocarpus turbinatus* (Talia Garjan 54), *Pinus densiflora* (51), *Cassia fistula* (57) and *Eucalyptus camaldulensis* (51) are occurring at Botanical Garden within the dominant tree species. The highest number of plant was found in *Polyalthia longifolia* (165) and the lowest number was found in *Arecaceae palmae* (6) and *Pennisetum glaucum* (6) at Botanical Garden.

Table 4.18: Structural attributes of dominant tree species at Botanical Garden are listed

Botanical name	Local Name	No	Relative density (RD %)	Relative frequency (RF %)	Relative abundance (RA %)	Relative dominance (RDo %)	Importance value index (IVI)
Acacia auriculiformis	Akashmoni	24	3.86	9.15	3.92	3.214	16.23
Artocarpus heterophylus	Jackfruit	9	1.45	4.93	2.73	0.825	7.20
Swietenia macrophylla	Mehagoni	45	7.25	9.15	7.34	7.383	23.78
Polyalthia longifolia	Debdaru	165	26.57	10.56	23.33	29.26	66.39
Arecaceae palmae	Palm	6	0.97	3.52	2.55	0.63	5.12
Dipterocarpus turbinatus	Garjan	135	21.74	10.56	19.09	24.92	57.22
Dipterocarpus turbinatus	Talia Garjan	54	8.70	9.86	8.18	8.599	27.15
Cordia eliodora	Cordia	9	1.45	4.93	2.73	1.27	7.65
Pinus densiflora	Green Pine	51	8.21	9.15	8.32	6.644	24.01
Cassia fistula	Casia	57	9.18	9.86	8.64	8.801	27.84
Terminalia chebula	Hortoki	9	1.45	4.93	2.73	0.261	6.64
Eucalyptus camaldulensis	Eucalyptus	51	8.21	9.15	8.32	7.936	25.30
Pennisetum glaucum	Bajra	6	0.97	4.23	2.12	0.261	5.45

CHAPTER -V

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The present study was conducted to identify the vegetation status and to find out the structure and composition of plant species in Dhaka North City Corporation (DNCC). The study was conducted from 1 January 2017 to 31 March 2017. Data was collected from three habitat category (Parks, gardens and roads) in DNCC. The study areas are Chandrima Uddan, Botanical Garden, Rokeya Sarani, Mirpur -2 Road and Chiriakhana Road. 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.

In this study, tree families were found at the Chandrima Uddan, Rokeya Soroni, Mirpur -2 Road, Chiriakhana Road and Botanical Garden were 18, 12,11, 2 and 13 respectively. Similarly, Shrub families were found at the Chandrima Uddan, Rokeya Soroni, Mirpur -2 Road, Chiriakhana Road and Botanical Garden were 11, 5,7,0 and 9 respectively. Herb families were found at the Chandrima Uddan, Rokeya Soroni, Mirpur -2 Road, Chiriakhana Road and Botanical Garden were 3, 0, 0, 0 and 5 respectively. Result found that the total number of plant was 226. The highest amount of tree individuals (44) was *Acacia auriculiformis* and it was 19.47% and the lowest amount of tree individuals 1.33% (number 3) was *Delonix regia* at Chandrima Uddan. The total number of shrub was 214. The highest amount of herb individuals (50) was *Thuja orientalis* and it was 23.36% and the lowest amount of tree individuals 4.21% (number 9) was *Ixora lutea* at Chandrima Uddan. The total number of herb was 370. The highest amount of herb individuals (275) was *Combretum indicum (Madhobilota)* and it was 74.32% and the lowest amount of tree individuals 4.32% (number 16) was *Ixora lutea* at Chandrima Uddan. Result found that the total number of plant was 85. The highest amount of tree individuals (40) was *Swietenia macrophylla* and it was 47.06% and the lowest amount of tree individuals 1.18% (number 1) was *Albizia lebbek* at Rokeya Sarani. The total number of shrub was 386. The highest amount of herb individuals (285) was *Bignonia indica* L.(Kanaidinga) and it was 73.83% and the lowest amount of tree individuals 3.11% (number 12) was *Jaeminum sambac* at Rokeya Sarani. Herb species are not found in Rokeya Sarani. Result found that the total number of plant was 60. The highest amount of tree individuals (15) was *Mimusops elengi* and it was 25.00% and the lowest amount of tree individuals 1.67% (number 1) was *Mangifera indica* at Mirpur -2 Road. The total number of shrub was 758. The highest amount of herb individuals (355) was Kanaidinga and it was 46.83% and the lowest amount of tree individuals 1.72% (number 13) was *Ixora cinensis* at Mirpur -2 Road. Herb species are not found in Mirpur-2 Road. Result found that the total number of plant was 276. The highest amount of tree individuals (264) was *Swietenia macrophylla* and it was 95.65% and the lowest amount of tree individuals 4.35% (number 12) was *Arecaceae palmae* at Chiriakhana Road. Shrub & Herb species are not found in Chiriakhana Road. Result found that the total number of plant was 621. The highest amount of tree individuals (165) was *Polyalthia longifolia* and it was 26.57% and the lowest amount of tree individuals 0.97% (number 6) was *Pennisetum glaucum* at Botanical Garden. The total number of shrub was 1165. The highest amount of shrub individuals (235) was *Codiaeum craigii* and it was 20.17% and the lowest amount of tree individuals 2.58% (number 30) was *Hibiscus rosa sinensis* at Botanical Garden. The total number of herb was 146. The highest amount of herb individuals (55) was *Adhtoda vasica* and it was 37.67% and the lowest amount of tree individuals 10.27% (number 15) was *Kalanchae pinnata* at Botanical Garden.

In Chandrima Uddan the tree ranges from 3.5 – 23 m in height class with an average 9.76 m.. Results found that the highest amount of tree individuals 117 was found at heights (8-16 m). In Rokeya Sarani the tree ranges from 1.20 – 18.00 m in height class with an average 6.52 m. Result found that the highest amount of tree individuals 46 was found at heights (1.6-8 m). In Mirpur- 2 Road the tree ranges from 2.25 – 16.00 m in height class with an average 7.64 m. Result found that the highest amount of tree individuals 46 was found at heights (1.6-8 m). In Chiriakhana Road the tree ranges from 0.25 – 17.50 m in height class with an average 11.2 m. Result found that the highest amount of tree individuals 184 was found at heights (8-16 m). In Botanical garden the tree ranges from 4.25-35.5 m in height class with an average 30.54 m. Result found that the highest amount of tree individuals 202 was found at heights (8-16 m). For comparison among five studies area it was found that tree individual of Botanical garden had more height among all study areas.

In Chandrima Uddan the tree ranges from 14 – 195 cm and with an average 112.4 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 72 was found at heights (>100 cm). In Rokeya Saroni the tree ranges from 15 – 250 cm and with an average 99.76 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 13 was found in DBH class (31-40 cm). In Mirpur 2 Rod the tree ranges from 87 – 140 cm with an average 87.54 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 16 was found in DBH class (10-20 cm). In Chiriakhana Road the tree ranges from 53 – 150 cm with an average 95.97 cm in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 31 was found in DBH class (61-70 cm). In Botanical garden the tree ranges from 17-207 with an average 154.00 cm m in diameter at breast height (DBH) class. Result found that the highest amount of tree individuals 503 was found in DBH class (>100 cm) at Botanical garden. For comparison among five studies area it was found at tree individual of Botanical garden had more diameter at breast height (DBH) among all study area.

5.2 CONCLUSION:

It was found that total 18 species and total number of 226 trees was found at Chandrima Uddan study area. The highest number of plant was found in *Acacia auriculiformis* (44) followed by *Borassus flabellifer* (39) and the lowest number was found in *Samanea saman* (3) and *Delonix regia* (3) at Chandrima Uddan. It was found that total 12 species and total number of 85 trees was found at Rokeya Saroni study area. The highest number of plant was found in *Swietenia macrophylla* (40) and the lowest number was found in *Azadirachta indica* (1), Rokeya Sarani. It was found that total 11 species and total number of 60 trees was found at Mirpur-2 Road stady area. The highest number of plant was found in *Mimusops elengi* (15) and the lowest number was found in *Dalbergia sissoo* (1) at Mirpur-2 Road. It was found that total 2 species and total number of 276 trees was found at Chiriakhana Road stady area. The highest number of plant was found in *Swietenia macrophylla* (264) and the lowest number was found in *Arecaceae palmae* (12) at Chiriakhana Road. It was found that total 13 species and total number of 621 tree was found at Botanical Garden study area The highest number of plant was found in *Polyalthia longifolia* (165) and the lowest number was found in *Arecaceae palmae* (6) and *Pennisetum glaucum* (6) at Botanical Garden.

5.3 RECOMMENDATIONS:

For both aesthetic and environmental perspectives, roadsides, parks and gardens tree planting is desirable and there are huge opportunities to enhance the urban plantation in DNCC. It is observed that the diversity and Composition of tree species was very poor in DNCC. It is also observed that a well-planned participatory program among DNCC, SAU, Forest Department and NGOs can secure a healthy sustainable future for the urban populations of Dhaka as well as other cities in Bangladesh. However some recommendations for a better protection and management of the Urban forests in DNCC are given below:

- Protection and maintenance of existing roads, parks and other green areas
- Similar study need to be carried out in other DNCC parks, road sides and garden areas to find out the composition and structure of plant species.
- The future study will be helpful, moreover, to obtain a clear picture about the urban forestry status in DNCC compare to other countries.

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