I. INTRODUCTION

1.1. Background

Urban area is center of population which facilitates development of social, culture, and economic (Irwan, 2005). Urban development is indicated by the increase of population as well as development in all aspects, for instance office and industry area, super and hyper market, medical and education facilities, also road network. These facilities are provided to support people activities.

In the other hand, urban developments also give negative impacts and ultimately, it can impact the degradation of environment quality. Urban environments only progress economically but decline ecologically, whereas ecology stability in urban area as important as economy stability (Dahlan, 1992). This fact is indicated by environment problems in urban area, for instance: air pollution which reduces oxygen supply and overwhelms production of Carbon dioxide (CO₂), also air temperature rising.

Air temperature in urban area is hotter than its surrounding area and it is called “urban heat-island” effect. There is a direct link between urban heat islands and global warming. First, the greenhouse effect could aggravate rising urban temperature significantly. Second, heat islands may contribute to the greenhouse effect. According to Herlianto (2007) starting from 1960 to 1969, the average global temperature was 13.9°C and in the period of 2000-2004, it is about 14.6°C and it is projected to raise 1.4—5.8°C by 2100 (see Figure 1.1). Prinanto, et.al (1991) in Jaelani (2006) states that Indonesia is the biggest producer of Carbon dioxide (CO₂) in South East Asia, moreover CO₂ emission in 2010 is estimated
will increase five times bigger than CO₂ emission in 1986, i.e. it will reach 469 million ton. In Indonesia, symptoms of global warming have been seen, i.e. the last decade, Indonesia has experienced long dry spells which were occurred in 1982-1983, 1987, and 1991, and this disaster gave negative impacts to people.

![Average Global Temperature by Decade, 1880-2004](image)

**Figure 1.1 Average Global Temperature by Decade. Source: Brown (2002)**

Meanwhile, Bogor as buffer zone for Jakarta tends to have high concentration of air pollution (Lestari, 2005). It is indicated from rapidly growth of vehicles and population. Total vehicles in 2003 were 66,541 and it increased twice bigger than total vehicle in 2000 (Polresta Kota Bogor, 2004), then number of population in 2005 reached 855,085 and it increased 1.2 times bigger than population in 2000 (BPS, 2006). In line with the growth of population, landcover change from naturally vegetated area to build up area also increased rapidly, and several types of landcover change tending to increase temperature significantly are: residential, industry, and bare land (Tursilowati, 2005).

From the foregoing problems, “back to nature” concept is needed to solve environment problem in urban area. Urban forest was introduced to recover environment and ecological condition, for instance: temperature reduction and other microclimatic effects, removal of air pollutants, emission of volatile organic
compounds and tree maintenance emissions, energy effects on buildings reduce air pollution) (Nowak, 2000).

Urban forest research in Bogor city has been conducted by Lestari (2005). She assessed minimum size of urban forest based on oxygen need. Based on this research, minimum size of urban forest to fulfill oxygen need in 2003 was 51,397.706 ha while existing urban forest in 2003 was only 4,214.39 ha, then minimum size of urban forest to fulfill oxygen need in 2020 will be 571,191 ha, and it will be even larger than total large of Bogor City (only 11,850 ha).

Research conducted by Lestari (2005) shows that the constraint in urban forest development is limitation of space for urban forest. Moreover many conflicting interests relate with land and expensiveness of land value in urban area. Therefore, alternative solution can be employed by increasing the effectiveness of existing urban forest in controlling quality of urban environment.

Urban forest development needs good planning and management in order optimal function and role of urban forest can be achieved. Accurate and efficient information will be very helpful for urban forest development, and Remote Sensing technology is precise tool which can give accurate and efficient information over large area (Jaelani, 2006). In this research, high resolution image is used to classify urban forest type (structure and form) and residential area. Meanwhile, geography information system (GIS) offers facilities to manage spatial data, starting from input data, store and manage data, analyze and manipulate, until produce the expect output. Therefore, in this study GIS is needed to obtain possible location for temperature measurement.
1.2. Problem Definition

Common problems faced in urban forest development, include: the limitations of space for urban forest, many conflict of interests related with landuse, and the expensiveness of land price in urban area. Moreover, urban forests are frequently suffered from land conversion causing urban forest space decrease than ever. To solve the limitation of urban forest space, alternative solution should be employed. The solution is the optimize function and role of existing urban forest, by analyzing relationship between urban forest structures (second-storey and multi-storey) and urban forest forms (linear, clustered, and dispersed) in reducing negative effects from urban activities.

From the foregoing problem, it is important to make problem definition on how the difference of urban forest types (structure and form) can give different effectiveness toward air temperature reduction.

1.3. Objective

The objective of this research is to find out the effectiveness of several urban forest types based on their structures and forms toward urban temperature reduction.

1.4. Output

Output of this research is information regarding the effectiveness of urban forest in reducing air temperature.
1.5. Research Assumption

The assumption of this research is heat sources in the study area are assumed as homogeneous.

1.6. Research Framework

Research framework can be seen in Figure 1.2. Urban area as centre for multiple functions such as: entertainment, economic, industry and governmental activities, city offers opportunities, dream and enjoyment. Therefore, many people put their dream and come to urban area to set their better life, so this phenomenon stimulates population break out in urban area.

In line with the growth of population, infrastructures and facilities development also increase rapidly for example: buildings, public facilities, business area, office, settlements, factories, and road network. During 1994-2001, landcover change from vegetated area into residential in Bogor was 11.3% and deforestation was 32.73% (Tursilowati, 2005). This facts impact environment problems in urban area, for instance: air pollution which reduces oxygen supply and overwhelms production of Carbon dioxide (CO₂), also air temperature rising.

Facing this problem, urban forest was introduced to minimize environment problem because of negative effects of urban activities. Yet, several constraints are also faced, for instance: limitation of available land for urban forest and conversion greenery space into other need. Optimizing function of urban forest is one of effort to overcome the constraints and research is needed to analyze function of combination of urban forest structure and form in order, alternative of urban forest which is effective in minimizing environment problem particularly in
term of temperature reduction in residential area.

Figure 1.2 Research framework