



The relationship between land use changes and the urban heat island phenomenon in Jakarta, Indonesia

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Land use change is a modification performed by humans toward the environment of natural functions to function differently. The analysis of land use change is carried out by using the R Mapper and Map Info Profesional 8.5 and land use of 1980, 1990, 2000, and 2010. The results showed that land development over time increased significantly from 1980 to 1990. This impacted the rate of population growth and increasing anthropogenic activities, number of vehicles, and public facilities. This is consistent with the increasing urban heat island (UHI) phenomenon in the Kemayoran and Pondok Betung station in Jakarta City.

Keywords: Land use, Urban Heat Island (UHI), Jakarta City, GIS.

1. INTRODUCTION

The increase in population has impacted the development of the city. It results in an increase of anthropogenic activities, that also means an increase in the number of buildings, as well as the length of the road^{1,2}.

Anthropogenic activities could impact directly or indirectly on climate change^{3,4}. The phenomenon of climate change especially the UHI phenomenon is already a case that requires serious attention, as it can have an impact that inconveniences the community⁵.

Some results of the study conducted in Jakarta city showed that there are differences in the maximum temperatures, and achieved a minimum of 1-3°C differences between Jakarta City (urban) and Bogor (rural)^{6,7,8,9}.

Since the occurrence of rapid urbanization in 1991, Jakarta City now consists of various buildings that include settlements, offices, and industrial buildings. Therefore, surely the increase of land development area in Jakarta City resulted in the increase of retained heat by buildings and the other objects, and the reduction of radiative heat emission at night. In addition, the effect can result in a sheltering effect which reduces heat loss convection from the surface and the air near the surface, causing an increase UHI phenomenon in Jakarta City. Based on the description, this paper attempts to study and analyze the relationship between the increase in land area development and the development of UHI phenomenon in Jakarta City.

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2. METHODS

This study uses temperature data from 1981 to 2010 and Landsat satellite imagery of four (4) areas namely 1980, 1990, 2000, and 2010. The analysis of the land use change is provided by the Geographic Information System (GIS) software R Mapper and Map Info Profesional 8.5 SCP. However, the relevance between changes in land use patterns with increasing temperature is counted using Excel program.

GIS is the data or associated information, with geo-located (spatial coordinates of the earth's surface). The first is the Canadian GIS (1960), a computer device used to input, store, edit, analyze and produce an output containing the information¹⁰.

The study area includes Jakarta City and the surrounding areas. Jakarta is the capital of Indonesia that consists of an area of about 66 152 km² and is at a height of about eight meters above sea level . It is located in the north of Java Island, bordering the City of Bogor in the south, while to the east lies West Java and Banten to the west. Map of the study area is taken from the terrain map of Indonesia (RBI) 2009 because the latest RBI map is produced in 2009. In addition, changes in land use from 2009 up to now are not significant. Therefore, the map is best to use as the basis for creating a location map of the study. Map locations are shown in Figure 1.

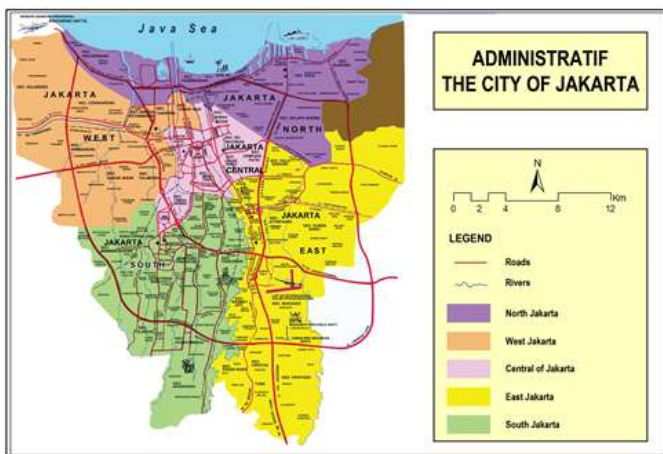


Fig. 1. Administrative Map Jabodetabek (Digital Map RBI, 2009)

3. RESULTS AND DISCUSSION

The results showed that changes in land use of Jakarta City over time were significant, based on Land sat TM imagery treatment in 1980, 1990, 2000, and 2010 in Figure 2. Additionally, the land use of each area is described in Table 1.

Based on Figure 2, it is known that the land use changes in Jakarta City are very significant. Land use changes are the most noticeable in the increased acreage of development from time to time. Starting in 1980, the land was awakened for 294.85 km² (42.03%), increased

to 607.55 km² (86.81%) in 1990. After that, it reached 681.79km² (97.2%) in 2000, and it grew to 686.24km² (97.8%) in 2010. The results showed the largely increasing acreage in Jakarta City especially starting from 1980 to 1990, with a progress of over 100% from 42.03% of the total land area, and 86.81% in 1990 increase in land development due to housing constructions, industries and paved streets in the years between 1980 and 1990. This resulted in the occurrence of a significant temperature rise in Jakarta City.

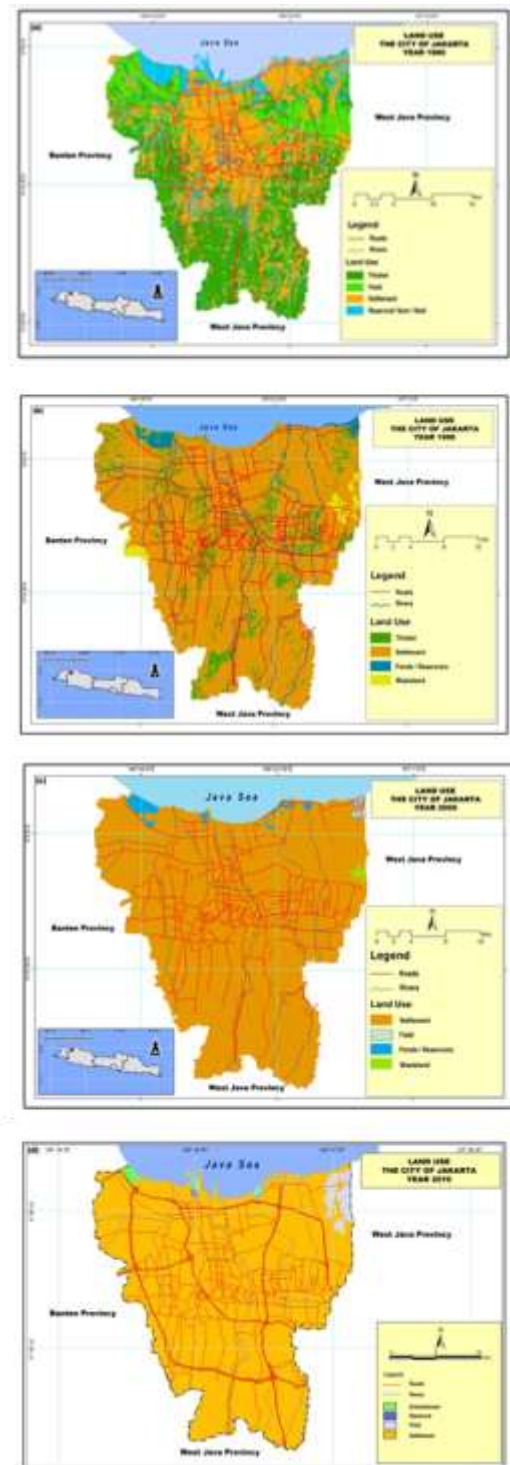


Fig. 2. Map of land use Jakarta City (a) 1980, (b) 1990, (c) 2000, and (c) 2010.

At the same time, rapid increase in temperature occurred in Jakarta. Therefore, the results showed a highly significant correlation between increasing acreage with an increasing temperature in the area. That applies at both stations namely Kemayoran and Pondok Betung stations with the correlation of each of $R^2 = 0.7187$ and $R^2 = 0.7319$ (Figure 3). According to the study in Bandung, Bogor and North Cianjur, the results of this study found that the more the land awakened, the bigger the increase in high temperatures^{1,11}.

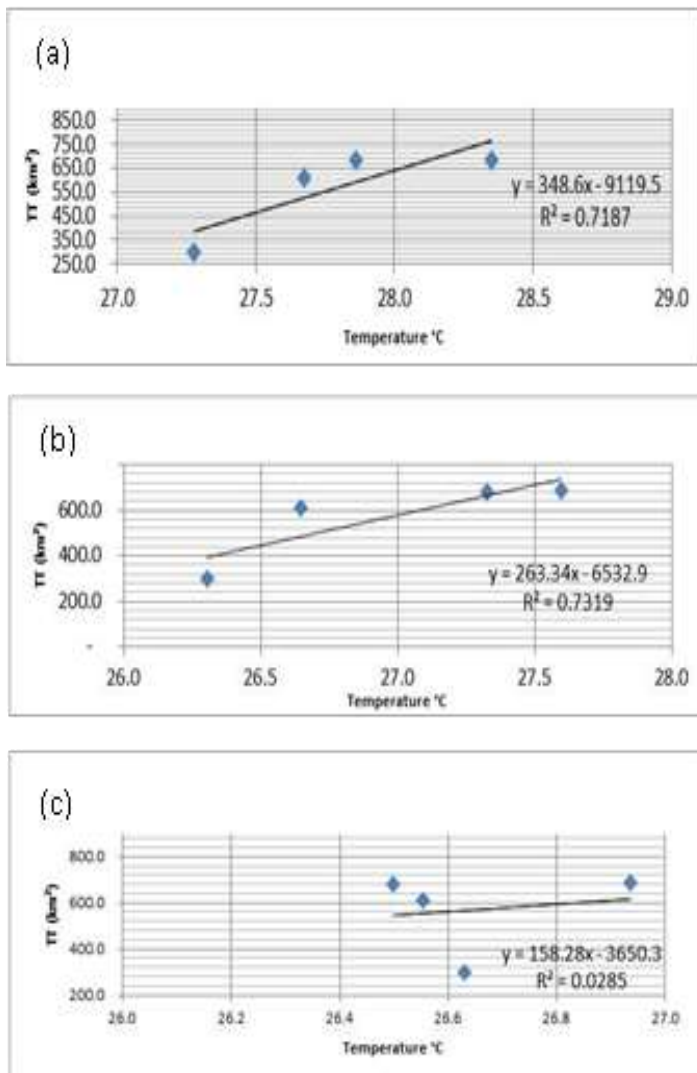


Fig. 3. The relationship between rising temperatures and breadth of the land awakened (TT) at the City of Jakarta in 1981-2010: (a) Kemayoran stations, (b) Pondok Betung stations, (c) Serang stations

The results of this study can show the extent of population growth in Jakarta City. The impact of increased anthropogenic activities, further accelerated development speed such as housing, industry, public facilities, and paved roads. It is tangible that rapid increased in land use change from naturally developed area. As a result, heat is trapped in urban areas, and an

increase UHI phenomenon occurs in Jakarta City.

The magnitude of the velocity increase UHI phenomenon in Jakarta City should get serious attention from the government, private, and community. The government should make a variety of policies that can reduce the velocity increase UHI phenomenon in the region, including policies regarding the addition and rejection damage of green open space (GOS). Currently, Jakarta City was almost full of buildings, therefore it can be replaced with good management of the park by planting greenery and providing shower in the home page or post. This could increase the humidity which can reduce the latent heat in the area. Furthermore, the buildings can also be constructed using white and green technologies such as: roof garden, green wall, and green roof. The white building has been developed in Yunani, meanwhile many green technologies developed in China and Seoul, South Korea. White building can increase the albedo acceptance of sunlight. Meanwhile, green technology can increase humidity in urban areas². Therefore, all these things can reduce the velocity of rising temperatures in urban areas, especially in Jakarta City.

3. CONCLUSION

The impact of changes in land use on the UHI phenomenon is very significant in Jakarta City, especially at the Kemayoran and Pondok Betung station. Kemayoran station is located in the downtown area, meanwhile Pondok Betung station is located in suburban area. That is a land use change from naturally developed land, which does not just happen in the Central Business District (CBD) but also in suburban areas outside the city. Also, temperature rise occurs not only in the CBD but also in the periphery of Jakarta City.

The increase of UHI phenomenon in Jakarta City is significant. Therefore, it takes real effort to deal with the phenomenon. Various things to do are developing the GOS, green technology, white building, and the procurement of the water body or shower around house or office. All of these things can reduce the rate of increasing UHI phenomenon in Jakarta City and the surrounding areas.

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