ENVIRONMENTAL IMPACTS OF URBANIZATION IN JABODETABEK AREA

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ABSTRACT

Jabodetabek plays a strategic role in national development in terms of national economic structure and political, socio-cultural and security contexts. This paper reports contemporary updates on the environmental issues related to urban sprawl. Series of remote sensing data were used to demonstrate land use change. Rice field ratio was employed to assess declining agricultural fields.

INTRODUCTION

In terms of demographic aspect, urbanization refers to a concentration process of population and non-agricultural activities in cities. In the aspect of modernization, urbanization is a process closely related to life values in cities, behaviors, and urban institutions that are actively dealing with urban issues. In this way, urbanization influences proportion of urban population to increase, or on the opposite, influences the rural population to decrease. The rate of urbanization can be defined as the growth rate in cities or percentage of population increase living in the urban areas. Urbanization also means a process of change from rural to urban characteristics. It includes physical change of a region such as the pattern of land use, as well as the change in people's life style, that is from rural to urban life style.

The causes of urbanization vary on different countries, but in general it can be said to be the result of spatial imbalances, including population and economic imbalances. Urbanization is commonly related to a number of social, economic and settlement problems in both urban and rural areas.

Urban sprawl has been one of important field of studies, especially in developing countries. In Indonesia, the phenomenon has been studied extensively.

Jabodetabek region is probably the most studied area of interest, for instance see papers by Rustiadi and Panuju (2002) and Rustiadi *et al.* (2002). Some extensions were also presented, such as Surabaya metropolitan (Damayanti 2003).

Urbanization and urban sprawl have direct or indirect impacts to environmental impact (Johnson, 2001). This paper assesses contemporary environmental issues related to urbanization in Jabodetabek region. Focuses are made to land use changes, food security and urban heat island.

JABODETABEK REGION

Jabodetabek area consists of several regencies and municipalities over three provinces i.e. Banten, DKI Jakarta and West Java (Figure 1). The region is morphologically divided into three categories of land according to its ecosystem. Those three landforms are coastal region in the north, plane or flat region in the center, and sloping or hilly region in the south.

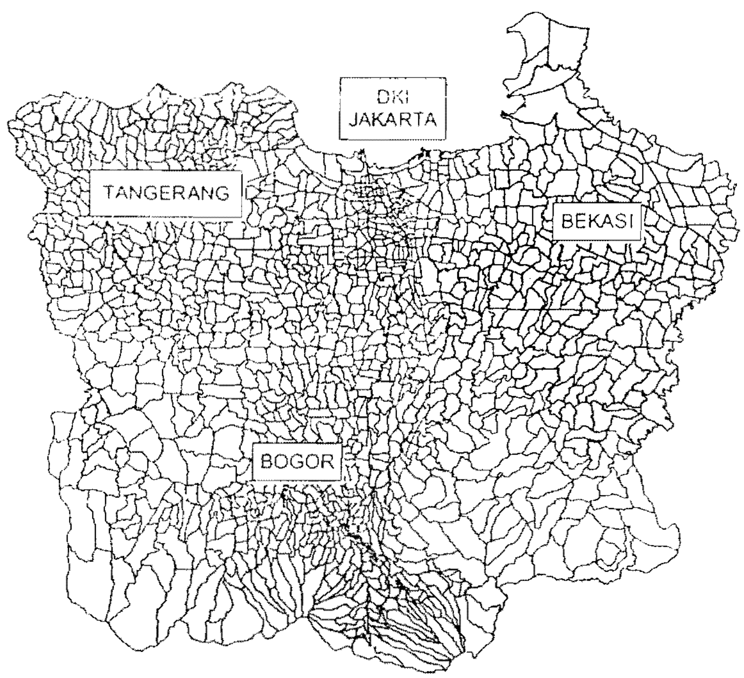


Figure 1. Jabodetabek region

...stal region is easily identified through flat or, in some areas, undulating topography with elevation varies from 0 to 25 meters above sea level. This region co... Tangerang Regency, DKI Jakarta, and Bekasi Regency

The plane region is the area with the height of 25-200 meters above the sea with v... opography, involving Tangerang, Depok, and Bekasi; whereas the hilly r... refers to the mountainous area with the height of 200 meters above the ...a, covering the Municipal and Regency of Bogor. Regions with different t... of topography have different geological formation. This information has ... served as one of the main references to construct regional development. Co... tal region is geologically dominated by Alluvium of marine and fluvial sediments, while plane region dominantly consists of Pleistocene Volcanic Facies. Mountainous region is primarily composed by young volcanic materials.

In general, soil resources in Jabodetabek vary greatly, which is determined by slope, bed rock, and climate. In the southern region, soil is typically dominated by Yellowish Red Latosol and Brown Latosol, which is the result of volcanic eruptions of both Gede-Pangrango and Salak mountains.

The coastal region of Jakarta is basically formed by soils which affected by water activity, such as Gley Humus, easily observed in grayish color. The coastal area of Bekasi is shaped by the combination of grey alluvial soil and grayish brown alluvial soil.

The coastal area of Tangerang hosts estuaries of some big rivers; therefore majority of soil type found is dark grey Alluvial. On other areas, minor types of soil are found, including yellowish red Podsolik (especially in Citeureup-Gunung Putri), Grumusol (around Cariu-Jonggol), and red Podsolik.

On the plane region, Red Latosol, Reddish-brown Latosol, and Laterit are the most common. This type of soil covers the largest area on the flat region. Meanwhile, on the low-land region, Red Latosol is the most dominant type of soil, covering most of the region of DKI Jakarta.

LAND USE CHANGE

One physical implication of the dynamic population growth and social activities of a region can be observed through changing land use, or often by analyzing the change in land cover. Such changes may indicate land transformation and alteration of environmental properties. Remote sensing images used to analyze the growth of Jabotabek metropolitan involve Landsat MSS of 1972, and Landsat TM/ETM of 1983, 1992, 2000, and 2005. Figure 2 presents dynamics of land cover between 1972 and 2005.

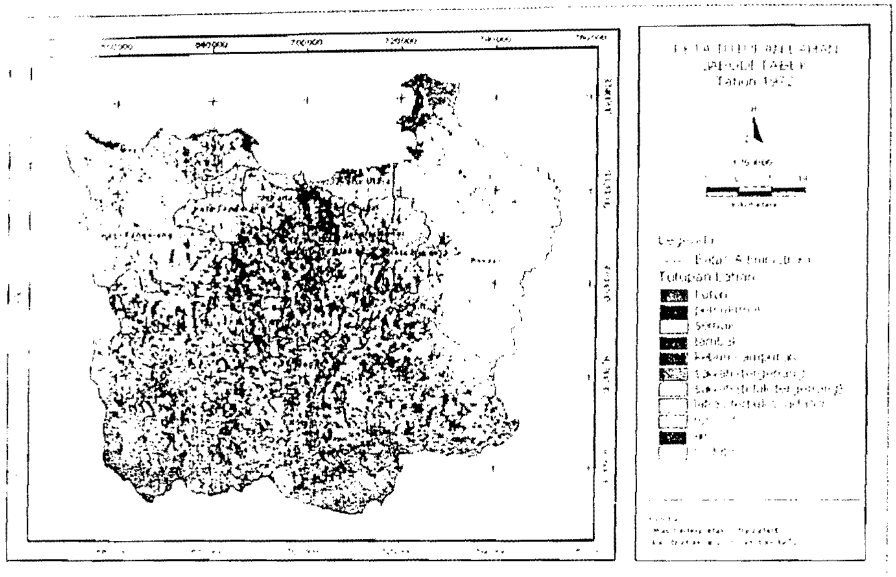
Land-use change in Jabodetabek from 1972 to 2005 appears to be significant particularly for settlement or built-up areas. In 1972, the built-up area seemed to concentrate on DKI Jakarta. Later, in 2005, it is visually seen that conversion spreads increasingly on Bogor, Tangerang and Bekasi. The result shows that the capital city of Jakarta along with its surrounding areas within the scope of Jabodetabek, involving the Municipalities and Regencies of Bogor, Tangerang and Bekasi, as well as Depok has experienced a very rapid urban growth and development.

The figure indicates changes in land cover, particularly increasing built-up area for various purposes such as settlements and offices, as well as facilities and infrastructures such as roads and trade centers. The sharp growth of population has increased the need for those land uses. Consequently, greenery open spaces have been often reclaimed. Reduction of green open space is presented in the following graphs (Figure 3).

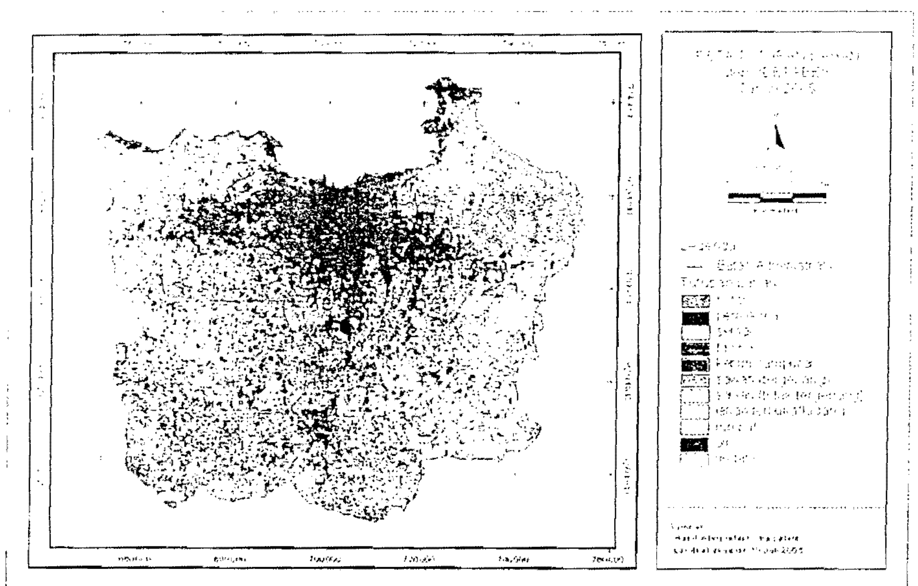
Analysis shows that a sharp increase of built-up area occurred in the period of 1972 - 1983, when a new policy was launched by the government on the formation of The Greater Jakarta Metropolitan Region, well known as Jabotabek, and declined in the period of 1983 - 1992, following fluctuating development rate on this region.

The observation of image pairs of 1992 and 2000 shows a very fast increase of built-up area compared to that of other periods of observation. Therefore, it is empirically proven that the period witnessed the fastest growth of development in Jabodetabek. Along with various changes in this country, in which there was a reform during the last period of observation, such socio-political change als affected the accelerated development to become slower during the period o 2000-2005.

In the period of 1972-2005, Jabodetabek lost its forest for more than 40.000 ha (46% of its original forest in 1972. On the other hand, in terms of settlement are reflected in the size of built-up area, it grew more than 12 times of the size in 1972. Totally, during the period of 33 years, since 1972, the region has lost mo than 27% of its green open space.



(a)



(b)

Figure 2. Land use information derived from Landsat data

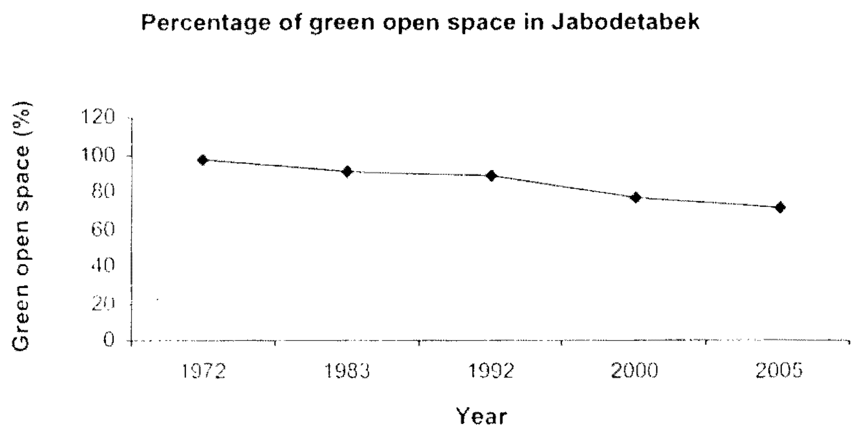


Figure 3. Declining green open space area in Jabodetabek

The areas of Regencies commonly have a larger green open space than township areas because the former areas are far away from the downtowns, therefore those areas have not experienced visible changes. In the Regency of Bogor, which is dominated by forests and mixed plantations, the size of green open space decreases every year; whereas in the Regencies of Bekasi and Tangerang, the acreage of green open space tends to increase. This is because most of the region was dominated by the closure of rice field. In the Regencies of Bekasi and Tangerang, their immediate boundary regions are known as the rice producing centers in the Province of West Java, namely Regencies of Purwakarta, Karawang, Rangkasbitung, Pandeglang, and Serang, hence these areas (rice fields) have received fairly great attentions from the Local Governments of Bekasi and Tangerang.

IMPACTS ON FOOD SECURITY

Urban sprawl on Jabodetabek region has also stimulated declining rice fields. Rice fields on Java have been widely known as one of production centers in Indonesia. One of the first reviews was presented back on the Dutch occupation era (van Valkenberg, 1925). Despite its long history, very limited reviews have been presented (Panuju and Trisasongko, 2008).

...technologies have been employed considerably to assist food ... gon-based spatial analysis was tested to retrieve changing in ... landscapes. A simple ratioing approach i.e. Rice Index is demonstrated in Figure 4. Although simple, the ratio indicates fairly good performance revealing substantial changes on rice fields. In 1992, majority of ... (kecamatans) in Tangerang and Bekasi provided superior support on agriculture. Nonetheless, the support was considerably low only in a decade.

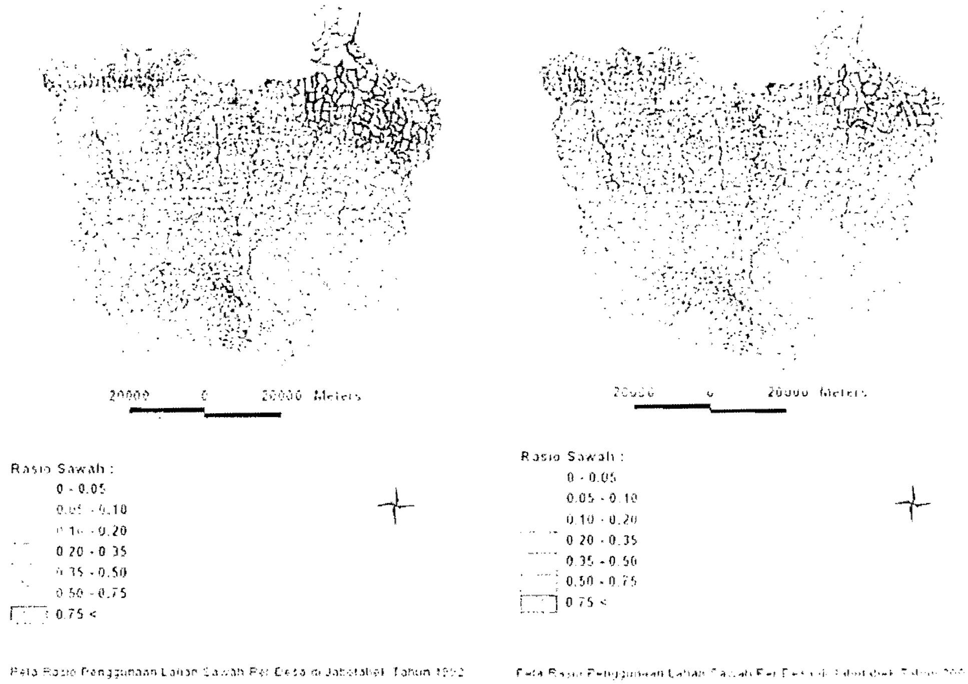


Figure 4. Comparison of rice fields 1992 and 2001

In addition to those spatial analyses, remote sensing data play a critical part on retrieving updated information. Field mapping and its yield estimation have been one of the major concerns among remote sensing communities. Employing various present-day approaches and optical datasets, several reports on Java have been presented, including Panuju *et al.* (2007a) who tested decision tree approaches and Panuju *et al.* (2007b) on cluster analyses.

While optical datasets have been favorable for operational monitoring, these kind of remote sensing data suffer from atmospheric disturbances. Previous reports such as Le Toan *et al.* (1997) showed potentials of SAR data on rice field assessment; however, the application was limited due to single polarization.

Recently, dual or quad polarization SAR data are available. Due to the importance of agricultural areas in Jabodetabek, both Department of Soil Sciences and Land Resources and P4W-IPB, Bogor Agricultural University independently assess high resolution multipolarization SAR data supported by Japanese JAXA, German TerraSAR-X and Canadian Radarsat-2. Preliminary results were presented elsewhere (Raimadoya *et al.*, 2007; Raimadoya *et al.*, 2008). Figure 5 presents a multitemporal composite of ScanSAR data detecting active rice plantation.

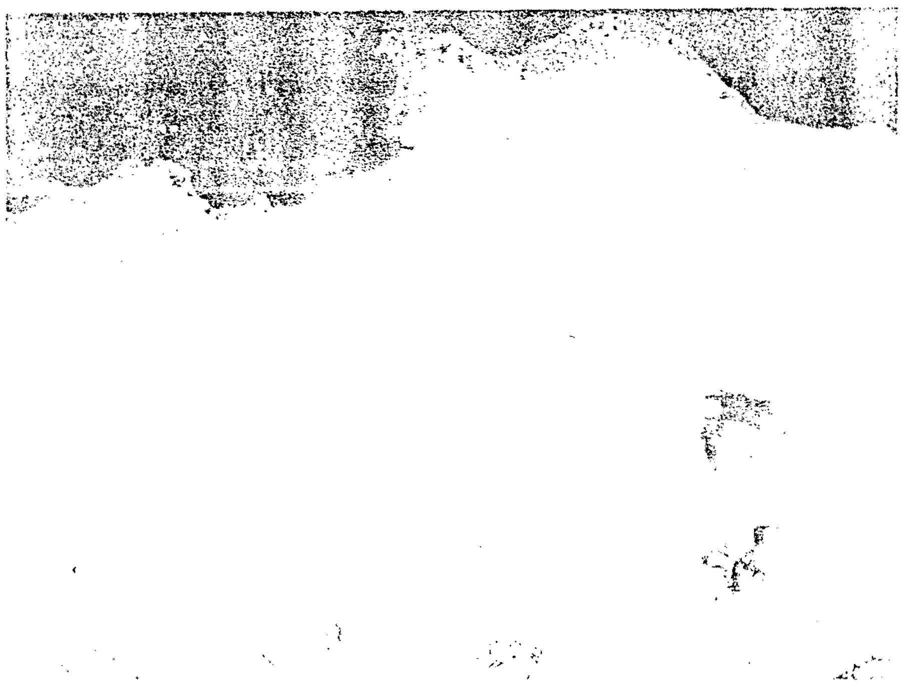


Figure 5. Multitemporal composite using ScanSAR data (Raimadoya *et al.*, 2007)

URBAN HEAT ISLAND: PRELIMINARY RESULTS

As indicated, the growth of built-up area as a result of population growth and economic development has correlated with decreasing green open space area in Jabodetabek which affecting quality of environment such as temperature. Green open space takes an important role in refreshing air and reducing pollution. Preliminary research of Panuju *et al.* (2003) showed significance of increasing temperature measured in three meteorological stations. Figure 6 shows measured temperature in Cengkareng meteorological station.

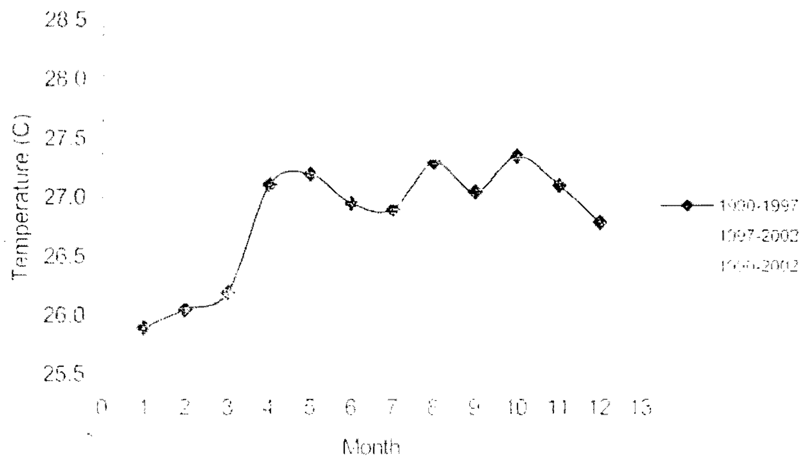


Figure 6. Temperature change detected at the Cengkareng meteorological station (Panuju *et al.*, 2003)

By grouping the temperature into two classes before and after 1997 (parallel with ENSO phenomenon), it was shown that in 5 years period after 1997 the temperature increased by more than 0.5 degree Celcius in average.

Employing thermal band of Landsat ETM+, the research also detected substantial impact of industrial development in increasing temperature. North and East Jakarta which have greater growth rate in industrial expansion than other parts of Jakarta were detected having higher temperature. Figure 7 shows spatial distribution of temperature derived from Landsat ETM+ thermal band.

Figure 7. Distribution of temperature derived from Landsat thermal bands 2001. Darker tone indicates lower temperature (Panuju *et al.*, 2003)

CONCLUSION

1. Due to strong linkages with environmental problems, urbanization in Jabodetabek region has been interesting from different po[illegible] of [illegible]. Various environmental issues have been indicated including temperature ri[illegible] urban sprawl, greenery open space and its relation to agriculture, in addition to flooding which is not covered in this report.