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STUDY ON IMPACT OF URBANIZATION AND RAPID URBAN EXPANSION IN JAVA AND JABODETABEK MEGACITY, INDONESIA

2015

Andrea Emma Pravitasari

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CHAPTER 1. INTRODUCTION

1.1 Research Background

There was a big change in this world in the last century. One of which is a significant increase in the number of urban population as compared to the population in the rural areas. In 1950, there was only 30% of the world population in urban areas, but in 2014 about 54% of the world population residing in urban areas. It means that more than half of the world population now lives in urban areas. Based on United Nation (UN, 2014), by 2050, about 66% of the world population is projected to be in urban. Increasing number of urban population have a significantly related to increasing the number of megacities in the world. With 153 million of population, there was 10 megacities in 1990, and became 28 megacities in 2014 with 453 million population which consisted of 12% urban population of the world. Asian megacities concentrate 60% of world megacities population in 2010 (Swerts and Denis, 2014) and UN (2014) projected there will be 41 urban agglomerations or megacities in 2030. The global rural population has grown slowly since 1950 and is expected to reach its peak in a few years. Based on UN (2014), now, the number of rural population is around 3.4 billion and is expected to decline to 3.2 billion by 2050. Several decades ago, most of the world's largest urban agglomerations were found in the more developed regions, but today's large cities are concentrated in the global South, and the fastest-growing agglomerations are medium sized cities and cities with 0.5 to 1 million population. The United Nations (UN, 2004) estimates that by 2030, 55% of 4.9 billion Asians, or 2.7 billion people, will live in urban areas. Continuing population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90% of the increase are concentrated in Asia and Africa (UN, 2014).

The urban population in Asia is growing faster than ever before and there will be more than 1.1 billion Asian people live in urban areas in 2030 (Asian Development Bank, 2008). Rapid urbanization has been the key driving factor of Asia's development growth. Urbanization and rapid urban development in several Asian countries is marked by increasing physical growth which extends beyond metropolitan and city boundaries (Hugo, 2006; McGee and Robinson, 1995). Urbanization is predicted as a process that will continue in the coming years, so that sustainable development challenges will be increasingly concentrated in cities, particularly in the lower-middle-income countries where experiencing fastest urbanization (UN, 2014). Asian megacities have huge of population and rapid growth of economic so that they become magnets for people, investments, businesses, and organizations. Since they facing urban expansion into their periphery areas, they bring both benefits and the problems of urbanization (ADB, 2008).

Urbanization process has been associated with other important aspects such as economic, social, and environment. Based on UN (2014), urban living is often associated with higher levels of literacy and education, better health condition, greater access to social and economic services, and enhanced opportunities for cultural and political participation. Nevertheless, rapid and unplanned urban growth as well as urban expansion threatens sustainable development when the necessary infrastructure is not developed or when policies are not well-implemented. Unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution, and environmental degradation, together with unsustainable production and consumption patterns (UN, 2014). The rapid urban growth, high population density and high consumption rate of residents in megacities has led to a wide range of local and global socioeconomic and environmental impacts which requires attention from the world community. Since it will significantly affect the global sustainability and future prosperity. Continuing urbanization or migration from rural to urban areas will expand the number of megacities, and it concedes that megacities are often plagued by environmental deterioration, inadequate housing, traffic congestion, slums, crime, homelessness and so forth (Makinde, 2012). Brian (2000) proposed urbanization issues such as: urban poverty, the rising crime rate, solid waste disposal, housing for the poor, environmental protection, pollution, and so on. are being emphasized by the government. Jusoh and Rashid (2008) argued that those issues need to be tackled holistically to ensure the role of urban centre as the engine of economic growth will be continuously maintained and enhanced.

Studies on urbanization and suburbanization process in Asian countries have stressed that the continuing outward expansion of the biggest metropolitan region has eroded the longstanding distinction between rural and urban (McGee 1991). The urbanization in East and South of Asian countries is characterized by the blurred distinction between 'rural' and 'urban' (Brennan, 1999; Hugo, 2006; McGee, 1991; 1994; 1995; McGee and Robinson, 1995). Some urban characteristics appear in rural areas, both physically and socioeconomically. Both agricultural and non-agricultural activities take place side by side in the adjacent areas of the urban centers, while the urban physical development extends beyond city administrative boundaries (Firman and Dharmapatni, 1994; Firman 1997; 2003; McGee, 1991; Swerts and Denis, 2014).

Furthermore, Ginsburg et al. (1991) explained the urbanization in East Asia and Southeast Asia, where large cities are often located in wet-rice production areas. Due to its labor-intensive nature of wet-rice agriculture, even before the period of industrialization, it had been common in these areas to have a population density almost equal to the cities in pre-industrialized Europe. The labor demand of wet-rice farming fluctuates from season to season, and this has prompted farmers to engage in various non-agricultural activities, such as petty trade and small-scale industry (McGee, 1991).

Indonesia is one of Asian countries which facing rapid urban development and urbanization. According to BPS (2010), Indonesia's total urban population reached more than 118 million people or about 50% of the national total population. As in most developing countries, urbanization in Indonesia is characterized by heavy concentrations of urban population only in a few large cities. Rustiadi et al. (2014) mentioned this tendency has been growing at an increasingly faster rate in the globalization era. The urban areas, especially large cities and megacities offer infrastructures and facilities as well as access to capital, labor and market for secondary and tertiary economic activities. The large cities and megacities have developed as concentrated economic activities, capital, and people facilitated by relatively better transportation facilities and communication technologies (Rustiadi et al., 2014).

High population growth and rapid development in recent years has resulted in high dynamic changes of land use in most of the city. Cities have changed from small, isolated population centers to large, interconnected economic, physical, and environmental features (Avicedo, 2013). According to Kitamura and Rustiadi (1997), the most frequent land conversion in Indonesia is from agricultural to urban uses, especially in cultivated areas around major cities. The phenomenon of agricultural land use change mainly due to urban expansion, especially in Java Island. Java Island is one of the main island in Indonesia which only consists of about 7% of Indonesia's land area (129,438 km^2), but it is inhabited by nearly 60% population and contributes about 59% of national GDP. Java also has very important role in Indonesian agricultural sector, by supplying nearly 55% of national rice production. But the pressure of urbanization has become a threat for these efforts to maintain Java as the national rice granary (Rustiadi and Wafda, 2007) and threaten Java's carrying capacity (Rustiadi et al., 2009).

Rapid growth of economic activities and population implies a growing need for space. The high demand for space can be seen from the rampant phenomenon of land use/cover changes (LUCC) that causes the decrease of forest area and agricultural lands (fertile rice fields). Several LUCC studies on Java, particularly from agricultural to non agricultural land, such research conducted by Laudjeng et al. (1997) on the North Coast of Java from the period 1990-1993, it is known that the vast amount of agricultural land converted into non-agricultural land is 32,037 hectare of the area. According to the LANDSAT imagery interpretation in 2005, natural forests on Java left only ± 400,000 ha, while land coverage by all categories of forest (secondary forest, upland, mangrove, swamp, and forest plantations) covers only 21% of mainland Java (not including the Madura island and other small islands) or 2.4 million ha. Based on LANDSAT image interpretation in 2005 was also largely unknown, only the remaining fields 2.63 million ha (20.8%), 7% decline for 15 years (Team of Environmental Study of Java Island, IPB, 2007). Barus (2009) compared the general appearance of land cover data from 1995 (RBI data, simplified) and 2007 (results of a simplified interpretation). These studies' results showed that the broad decline in forest cover from 17% (1995) to 14% (2007). Wetland also decreased, from 30% to 22% while the land area had increased the settlement area and dry land. Settlement area increased from 12% to 18%, and also dry land from 38% to 43%. The reduction of forest cover and agricultural land (productive paddy field) have been threatening buffer zone (conservation areas) to maintain the balance of the ecosystem and threaten the occurrence of food insecurity.

As a result of such rapid LUCC, Java is currently experiencing a threat due to its decreasing trend of its enviromental carrying capacity which mainly due to the pressure of land use changes. The high density and population growth (due to urbanization) as well as the rapid growth of economic activity threaten sustainability in Java. Research conducted by Adiwibowo *et al.* (2007) indicate that the environmental carrying capacity in Java has been exceeded (overshoot). This condition threatens the sustainability of agricultural systems in Java. Indicators of environmental damage according to the results of various studies are not only seen from the decreasing area of forest cover and the high conversion of paddy fields, but also can be seen from the condition of watershed damage and high frequency/intensity of anthropogenic disaster such as droughts, floods and landslides.

One of regions which experiencing the most highest pressure from urban expansion is the Jabodetabek Megacity. Jabodetabek Megacity is the largest urban concentration in Indonesia which located in Java. Its involving several administrative regions, and consists of three major provinces: Capital City of Jakarta Province, Banten Province (Tangerang Regency, Tangerang Municipality and South Tangerang Municipality) and West Java Province (Regency and Municipality of Bogor, Regency and Municipality of Bekasi, and Depok Municipality) with Jakarta as its center and Bodetabek (Bogor, Depok, Tangerang and Bekasi) as its suburban areas (hinterland). Jabodetabek Megacity has a strategic role in the national development, particularly the economic, political, and socio-cultural structures. It consists of 5% of total Java's area and inhabited about 17% of Java's population, but it contributes about 25% of total national GDP. The growing socioeconomic concentration and activities in Jakarta and its surrounding areas have attracted migrants, particularly those from rural areas. In spite of the conceptual unity, Jakarta and the surrounding regencies and municipalities governments have found it extremely hard to carry out wellcoordinated policies as urbanized areas have expanded farther beyond the environs of Jabodetabek Megacity following the expansion of the highway network. Due to suburbanization, Jabodetabek Megacity is experiencing fast growth of peripheral areas which is faster than the core of the region and as a lifestyle involving a daily commuting to job places in Jakarta City.

The trend of urban transformation in Jabodetabek Megacity has been driven by economic expansion such industrial complex and new satellite towns, and it has resulted in extended areas of mixed land use of city peripheries (Rustiadi and Kitamura, 1998; Rustiadi et al., 1999; Rustiadi and Panuju, 2000; 2002). By employing spatial statistics, Rustiadi et al. (1999) showed the land use mixture in suburban areas of Jabodetabek Megacity as well as in Tokyo Metropolitan suburbs (Rustiadi and Panuju 2000). McGee (1995) labels this phenomenon as 'mega-urbanization' (Jones, 2002; Lin, 1994; McGee, 1995), whereas in his earlier work he calls this phenomenon 'Kotadesasi' a phrase coined from the Indonesian language (Bahasa Indonesia) means the process of socioeconomic and physical integration between urban areas (*Kota*) and rural areas (*Desa*) (McGee, 1991). Aguilar and Ward (2002) also identified similar phenomenon in Latin America. Despite McGee's "*desakota*" concept, many scholars have tried to develop various terms to describe the phenomena related to this region-based urbanization such as "extended metropolitan region" (McGee and Greenberg, 1992; McGee and Robinson, 1995; Leaf, 2002; Firman, 2003; Jones, 2006; Wong, 2006), "mega urban regions" (McGee and Robinson, 1995), "global city-regions" (Scott, 2001), and "megacities".

Jabodetabek Megacity has developed from a small and separated city regions into a larger and unified megacity. Jabodetabek Megacity becomes a center of national activities that are characterized by high population density and spatial interaction between regions. The size of population and high economic growth in this area led to significant increased demand for space. Those two components become the factors of urban expansion and high rates of land-use conversion into industrial areas and settlements in Jabodetabek Megacity. From the Carolita's research (2005) can be seen that land use conversion that occured from agricultural land to non agriculture land in Jabodetabek Megacity was about 69,362 ha in the period of 1992-2001. According to Rustiadi et al. (2002) and Wulandhana (2007) regarding LUCC that the trend of built up area in the Jabodetabek Megacity continues to increase from 1972 to 2005, and now greenery area in that region were only about 9% of the total area.

Various observers have pointed out that urbanization in Indonesia as well as other Southeast and East Asia countries are not centripetal, but rather proceeds as the formation of vast city-regions. As a functional mega urban system, Jabodetabek Megacity is still undergoing physical growth and the development of various activities. Various interests and rapid development in Jabodetabek Megacity have great impact on the spatial aspects and decreased carrying capacity of the environment. The results of the study by Rustiadi et al. (2009) showed that the carrying capacity of the environment, especially land and water in Java Island, where Jabodetabek Megacity lies, is already overshot. Spatial pattern in Jabodetabek Megacity is characterized by spatial inconsistencies that occurred between existing land use and spatial plan. This condition generally occurs in urban areas and their surrounding areas. Inconsistencies also occurred between spatial planning (RTRW) and land capability (as a proxy of carrying capacity). These inconsistencies have caused some problems, such as land conflict as well as environmental degradation which may impact on the occurrence of anthropogenic disasters (floods, landslides, and so on). The previous research stated that there have been land use inconsistencies in Jabodetabek Megacity (2001) by 8.50% of the total area (Nurhasanah, 2004) and in 2010, there were 10.21% inconsistent actual land use (Rustiadi et al. 2012). It requires a significant breakthrough to improve the controlling system of spatial planning effectively and gear it into a more efficient, productive and competitive Global Megacity.

Both Java and Jabodetabek Megacity currently get most of the pressure due to urban expansion in Indonesia, with the scope (coverage) of different regions. Java on regional scale (macro-scale), whereas Jabodetabek Megacity on the meso-scale. Since the Java island and especially Jabodetabek Megacity have become one of the most strategic area in the country, research associated with the development of assessment methods or models to solve all issues and problems that occur in these areas should be very strategic to be conducted.

1.2 The General Objectives

The general objectives of this research are:

(1) To provide a broad overview of the recent patterns and trends of urbanization and urban expansion in Indonesia as one of Asian countries which are facing rapid urban development in the world.
(2) To detect positive and negative impact of urbanization and identify the driving factor of urbanization and urban expansion in the macro and micro scale of region.
(3) To give some policy recommendations about how to manage urban growth in sustainable way in order to address the urban problems caused by urbanization and rapid urban expansion in the developing countries.

1.3 Structure of The Dissertation

The dissertation consists of 7 chapters (Figure 1-1). Chapter 1 presents an introduction, including the overview of research background, the problem statements, the general objetives and structure of this dissertation. Chapter 2 provide the review on the concept of cities, megacities, urbanization, and suburbanization, as well as overview of urbanization and suburbanization process in Indonesia. In this chapter, description of the study area and methodology will be explained. Chapter 3 is discussed about urbanization and rapid urban development process in Java Island. The objectives of this chapter are exploring the causes and impacts of rapid urban development and urbanization in Java as well as investigating the local factors that affecting urbanization or rapid urban development in Java Island. Chapter 4 presents analysis on the urban expansion process and identifying the environmental impact which caused by urban expansion in Jabodetabek Megacity as the biggest metropolitan area in Indonesia which located in Java Island. Chapter 5 discusses about local spatially dependent driving force of urban expansion in Jabodetabek Megacity. In Chapter 6, a local sustainability index considering local spatial interdependency is developed. This chapter will show the spatial distribution and spatial association map of local sustainability index on three dimensions of sustainable development (economy, social, and environment); and in the last chapter (Chapter 7), there will be a conclusion which consists of wrap up synthesis including giving recommendation for the policy maker regarding the planning effort or policy scenarios to be developed to address urban problems in Java as well as in Jabodetabek Megacity to support more productive, comfortable, and sustainable development.

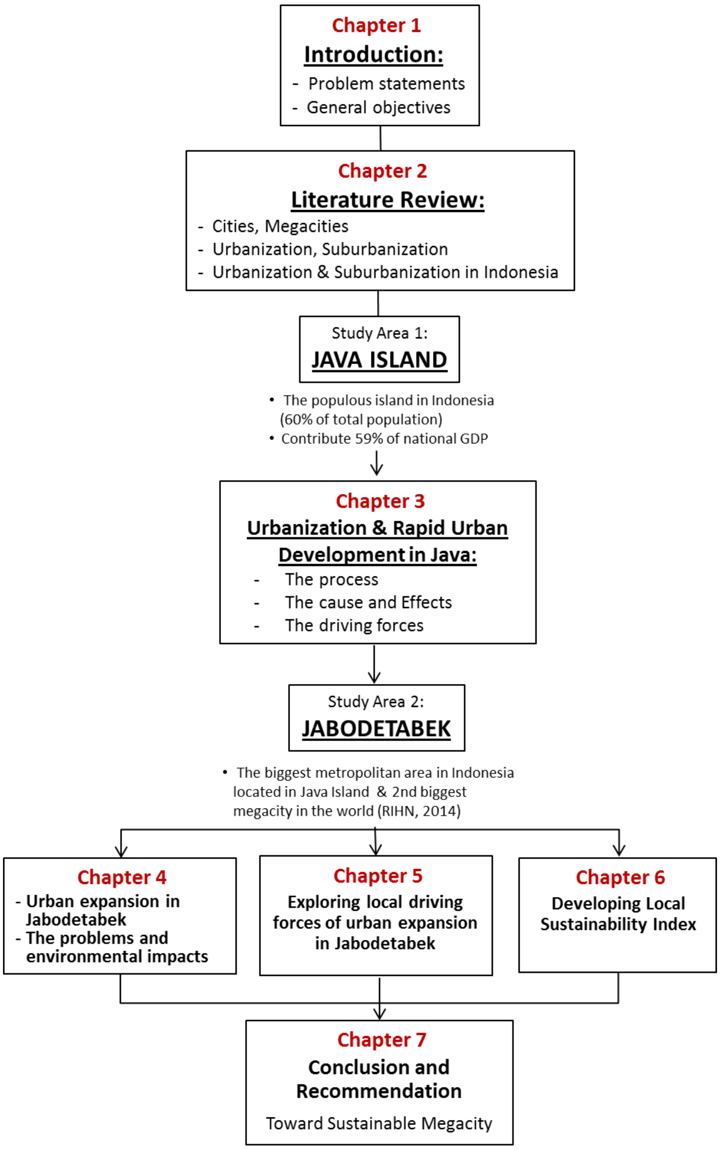

Figure 1 - 2. Structure of dissertation

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CHAPTER 2. LITERATURE REVIEW AND GENERAL DESCRIPTION OF THE STUDY AREA

2.1 Review on The Concept of Cities, Megacities, Urbanization, and Suburbanization

2.1.1 Cities and Megacities

Cities have important role on global development. Cities are complex human systems and serve as magnets for people, enterprise and culture (Singh, 2014). Cities in the developing countries are growing rapidly and become the engines of the region's economic development or motor engine of growth (Harris, 1988). Most of the developments are in the form of urban sprawl at the periphery of the urban areas (Ginsburg et al., 1991). Based on Yeh (2002), these urban sprawls have led to a lot of environmental and transport problems and the loss of valuable agricultural land as well. Wirth (1938) defined the city as a permanent settlement with large population size, high population density and social heterogeneity. There are several urban issues that usually occurred in the big cities, such as: urban sprawl; climate change and air pollution; urban waste management; water supply; inadequate energy; public health problems; pressure on natural habitats and so on (UNEP, 2004). Singh (2014) mentioned that in traditional concept, the city is defined as a catalyst of economic growth. But recently the cities and urban development challenges not only focus on economic growth but also express concern about unsustainable development and its negative impacts of rapid urban development such as urban sprawl, deteriorating inner-city infrastructure, traffic congestion, environmental degradation and so on. Based on United Nations (UN, 2014), a city is defined as a continuous urban built up with less than 200 m between construction, and bringing together more than 10,000 inhabitants. Cities occupy only 2% of the world's land but consume 75% of its resources and produce a similar percentage of its waste (ADB, 2008). They consume most of the fuel and electricity used by transport, industry, infrastructure, and household daily activity. Cities are major contributors to climate change since they contribute approximately 75% of the greenhouse gas (GHG) emissions (ADB, 2008; Singh, 2014). They generate significant environmental footprints, including contamination of air and water. Asian big cities like Delhi, Kolkata (Calcutta), Mumbai (Bombay), Dhaka, Karachi, Bangkok, Beijing, Shanghai, Jakarta, and Manila are concerned to be one of the most polluted cities (Baldasano et al., 2003; Faiz and Sturm, 2000). Asia's projected global share of CO_2 emissions for energy consumption will increase from 30 % in 2006 to 43% in 2030 (Singh, 2014). Rapid urbanization in Asian developing countries have been followed by excessive of the urban population concentration in very large urban agglomerations (megacities). Dispersed urban development in Asian developing countries has led to environmental degradation, increased energy consumption for transportation, serious problems of air and water pollution, traffic congestion, and another environmental problems (Singh, 2014; Sorensen et al., 2004). Cities in Asian developing countries tend to have thriving inner city areas. These are usually the oldest parts of the city and facing the worst physical deterioration. Since these are deteriorated physically especially in the inner areas of the city, they have attracted poor urban dwellers seeking cheaper rent for housing. To accommodate rising populations and increasing of land demand for settlement and urban activities, most of Asian cities are growing outward encroaching on fertile agriculture lands. They have insufficient open space and many of them have poor urban infrastructure (Sorensen et al., 2004). Based on Jusoh and Rashid (2008), cities also need to be governed efficiently and effectively to promote a sustainable and conducive environment as a place of work and living.

Megacities is a general term for cities together with their suburbs or recognized metropolitan areas as a spatially contiguous large agglomeration. It used to address cities which exceed other cities or urban agglomerations in terms of size, speed of growth, and complexity. The common criteria used to identify and rank megacities is number of population. Until the end of the 2010 metropolis with more than eight million population were considered as megacities but since then ten million becomes the limit (Chen and Heligman, 1994; Fuchs et al., 1994; Kraas et al., 2014; UN 1986; 1987; 1989; UN Habitat, 2011). Based on UN (2014), megacities are defined as agglomeration with at least ten million inhabitants. There is no exact definition of its boundaries, where it starts and where it ends. The emergence of megacities is a modern phenomenon, occurring over the last half century (Brennan, 1999). Asian megacities concentrate 60% of world megacities population in 2010. The eighteen largest megacities in the world based on number of population in urban area are shown in Figure 2-1. It become bigger by expanding functionally in metropolitan region marked by polycentrism and tend to form huge Mega Urban Region that shares an important part of Asian population and national economy (Swerts and Denis, 2014). The rapid growth of metropolitan cities has changed the urban landscape, urban shelter, urban society, urban environment, urban economy, urban governance, and urban infrastructure (Singh, 2014). Singh (2014) also mentioned that rapid urban growth have a significant effect on various dimensions of cities, including land use, transportation, environment, economic growth, housing, and infrastructure. Therefore, to achieve sustainable megacities, urban development have to consider economic, environmental, and social aspects of cities in a holistic way.

The largest megacity remains the Tokyo-Yokohama area, followed by the Indonesian capital of Jakarta, Seoul-Incheon, Deli, Shanghai and Manila (Kotkin and Cox, 2013). The emergence of large Asian cities in the second half of the twentieth century is the result of their continued growth during this period. Based on Swerts and Denis (2014), between 1960 and 2010, among the 100 world largest cities, Asia’s large cities experiment an average annual growth rate of 3.4%, that goes up to 3.7 for megacities, when in the rest of the world, the growth was 2.6% (and 2% for megacities), and 1.3 only for the large cities of the ancient industrialized country (Western Europe and North America), this growth rate dropping to 0.7 for megacities. The Asian cities growth rate became significantly highest during the 1980–1990 with an height during the 1990–2000 decade. Although this trend continues until 2010, the annual growth rate of larges cities tend to converge (2.8% in Asia again 2% for other cities between 2000 and 2010) (Swerts and Denis, 2014).

Based on EURAMET (2013), megacities are concerned by the 3 following main dimension: (1) economical dimension (including new technologies, capital equipment, employment-unemployment, improvement of infrastructure, etc); (2) social dimension (including education, living condition, health care, security, innovation, cultural diversity, etc); and (3) environmental dimension (including sustainable development, energy sources, urban sprawl, traffic congestion, waste management, urban environment protection, public transportation, air and water pollution, etc). Megacities can continue to attract population and expand their areas physically as banal activities are moving outside pushed away from transport congestion, labour cost and regulations related to pollution. Negative externalities counterbalance the growth potential, but there is no maximum or equilibrium size for megacity. The megacities size become bigger not only in concentrating command and innovative function in their core area, but also by expanding functionally in metropolitan region (Singh, 2014).

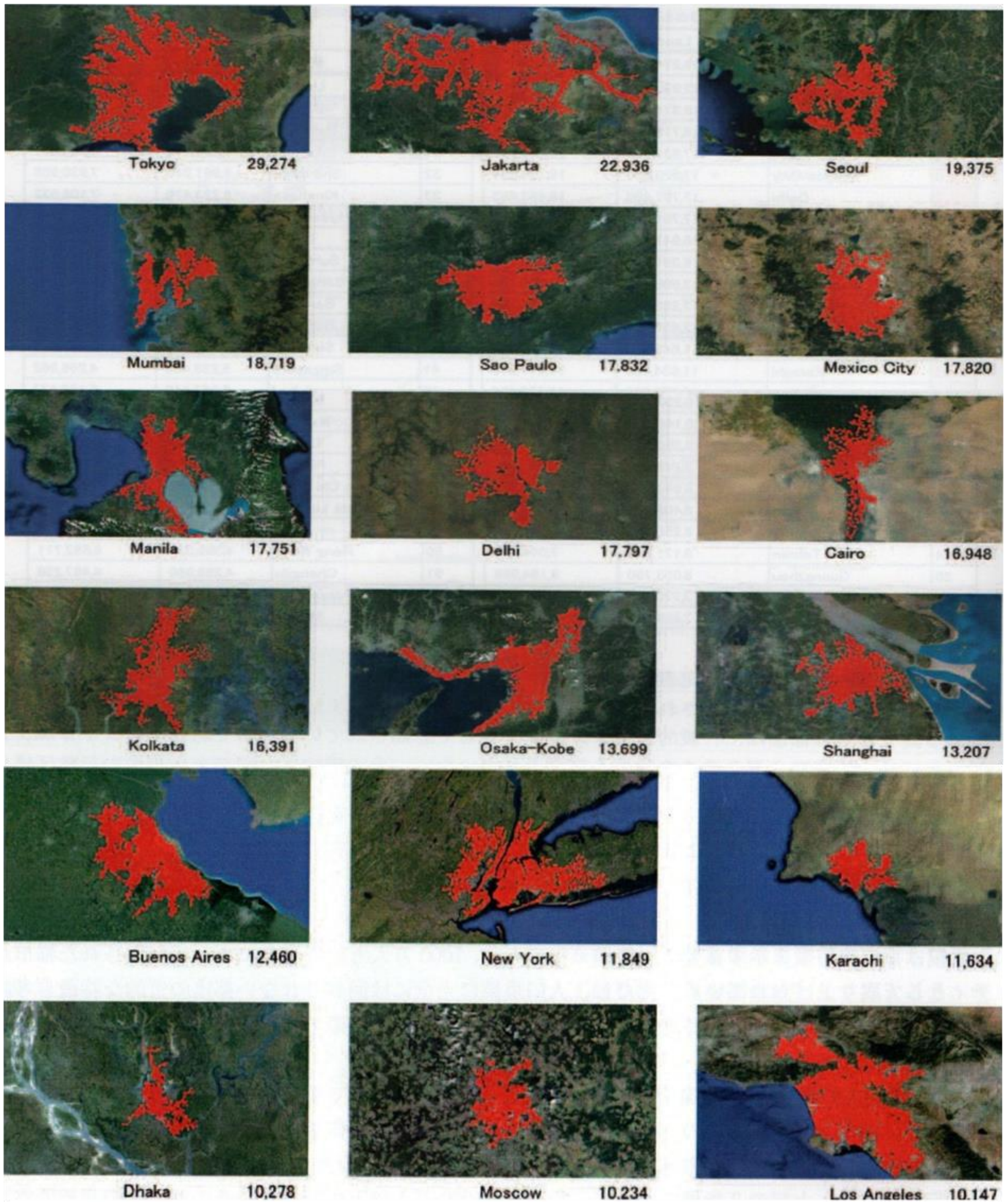


Figure 2 - 24. The 18 largest megacities in the world based on the number of population in urban area
(Source: RIHN, 2014)

2.1.2 Urbanization

Urbanization is a world-wide phenomenon. It is a process of relative growth in a country's urban population accompanied by an even faster increase in the economic, political, and cultural importance of cities relative to rural areas. The term "urbanization" describes an increase in human habitation linked with increased per capita energy and resource consumption, and extensive landscape modification (McDonnell and Pickett, 1990). Since the population becomes more prosperous, demand for goods and services is often driven by more than just pure population growth. There is a worldwide trend toward urbanization. In most countries it is a natural consequence and stimulus of economic development based on industrialization and postindustrialization. Urbanization refers to a growth in the proportion of a country's population living in urban centers of a particular size (Abercombie et al., 1988). Mayhew, (1997) mentioned that urbanization synonymous withthe increasing of population in cities or towns through migration from rural areas because of social and economic changes , or in other words, a transformation from a rural to urban-based societies. From a demographic point of view, the level of urbanization is measured by the percentage of the population living in urban areas (Davis, 1962). In some cases, urbanization has strong relationship with level of economic development, in which developed countries have higher level of urbanization than in developing countries. Since the industrial revolution in the late 18^{th} century, the urbanization process was led in England and then followed by many other countries. During the early stages of industrialization, population tended to concentrate in cities at a steady pace, yet rural population did not decrease during the second stage, while the natural population growth rate slowed down. Families diminished in size, and the age structure took a more cylindrical form. During the third stage, as urbanization became prevalent, natural population growth rate was minimal. Population in the big cities decrease through a movement to the suburbs, as well as with the shift of industries from their areas (Honjo, 1980).

The trend towards urbanization is only accelerating and 96% of all urbanization by 2030 will occur in the developing world. Runde (2015) argue that this global shift towards a more global population has profound implications for a wide range of issues including food, water, and energy consumption. Weisman (1980) mentioned there are two dominant trends pattern of urbanization in the world: (1) pattern of urbanization on the national scale; and (2) pattern of urbanization on the regional scale. On the national scale, there is an increasing concentration of people and production in one or a few places in the form of large metropolitan agglomerations. The ultimate form of this process is the megalopolis. Megapolitan development is occurring both in the highly industrialized and in the developing countries. However, the pace of transformation is dangerously rapid in the developing countries with limited capital, physical resources, as well as experience and skills. On the other hand, in the metropolitan regions themselves, the trend is inverted. The more affluent classes are moving into the surrounding country side to escape from the social and environmental consequences of excessive concentration, the physical congestion and the other negative externalities. However, in both cases, the population and activities in the metropolitan regions continue to grow, although their central cities may be decaying and losing both.

Darin-Drabkin (1977) mentioned that the basic trends in world urbanization are: (1) An increasing percentage of world population is living in urban areas, the largest cities having the fastest growth; (2) Employment within these metropolitan areas is becoming concentrated in the city center; and (3) Population growth is mainly occurring in the outlying regions of the metropolitan area. Rapid population growth itself is a result of the diffusion of scientific-medical knowledge, and is the underlying cause of the growth of urban population. But the concentration of population in urban areas is also affected by economic growth, which is reducing the percentage of the population employed in agricultural (and rural) areas. Structural changes in employment, especially the raising of tertiary (service) sector have led to increased number of employment in the city center. Because most of the service firms need to be centrally located so they can obtain benefit from close interaction with each other. Industrial activities alsocontinues to concentrate in the metropolitan area, which has a pool of skilled man-power, access to consumer markets, and a variety of auxiliary commercial services.These structural changes have also had an impact on the distribution of population in the urban areas. The increasing role of the city center for commercial purposes forces population shift to outlying districts. Developing new transportation systems has allowed it a degree of dispersal within the metropolitan region and facilitate outward spreading of urban areas.

The process of urbanization can be related to the development's process and economic growth. Numerous studies have previously found that the level of urbanization is strongly correlated with the level of GDP per capita (Chenery and Taylor, 1968; Henderson, 2003). Based on OECD-CDRF report (2009), urbanization measures by the growth of urban population shares or by urban population growth rates can arguably track economic development. Van den Berg et al. (1981) proposed the four stages of urbanization process, namely: (1) urbanization stage, migration from rural parts of town; (2) suburbanization stage, the stage when the town spills over to the nearest surrounding municipalities and outward "tickle" due largely to rising prosperity, the inhabitants of suburban municipalities go on looking to the central town for most services; (3) disurbanization stage, absolute decline in numbers of town populations, followed by an economic decline, with a loss of job opportunities, and (4) reurbanization, building up a new center in smaller agglomerations at some distance. Based on Cheshire (1995), several stages of urbanization and development can be outlined as: (1) early stages of economic development – rapid growth of urban share and centralization of population in urban cores; (2) intermediate stage – slower urban share growth as rural population and peasant agriculture declines and spread of growth to intermediate sized cities and to suburban hinterlands; (3) mature economic development – slower growth of urban share and even loss of urban populations from some cities and cores; and (4) post-industrial stages – more or less stable but high share of urban population with renewed growth in largest metropolitan cities and in selected cores but continued growth of many medium sized cities. Decline of older industrial cities and regions. Burns (1981) described the urbanization in the United States. The first stage of urban growth is perhaps best analyzed as a period of intensive expansion within well-defined boundaries. In contrast, suburbanization, which has started for most cities become widespread in unincorporated rural areas and was simultaneously less dependent on any single urban center and the distinction between urban and rural was reduced. The second stage is the conflict among demands. The population density in the urban region decreases and the urban change in population ratio the same period drops off. The second stage is the spill over of urban culture into a regional enlargement. Based on Jansen and Paelinck (1981), the western European cities was experiencing different stages of urbanization, simultaneously, namely: the large-size cities are dominantly disurbanizing, the medium-size cities are still suburbanizing, and the smaller sizes, strangely enough, are both urbanizing and reurbanizing. Honjo (1980) argued that most of the Asian less developed countries is still in their early stage of urbaniziation, its present form proceeded parallel with industrialization in the more developed countries.

Burns (1981) describing the three stages of metropolitan development in U.S.A: (1) the shift of population from non metropolitan areas into the metropolitan sphere, (2) movement outward from established central cores of the metropolitan areas to their suburbs and beyond, and (3) the size redistribution of the population away from the largest to smaller metropolitan areas. From the regional economics point of view, Isard and Reiner (1981) described the interrelated shift in U.S.A. urban areas: (1) diffusions continued in a movement of population and investment outward from older center cities to suburban areas, (2) dispersion or shift to peripheral metropolitan areas or smaller urban places or even rural areas away from the major conurbation which have come to dominate the national scene, and (3) interregional shift or redirection of economic activity which has led to growth in formerly impoverished and underdeveloped parts of a nation.

Urbanization is crucially linked to migration. Based on Bhagat and Mohanty (2009), whether migration is a strong or weak force in the urbanization process depending upon the nature and pattern of migration. From the research conducted by Drewett and Rossi (1981) on more than 100 towns in western Europe classified into groups according to the stage of development, for the period of 1960-1970, and analyzed with respect to the component of population change between core and rings, migration is clearly the predominant force responsible for steering the patterns of change. In the early stages, it was the migration loss in the rings that produced the stage of population concentration, and in later stages the migration loss in the core triggered the decentralization.

Many scholars have tried to distinguish the major determinant factors of migration from rural area to urban area. Jansen and Paelinck (1981), Kaida (1992) and Mazumdar (1987) conducted researches to identify the determinants to be pull factors (from the urban area) and push factors (from the rural area), whereas Jansen and Paelinck (1981) analyzed the major determinant along with the improvements in communication between rural and urban areas. The main pull factor of migration from the urban area is the expectation of better chances of income improvement or wage (Jansen and Paelinck, 1981; Mazumdar, 1987), and the main push factors of migration from the rural area are conditions in the rural area due to over population and low agricultural productivity (Kaida, 1992). Strong push factors and weak pull factors of migration in the Asian countries caused rapid growth of the urban informal sector and resulted in expanded slums area around big cities (Kaida, 1992).

2.1.3 Suburbanization

Suburbanization refers to the spreading of urban population and employment from the central cities to satellite communities called suburbs. This movement results in an increased dispersion of urban population and employment over a land area (Kopecky and Suen, 2010). Suburbs refers to residential clusters on the periphery of a city or town. Jackson (1985) and Mayhew (1997) defined suburbanization as the creation of residential areas, and to some extent industrial area, at the edge of the city. It occurs as a result of the urbanization of the city center creating a need for larger areas of land and a better environment for housing. Based on Jackson (1985), suburb as a residential place, as well as a site of scattered dwellings and businesses outside a city, is as old as civilization and an important part of an ancient, medieval, and early modern urban traditions . However, suburbanization as a process involving the systematic growth of peripheral areas at a more rapid than that of core cities, and as a lifestyle involving a daily commuting to job places in the center, occurred first in the U.S.A. and the Great Britain in the early 19th century. In other words, residential suburbanization, or population deconcentration refers to the relocation or movement of the population from the core of a city to the new housing in the peripheral areas or suburban zones.

Jackson (1985) defined the suburbs based on four components: (1) functions (non-form residential), (2) class (middle and upper status); (3) separation (a daily journey-to-work), and (4) density (low density in relatively to old settlements). Economic causes have been most important among many causes of suburbanization. There are six components/elements of economic causes that make the cost of suburban houses in the U.S.A. relatively low and affordable: (1) increase of per capita wealth, (2) inexpensive land, (3) inexpensive transport costs, (4) balloon frame house (big house) type, and (5) role of government subsidy, and (6) capitalistic system. The process of suburbanization effects population settlement, environment and society. Residential and commercial suburbanization is a global phenomenon which began in the 20th century. In many big cities, suburbanization process has been occurred as a response of the new transportation technologies, the development of highway systems, new single-dwelling construction, changing family structures, development of telecommuting systems, new conceptions of employment and public policy, and so on.

Suburbs are socially and economically inferior to cities. The developments of suburb areas significantly depend on the development of the city. The city and suburbs are independent in the sense that long-run changes in population, employment, and measures of urban life in cities and suburbs tend to be correlated. Using cause data on city and suburban growth for most of the U.S.A. metropolitan areas, Voith (1988) provide evidences that city income growth enhanced suburban growth in income, house-price appreciation, and population, especially in metropolitan areas with large central cities. From point of view of spatial patterns, cities and suburbs provide very different sets of local attributes. Suburbs are characterized by widely dispersed development and privately controlled space. Cities, on the other hand, have dense development with a considerable amount of publicity accessible space (Voith, 1988).

Being significantly different from the urbanization and suburbanization processes in U.S.A. and Europe, recent studies on Asian urbanization have stressed that the continuing outward expansion of the largest metropolitan regions has eroded the longstanding distinction between rural and urban areas (McGee, 1987; McGee, 1991; McGee and Greenberg, 1992). This trend has been driven by economic expansion and has resulted in extended areas of mixed land use on city peripheries. McGee (1987) argued that there was a distinctive Asian variation of the usual pattern of suburbanization. McGee (1987) calls it a *desakota* region, derived from the Indonesian words for village (*desa*) and city (*kota*). *Desakota* are dense regions, extending over 30 km and characterized by a mixture of agricultural and urban activities and the competitive complementarity of formal and informal activities associating large scale industries and chain of subcontracting as a huge share of self employed and daily wage workers. They are also characterized by the diversity of activities, pluri-activities and intensity of commuting. *Desakota* are deployed along corridors linking major dense urban centers. They include major cities with their periurban surrounding, which correspond to the functional area of the city, plus extensive areas developed along transport corridors and incorporating villages, where agricultural and urban activities are intermingled (McGee, 1991). *Desakota* is a complex entity and this concept shares many characteristics with the more universal notion of Mega Urban Region but it insists on the very dense and particular settlement conditions observed in Asia. It encompasses a particular attachment to the delta and agriculture irrigated region where agricultural and nonagricultural activities mingled much before urban sprawl occurs. McGee (1990; 1991) describes *desakota* regions as previously agricultural areas with an intense mix of settlement and economic activity, comprising agriculture, industry, housing development, and other land uses.

Suburbanization can affects some externatilies, including environment, economic, and communities. For local environmental aspect, for instance, suburbanization can contribute to decrease air quality as well as endangered the health of animal species and water bodies by the rise in commuter pollution caused by suburban residents commuting by car to their job places in the urban centers. Smith (1996) argued that strategies for reducing the negative environmental impact of suburbs include carpooling, rapid transit train, bus and ferry systems, bicycle commuting, and reverse commuting. To address urban sprawl and urban decline caused by suburbanization, some public policies can be implemented such as: impact fees[1], congestion pricing[2], tax-base sharing[3], concurrency planning[4], reverse commuting program[5], affordable housing strategies[6], growth management[7] and so forth (Keil, 2006).

- [1] Impact fees refer to charges that localities impose on developers to generate revenue instead of making existing residents pay for the new or improved capital projects necessitated by development.
- [2] Congestion pricing is a mechanism that accounts for traffic-related costs and imposes them on local businesses and commuters. One of the main examples of congestion pricing is peak-hour road pricing in which motorists are charged higher tolls on congested highways during peak hours.
- [3] Tax-base sharing programs refer to a tax system in which urban and suburban municipalities share revenue with each other rather than keeping funds for the exclusive use of their area. Tax-sharing programs address the problem of unequal taxable property and businesses.
- [4] Concurrency planning refers to "planning in which public services and infrastructure must be provided at the same time as new development is built."
- [5] Reverse commuting programs promote and, in some cases, provide inner-city residents with transportation to and from suburban jobs.
- [6] Affordable housing programs aid city residents in moving to the outer suburbs and gaining access and proximity to the new centers of job growth. These programs may include loans, information, zoning changes, grants, and subsidized suburban housing.

[7] Growth management refers to an explicit, ongoing program to shape or control growth through some combination of intervention techniques and policies.

2.1.4 Urbanization and Suburbanization in Indonesia

Definition of 'urban' greatly varies from one country to another. Studies of urbanization are forced to rely on the definition of urban areas is adopted in each country. The urbanization as a general physical phenomenon in Indonesia is still continuing. DGHBU-PU (1973) reported that in 1930 only 7.5% () of the total population of Indonesia lived in cities/ or urban areas. After the World War II, the urbanization and urban growth in Indonesia increased, mainly caused by the push factor of the insecurity condition in the rural areas. In 1961, the number of the Indonesian population lived in cities or urban area was increased became 15%. Based on Hill (1990), the percentage of Java's urban population increased from 15.6% up to 18.0% in 10 years, particularly because of the increasing share of Jakarta . Based on Rustiadi (1999), in spite of the increasing urban population, the built-up surfaces of many cities and towns have hardly been extended since 1945. In fact, this increase has been made possible by a heavy intensification of the pre-existing urban area. The morphologic result of this intensification is mainly the traditional and irregular settlements called as '*kampungs*' in and close to the cities. The *kampung*, 'villages' in Indonesian, is associated with informality, poverty, and the retention of rural traditions within an urban setting. Firman (1999) argues the existence of *kampungs* and modern cities reflect spatial segregation and socio-economic disparities. Rustiadi (1999) mentioned that the most important factor in the economic urbanization is the transition from a mainly agricultural economy towards an industrialized economy. Rustiadi (1999) argued that this means a shifting in employment and income from the primary sector (especially agriculture sector) towards the secondary sector (such as: industrial, manufacturing, trade, construction, etc.), or tertiary sector (services). This transition is usually attended with physical urbanization because the much more intensive use of land by industry caused a concentration of population near the industrial areas (Rustiadi, 1999).

Rustiadi (1999) explained that in the early stage of urbanization in Indonesia, the push factor from rural areas, especially in Java could not find a complementary pull factor in the urban areas, in the sense of a demand of industrial labor force. In fact, apart from this over employment, there is greatly disguised unemployment, not officially registered. So, the conclusion has to be that the push factor towards urbanization, caused by the unemployment in the rural areas, does not actually find a real complement in a pull factor, consisting of demand for labor force. Nevertheless these push factors are working and lead to migration into the cities, because there is an acute need for many people in their villages, supporting hopes, that they will find better opportunities in the city. Based on Rustiadi (1999), the lack of employment in the primary sector (especially in agriculture sector) and industrial or manufacturing sector causes a strong push factor. The effect of this situation is that many migrants forced to enter the tertiary sector of trade, service and transport, characterized by a structural over-employment. In the meantime, powerful social pull factors are working from the towns, but still more from the cities, because the poor villager hopes and expected to find a new and better way of life.

The number of urban localities in Indonesia increased from 12,351 to 15,786 over the 2000 to 2010 period, which make the proportion of urban localities added from 17.96% to 20.46% over the period. However, the urban localities in Java had increased even more significantly (from 30.02% to 36.66%) (Firman, 2013). In Indonesia, a locality is defined as 'urban' on the basis of three criteria: (1) population density; (2) households engaging in the agricultural sectors; and (3) urban facilities and physical distance to reach them. Where the total Indonesia's population increased from 203.5 million to 237 million, the urban population grew from 85.2 million to 118.3 million over the period 2000 to 2010. The level of urbanization, that is the proportion of urban population increased significantly from 41.9% to 49.7% over the period (Firman, 2013). The annual growth rate of Indonesia's population increased from 1.35%

between 1990 and 2000 to 1.49% between 2000 and 2010, but urban population growth rate declined from 4.40% to 3.33%.

The number of millionaire cities has increased significantly from only one in 1950 to three in 1980, and eleven in 2010. Based on Firman (2013), five of the ten millionaire cities, namely Jakarta, Tangerang, South Tangerang, Bekasi and Depok are located in Jakarta Metropolitan Region (Jabodetabek Megacity), resulting in about 20% of Indonesia's urban population being concentrated in this metropolitan region. The rate of annual population growth of the millionaire cities is lower than the average national annual population growth rate of 1.49%, with the exception of Bekasi (3.44%), Tangerang (3.20%), Depok (4.25%) and Makasar (2.07%). The lower growth rate of other millionaire cities, including Jakarta, Surabaya, Bandung and Medan is basically due to suburbanization processes which have resulted in the faster growth rates in the metropolitan peripheral areas adjacent to the core cities. The peripheral areas of the largest cities are experiencing much more rapid population growth than the core cities. Jakarta's adjacent cities (municipalities) and regencies had a higher annual population growth over the period 2000 and 2010: Bogor Municipality (3.15%), Bogor Regency (2.40%), Bekasi Regency (4.70%), Bekasi Municipality (3.44%), Depok Municipality (4.33%), and Tangerang Municipality (3.50%), compared to Jakarta City, the core of Jabodetabek Megacity (1.40%). In 2000 Indonesia had 27 provinces, but the number increased to 33 in 2010 due to some provincial proliferation. All provinces in Java have a relatively high proportion of urban population, and also experienced increase in the proportion of urban population since 2000.

The spatial pattern of urban development in Java essentially indicates the importance of the integrated development of large cities with their surrounding *kabupatens* (regencies). Metropolitan development approaches are needed to cope with problems of urban and regional development in Java. These approaches should include development for settlement systems, industrial estates, land use and environment as a whole. Based on Rustiadi (1999), the suburbs of the main cities in Indonesia have special characteristics because of their high population growth and economic activities. The urban facilities and infrastructure of Jakarta have largely supported the growth of industries in the suburbs with a very significant impact on land use.

2.2 Study Area

2.2.1 The Java Island

Java is the most populated island in Indonesia. With a population of 143 million (in 2014), Java is the home of 57% of the Indonesian population, and highly urbanized region. The population density is about 1,120/km^2. With a total area of 138,794 km^2, Java is 13th largest island in the world and the fifth largest in Indonesia. Java is divided into 6 provinces: Banten, DKI Jakarta, West Java, Central Java, Yogyakarta, and East Java (Figure 2-1). Java dominates Indonesia politically, economically, and culturally.

Figure 2 - 25. Administration map of Java Island

Java is almost entirely of volcanic origin. It contains thirty-eight mountains forming an east-west spine that have at one time or another been active volcanoes. The highest volcano in Java is Mount Semeru (3,676 meters) or 12,060 feet. The most active volcano in Java and also in Indonesia is Mount Merapi (2,930 meters). More mountains and highlands help to split the interior into a series of relatively isolated regions suitable for wet-rice cultivation. The rice lands or paddy fields of Java are among the richest in the world. Topography map and slope of Java are shown in Figure 2-3 and Figure 2-4 respectively.

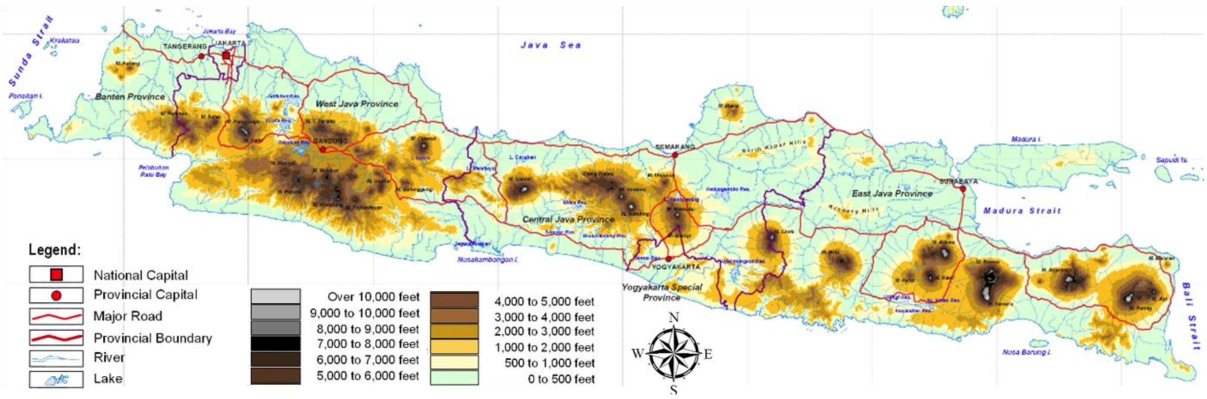


Figure 2 - 26. Topography map of Java (Source: Bappenas, 2003)

Figure 2 - 27. Slope map of Java (Source: Bappenas, 2003)

The area of Java is approximately 150,000 km^2. It is about 1000 km (620 mi) long and up to 210 km (130 mi) wide. The longest river in Java is the Bengawan Solo river with 600 km length. The river rises from its source in Central Java at the Lawu volcano, then flows north and eastward to its mouth in the Java Sea near the city of Surabaya. Other major rivers are Brantas, Citarum, Cimanuk, and Serayu. Spatial distribution map of main rivers and watershed (*satuan wilayah sungai* = SWS) area in Java can be seen in Figure 2-5.

The natural environment of Java is tropical rainforest, with ecosystems ranging from coastal mangrove forest on the north coast, rocky coastal cliffs on the sourthern coast, and low-lying tropical forest to high altitude rainforests on the slopes of mountainous volcanic regions in the interior. The Java environment and climate gradually alters from west to east; from wet and humid dense rainforest in western parts, to a dry savanna environment in the east, corresponding to the climate and rainfall in these regions.

SWS No.	SWS Name
0201	Ciujung-Ciliman
0202	Cisadane-Ciliwung
0203	Cisadeg-Cikuningan
0204	Citarum
0205	Cimanuk
0206	Ciwulan
0207	Citanduy
0208	Pemali-Comal
0209	Serayu

SWS No.	SWS Name
0210	Jratun Seluna
0211	Progo-Opak-Oyo
0212	BengawanSolo
0213	K.Brantas
0214	Pekalen-Sampean
0215	Madura

Figure 2 - 28. Spatial distribution of Main rivers and watershed (SWS) areas (Source: Bappenas, 2003)

Java is the most developed island in Indonesia since the era of Netherlands East Indies to modern Republic of Indonesia. The road transportation networks that have existed since ancient times were connected and perfected with the construction of Java Great Post Road by Daendels in the early 19th century. The Java Great Post Road become the backbone of Java's road infrastructure and laid the base of Java North Coast Road (in Indonesia, we called '*Jalan Pantura*' – abbreviation from '*Pantai Utara*'). The need to transport commercial produces such as coffee from plantations in the interior if the island to the harbour on the coast spurred the construction of railway networks in Java. The toll road highway networks was built and expanded since Suharto era until now, connecting major urban centers and surrounding areas, such as in and around Jakarta and Bandung, and also the ones in Cirebon, Semarang, and Surabaya. Java has 16 national highways. The spatial distribution map of transportation network and basic infrastructure in Java can be seen in Figure 2-6. The spatial structure map and spatial pattern map of Java Island based on spatial planning map which released by Ministry of Public Work can be seen in Figure 2-7 and Figure 2-8, respectively.

Figure 2 - 29. Transportation network and basic infrastructure map of Java (Source: Bappenas, 2003)

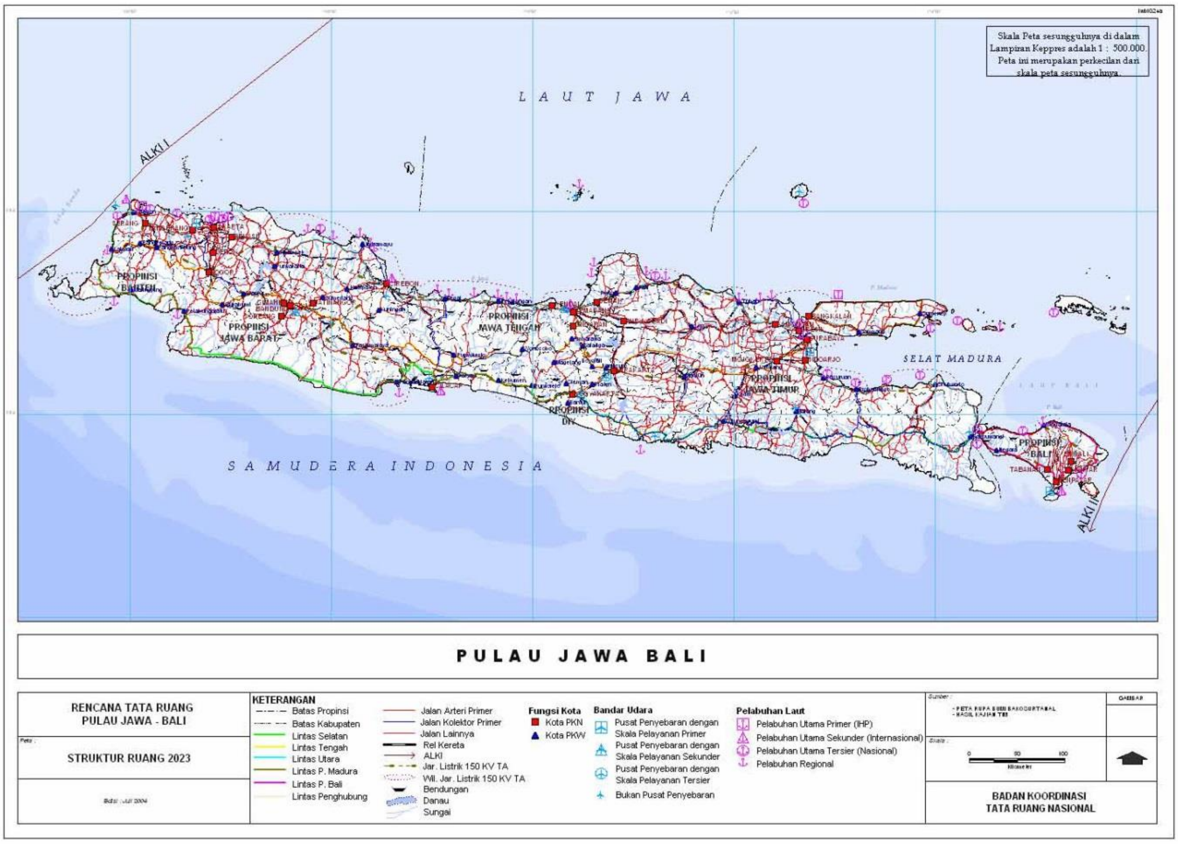


Figure 2 - 30. Spatial structure map of Java Island (Java-Bali)
(Source: Ministry of Public Work, 2004)

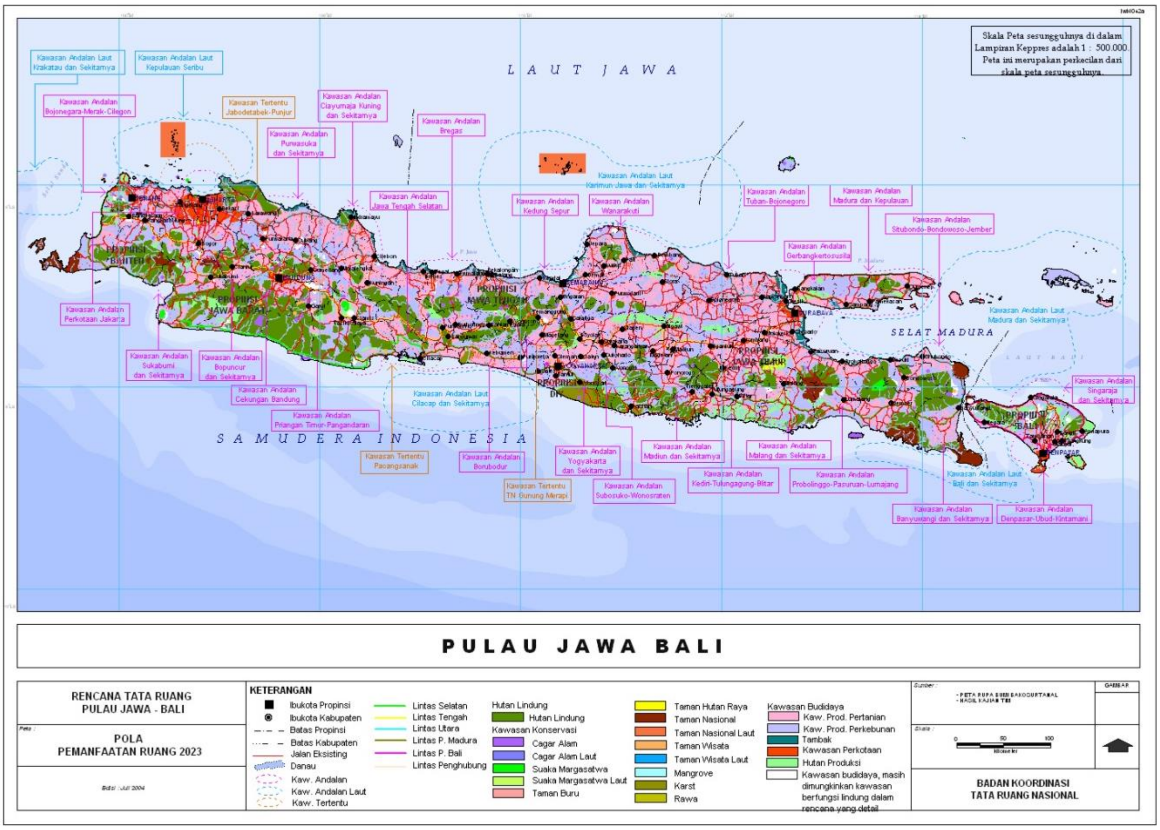


Figure 2 - 31. Spatial pattern map of Java Island (Java-Bali)
(Source: Ministry of Public Work, 2004)

Java is the most populous island in the world and is home to 57% of Indonesia's population (The Jakarta Post, August 23, 2010). Number of population in Java was increasing from around 100 million in 1986, become 107.5 million in 1990, 121 million in 2000 and 136.5 million in the 2010 census. Though little population growth is registered in Central Java, East Java, and Yogyakarta, these regions have higher birth rates than one would assume due to mass emigration to the western side of Java, Sumatera, Borneo, and Papua. The western third of the island (West Java, Banten and DKI Jakarta) has even higher population density, of nearly 1,500 per square kilometer. Based on the statistical data by the year of 2012 which's released by Central Bureau of Statistics or *Badan Pusat Statistik* (BPS), Java itself contributes at least 57% of Indonesia's Gross Domestic Product (GDP). The total GDP of Java was also increasing from less than 400,000,000 million rupiah (equals to 40 billion USD) in 1986, and become 1,300,000 billion rupiah (or equals to 130 billion USD). The trends increasing number of population and total GDP of Java during period 1986-2010 can be seen in Figure 2-9. The trends of population density and GDP per capita of Java during period 1986-2010 are shown in Figure 2-10 (A) and (B), respectively.

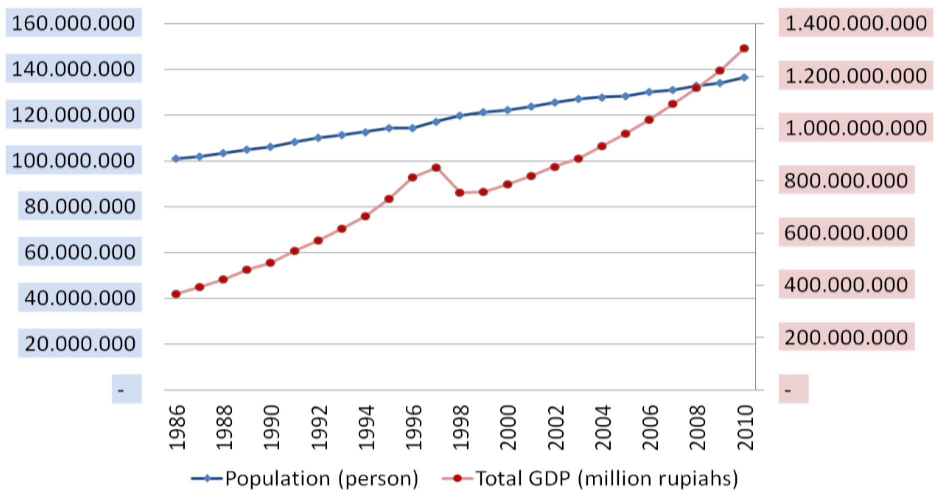


Figure 2 - 32. Trend of Population and Total GDP of Java 1986-2010

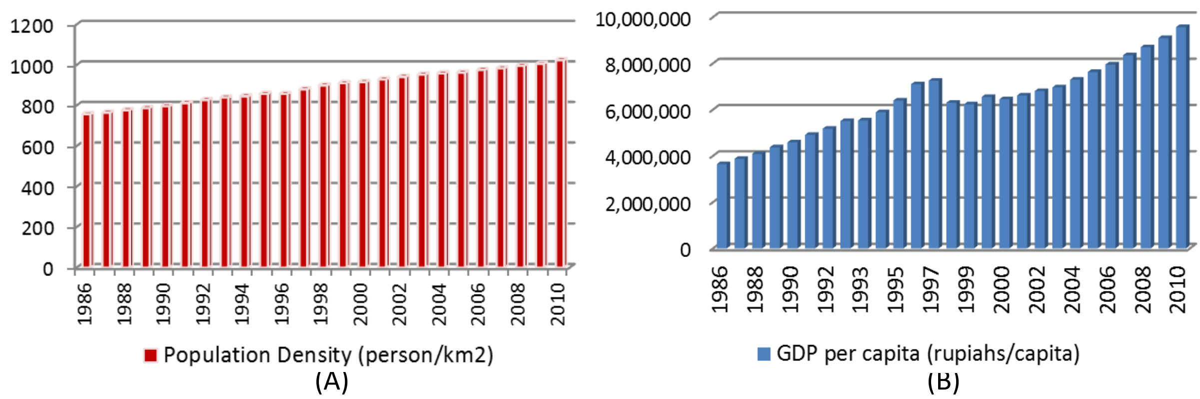
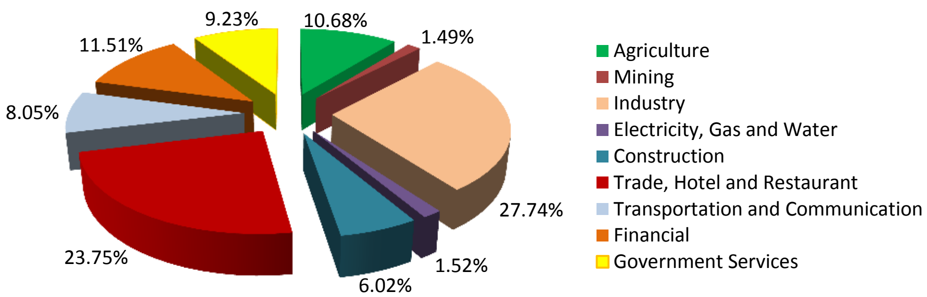


Figure 2 - 33. (A) Population density of Java (person/km^2) and (B) GDP per capita of Java (rupiahs/capita)

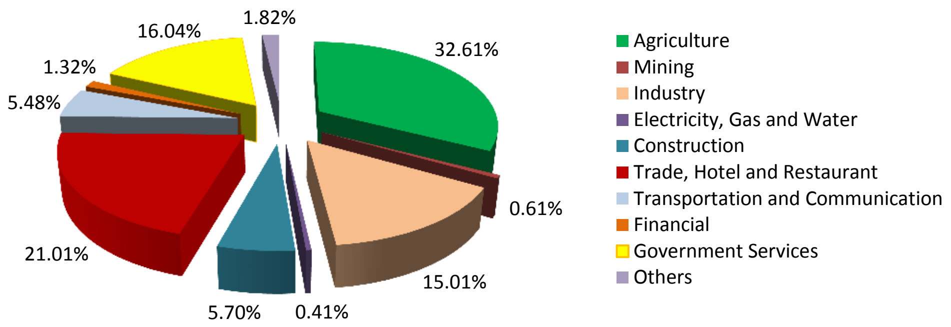
Figure 2-11 shows the contribution of each economic sector to the total GDP of Java. There are 9 economic sectors of GDP, and the percentage of 9 sectors Java's GDP are: (1) agriculture (10.68%); (2) mining (1.49%); (3) industry (27.74%); (4) electricity, gas and water (1.52%); (5) building construction (6,02%); (6) trade, hotel, and restaurants (23.75%); (7) transportation and communication (8.05%); (8) finance, corporate and corporate services (11.51%); and (9) services (9.23%).



Total GDP of Java (2010): 1.308.521.082 million rupiahs
(Source: BPS, Central Bureau of Statistics, 2010)

Figure 2 - 34. Share of economic sectors to total GDP of Java (2010)

Figure 2-12 shows the proportion of Java's employment based on economic sectors. From the highest to the lowest percentage, there are: (1) agricultural sector with 32,61% of total Java's employment; (2) trade, hotel and restaurant sector (21.01%); (3) government services sector (16.04%); (4) industrial sector (15.01%); (5) building construction (5.70%); (6) transportation and communication (5.48%); and the other sectors have less than 2% of Java's employment for each.



Number of employment in Java (2010): 61.443.876
(Source: BPS, Central Bureau of Statistics, 2010)

Figure 2 - 35. Proportion of Java's employment based on economic sectors (2010)

Comparing the proportion of total GDP and number of employment working on each economic sector (Figure 2-13), it can be seen that agricultural sector contributes around 10.68% of total GDP of Java, less than industrial sector, hotel trade and restaurant sector, as well as financial sector, with the percentage of GDP contributions are 27.74%, 23.75% and 11.51%, respectively. Although the agricultural sector contributes not as much as the other sector on total GDP, more than 32% of Java's employment still working on this sector. Its mean that agricultural sector is one of the vital sector in Java's economic activity. On the other hand, the industrial sector contributes to the total GDP of Java much higher than agricultural sector, but the employment working on this sector is only about 15% of total Java's employment, since the industrial sector use much more man-made resources and technology rather than human resources.

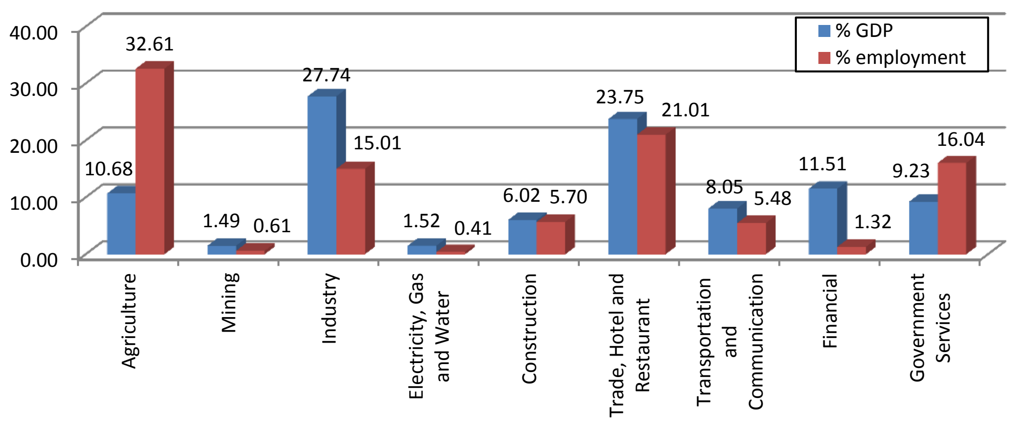


Figure 2 - 36. Proportion of GDP vs. Employment in Java (2010)
(Source: BPS, Central Bureau of Statistics, 2010)

There are 5 metropolitan areas in Java Island. From the western to southern part of Java, there are: Jabodetabek Megacity, Bandung Raya, Kedungsempur, Kartamantul, and Gerbangkertosusila. The location of each metropolitan area in Java can be seen in Figure 2-14, whereas the detail information about the number of population, total area and population density of each metropolitan area are shown in Table 2-1.

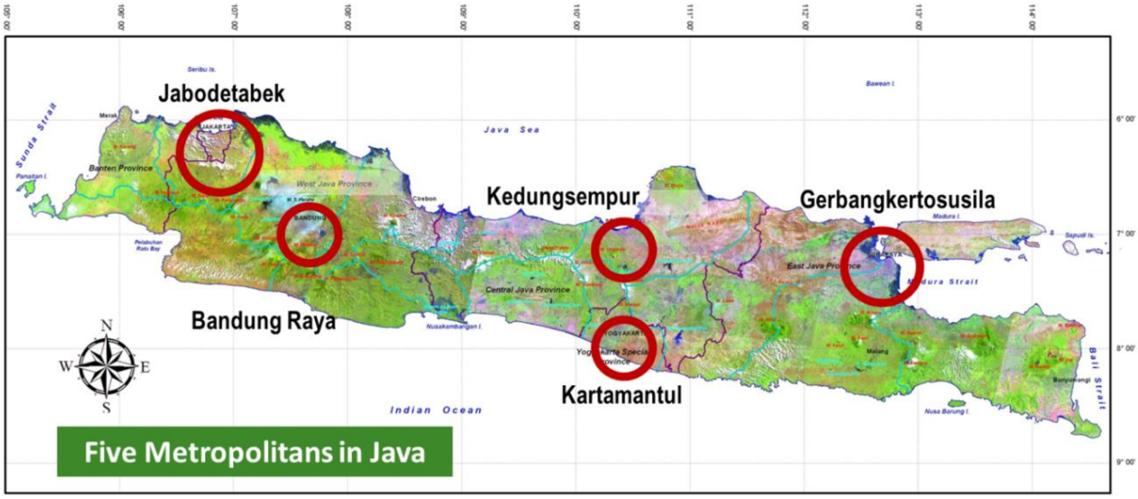


Figure 2 - 37. Location of five metropolitan areas in Java

Table 2 - 3. Name of 5 metropolitan areas, regions, population, total area and population density

No.	Name of Metropolitan Area	Official Acronym	Region	Population (2010 census)	Area (km^2)	Population Density (2010)
1	Jakarta Metropolitan Area (Greater Jakarta)	**Jabodetabek**	Including DKI Jakarta, covers areas in Banten and West Java Province, namely: Bogor Regency, Bogor Municipality, Depok Municipality,Tangerang Regency, Tangerang Municipality, South Tangerang Municipality, Bekasi Regency and Bekasi Municipality.	28,336,934	6,682.8	4,240.3 per km^2
2	Bandung Metropolitan Area	**Bandung Raya**	Bandung Municipality, Bandung Regency, Cimahi Municipality, and West Bandung Regency	7,889,047	3,382.89	2,332.0 per km^2
3	Semarang Metropolitan (Greater Semarang)	**Kedungsempur**	Semarang Municipality, Semarang Regency, Salatiga Municipality, Kendal Regency, Grobogan Regency, and Demak Regency	6,544,289	5,287.96	1,238.8 per km^2
4	Yogyakarta Metropolitan (Greater Yogyakarta)	**Kartamantul**	Yogyakarta Municipality, Sleman Regency and Bantul Regency	2,366,340	1,114.18	2,148.0 per km^2
5	Surabaya Extended Metropolitan Area	**Gerbangkerto susila**	In East Java Province, covers Surabaya Municipality, Gresik Regency, Bangkalan Regency, Mojokerto Municipality, Mojokerto Regency, Sidoarjo Regency, and Lamongan Regency.	9,115,485	5,925.8	1,538.3 per km^2

(Source: Data processed from BPS, Central Bureau of Statistics, 2010)

Based on total GDP of each metropolitan area, Jabodetabek Megacity has highest total GDP comparing with the other metropolitan areas in Java (Figure 2-15). Jabodetabek Megacity's GDP contributes around 41% of total GDP of Java. The second highest contributor is Gerbangkertosusila (Surabaya Metropolitan Area). The other three metropolitan areas contributes less than 10% of total Java's GDP. The excluded area (non metropolitan areas in Java or 'rest of Java') contributes about 39% indicated by the orange color in the pie chart of GDP's proportion in Figure 2-15. Comparison of GDP per capita of 5 metropolitan areas in Java is shown in Figure 2-16.

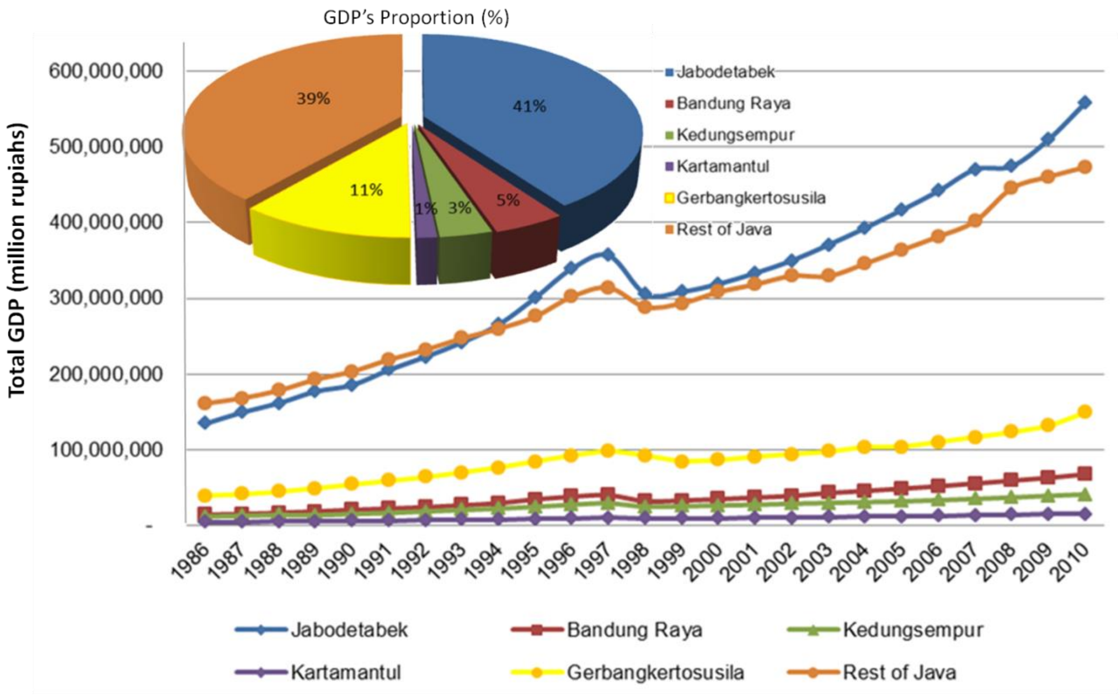


Figure 2 - 38. Total GDP and GDP's Proportion of 5 metropolitan areas in Java

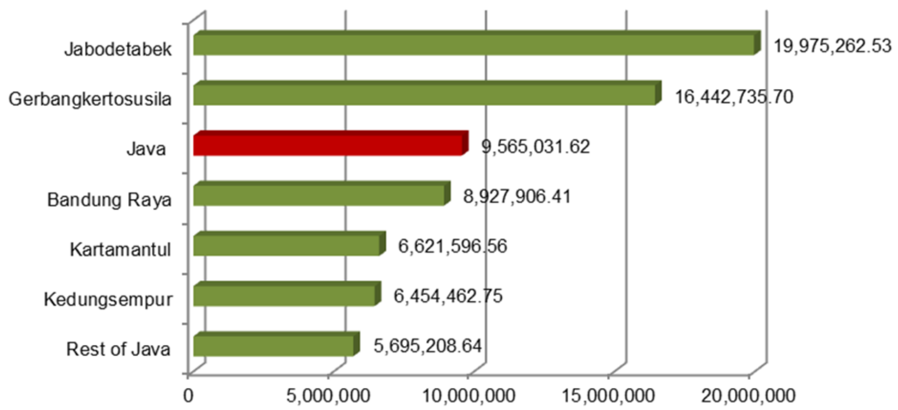


Figure 2 - 39. GDP per capita of 5 metropolitan areas in Java, 2010 (rupiahs/capita)

2.2.2 The Greater Jakarta (Jabodetabek Megacity)

Jakarta is the capital of Indonesia and the largest metropolitan area in Southest Asia with tremendous population growth and a wide range of urban problems. The overall population of the megacity of Jakarta grew in the 20th Century, from about 5 million in 1960 to about 28 million in 2010.

The megacity of Jakarta is also called Jabodetabek Megacity, taken from the initial letters of the administrative units of Jakarta, Bogor, Depok, Tangerang, and Bekasi. The center of Jabodetabek Megacityis Jakarta, also called the Special Capital Region of Jakarta (*Daerah Khusus Ibukota*/DKI Jakarta), and the peripheries of the megacity of Jakarta are Bogor, Depok, Tangerang and Bekasi, or we called it Bodetabek. The inner peripheries of the megacity of Jakarta include four municipalities (Tangerang Municipality, Tangerang Selatan Municipality, Depok Municipality and Bekasi Municipality), whereas the outer peripheries of Jabodetabek Megacity include Bogor Municipality, Bogor Regency, Tangerang Regency, and Bekasi Regency (Figure 2-17).

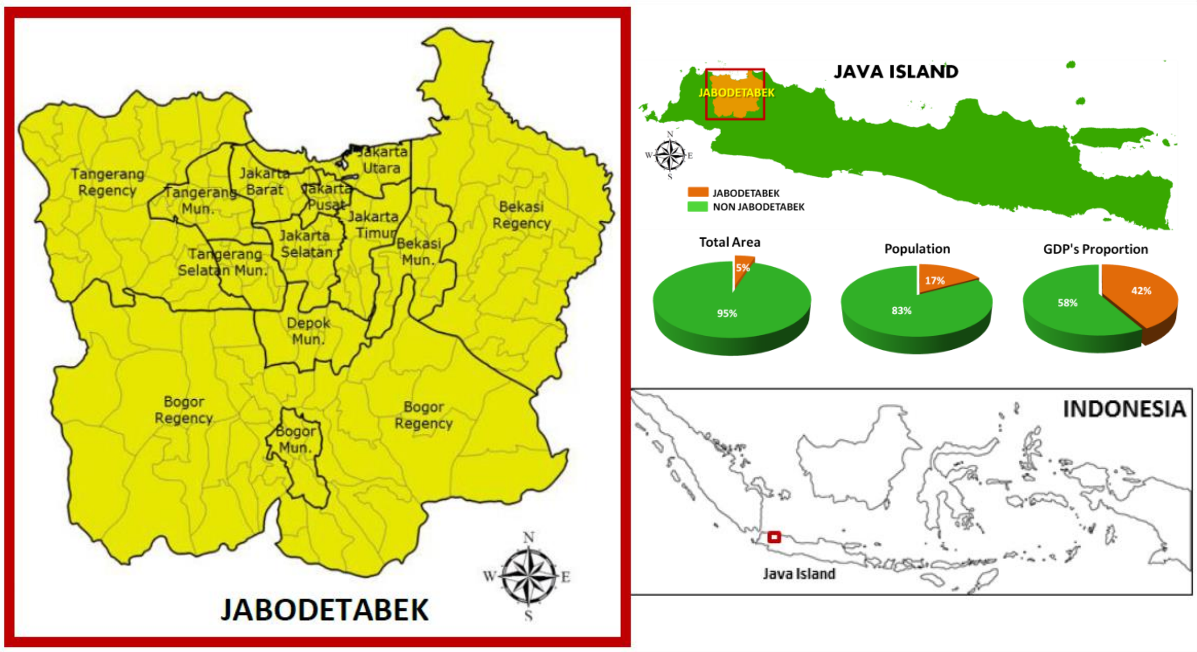
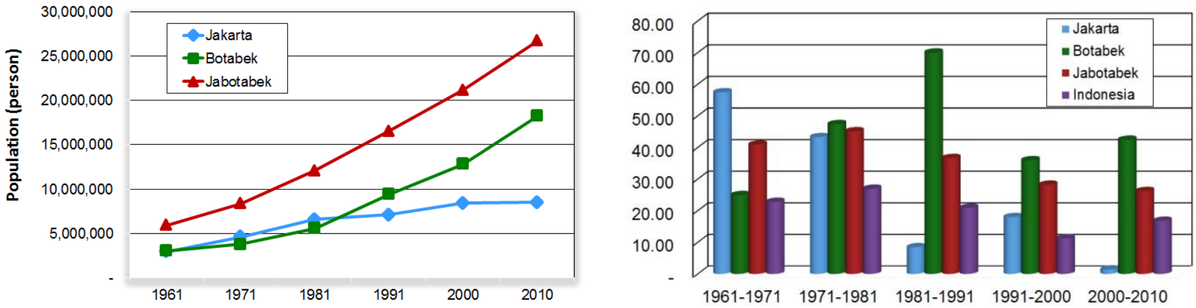


Figure 2 - 40. Administration map of Jabodetabek Megacity

Jakarta, or the Special Capital Region of Jakarta (DKI Jakarta), has 'provincial government level' status. The peripheries of Jabodetabek Megacity are within the jurisdiction of two provinces. The Bogor Regency and Bogor Municipality, Depok Municipality, Bekasi Regency and Bekasi Municipality are within the jurisdiction of West Java Province, whereas Tangerang Municipality, Tangerang Selatan Municipality and Tangerang Regency are within the jurisdiction of Banten Province. The four municipalities within the inner peripheries of Jabodetabek Megacity are new municipalities founded in the 1990's and 2000's. Tangerang Municipality, Bekasi Municipality, Depok Municipality and Tangerang Selatan Municipality were founded in 1993, 1996, 1999 and 2008 respectively. The Tangerang Municipality and Tangerang Selatan Municipality seceded from Tangerang Regency. Meanwhile, Depok Municipality was part of Bogor Regency and Bekasi Municipality seceded from Bekasi Regency.

Jabodetabek Megacity covering an area of approximately 6,700 km^2. The population of Jakarta city as the core of Jabodetabek Megacity was about 9 millions in 2010 and in Bodetabek reached more than 18 millions (Rustiadi et al. 2012). Trend of population and population growth in Jakarta, Bodetabek and Jabodetabek Megacity during 1961-2010 can be seen in Figure 2-18 (A) and Figure 2-18 (B). From the data shown in Figure 1, it can be seen that in 2010 the number of population in Jakarta was only half of Bodetabek's population. Figure 2-18 (B) shows that Jakarta reached its peak population growth in the periods of 1961-1971 and 1971-1981. In those periods, the population increase in Jakarta was much greater than that of Bodetabek region. However, after 1981, the rate of population growth in Bodetabek has changed significantly and always been higher than that of Jakarta. This indicates that the population growth in Jabodetabek Megacity is no longer happening in Jakarta as the core, but it is distributed to Bodetabek region as its hinterland.



(A) (B)

Figure 2 - 41. (A) Population of Jakarta, Bodetabek and Jabodetabek Megacity in 1961-2010 and (B) Population growth in Jakarta, Bodetabek, Jabodetabek Megacity and Indonesia in 1961-2010 (%)
(Source: Rustiadi et al. 2012)

Figure 2-18 (B) indicates that the highest population growth of Jakarta was occured in 1961-1971. The biggest population growth in the suburban areas of Jakarta (Bodetabek) happened in the period of 1981-1991. When the suburbanization was reaching its peak, the Jakarta population was already less than that of Bodetabek. Between 1991 and 2000 there was a decrease population growth in both Jakarta and Bodetabek. This was caused by the economic crisis in Asia, which also had an impact on the economy and population growth in Indonesia. However, in the period of 2000-2010 the number of population in Bodetabek increased again. It is necessary to examine this, which also becomes a major question: Is re-suburbanization happening again in Bodetabek in those periods.

Based on Rustiadi et al. (2012), the population share of Jabodetabek Megacity to the national population was increased from 6.10 % in 1961 to 11.26 % in 2010, but the proportion of the Jakarta city population to the total Jabodetabek Megacity population declined over time, from 49.1 % in 1961 to only 31.8 % in 2010 (Figure 2-19). This reflects the suburbanization process in the peripheral areas.

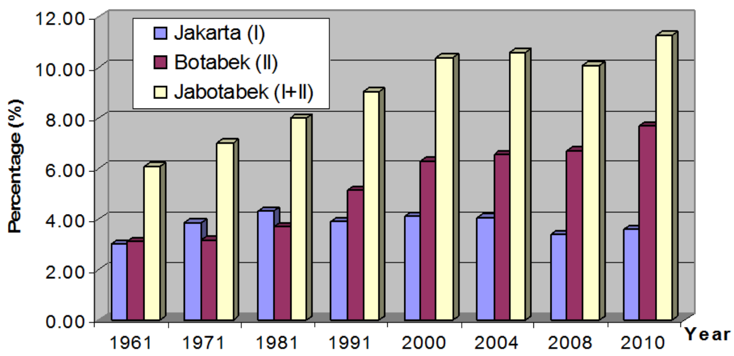


Figure 2 - 42. Population Share of Jabodetabek Megacity to National Population (%) 1961-2010
(Source: Rustiadi et al. 2012)

Jabodetabek Megacity becomes a center of national economic activities that are characterized by high population density and high spatial interaction with other regions. In national economy, Jabodetabek Megacity contributed 25.52% of total national GDP in 2010, 17.92% from Jakarta city and 7.59% from Bodetabek (Rustiadi et al. 2012). GDP consists of 9 sectors: (1) agriculture; (2) mining; (3)

industry; (4) electricity, gas and water; (5) building construction; (6) trade, hotel, and restaurants; (7) transportation and communication; (8) finance, corporate and corporate services; and (9) services. Figure 2-20 shows the percentage contribution of each economic sector of Jabodetabek Megacity to the national economic sector compared to the rest of Indonesia.

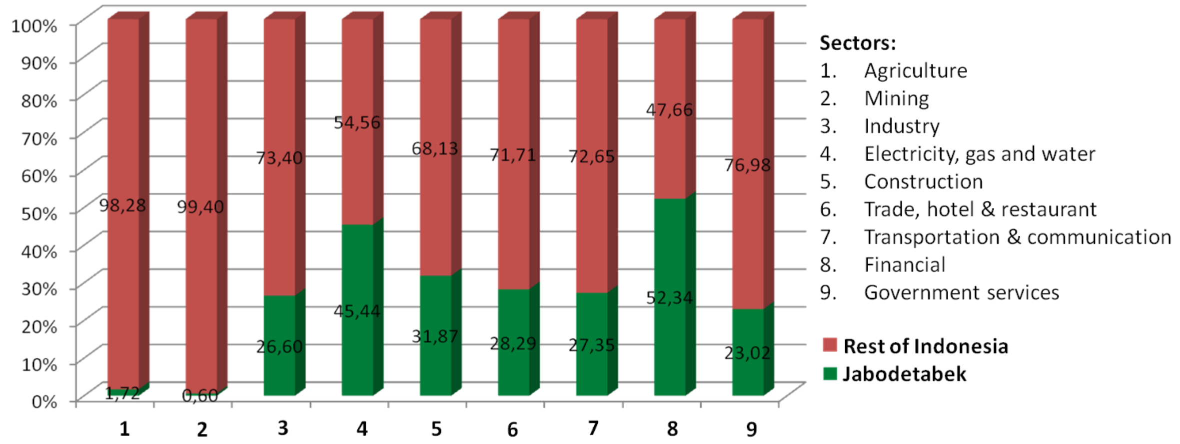


Figure 2 - 43. Share economic sector of Jabodetabek Megacity vs. Rest of Indonesia (%)
(Source: Analysis on GDP (2010), established by BPS)

Based on the contribution of each sector to the total GDP of Java Island in 2010 (Rustiadi et al., 2012), it can be seen that Jabodetabek Megacity contributed 76.8% for finance, 60.7% for construction and building, and 56.6% for transportation. Other sectors which also had significant contribution were industrial sector; government services; electricity, gas and water; as well as trade, hotel and restaurants with these percentages: respectively 43.8%, 41.6%, 41.3% and 36.5%. The other two sectors (agriculture and mining) had small contribution, respectively 3.7% and 5.8%. Jabodetabek Megacity's GDP contributed around 42.8% to the total GDP of Java Island (Figure 2-21).

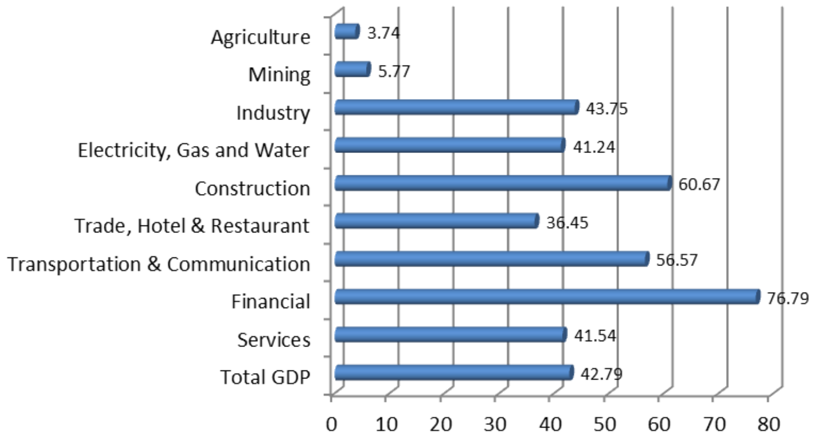


Figure 2 - 44. Domination of Jabodetabek Megacity's GDP in Java Island Economy (2010,%)

In terms of number of employees which works in each sector (Figure 2-22), it indicates that the financial sector as the biggest contributor to GDP also contributed the largest to employment at around 47%. On the other hand, other sectors with a quite high number of employment are electricity, gas and water (38%); transportation (31.2%); services (27.8%); trade, hotel and restaurants (27.6%); industries (27%) and other sectors (39.5%).

Related to the productivity with the comparison of GDP to the total employment, it shows that Jabodetabek Megacity had the productivity of Rp 48.55 million/worker per year, whereas non Jabodetabek Megacity (*rest of Java*) had the productivity of Rp 15 million/worker per year. This shows that high productivity in terms of GDP in Jabodetabek Megacity is greater than the rest of Java.

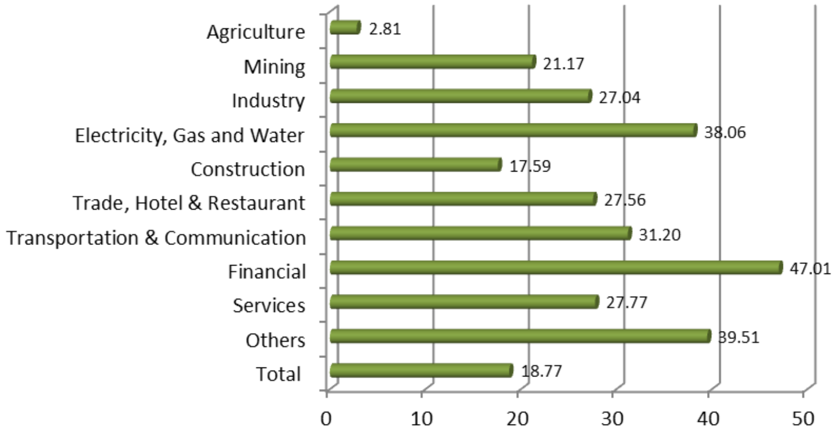


Figure 2 - 45. Domination of Jabodetabek Megacity's Employment in Java Island Economy (2010,%)

Figure 2-23 shows the contribution of each economic sector to the total GDP of Jabodetabek Megacity. From the data, it can be seen that there were 3 dominant sectors which have high contribution to the total Jabodetabek Megacity's GDP, namely: industrial sector (28.36%), financial sector (20.66%) and also trade, hotel and restaurant sectors (20.24%).

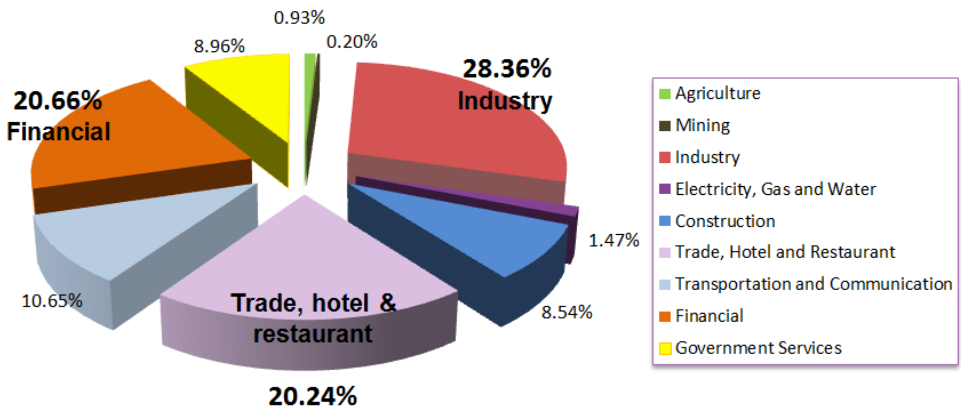


Figure 2 - 46. Share of economic sectors of Jabodetabek Megacity (2010)

Rustiadi et al. (2012) compared some aspects (land size, population and GDP) between Jakarta, Bodetabek, Jabodetabek Megacity and the rest of Indonesia used data in 2010 (Table 2-2). The land sizes compared between Jakarta, Bodetabek and Jabodetabek Megacity against the national scale are respectively 0.03%, 0.32% and 0.35%. The population of Jakarta, Bodetabek and Jabodetabek Megacity in comparison against the national total population in 2010 was respectively 3.58%, 7.68% and 11.26% (BPS, 2010). Meanwhile, within the national economy, Jabodetabek Megacity contributed 25.52% of total national GDP in 2010, 17.92% from Jakarta city and 7.59% from Bodetabek (Rustiadi et al., 2012).

Nine sectors of GDP can be classified into three groups based on the types of sectors: (1) primary sector; (2) secondary sector; and (3) tertiary sector. The primary sector includes agriculture sector as well as mining sector. The secondary sector consists of industry, electricity, gas and water, and building construction. The tertiary sector involves trade, hotel and restaurants, transportation and communication, finance, corporation, and corporate services, and government services. Table 2-2 shows that the contribution of Jabodetabek Megacity GDP to the national GDP, especially in secondary and tertiary sector were 25.26% and 14.24%. On the other hand, the contribution of the primary sector in Jabodetabek Megacity was less than 2%. The comparison of GDP, land size, and population between Jakarta, Bodetabek, Jabodetabek Megacity and the rest of Indonesia is presented in Table 2-2.

Table 2 - 4. Comparison of GDP, area, population shares, and GDP per capita in Jakarta, Bodetabek, Jabodetabek Megacity and Rest of Indonesia in 2010

Sectors	**Jabodetabek** Megacity **(I+II)**		Rest of Indonesia (III)	INDONESIA (I+II+III)
	Jakarta (I)	Bodetabek (II)		
GDP (%)	17.92	7.59	74.48	100.00
GDP (million Rp)	392,299,039	167,623,981	1,753,876,979	2,313,800,000
Primary sectors	0.004	1.42	98.57	100.00
Secondary sectors	1.00	24.26	74.74	100.00
Tertiary sectors	5.02	9.22	85.76	100.00
Area (Km^2)	661	6,361	1,984,710	1,991,731
Area share (%)	0.03	0.32	99.65	100.00
Population (people)	8,502,818	18,253,144	210,885.367	237,641,326
Population share (%)	3.57	7.68	88.75	100.00
GDP per capita (Rp/capita)	46,137,532	9,183,294	8,316,731,521	9,736,522

(Source: Rustiadi et al. 2012)

2.3 Research Methods

2.3.1 Geographically Weighted Regression

Geographically weighted regression (GWR) is an exploratory technique mainly intended to indicate where non-stationarity is taking place on the map, that is where locally weighted regression coefficients move away from their global values. Its basis is the concern that the fitted coefficient values of a global model, fitted to all the data, may not represent detailed local variations in the data adequately – in this it follows other local regression implementations. It differs, however, in not looking for local variation in 'data' space, but by moving a weighted window over the data, estimating one set of coefficient values at every chosen 'fit' point. The fit points are very often the points at which observations were made, but do not have to be. If the local coefficients vary in space, it can be taken as an indication of non-stationarity.

GWR is a local version of an ordinary least square (OLS) regression analysis which has been proposed by Fotheringham et al. (1995; 2002). The point of GWR is that regression parameters are not constant over space as characterized by traditional regression models and that thevariation can be explicitly modeled. GWR attempts to capture spatial variations by allowing the regression model parameters to change over space. Model parameters are estimated by weighting all neighboring observations that have a greater influence on the regression point than those observations further away. By using a *W*, usually a Gaussian or near-Gaussian spatial weights decline function for each *i* as elements in the matrix, a regression can be estimated for each *i*th location. Although each weight matrix need not be focused on data sites, the point of the analysis is to estimate the variation in parameters across space. GWR then produces a set of local regression results including local parameter estimates and their t-test values for the location of each observation. Visualizations and analyses of the local regression results can demonstrate the spatial variations in the relationships between the dependent and independent variables. Therefore, GWR may serve as a useful tool for exploring spatial variations in the associations between urban expansion and its relevant influencing factors. GWR is a type of local statistic that assumes that the regression results can change over time. For the location of each observation, it produces a set of local regression results including local parameter estimates and their t-test values, local R^2 values, and local residuals. The formula of the GWR model is as follows:

$$\mathrm{Y}_j = \beta_0(u_j, v_j) + \sum_{i=1}^{p} \beta_i(u_j, v_j)\mathrm{X}_{ij} + \varepsilon_j \qquad (2 - 1)$$

where Y_j is the dependent variable of observation *j*, X_{ij} is the independent variable X_i at location *j*, u_j and v_j are the coordinates for the location of observation *j*, $\beta_0(u_j,v_j)$ is the intercept for observation *j*, and $\beta_i(u_j,v_j)$ is the local parameter estimate (regression coefficient) for independent variable X_i at location *j*. In this study, the optimal bandwidth was determined by minimizing the corrected Akaike Information Criterion with a correction for finite sample sizes, as described in Fotheringham et al. (2002). The bi-square kernel has a clear-cut range where kernel weighting is non-zero. This was selected since it is suitable for clarifying local extents for model fitting. By contrast, the adaptive kernel can adapt the size of the bandwidths to the spatial variations in the locations where data are denser, and the number of areas included in the kernel is kept constant so that using the bi-square kernel is secure. The weighting function for the adaptive bi-square kernel bandwidth can be stated in the following form:

$$W_{ij} = \begin{cases} (1 - d_{ij}^2/\theta^2)^2 & d_{ij} < \theta_{i(k)} \\ 0 & d_{ij} > \theta_{i(k)} \end{cases} \qquad (2 - 2)$$

where W_{ij} is the weight of observation at location *j* for estimating the coefficient at location *i*, d_{ij} is the Euclidean distance between observations *i* and *j*, and $\theta_{i(k)}$ is an adaptive bandwidth size defined as the *k*th nearest neighbor distance. The regression results of the GWR model including the local parameter estimates and their t-test values were interpreted to examine the spatial variations in the relationships between the dependent and independent variables. Main output from GWR is a set of location-specific parameter estimates which can be mapped and analysed to provide information on spatial non-stationarity in relationships.

A result of GWR is a map of what might be called 'parameter space.' Areas with high parameter values indicate particularly strong correlative relationships between regressor and response variables, but the parameters are not directly indicative of spatial autocorrelation. Since the θ values are a function of the spatial weighting scheme, to the extent that *W* captures the spatial autocorrelation effects in each of the variables, it is reasonable to say that high beta values reflect on the pattern of spatial autocorrelation in the system. It is possible, however, to specify autoregressive instead of OLS models, thus the GWR parameters can play the same role as in spatial autoregressive models. The implication is that one or more spatial autocorrelation maps can be produced for each equation in the system (Fotheringham et al, 1995). GWR can also: (1) estimate local standard errors; (2) derive local t- statistics; (3) calculate local goodness-of-fit measure; (4) perform tests to assess the significance of the spatial variation in the local parameter estimates; (5) perform tests to determine if the local model performs better than the global one, accounting for differences in degree of freedom (Fotheringham et al., 1995). The GWR model was constructed by using ArcGIS 10.2 and GWR 4.0 software. In this study, because the location of an observation was defined by using the longitude and latitude of the district and regency/municipality centroid, the adaptive bi-square kernel bandwidth was used.

2.3.2 Global and Local Moran Index

Spatial autocorrelation measures and tests can be differentiated by the scope or scale of analysis. Traditionally, they are separated into 'global' and 'local' categories. Global implies that all elements in the *W* and *Y* matrices taken together are brought to bear on an assessment of spatial autocorrelation, that is, all associations of spatial units one with another are included in any calculation of spatial autocorrelation. This results in one value for spatial autocorrelation for any one *W* and *Y* matrix taken together. Local measures are focused, that is, they usually assess the spatial autocorrelation associated with one particular spatial unit. Thus, only one row of the *W* and the matching row of the *Y* matrix reflect on the measure of spatial autocorrelation although all elements' interactions may be used as a scalar.

Moran's *I* can be used in a wide variety of circumstances. As a global statistic, Moran's *I* quickly indicates not only the existence of spatial autocorrelation (positive or negative) but also the degree of spatial autocorrelation If the variable of interest is the error term in a regression model, the question of model misspecification can be evaluated by applying Moran's *I*. In spatial econometrics, the test has power for testing residuals for many types of spatial autoregressive models (Anselin, 2006). Since Moran's *I* is distributed normally, its value may be assessed by the *z* values of the normal distribution. The statistic is flexible in that the *W* matrix may be of any form – it has no restrictions on the spatial system used. Of course, outliers in one or both of the *W* and *Y* matrices will yield meaningless results. The local version of Moran's *I*, discussed later, lends itself to spatial cluster identification and spatial filtering. A large literature has been developed to explore the properties of Moran's *I*. In addition to the basic references given in the first paragraph of this contribution (Hepple, 1998; Tiefelsdorf and Boots, 1995; 1997).

Local Moran's I is a measurement of local spatial autocorrelation based on the Moran's I and was developed by Anselin (1995) as a Local Indicators of Spatial Association (LISA) statistic. Anselin defines LISA statistics as having the following two properties: (1) "the LISA for each observation gives an indication of the extent of significant spatial clustering of similar values around that observation and (2) the sum of LISAs for all observations is proportional to a global indicator of spatial association." Global SA measured by Moran's I, captures the extent of overall clustering that exists in a dataset. Local SA indicates the location of local clusters and spatial outliers. The formula of Global and Local Moran's I can be expressed as follows (Anselin, 1995):

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(\mathrm{Z}_i - \bar{\mathrm{Z}})(\mathrm{Z}_j - \bar{\mathrm{Z}})}{S_{\mathrm{Z}}^{\,2}\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \qquad [2-1]$$

$$I_i = \frac{\sum_{j=1}^{n} W_{ij}(\mathrm{Z}_i - \bar{\mathrm{Z}})(\mathrm{Z}_j - \bar{\mathrm{Z}})}{S_{\mathrm{Z}}^{\,2}\sum_{j=1}^{n} W_{ij}} \qquad [2-2]$$

$$= (\mathrm{Z}_i - \bar{\mathrm{Z}})\sum_{j=1}^{n} W_{ij}(\mathrm{Z}_j - \bar{\mathrm{Z}}) \qquad [2-3]$$

$$= (\mathrm{Z}_i - \bar{\mathrm{Z}})\frac{\sum_{j=1}^{n} W_{ij}(\mathrm{Z}_j - \bar{\mathrm{Z}})}{\sum_{j=1}^{n} W_{ij}} \qquad [2-4]$$

Where:
I = Global Moran's Index
I_i = Local Moran's I
Z_i = value of interest of variable *Z* for point *i*
$\bar{Z}$ = average value of *Z*
W_{ij} = contiguity matrix; representing the proximity of point *i*'s and point *j*'s locations, with $W_{ii} = 0$ for all points
n = total number of points
$S_Z^{\,2}$ = variance of the observed values

LISA statistics were created by Anselin (1995), whose motivation was to decompose global statistics such as Moran's *I* into the local components for the purpose of identifying influential observations and outliers. The individual components of *Ii* are related to *I.* The LISA statistics are particularly useful for identifying spatial clusters. High spatial autocorrelation values indicate clusters of high or low values.

For each location, LISA values allow for the computation of its similarity with its neighbours and also to test its significance. Five scenarios may emerge: (1) Locations with high values with similar neighbours: *high-high (HH)*. Also known as "hot spots"; (2) Locations with low values with similar neighbours: *low-low (LL)*. Also known as "cold spots"; (3) Locations with high values with low-value neighbours: *high-low (HL)*. Potential "spatial outliers"; (4) Locations with low values with high-value neighbours: *low-high (LH)*. Potential "spatial outliers"; and (5) Locations with no significant local autocorrelation. Software provided in GeoDa provides graphics in which the ++, – –, + –, and – + types of spatial association are differentiated. Sokal et al. (1998) take a different view of local analysis, and Boots (2002) analyzes local measures of spatial autocorrelation.

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CHAPTER 3. URBANIZATION AND RAPID URBAN DEVELOPMENT IN JAVA ISLAND

3.1 Population Growth and Urban Development Process in Java

Southeast Asia's big cities have experienced tremendous population and physical growth in the last five decades, including in the peripheral areas of urban areas, owing to economic development in the urban centers. This "mega-urbanization" refers to urban development characterized by a mix of different economic activities, including industrial estates' new-town projects and agricultural activities, and through the expansion of built-up areas from the urban centers to almost all directions (Firman, 2014). Urbanization continues to occur at increasingly faster rates in developing countries. In Indonesia, urbanization increased tremendously following the country's rapid development in the 1970s (Resosudarmo and Suryadarma, 2010). Since then, Indonesia has been facing high urbanization rate driven by rural-urban migration. In 1950, 15% of Indonesia's population lived in urban areas. In 1990, 40 years later, this number is doubled to 30% (Sarosa, 2006). Indonesia took only another 20 years to increase the urban population to 44% as reported in 2010 (Figure 3-1).

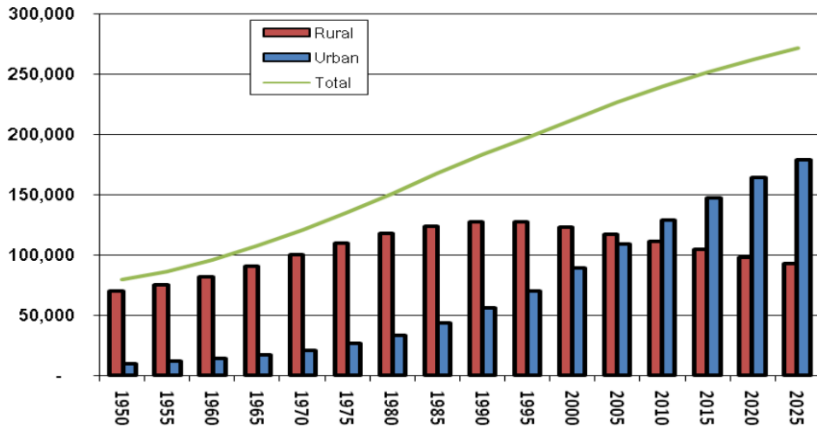


Figure 3 - 13. Comparison number of population in urban and rural area in Indonesia

The 2010 census shows that Indonesia's total population increased from 203.5 million to 237.6 million in the last 10 years, and the urban population grew from 85.2 million to 118.3 million during the same period with an annual growth rate of 3.33%. Likewise, the proportion of the urban population, that is, level of urbanization, increased significantly from 41.9% to 49.7% over the period. In other words, about half of Indonesia's population is urban. However, the distribution of the urban population is extremely uneven, where about 68% or about 80.5 million out of this urban population live in Java, and 37.8 million live on other islands (Firman, 2012; 2014). It can be said that in most parts of the country urbanization and urban development have been greatly fueled by foreign and domestic investment, especially in large cities like Jakarta, Surabaya, Bandung and Medan. Economic activities have been increasingly concentrated in those cities, most notably the manufacturing, finance, services, property and trade sectors.

In the 1950s-1960s many researchers predicted that Java would become the Island of Cities, and even now it was growing with its massive urban belts connecting large cities. The population growth rate increased from 1.35% per year between 1990 and 2000 to 1.49% between 2000 and 2010. But the annual urban population growth rate, which had reached 4.40% in the period of 1990–2000, declined significantly to 3.33% over the period of 2000–2010. Meanwhile, the urban population growth in Java hit 3.17% in 2000–2010, whereas in the outer islands the rate was significantly higher at 3.66%. The number of cities with million-plus populations has increased tremendously. In 1950, Jakarta was the only city with a population of more than 1 million. By 1980, Surabaya, Bandung and Medan joined this rank. By 2010, there were 12 cities with populations of 1 million or more in Indonesia, but nine of those cities were in Java, namely Jakarta, Surabaya, Semarang, Bandung ,Tangerang, South Tangerang, Bekasi, Bogor and Depok. Interestingly, five of the big cities in Java are located in Jakarta Metropolitan area or Jabodetabek Megacity.

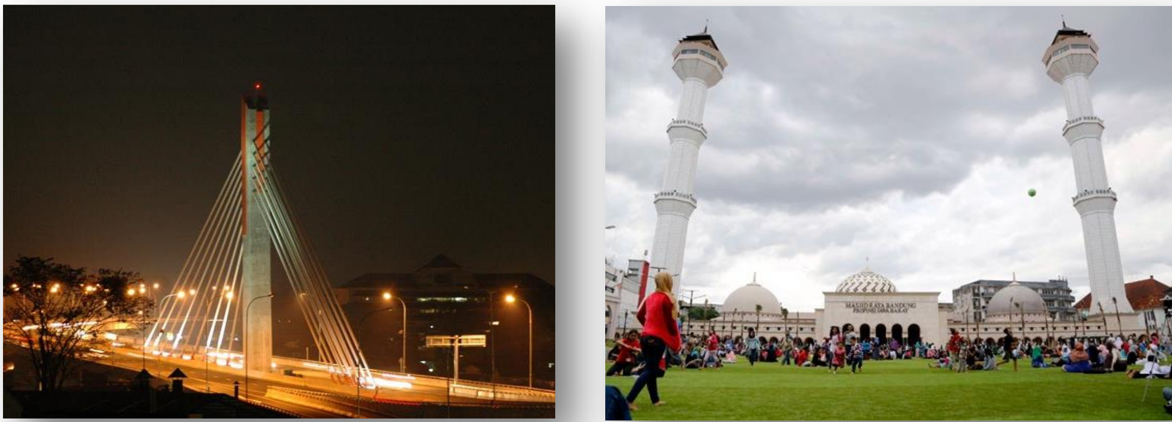
This resulted in about 20% of Indonesia's population living in Jabodetabek Megacity in 2010. The Jabodetabek Megacity urban population constituted about 31% of Java's urban population, which makes this metropolitan region the largest in the nation, or a primate city. The population census data also shows that the rate of annual population growth of the million-plus cities is lower than the national average population growth rate of 1.49%, with the exception of Bekasi (3.44%), Tangerang (3.20%), Depok (4.25%) and Makassar (2.07%). The low population growth rate of Java's large cities, including Surabaya, Bandung, Semarang and even Jakarta, is largely due to suburbanization, which has caused faster population growth on the outskirts of metropolitan areas adjacent to the core cities. The most obvious one is suburbanization in Jabodetabek Megacity (Figure 3-2).

(Source: en.wikipedia.org)

Figure 3 - 14. Jabodetabek Megacity (Special event in Jakarta: Car Free Day)

The annual population growth rate in Jakarta reached only 1.40% during 2000-2010, whereas, the cities of Bekasi, Tangerang and Depok have annual population-growth rates much higher than the city of Jakarta, including Bekasi (4.70%) and Depok (4.33%). In comparison, Jakarta's annual population growth rate once reached 5.5% during 1930-1961. The ratio of Jakarta's population to the Jabodetabek Megacity population declined from 55% in 1990 to 43% in 2000, and decreased further to 36% in 2010. Meanwhile, the lifetime in-migration in Jakarta itself, indicated by place of residence being different from place of birth at the time of census enumeration, was 4.1 million in 2010, in contrast to the lifetime out-migration which reached only approximately 3 million (Firman, 2014). Jakarta thus experienced negative lifetime migration during 2000-2010. This most likely also reflected the change of destination place of in-migration from Jakarta to its outskirts.

Another example is Bandung metropolitan area (Figure 3-3), where the rate of annual population growth of Bandung City, the core, was only 1.11% over the period 2000–2010, compared to the adjacent areas; Bandung regency (2.50%), Cimahi (2.06%) and West Bandung regency (1.99%). In comparison, the annual population rate of growth of Bandung itself reached 5.9% during 1930-1961. Like Jabodetabek Megacity, the proportion of Bandung to the total population of its metropolitan area declined from 34% in 1990 to 29% in 2000 and decreased further to only 28% in 2010. The recent physical development of the Bandung and Jabodetabek Megacity is marked by the urban corridor of about 200 kilometers from Bandung to Jakarta, characterized by a mixture of activities, including industries, residential, and agricultural activities, which blurred the rural-urban distinction in the areas. Millions also commute daily between Jakarta and the adjacent areas.



(Source: dejulogy.wordpress.com) (Source: jabar.tribunnews.com)

Figure 3 - 15. Bandung Metropolitan Area (Left: Surapati Bridge; Right: Bandung Mosque and Plaza)

Similarly, annual population growth in Surabaya (Figure 3-4) reached only 0.53% during 2000-2010, whereas the city had an average population growth rate of as much as 3.5 % during 1931-1961. The peripheral areas of this metropolitan area experienced higher annual population growth, such as Gresik (1.59%) and Sidoarjo (2.21%). Also, the rapid development of the Surabaya-Malang urban corridor also shows the recent urban transformation in East Java (Firman, 2014).

The spatial dimension of urban development in Java basically has taken the form of an urban belt connecting large cities and consisting of highly networked cities of different sizes, including Jakarta-Bandung; Surabaya-Malang; Semarang-Yogyakarta; Cirebon-Semarang. A notable characteristic of these urban belts is the increasing mixtures of industrial, economic and agricultural activities, and the blurring of the distinction between "urban" and "rural" in the region both physically and socioeconomically (Firman, 2012). Based on Firman (2014), the growth of the urban population in the peripheral big cities in Java not only resulted from in-migration from the city center to the outskirts but also from reclassification of localities previously defined as "rural" to "urban".

(Source: kisahasalusul.blogspot.com)

(Source: zonawisata.com)

Figure 3 - 16. Surabaya Metropolitan Area (upper: The icon of Surabaya City; bottom: Suramadu bridge – connecting East Java Province (Surabaya) and Madura Island)

Based on Firman (2014) this process which in line with social and economic development indicates the continuity of mega-urbanization in Java for almost 25 years. Unfortunately, this is an unstoppable process and have a great impact on environmental deterioration, including floods, soil, air and water pollution, traffic congestion, and loss of prime and irrigated agricultural land. The major problem which usually occurred in Indonesia is inconsistency between spatial planning (from national, provincial to regency/municipality level) and their implementation. Most of the plans in Indonesia do not work effectively and many are even violated because of raising pressures, especially from the businesses and political interests. Under the new government cabinet in Jokowi era, we have new Ministry of Agrarian and Spatial Planning. Therefore, Firman (2014) mentioned that one of its priorities should be to ensure the consistency between plans and their implementation as well as to strengthen local government capabilities in implementation planning.

Urbanization, urban population and urban development in Indonesia have been growing rapidly and centered in large cities, especially those are located in Java. Nevertheless, small towns and medium cities on the outer islands are growing more rapidly than those in Java. Based on Firman (2014) in the near future, the national and local urban development policy should be focused on stimulating development of cities in the outer island to become new growth centers, especially on economic activity, so that urban development can be more distributed.

3.2 The Causes and Effects of Urbanization and Rapid Urban Development

By definition, urbanization refers to the process by which rural areas become urbanized as a result of economic development and industrialization. In other word, urbanization is the increase in the proportion of people living in towns and cities. Urbanization occurs because people move from rural areas to urban areas. This usually occurs when a country is still developing. There are several causes of urbanization, such as: (1) industrial revolution; (2) industrialization following the industrial revolution; (3) emergence of large manufacturing centers; (4) job opportunities; (5) availability of easy transportation; as well as (6) migration. Rural to urban migration is happening on a massive scale due to population pressure and lack of resources in rural areas. People living in rural areas are pulled to the city. Often the believe that the standard of living in urban areas will be much better in urban areas.

The effects of urbanization can be positive or negative. Benefits include reduced transport costs, exchange of ideas, and sharing of natural resources. Cities offer opportunities to people not available in the countryside. The benefits of urbanization are: (1) economic's improvement; (2) growth of commercial activities; (3) social and cultural integration; (4) efficient services, and so on. On the other hand, the negative effects of urbanization are: (1) industrial cities were difficult place to live in due to public health issues resulting from contaminated water and air and the spread communicable disease due to overcrowding; (2) increasing unemployment; (3) severe shortage of housing; (4) transportation-commuting issues, lack of public transport, no adequate investment; (5) social effects, such as: poverty, lack of opportunities, psychological problems, alcoholism, drugs, crime, violence and other deviant behaviors.

The effects of urbanization and rapid urban development can include a dramatic increase and change in costs, often pricing the local working class out of the market, including such functionaries as employees of the local municipalities. Similar problems that now affect the developing world is rising regional disparity or inequality resulting from rapid urbanization trends. One of problem which usually occurred in urbanized areas is related to labor. Most of people who come from rural to urban area are low-skilled and unskilled labor. This condition makes them difficult to obtain a decent job because of their inadequate ability and limited job opportunities. To solve this problem, the local government can propose some policies to encourage labor-intensive growth as a means of absorbing the influx of low-skilled and unskilled labor (Grant, 2008). But another problem that arises with the increasing number of low-skilled and unskilled labors is the growth of slums. In many cases, the rural-urban low skilled or unskilled migrant workers, attracted by economic opportunities in urban areas. Unfortunately, because of their inadequate ability, they cannot find a job and not be able to afford housing in cities, so thatthey have to dwell in slums (Todaro, 1969). In many developing countries whose economies are growing, the development is often erratic and sometimes influenced by the small number of industries. People who live in villages mostly have obstacles such as lack of access to financial services and business consulting services, difficulties in obtaining credit to start a business and a lack of entrepreneurial skills. It is difficult for them to be able to have the opportunity or access in the industry. To overcome the economic constraints, the local government can involve in human capital investments, such as improving skills and education, as well as providing adequate infrastructure facilities (UNFPA, 2014). Urban problems which accompanied by infrastructure developments, also contribute to trigger suburbanization trends in developing countries. Another positive effects of urbanization can be shown in the reduction of expenses in commuting and transportation while improving opportunities for jobs, education, housing, and transportation.

Due to uncontrolled urbanization in Indonesia particularly in Java, environmental degradation has been occurring very rapidly and causing many problems. The most emerging issues are climate changes, freshwater scarcity, deforestation, and fresh water pollution because of raising population growth.

Related to the issue on climate changes, urbanization can contribute on the creation of urban heat island (Park, 1987). Urbanized areas have much more building and another urban land use which consists of materials like concrete, asphalt, bricks, etc. which absorb and reflect energy differently than vegetation and soil. Cities remain warm in the night when the countryside has already cooled. Urban activities also give bad effect on changing the air quality. Human activities release a wide range of emissions into the environment including carbon dioxide, carbon monoxide, ozone, sulfur oxides, nitrogen oxides, and many other pollutants. Air pollution results from over-dependence on motorized transport and from burning of coal to supply energy. Urbanization also give negative effects on land and water resources. Waste are a major problem in large cities. Vast quantities of solid waste are produced in industries. Rapid urban development can result in very high levels of erosion and sedimentation in river channels as shown in the most river in Java, especially in urbanized areas. The adverse effects of urbanization not only erosion and other changed in land quality, but also pollution. Pollutants are often dispersed across cities or concentrated in industrial areas or waste sites since people sometimes burying tremendous amounts of waste in the ground at municipal and industrial dumps. The water quality has also degraded with time due to urbanization that ultimately leads to increased sedimentation there by also increasing the pollutant in run-off. Water pollution results from poor sewage facilities and disposal of industrial heavy metals into waterways. The public health effects due to urbanization such as: (1) sanitation – the settlements were ill equipped to handle large populations and their sanitation needs; (2) pollution – caused by effluents, smoke, and smog; (3) fire hazards – due to use of flammable material and proximity/congestion; and (4) epidemics – due to spread of communicable diseases caused by contaminated water and air.

Urbanization give effect not only on environment and public health, but also on social and economic aspects. For high quality workers/skilled-labors who live in rural area, urbanization can contribute as a links to labor markets. They can find a new job in the urban area with higher salary/wages, so it will influences the changing well-being of the individuals in those households based on their occupational status. Urbanization also can give good impact on reducing fertility rate and declining the growth rate of urban population. The fertility rate in cities is often lower than in rural areas due to the absence of agriculture, the cost of children, food and living space in cities, and family planning program. Contrary to public perception, however, it first reduces the death rate, despite the often appalling living conditions in many cities. Only later does urbanization reduce the birth rate (i.e. the fertility rate). The time lag between declining death and birth rates initially means rapid urban population growth; subsequently, fertility rates drop sharply and the rate of growth of urban populations declines.

However, when the cities are growing, the cost of housing and infrastructure also grows, since there are limited water, land and building material available and also increasing traffic congestion problems. Migrants who have adequate skill can survive to live in the big city with all great challenges. On the other hand, it will be difficult for unskilled-migrants to survive without any job. Thus, another social problem appears such as unemployment grows, increasing drug abuse, crime and homelessness.

Those problems are very complex and their interactions are still difficult to define. It is very important to examine problems through the social-economic-cultural approaches. Even the interconnections between environmental problems are now better known, we still lack exact information on how the issues are linked, on what degree they interact and what are the most effective measures. One problem is to integrate land- and water use planning to provide food and water security (UNEP 1999).

3.3 Exploring Local Factors Affecting Urbanization or Rapid Urban Development in Java

3.3.1 Data and Variables

To identify the driving forces that are affecting rapid urban expansion in Java Island, several variables were included in the GWR analysis. The delta of urbanized area from 2006-2010 or the total conversion land from agricultural to non agricultural land (non greenery area) or symbolized by URB was selected as the dependent variable (Y). This variable was chosen as a proxy of increasing urban development or urbanization. Higher land conversion from agricultural land to non agricultural land (especially urban uses) show the higher impact on urbanization or rapid urban development. The independent variables (X) in this GWR model represented three types of driving forces, namely demographic, socio-economic, and infrastructural aspects. In the GWR model, population density (POPDEN) and population (POP) were selected as proxies of demographic driving forces. For socio-economic driving forces, this analysis employed four independent variables, namely a literacy rate (LITERACY), average of per capita expenditure (EXPEND), entropy index (ENTROPY), and Theil index (THEIL). Finally, a variable for scalogram index (SCALOGRAM) was selected as the proxy of infrastructure. The Y and X variables used in the GWR model are described in Table 3-1.

The URB, POPDEN, and POP variable were collected from the PODES datasets on village-level statistics provided by the Central Bureau of Statistics (BPS) for 2006 and 2010. LITERACY and EXPEND variables were collected from National Development Planning Agency (Bappenas), and both of them are extracted from human development index (HDI) data. ENTROPY and THEIL variables were collected from entropy and theil index analysis. To analyze ENTROPY and THEIL variable, GDP data was used. Entropy index is an index for measuring diversity of regional income per GDP. In the context of the region, the general equation of entropy value calculation is as follows (Shannon, 1949):

$$S = -\sum_{i=1}^{n}\sum_{j=1}^{n} P_i \ln P_i \qquad [3-1]$$

Where:
S = entropy value (diversity of regional economic structures
P_i = GDP ratio sector *i* to total GDP of the region
i = *i* –th economic sector
n = number of sectors

Whereas the entropy index value is obtained by dividing the value of entropy (S) with a maximum entropy value (Smax), as the following equation:

$$\text{Entropy index} = \frac{S}{S\max} \qquad [3-2]$$

S_{max} obtained by the formula S_{max} = ln n (where n is the number of all sectors). Entropy index values ranging from 0 - 1. If the value of entropy index is 1, it means that all the economic sectors are developed, and vice versa.

Theil index is an index for measuring regional disparity using GDP/income per capita. According Wibisono (2003), Theil index has several advantages: (1) it is not sensitive to the scale of the area and is not affected by extreme values; (2) Theil index independent of the number of areas so that it can be used as a comparison disparities of different regional systems; (3) Theil index can be decomposed into between-region inequality and within-region inequality. Excess Theil index compared to other indices are able to make comparisons for a certain time and provide in detail in the sub-units of a smaller geographical (Kuncoro, 2002), which is used as a share of total population-weighted in the measurement.

Lower Theil index value shows lower disparities between regions, and vice versa, the higher Theil index value indicates a higher degree of disparity.

The main characteristics of Theil index is the ability to distinguish disparities between regions (between-region inequality) and disparities in the area (within-region inequality) (Kuncoro, 2002). Theil index formula is as follows (Theil, 1967):

$$I_{Theil} = \Sigma(y_j/Y).\log [(y_j/Y)/(x_j/X)] \quad [3-3]$$

Where:
I_{Theil} = Total disparity in Java (Theil index)
y_j = GDP at the regency/ municipality *j*.
Y = GDP in Java.
x_j = The number of population in the regency/ municipality j.
X = Number of population in Java.

Total disparity calculated by theil index can be decomposed into inter-regional disparity (between-regions inequality) and disparities in the region (within regions inequality) with the following equations:

$$I = I_0 + \sum_{g=1}^{n} Y_g I_g \quad [3-4] \qquad \text{where:} \qquad I_0 = \sum_{g=1}^{n} Y_g \log\left(\frac{Y_g}{X_g}\right) \quad [3-5]$$

$$Y_g = \sum_{i \in S_g} y_i \quad [3-6]; \qquad X_g = \sum_{i \in S_g} x_i \quad [3-7]; \qquad \text{and} \qquad I_g = \sum_{i \in S_g} \frac{y_i}{Y_g} \log\left(\frac{y_i / Y_g}{x_i / X_g}\right) \quad [3-8]$$

Where:
I = total disparity in Java (Theil Index entropy).
I_0 = disparities between regions (between regions).
$\sum_{g=1}^{n} Y_g I_g$ = Disparities among districts / cities in the area (within regions).
Ig = total regional disparities.
Yg = total regional GDP.
Yi = GDP at the district / city i.
Xg = the population of the region.
Xi = total population in the district / city i.
g = 1, 2, 3, ..., n (the number of department).

Scalogram index is an index for measuring urban development level by considering number of infrastructures or facilities. This analysis used several types of facilities as parameters to measure the scalogram index, such as: (1) economic facilities (example: number of market, hotel, restaurant, bank, etc); (2) social facilities (example: number of worship facilities, park, etc); (3) education facilities (example: number of primary school; junior high school; senior high school, university); (4) health facilities (example: number of medical clinic, hospital, drugstore, etc). The region with higher scalogram index means that it has higher level of urbanization because of rapid urban development, and vice versa. The dependent (Y) and independent (X) variables used in GWR model are listed in Table 3-1.

Maps of the parameter estimates (*C* coefficient), local R^2, and standardized residuals obtained from the GWR models provide a simple way in which to detect spatially varying relationships between urbanization and related factors. R^2 alone is simply a measure of the error in the regression over the total regression. Local R^2 indicates how well the local regression model fits the observations (local models with low values perform poorly). Residuals are the differences between the observed and predicted y values, while standardized residuals have a mean of zero and a standard deviation of one.

Table 3 - 2. The dependent (Y) and independent variables (X_n) used in the GWR model

Variable	Variable Code	Detail Explanation
Y	URB	Δ of urbanized area from 2006-2010 (Total conversion land from agricultural to non agricultural land (non greenery area) (ha)
X_1	POPDEN	Population density
X_2	POP	Number of population
X_3	LITERACY	Literacy rate (%)
X_4	EXPEND	Average of per capita expenditure (Rp. 000)
X_5	ENTROPY	Entropy index[1]
X_6	THEIL	Theil index[2]
X_7	SCALOGRAM	Scalogram index[3]

Note:

[1] Entropy Index →index for measuring diversity of regional income/GDP
[2] Theil Index → index for measuring regional disparity using GDP/income per capita
[3] Scalogram Index → index for measuring urban development level by considering number of infrastructure

3.3.2 Results and Discussion

Figure 3-5 is spatial configuration for Y-observed, Y-predicted, and local R^2 based on GWR model. The local R^2 value in range 0.53 to 0.78. Figure 3-5 (A) is the existing urbanized area in Java. The darkest red color are the areas with the highest land use conversion. The most urbanized area is located in West Java province, especially in Bogor, Sukabumi and Bandung Regency.

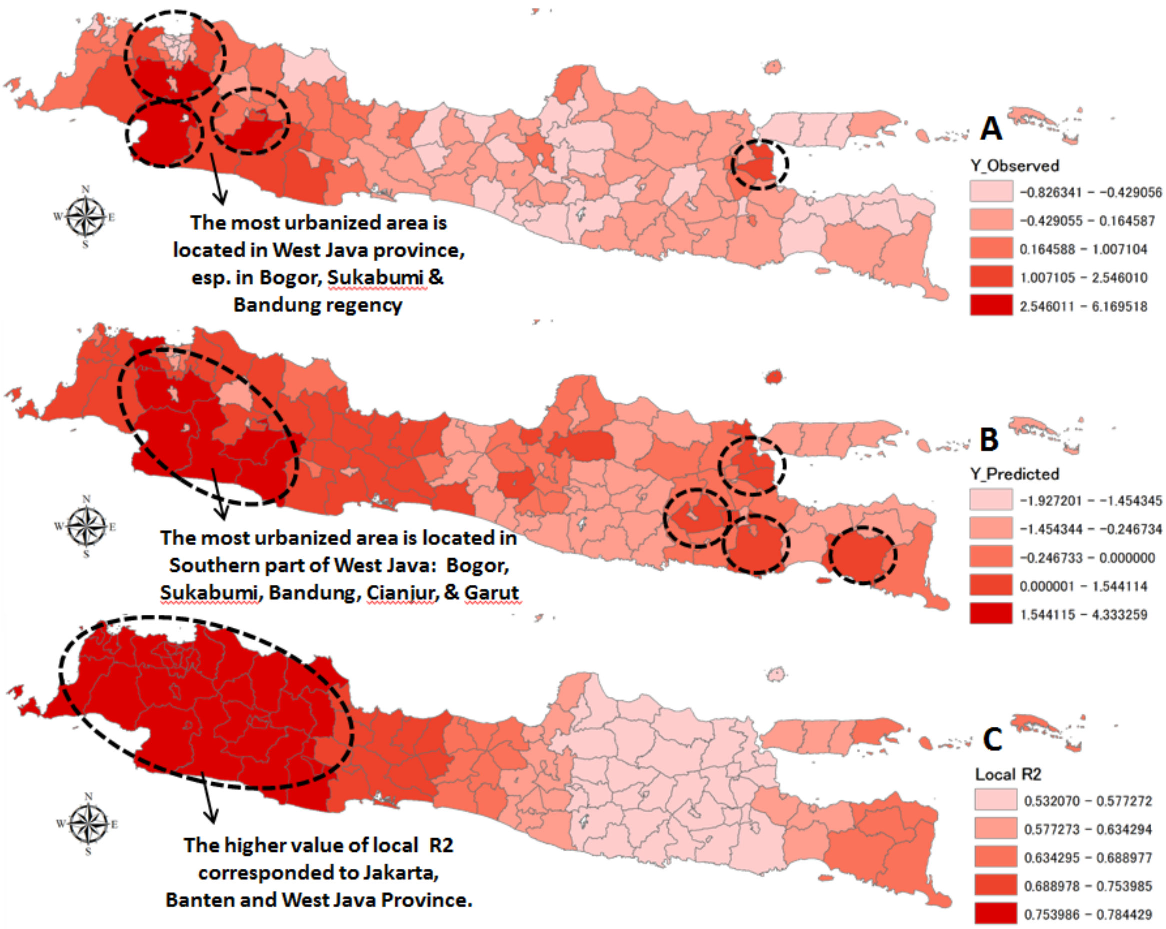


Figure 3 - 17. GWR result: (A) Y_observed; (B) Y_Predicted; (C) Local R_2

Figure 3-5 (B) is urbanized areas which predicted by the GWR model. The most urbanized area is located in Southern pasrt of West Java: Bogor, Sukabumi, Bandung, Cianjur, and Garut. Figure 3-5 (C) shows that Jakarta, Banten, and West Java are the most influenced area which potentially converted to urbanized area. The higher value of loacal R2 corresponded to Jakarta, Banten and West Java Provinces.

Figure 3-6 shows the spatial distribution of population density and the local parameter estimates for X_1. Based on Figure 3-6 (the upper map), Jakarta city and its surrounding areas is the cluster of highest population density in Java which located in Jabodetabek Megacity. Based on GWR result (the bottom map of Figure 3-6), increasing population density in the red color areas (including Jakarta, Banten and some regency/municipalities in West Java province) give negative impact to the urbanization. Population density in the light green color area in East Java give positive impact to the urbanization. Some parts of East Java relatively still categorized as developing area. So, increasing of population density will encourage urban development in those areas.

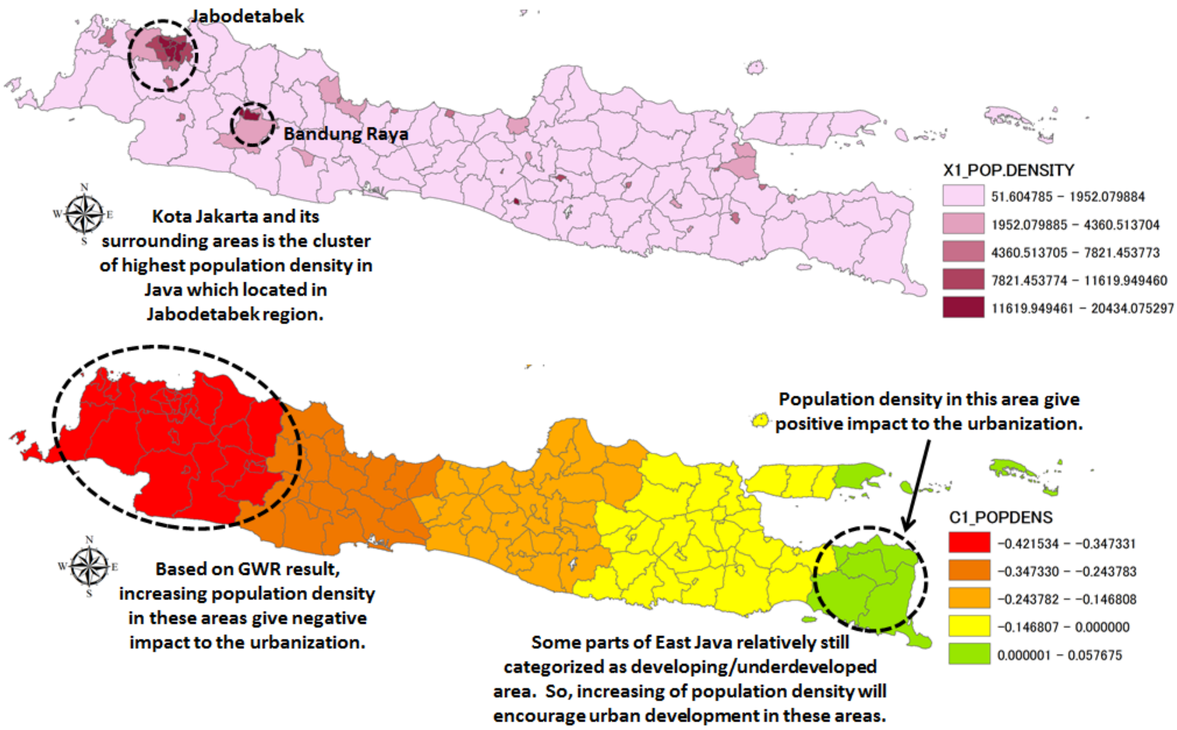


Figure 3 - 18. Spatial distribution of population density (X_1) and the local parameter estimates of X_1

Figure 3-7 shows the spatial distribution of population and the local parameter estimates for X_2. Jabodetabek Megacity and Bandung metropolitan area are the center of growing population which located in the western part of Java Island (the upper map of Figure 3-7). Based on GWR result, population is one of variable which has significant impact to the urbanization process. Based on the value of local parameter estimates, growing population in the Jabodetabek Megacity and Bandung region as well as its surrounding areas in the dark green zone impact to increase urbanization or urban development in Java.

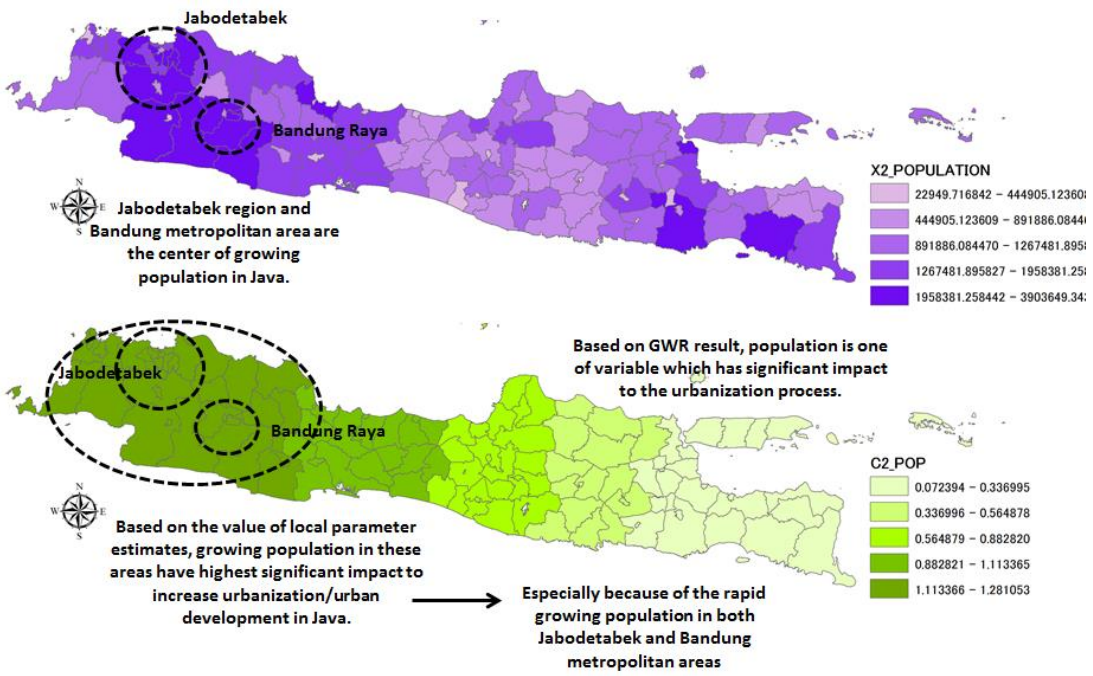


Figure 3 - 19. Spatial Distribution of Population (X_2) and The Local Paramater Estimates of X_2

Figure 3-8 shows the spatial distribution of literacy rate and the local parameter estimates for X_3. Compared with the other area of Java, Jakarta and some regions in the southern part of West Java province has higher literacy rate, as well as some parts in East Java (especially in Surabaya and Sidoarjo). Based on GWR result, literacy rate is one of factor which affecting the urbanization or urban development process in Java. Literacy rate is one of the component of Human Development Index (HDI). The GWR result of Figure 3-8 (the bottom map) shows that increasing of human development (as shown by increasing literacy index) will encourage urban development in the western part of Java Island.

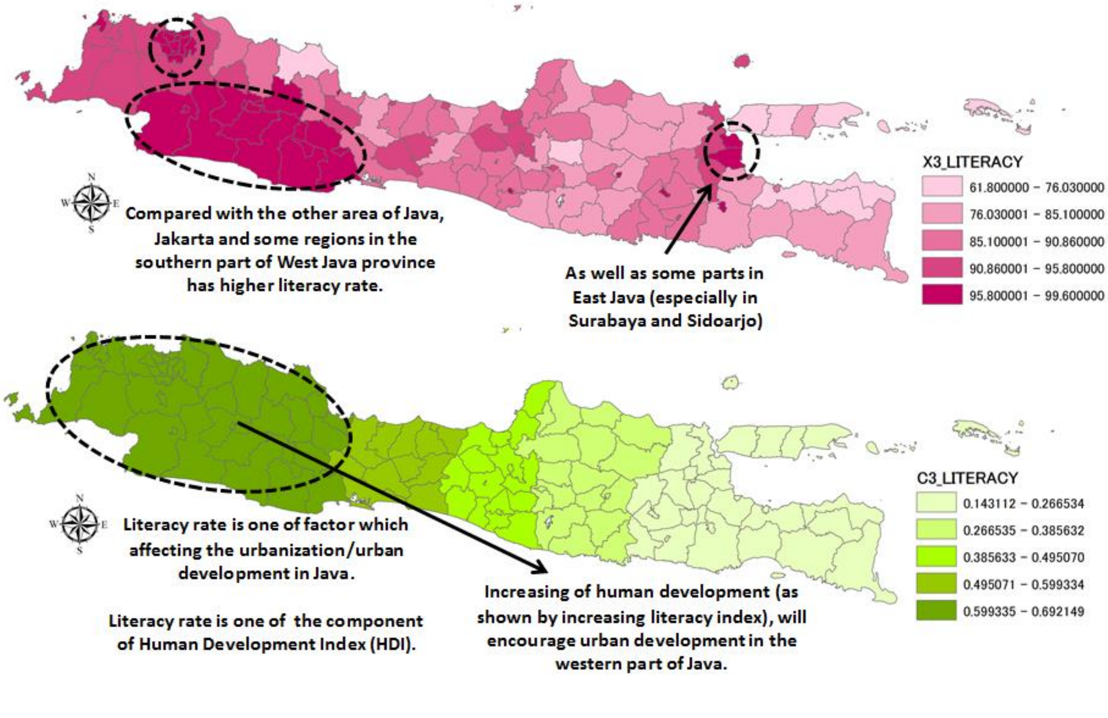


Figure 3 - 20. Spatial Distribution of Literacy Rate (X_3) and The Local Paramater Estimates of X_3

Figure 3-9 shows the spatial distribution of average of per capita expenditure and the local parameter estimates for X_4. Jakarta, Depok, Bogor (Jabodetabek), Surabaya and some others regions in Java have higher average per capita expenditure. Based on GWR result, average per capita expenditure has negative correlation with the urbanization process/urban development. Increasing of average per capita expenditure in the red color areas (in the western part of Java Island) have a negative impact since they are relatively already urbanized areas. On the other hand, increasing average per capita expenditure in light green area (located in East Java province) has a positive impact to stimulate urbanization process/urban development.

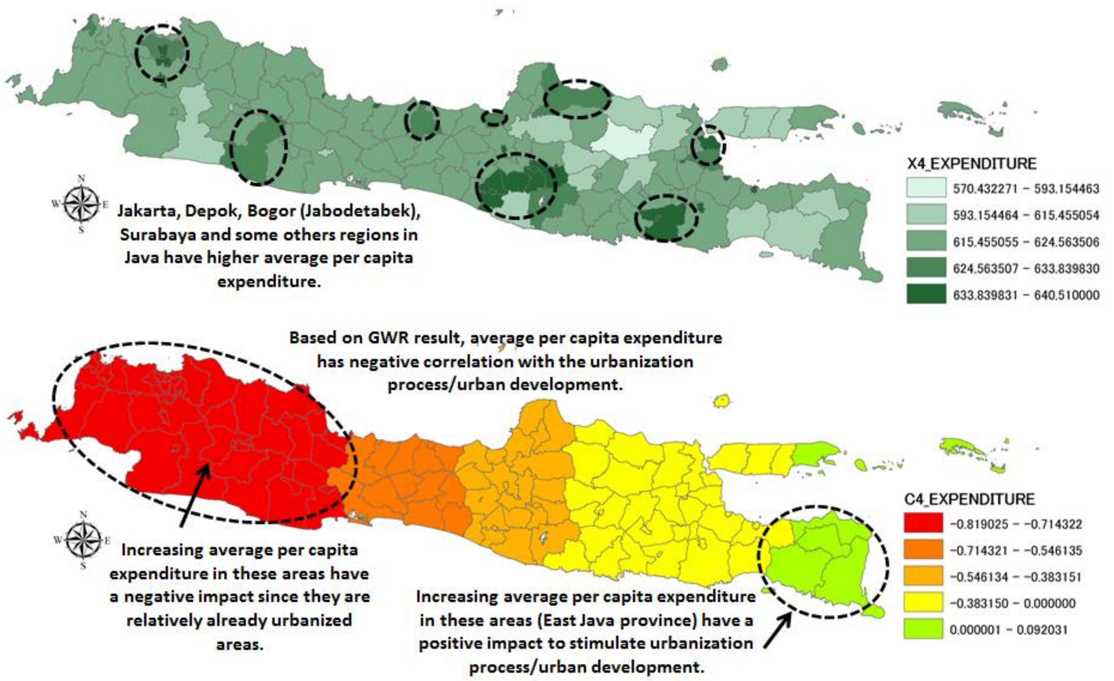


Figure 3 - 21. Spatial Distribution: Average of Per Capita Expenditure (X_4) and The Local Paramater Estimates of X_4

Figure 3-10 shows the spatial distribution of entropy index and the local parameter estimates for X_5. Entropy iindex is an index for measuring diversity of regional income or GDP. Region with higher entropy index means that those region are more developed than the other regions. On the other hand, region with lower entropy index means that only a few economic sectors in the regions are developed. Based on the spatial distribution map of entropy index in Java (Figure 3-10: upper map), Jabodetabek Megacity, Bandung, Semarang, CIlacap and Surabaya have a higher entropy index compared with the other region in Java. It means that those areas are more developed than the others based on the performance value of the entropy index. The GWR result shows that the areas with lower entropy index in the red zone color located in the western part of Java Island are potential to be converted to urban area. Since the region with a higher entropy index value give significant influence to its surrounding areas. In East Java Province (see the green color zone in Figure 3-10 bottom),increasing entropy index value will impact to the land use conversion from agricultural/greenery area to urban land use. Since in this region, there is still low density of urban area as well as urban population.

Figure 3-11 shows the spatial distribution of theil index and the local parameter estimates for X_6. Theil index is an index for measuring regional disparity using GDP or income per capita. Higher theil index value means that there is a significant gap between the rich people and the poor people.

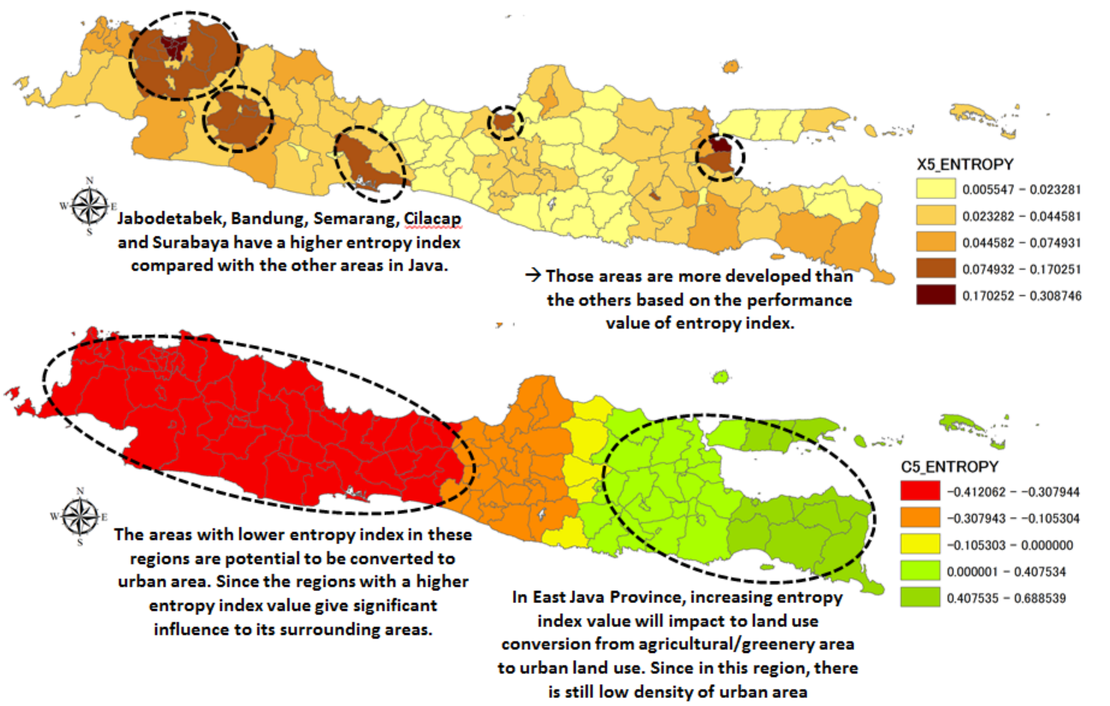


Figure 3 - 22. Spatial Distribution of Entropy Index (X_5) and The Local Paramater Estimates of X_5

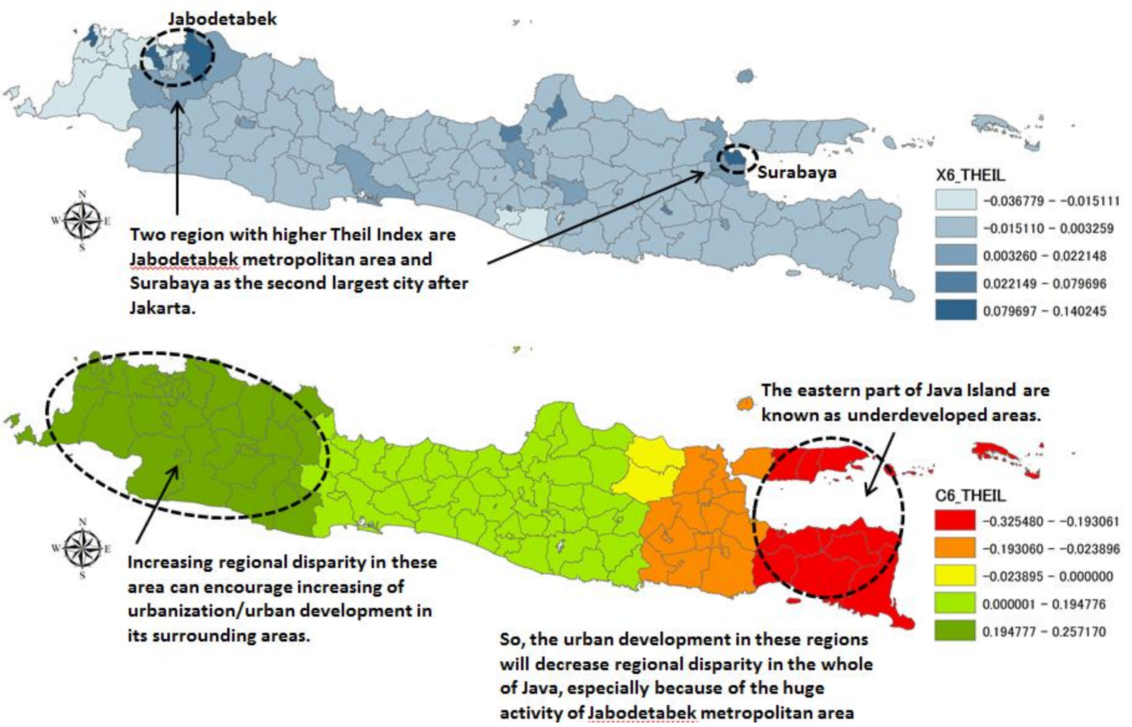


Figure 3 - 23. Spatial Distribution of Theil Index (X_6) and The Local Paramater Estimates of X_6

Two region with the higher Theil index are Jabodetabek Megacity and Surabaya as the second largest city after Jakarta which located in the East Java Province. Increasing regional disparity in the dark green zone in the western part of Java can encourage increasing urbanization or urban development in its surrounding areas. The eastern part of Java are known as underdeveloped areas. So, the urban development in those regions will decrease regional disparity in the whole Java, especially because of the huge activity of Jabodetabek Megacity.

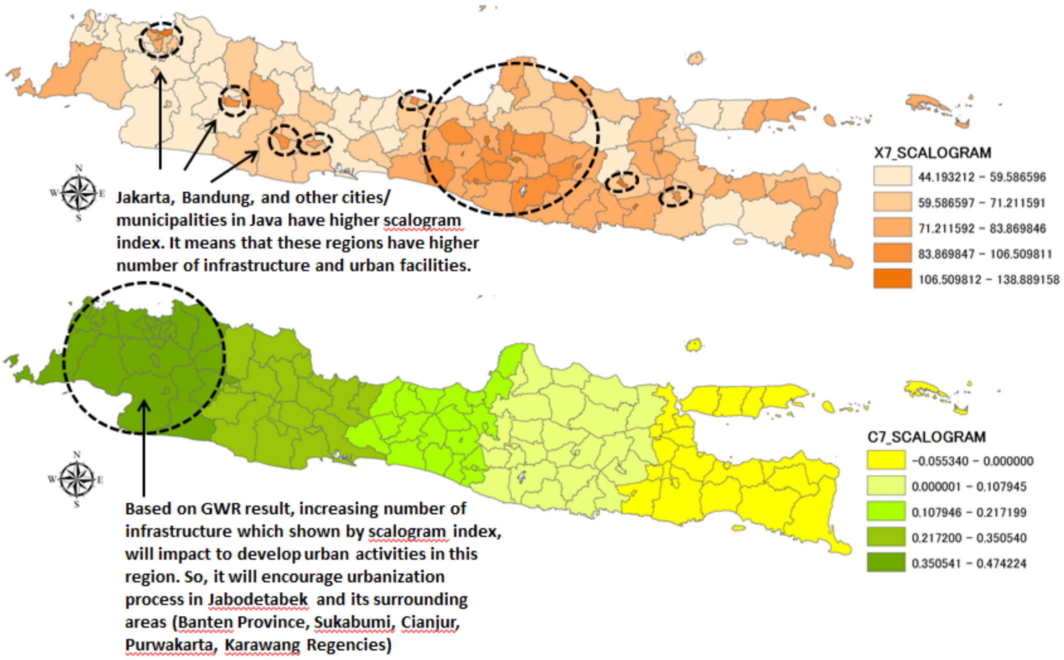


Figure 3 - 24. Spatial Distribution of Scalogram Index (X7) and The Local Paramater Estimates of X_7

The last variable which used in the GWR model is the scalogram index. Scalogram index is an index for measuring urban development level by considering number of infrastructure. Based on spatial distribution map of scalogram index (Figure 3-12: upper map), Jakarta, Bandung and other cities or municipalities in Java have higher scalogram index. It means that those regions have higher number of infrastructure and urban facilities. Based on GWR result, increasing number of infrastructure which shown by scalogram index, will impact to develop urban activities in the dark green zone in the western part of Java. So, it will encourage urbanization process in Jabodetabek Megacity and its surrounding areas (Banten Province, Sukabumi, Cianjur, Purwakarta, and Karawang Regencies).

3.3.3 Conclusion and Recommendations

Conclusion

By employing GWR model, it was found that local demographic, social, and economic factors spatially affected urban development in Java Island. The most influenced area which potentially converted to urban area is located in the western part of Java (including DKI Jakarta, Banten and West Java Provinces), since there are 2 metropolitan areas located there (Jabodetabek Megacity and Bandung Raya). Higher population and economic activities in Java especially in both metropolitan areas have the implication in the high demand for food, natural resources and excessive utilization of land which results in the conversion of forest region, agricultural area or other greenery area to non agricultural/greenery area.

Recommendation

The overexploited supporting capacity of Java Island has created a series of anthropogenic disasters. So the urban development activities in Java must be considering the potential hazard and the risk so that the urban activities can going well. Since it is still necessary to keep Java as national rice storage, effective measures are required to control the conversion of the best rice field in the country.

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CHAPTER 4. URBAN EXPANSION AND ENVIRONMENTAL IMPACTS OF JABODETABEK MEGACITY

4.1 Jabodetabek's Urban Expansion and the Environment

The rapid expansion of Jakarta and surrounding areas was seriously endangering its environmental foundations. Intensifying population concentration in the core was depleting well water and causing intrusion of salt water into the city's water system. Ground subsidence occurred with some tall buildings at risk collapse. With expansion towards Bogor and the uplands of Puncak, the region's aquifers were in danger of severe pollution and the felling of tress and natural vegetation was leading to flooding in rainy seasons and droughts in dry seasons in and around Jakarta. Based on Douglass (1991), these elements of environmental risk can be shown schematically in Figure 4-1.

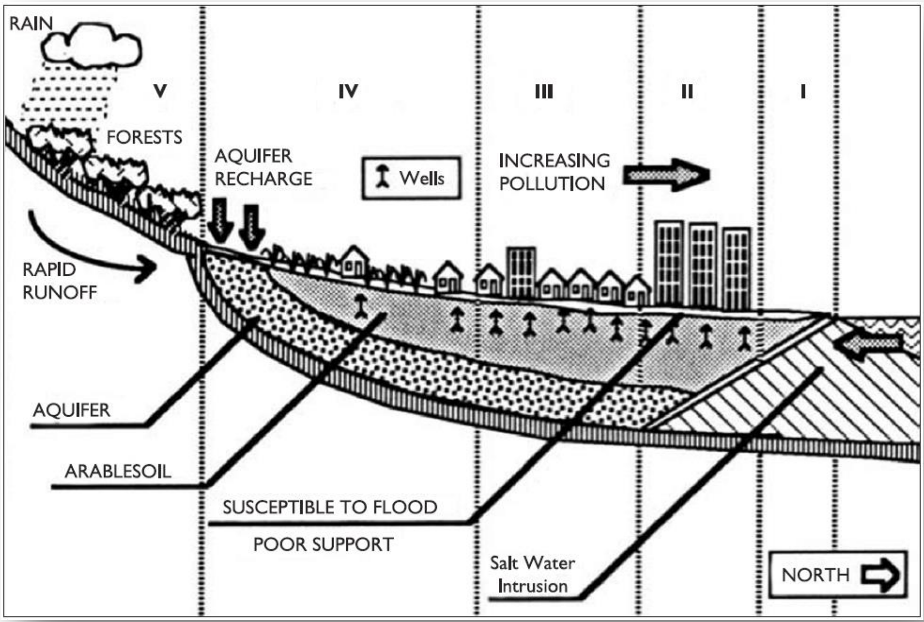

Figure 4 - 24. Environmental Risks of Jabodetabek Megacity Expansion
(Source: Douglass, 1991)

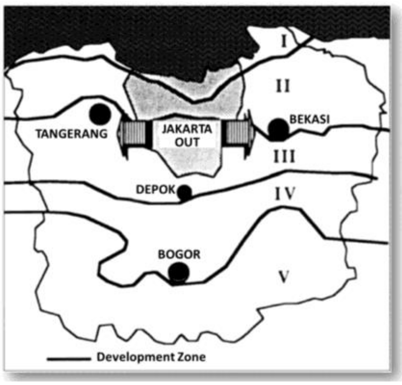

Figure 4 - 25. The 'Jakarta Out' Strategy
(Source: Douglass, 1991)

One result of these realizations was to begin to assess the larger area around and including Jakarta as a single city region, called Jabotabek, which also represented a relationship between urbanization and ecology. Recognizing that expansion both right along the northern coast and into the uplands in the south were the most ecologically threatening directions of expansion, the 'Jakarta Out' plan of east-west expansion was advocate by the Ministry of Public Works, the agency in charge of most of the physical planning of cities in Indonesia (Figure 4-2).

This plan was elaborated by dividing the region into a number of zones, each of which was to have its own relation to urban expansion depending on its particular environmental management requirements (Figure 4-3). The weaknesses of the plan were not readily apparent at the time. Foreign direct investment in assembly and manufacturing was becoming the leading sector and exporting firms readily located along the Jakarta-outpathways. However, guiding industry to locations without inhibiting population and enterprise location elsewhere meant that migration to the megacity continued unabated and could to locate away from the environmentally desired areas (Douglass, 2010).

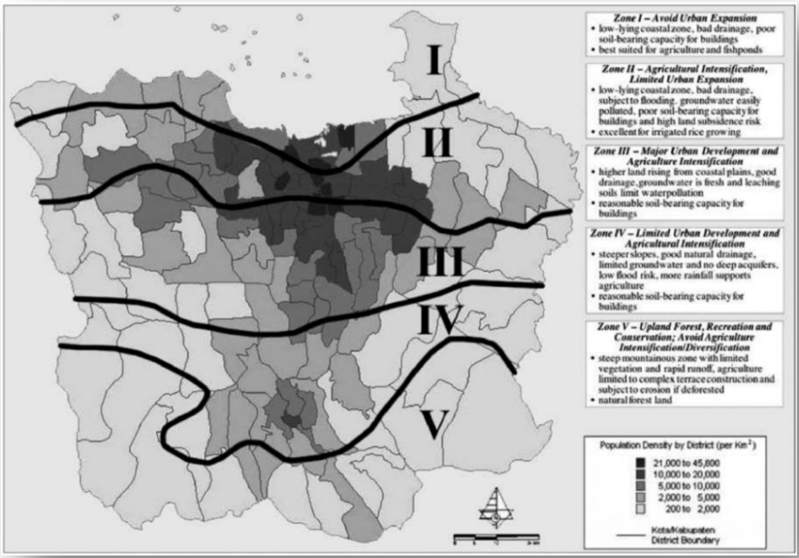

Figure 4 - 26. Proposed Environmental Management Zones for Jabotabek, 1984 and 2005 Population Distribution by District, 2000 (Source: Douglass, 1991; Census data from BPS, 2000)

Douglass (2010) mentioned that the likelihood of this eventuality became real in subsequent years as Indonesia was engulfed in a bubble economy of heady land speculation along with the surge in export-processing operations. Like Bangkok, Manila, Kuala Lumpur and other Southeast (and East) Asian cities, Jakarta began to be the target for large-scale land development schemes not for industry but for urban living and consumption—housing, shopping malls, and tall buildings in a designated 'Golden Triangle' of world business functions (Figure 4-4). The 'Golden Triangle' is a new style commercial zone – was built in Thamrin-Sudirman corridor to push the urban skyline upward in response to high land costs in key areas and the convenience of the automobile (Cybriwsky and Ford, 2001). Figure 4-5 shows a map of private new town development in Jabodetabek Megacity. The largest of which (named: Bumi Serpong Damai (BSD) and Lippo Cikarang) were each intended as self-contained cities for more than a half million residents. Though not conforming to government's ideas of where they should be located, the building of these new towns proceeded. In fact, government regulation over such projects was relaxed in a number of ways (Douglass, 2010):

- 1989: Development of industrial estates by private sectors was liberalized following the deregulation in banking system.
- 1993: Development permits for large-scale housing projects were simplified.
- 1994: Private developers were approved to develop 80 km^2 of Tangerang's coastal area (Teluknaga) for resorts and residential uses on reclaimed land.
- 1996: 650 km^2. land in the Botabek regions contiguous to Jakarta was occupied by private developers for new town projects.
- 1996: Jakarta Waterfront City proposal to reclaim 28 km^2 of the coast line of North Jakarta for residential, business, office and residential areas was approved.

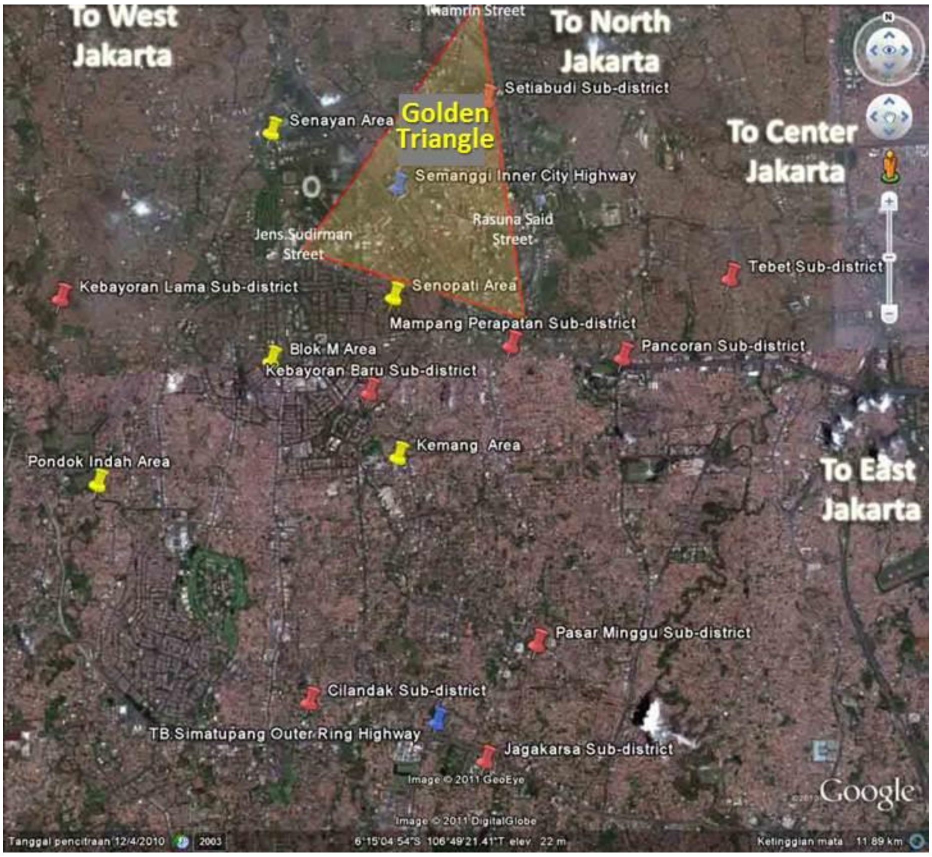

Figure 4 - 27. Location of 'Golden Triangle' in Jakarta
(Source: Google Map)

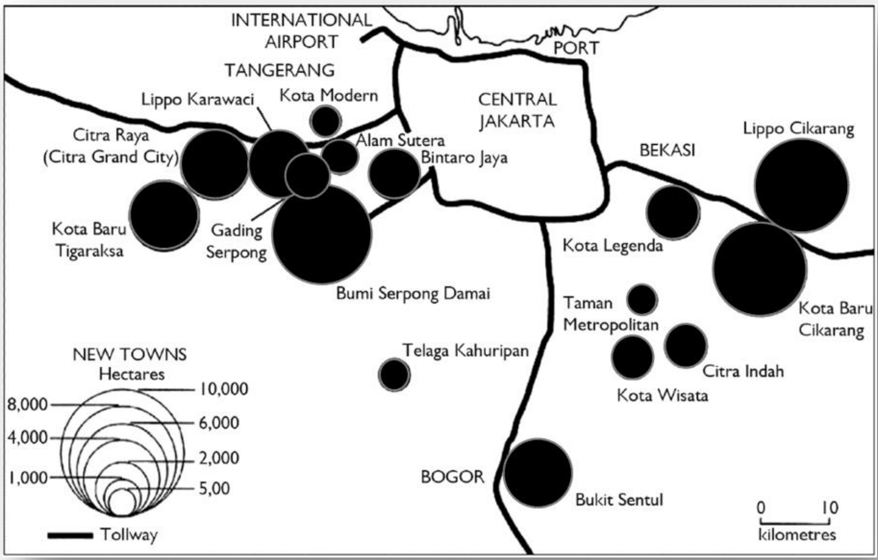

Figure 4 - 28. Private New Towns in Jabodetabek Megacity, 1985-1997
(Source: Mamas and Komalasari, 2008)

At the same time that land development was being deregulated, the status of region-wide environmental planning gained no ground. The Jabotabek development plan was to be indicative or suggestive and was never adopted by the West Java government. Lack of coordination among government bureaus further deferred any actions. The result was that less than half of all land use permits were issued in accordance with the plan and, over time, market and private developer interests became increasingly able to determine the use of very large areas in the region. This involved large-scale conversation of prime agricultural land and green spaces to urban functions. Among the new additions to Jabotabek from the mid-1980s were shopping malls. Nearly 100 of such centres were built in the region since the late 1980s (Figure 4-6. (A)). In 2003 alone, 20 new malls were constructed. This construction paralleled the construction of gated communities in suburban areas of the inner zone. As shown in Figure 4-6. (B), this has become the leading force in the expansion of Jabotabek beyond Jakarta and into environmentally risky areas. The core of Jabodetabek Megacity continues to attract rural migrants seeking livelihood in the megacity, but over time the larger shift of population is outward into the inner and outer zones of the region.

Figure 4 - 29.(A) Malls and Shopping Centers in Jakarta 1990-2004 (Source: BPS Indonesia, 2003); and (B) Expansion of Housing Estates and Environment Zones (1990s) (Source: Mamas and Komalsari, 2008; and Indonesia 2000 Census)

The response to the new realities of land development that have followed from new global linkages continues in the same style as before. Regional plans intended to guide expansion in an environmentally sound manner continue to be put forth by local governments and central planning bureaus alike. Figure 4-7, which is a plan drafted in 1995 by the Jabodetabek Megacity planning body and intended for the year 2015, is revealing in this regard. In embracing the large-scale private new town development in the plan, it implicitly acknowledges that previous intentions to guide land development away from the south for the sake of environmental management and integrity is not practicable. If so it represents a broader acknowledgement that, in the new era of private–public partnerships and neoliberal deregulation and reform, environmental sustainability by whatever definition is also becoming more difficult to pursue.

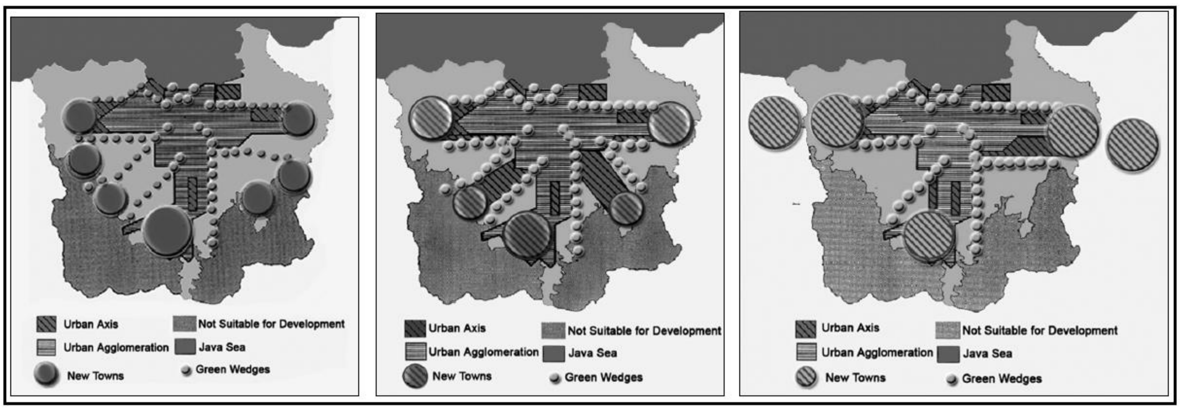

Figure 4 - 30. Regional Strategy for Jabodetabek Megacity 2015 (Source: Ministry of Public Work, 1995)

Land use changes in Jabodetabek Megacity were dominantly caused by land conversion into the concentrated urban activities. Land conversion in this region tends to increase every year. In Jabodetabek Megacity, many fertile farmlands and other greenery areas converted to built up areas (settlement, industries, commercial services and others). The resulting images and the trends of land use/cover changes (LUCC) from 1972 to 2012 are presented in Figure 4-8 and Figure 4-9 respectively.

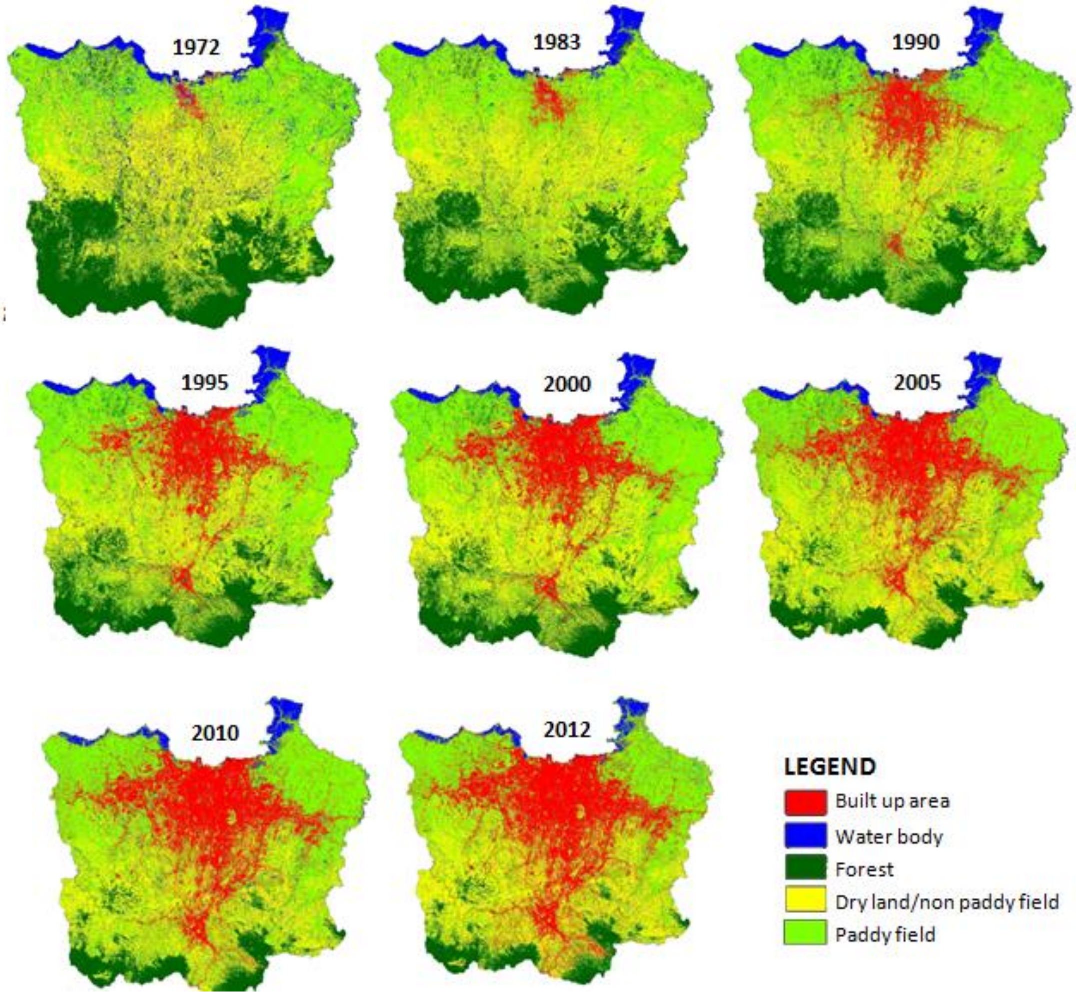

Figure 4 - 31. Map of land use/cover in Jabodetabek Megacity in 1972 – 2012 (Source: Rustiadi et al. 2014)

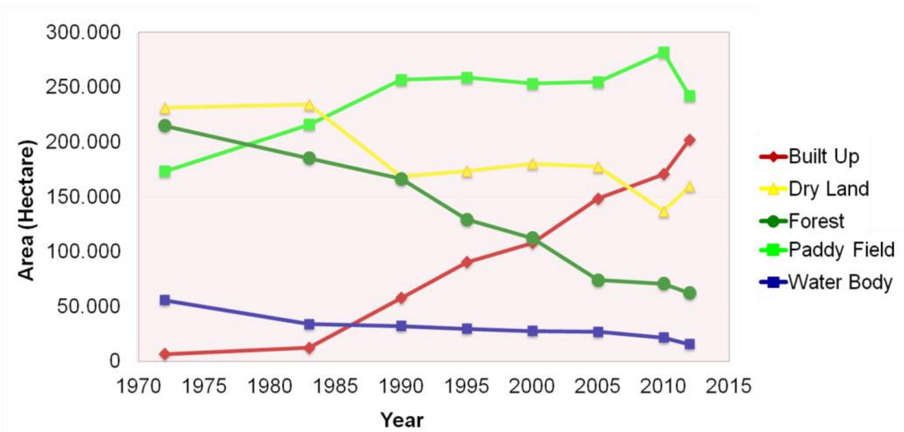

Figure 4 - 32. Trend of land use/cover change in Jabodetabek Megacity 1972-2012
(Source: Rustiadi et al. 2012)

The land conversion from paddy field and dry land to built-up areas has had a significant impact on the condition of the surrounding areas. Since the expansion of urban area, the land conversion for housing and built-up area continues to increase. The land use of the forest area was falling significantly. Approximately 71% or 152,000 ha of forest have disappeared from Jabodetabek Megacity through land conversion during 1972-2012. Dry land has also reduced by 31% or 71,000 ha, whereas the built up area has expanded 31 folds from that of 1972 (increased around 195,000 ha during the same period). This reflects a rapid conversion rate over time. Table 4-1 shows critical facts of land use changes in Jabodetabek Megacity due to urban spatial expansion.

Table 4 - 5. Critical Facts of Land Use Changes in Jabodetabek **Megacity** due to Urban Spatial Expansion

Land use	Increase (1972-2012)		Ratio 1972/2012
	Ha	%	
Built up area	195,610	3033.18	31.33
Paddy Field	68,801	39.74	1.40
Dry Land (Non Paddy Field)	-71,629	-30.99	0.69
Water Body	-40,275	-72.31	0.28
Forest	-152,505	-71.02	0.29

Note: Significant loss: Forest: -152,000 ha
Significant increase: Built up area: +195,000 ha (31 folds)

Based on Rustiadi et al. (2012), suburbanization of Jakarta results the expansion of housing and industries in more distant areas from the city. The results of analysis using a model of urban sprawl (called decay function model: RTB (i, t) = RTB (o, t) exp ($a - bx_i$)) as presented in Figure 4-10 indicate that the housing area or built-up area in Jabodetabek Megacity was moving away from the center (Jakarta) over time, or experiencing urban sprawl phenomenon. This can be seen from the distance between the built-up area border and the city center of Jakarta (here the distance is calculated from National Monument, Monas). In 1972, the average distance to the built-up area border was 28 km. In comparison in 2010, the built up area was getting further away, that is, at the distance of 60 km. This shows that from time to time an expansion of the urban area has occurred. The combination of the poor transportation system reflected from the high intensity of traffic jam and the tendency of spatial expansion for housing area in Jabobetabek has increased the average time-distance to go to work and made this region an inefficient and less competitive global city (Rustiadi et al. 2012).

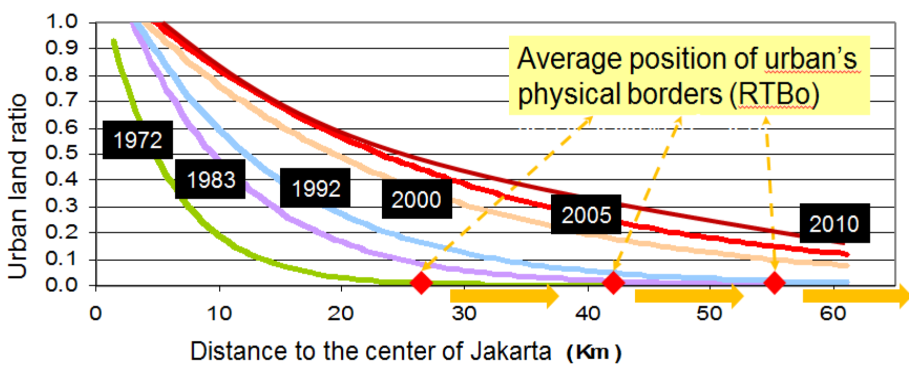

Figure 4 - 33. Model of Urban Sprawl Suburbanization of Jakarta resulting in the expansion of housing and industries in more distant areas from the city (Source: Rustiadi et al. 2012)

4.2 The Problems and Environmental Impacts in Jakarta and its Peripheries

Jakarta megacity has experienced a tremendous population growth and faced a wide range of urban problems in the last few decades. As the biggest economic center in Indonesia, Jabodetabek Megacity has powerful attractiveness that has pulled many people from other areas to come, live and work. Excessive in-migration has significantly contributed on rapid population growth and urbanization. The growing numbers of migrants to Jakarta and poor Jakarta natives have produced new squatter kampungs on the periphery of Jakarta (Cybriwsky and Ford, 2001). Many constructions in the central city also caused some residents of kampungs to be evicted and relocated to the periphery (Silver, 2007). The periphery also attracted migrants because of its improved infrastructures and facilities in (Goldblum and Wong, 2000). Since 1950, Jakarta has attracted people from all parts of Java and other Indonesian islands. The flood of migrants came to Jakarta for economic reasons as Jakarta offered the hope of employment. The 1961 census showed only 51% of the city's population was actually born in Jakarta (Cybriwsky and Ford, 2001). And many times, Jakarta officials tried to control migration by declaring the city closed; new migrants were not allowed entry. However, these attempts proved useless; a large number of migrants ignored the law.

Accelerating population growth has caused many problems related to providing sufficient infrastructure and maintaining the sustainability of the urban environment (Rustiadi et al., 2014). Based on the Central Bureau of Statistics (BPS), high in-migration not only happened in Jakarta but also in its surrounding area called Bodetabek. It could be seen in Table 4-2 that number of migrants moved to Jabodetabek Megacity consist of around 1,4 million people who live in Jakarta and around 2,6 million people who live in Bodetabek (Rustiadi et al., 2014). Although the number of migrants in Bodetabek is twice as Jakarta, the percentages are relatively similar. From this result, it shown that the expansion of urban area beyond Jakarta has developed new pull factor that attracts more number of people. In total, the number of migrants in Jabodetabek Megacity reached more than 4 million people or 14.56% of the total population. This number is relatively high and contribute significantly in the population growth. Instead, the number could be higher if the migrants that have lived less than 5 years, which are not defined as a migrant in BPS data, is also counted. Parallel with government plan to accelerate economic growth of Jabodetabek Megacity, the number of migrants will continue to increase in the future. Several problems will increase if the pace of population growth persists. Various services including infrastructure, housing, education, health, job opportunities, water, energy, food, waste treatment, green open space, etc. will be difficult to provide. Therefore Rustiadi et al. (2014) mentioned that it should be anticipated by starting to develop the alternative urban development concept such as vertical growth, smart growth, compact city and so forth.

Table 4 - 6. Migration Characteristic in Jabodetabek Megacity

Area	Population Number	Migrant from Outside Jabodetabek	
		Number	%
Jakarta	9,556,049	1,427,933	14.94
Bodetabek	18,320,530	2,630,119	14.36
Jabodetabek	27,876,579	4,058,052	14.56

(Source: Analysis on Population Census Data 2010 established by BPS; Rustiadi et al., 2014)

The other social problem in Jabodetabek Megacity is urban poverty. Along with the increasing share of urban inhabitants within the total population, the number of poor people in urban area is also growing. In addition, many poor people are interested to move to urban areas because high economic growth in the cities offers many alternative occupations within formal and informal sector. In year 2011, the national task force for poverty alleviation (*Tim Nasional Percepatan Penanggulangan Kemiskinan* -

TNP2K) has established integrated basis data for the development of social security program. They collected social economic data of 40% population with the lowest prosperity. Afterward, this population is divided into 4 categories including very poor, poor, almost poor and vulnerable poor based on a poverty line established by BPS in the year 2011 which is Rp 233,740/capita/month (Rustiadi et al., 2014). The first two categories include number of people who get income below the poverty line, while the rest include number of people who get income slightly above the poverty line. All categories could be called as vulnerable population because they are a group of people with the highest risk when the economic situation is changing. Within this paper, the group of poor people only divided into two groups which are poor population (below the poverty line) and almost poor population (slightly above the poverty line).

Based on Rustiadi et al. (2014), it could be seen in Table 4-3 that the number of poor people just 4.97% of the total population in Jakarta and 6.27% of the total population in Bodetabek. However, the number of almost poor people is higher which is 7.62% of the total population in Jakarta and 11.75% of the total population in Jabodetabek Megacity. It showed that many people will be easily fall down to the below poverty line if there is a shock within the economic system. Afterward, the number of vulnerable population in Bodetabek is higher than Jakarta. It showed that accumulation of vulnerable people mostly happened in the peripheral areas Jakarta. This area is characterized by mix urban-rural livelihoods, therefore seemingly the conflict between urban and rural has lessened prosperity of the people (Figure 4-11).

Table 4 - 7. Poverty Characteristic in Jabodetabek Megacity

Area	Population Number	Poor Population		Almost Poor Population		Vulnerable Population	
		Number	%	Number	%	Number	%
Jakarta	9,557,798	475,008	4.97	728,604	7.62	1,203,612	12.59
Bodetabek	18,290,356	1,145,939	6.27	2,148,489	11.75	3,294,428	18.01
Jabodetabek	27,848,154	1,620,947	5.82	2,877,093	10.33	4,498,040	16.15

(Source: Analysis on Integrated Basis Data for the Development of Social Security Program 2011 established by TPN2K; Rustiadi et al., 2014)

Figure 4 - 34. People in Jabodetabek Megacity who are living under the poverty line

In total, the number of vulnerable population in Jabodetabek Megacity is relatively high which reached almost 4.5 million people or 16.15% of the total population. Thus if the economic system is unstable such as happened with the last Asian economic crisis in 1998, the number of people who live below the poverty line will become threefold. It will disturb the resilience of the city since almost 16-17% of the city dwellers will need the government aid just to survive. It is known that poor urban dwellers are the most risky people than the poor in rural because they depend on the market for providing their needs.

This issue should be carefully anticipated because there are a lot of global-local issues that will threaten Jabodetabek Megacity social-economic system in the future (Rustiadi et al., 2014).

The next social problem that become important issue is the existence of the informal sector. As other megacities in the developing countries, the existence of informal sector in Jabodetabek Megacity is inevitable. The economic crisis in 1998 – commonly known in Indonesia as *krismon (krisis moneter)* - largely paralyze the economy of Jakarta. Domestic and foreign investment dropped dramatically. Many factories, manufacturing industries and services corporations in Jabodetabek Megacity especially in Jakarta closed. Several bank were also liquidated on that time. Many factory workers or employees were forced to dismissed from their jobs, so that resulting in the rapid increase of uncontrolled unemployment. In order to survive living in Jakarta during the economic crisis, most of them shifted their job to become informal workers. They work as food traders or then engaged in other informal sector jobs. In Indonesia, the impact of economic crisis can be shown by the increasing number of street vendors called as *pedagang kaki lima*. They increased rapidly almost three folds from about 95,000 in 1997 to 270,000 in 1999 (Firman, 1999). Firman (1999) mentioned that the increasing informal labor force is a distinctive characteristic of cities in developing countries since the formal sector fails to accommodate a large labor force.

The informal activities have become the easier entrance for migrant to get involved in economic activities and earn any income. In addition, local residents who don't have enough skill and education also keep their life by working in informal activities. Within the situation in developing countries where most of the people have limited education and skill, the existence of the informal sector has become a solution. This sector could strengthen the resilience of underprivileged urban dwellers and this is also important to support resilience of the city.

The informal activities actually not only important for the informal workers, but also for formal workers that have limited wage. The competitiveness of Indonesian economic that rely on low wage labor actually is supported by the existence of the informal sector that could provide various cheap products. Those products are cheaper because the price is free of tax, usually come from the black market, or dominated by rejected product with various qualities. Unfortunately, recent studies only focus on the benefit of the informal sector in supporting informal workers, but neglect its important role to support the performance of the formal sector.

Figure 4 - 35. Street vendors as one example of informal workers in Jabodetabek

Actually the problem of the informal sector is not related to its existence but how to minimize its negative impact on Jabodetabek Megacity development. It is known that the informal sector in developing countries is disorganized, thus it produces numerous negative externalities such as congestion, waste, slum areas, crime, etc (Figure 4-12). Therefore it should be managed in a proper way thus the positive impact could be maximized, on the other hand the negative impact could also be minimized.

It could be seen in Table 4-4 that the informal workers in Jabodetabek Megacity could be divided into 4 groups comprising self employed; self employed with temporary workers; free worker; and unpaid worker. Self employed is a person who has own business or offer a particular skill such as tailor, carpenter, builder, serviceman, etc. Self employed with temporary workers is self employed which is helped by impermanent worker or sometimes unpaid worker. Free worker is a person who doesn't have permanent employer. Unpaid worker is a person who works without payment and usually this person work on his/her family. Based on Rustiadi et al. (2014), informal workers in Jabodetabek Megacity are dominated by self employed which reached 22.22% of the total labor. It was followed by free workers 7.74%, unpaid workers 2.01%, and self employed with temporary workers 1.25%. In total the number of informal workers in Jabodetabek Megacity reached 33.22% of total labor. This number is quite high since one third of labor in Jabodetabek Megacity work in the informal sector. It showed how the informal sector is important as a source of income for a significant number of people.

Table 4 - 8. Informal Workers Characteristic in Jabodetabek Megacity

Area	Labor Number	Self Employed		Self Employed with Temporary Workers		Free Workers		Unpaid Workers		Informal Workers	
		Number	%	Number	%	Number	%	Number	%	Number	%
Jakarta	4,285,981	849,563	19.82	46,704	1.09	248,386	5.80	77,310	1.80	1,221,963	28.51
Bodetabek	7,175,529	1,697,212	23.65	97,126	1.35	638,766	8.90	153,004	2.13	2,586,108	36.04
Jabodetabek	11,461,510	2,546,775	22.22	143,830	1.25	887,152	7.74	230,314	2.01	3,808,071	33.22

(Source : Analysis on Population Census Data 2010 established by BPS; Rustiadi et al., 2014)

Furthermore, Rustiadi et al. (2014) argued that if their role in supporting low wage labor is also considered, then we will find more numbers of people who depend their daily life on the informal sector. In general, the number of informal workers in Bodetabek is higher than Jakarta. It might be caused by the high pace of urbanization in this area whereby the interaction between urban and rural has opened more opportunities for the informal sector development. Still it needs to be managed and organized in order to avoid chaotic development as well as negative externalities that could harmful for the public life.

Another urban problem which usually happened in Jabodetabek Megacity is traffic congestions and emerging of slum areas. The daily jams in Jakarta are getting worse (Figure 4-13). Based on Rukmana (2014), Jakarta is estimated to lose US$3 billion a year because of traffic congestion. Rukmana (2014) also mentioned that the peripheries of Jabodetabek Megacity are become “bedroom suburb” for the daily commuters of Jakarta, especially for people who works at the center of government and corporate offices, commercial and entertainment enterprises. The economy of Jakarta dominates its peripheral areas. In the daytime, the total population in Jakarta is much more than its population in the nighttime; the number of daily commuters in Jakarta is estimated 5.4 million (Suara Pembaruan, March 9, 2011).

Most commuters go to Jakarta for working, study in universities, or access to the higher quality of public facilities such as international hospital, luxury hotels, big malls, conference hall, exhibition centers, as well as go for entertainment and cultural activities. Commuters from the suburban areas commonly used three highways including the Jagorawi toll road, the Jakarta-Cikampek toll road, and the Jakarta-Merak toll road. The Jagorawi toll road connecting Jakarta and the southern peripheries, the Jakarta-Cikampek toll road connecting Jakarta and the eastern peripheries and the Jakarta-Merak toll road connecting Jakarta and the western peripheries. The central and local government always try to solve traffic congestion in Jabodetabek Megacity especially in Jakarta by developing the new roads. However, the development of new roads can not solve traffic congestion problems since it can never catch up to the growth rate of vehicle ownership. Rukmana (2014) mentioned that a new development of highway or a widened road only alleviates traffic congestion for a short period of time. Then, after a few years, any new or widened highway fills with traffic that would not have existed if the highway had not been built. Based on Rukmana (2014), this phenomenon is called 'induced demand'. Therefore, he argue that neither building new roads nor widening existing roads are viable long-term solutions to traffic congestion especially in Jakarta.

Figure 4 - 36. Traffic congestion in Jabodetabek Megacity

To reduce traffic congestion in Jakarta, the local government was developing a mass transportation system, including the TransJakarta busway, the monorail and Mass Rapid Transit projects. The main idea behind developing those mass transportation system is to reduce the number of motorists especially motorcyclists on Jakarta's streets which tend to become increasingly congested. The local government expect that peopleprefer to use the mass transportation and reduce traffic, whereas new roads only attract more motorists. Rukmana (2014) argue that the development of new roads not only would elevated roads stimulate induced demand and thus worsen traffic congestion, they could also jeopardize the livability of neighborhoods along them.

One seemingly inevitable consequence of rapid economic development in Jabodetabek Megacity is rising inequality. Policy makers trying to juggle growth and equity in many areas. One particularly difficult case is emerging slum areas in Jakarta as well as in other areas in its peripheries. Jakarta's growth as both the nation's capital and primary center of business has been accompanied by waves of new, mostly poor, arrivals. Rapid urbanization has created problems of land and housing scarcity, and as these scarcities increase and housing prices rise, economic constraint s force the poor to inhabit land that no one else wants. The slum areas can be found in any back alley, riparian areas and along the railroad in Jakarta and the peripheries (Figure 4-14).

Figure 4 - 37. Slums in riparian areas (*left*) and along the railway (*right*)

Reports by the UN Human Settlements Program (2010) estimate that 26% of Indonesia's urban population lives in slums area, with more than five million slum dwellers located in Jabodetabek Megacity. Indrakesuma (2011) mentioned that the first problem is because of physical condition. The dwellings lack of the basic amenities so that they self-constructed the slums with insecure housing tenure, inadequate basic services, lack of access to the clean water, poor sanitation, unhealthy living condition, poverty and social exclusion. Data from the Central Statistics Agency (BPS) shows that in 2009, only 35% of Jakarta's homes had access to potable water, and 32% of homes had a per capita living space of less than 7 square meters. Furthermore, Indrakesuma (2011) argued that the second problem because many of Jakarta's slums are illegal. Many slum dwellers are actually squatting on state land, which creates a hostile relationship between slum dwellers and authorities. The constant threat of demolition and eviction gives these citizens no incentive to invest in infrastructure. A final dimension concerns the city as a whole. Slums are associated with concentrations of poor people, crime and overall social undesirability. As a result, other citizens are driven away and land values plummet (Indrakesuma, 2011).

Jakarta, a core city of Jabodetabek Megacity with around 10 million inhabitants, is dotted with slums area. One of example of slums area in Jakarta can be seen in Muara Angke. Many people there live with poor sanitation, lack of access to clean water, overcrowding and poor nutrition The local government's commitment is needed to address these problems. In Jakarta's northern Muara Angke coastal area, a lack of access to clean and piped water has forced people to bathe and wash clothes using dirty water from fish ponds. Unfortunately, less than 50% of Jakarta's residents have access to piped water, according to the NGO, which runs water, sanitation and health programmes in the city.

Based on IRIN news on 16 April 2010, more than 75% of the city's residents rely on shallow groundwater, but an official study found that 90% of shallow wells are contaminated with coliform bacteria or heavy metals. Jakarta produces 6,000 tons of waste each day, but can only manage 50% of it. Some projects aimed at increasing access to sanitary facilities, including toilets, providing access to clean water, and educating child caregivers about nutrition in several villages in Jakarta and neighbouring Bekasi Regency. A study released by the World Bank's Water and Sanitation Programme in 2008 revealed that only 57% of Indonesian households had easy access to a private and safe place to urinate and defecate in 2004. Poor sanitation, including poor hygiene, causes at least 120 million disease episodes and 50,000 premature deaths annually. The study also found that poor sanitation costs the Indonesian economy $6.3 billion per year, or equal to 2.3% of the country's GDP. Part of the problem was a lack of funding, with spending on sanitation accounting for only 1 % of the city's budget. Both the general public and authorities have yet to realize the importance of sanitation, not only to health but also to the economy.

To solve the problems, the government last year launched a programme to provide access to adequate sanitation to 80% of urban households by 2014. The Settlement Sanitation Development Programme, estimated to cost $5.5 billion, aims to develop waste water services in 226 cities, build sanitary landfills serving 240 urban areas, and stop inundations in strategic urban locations covering 22,500 hectares. Under a separate programme called the National Strategy for Community-Based Total Sanitation, launched in 2008, the government aims to provide access to sanitation and introduce more effective water treatment methods in 10,000 villages by 2012 (IRIN, 2010).

4.3 Detection of Spatial Clusters of Flood- and Landslide- Prone Areas using Local Moran Index in Jabodetabek Megacity

4.3.1 Introduction

The rapid urban and economic growth in many developing countries has led to a serious deterioration in urban environmental conditions and the degradation is accelerating in some aspects. In many developing countries, development can be a greater priority than the environment. Slowing economic growth in the interest of protecting the environment might appear to be a worthy cause to richer countries, but is certainly not high on the agenda of developing countries. Tobey (1989) mentioned that, in developing countries, industrial growth without pollution control measures not only leads to the deterioration in environmental quality and degrades natural systems, but may also increase poverty and, in turn, lead to what is called poverty-related pollution. Urban expansion, which can be seen from population growth and settlement expansion as well as lifelines over hazardous areas have increased the impact of natural disasters (Alexander, 1995; Rosenfeld, 1994). Urban environmental problems are threats to present or future human well-being, resulting from human-induced damage to the physical environment, originating in urban areas (DANIDA, 2000).

The geographical pattern of the expansion of a city has a direct relationship with its environmental quality. A key question for urban policy and planning is how to direct these change in ways that minimize environmental impacts and risks. Based on Douglass (2010), answering this question in Asia is made all the more problematic by, first, the tremendous rates of population and economic growth that have focused on a few mega-urban regions (MURs) and, second, the intensity of urban transformations linked to processes of globalization. From the early 1980s, the Indonesian government began to attempt to guide the direction of the expansion of the Jakarta MUR to better ensure its environmental sustainability. The tools used for implementation in the early 1980s could not, however, cope with the advent of a new age of mega-projects and global consumption coming to the region along with the bubble economy of the 1990s and neoliberal policy turn thereafter.

Jabodetabek Megacity is the largest metropolitan area in Indonesia, which characterized by rapid urban development and expansion. Urban areas in Jabodetabek Megacity have been expanding mainly by land-use conversion, from agricultural lands to urban uses, especially around major cities. As a functional mega-urban system, Jabodetabek Megacity is still expanding and various activities are being developed. Diversity of economic interests and rapid development have a great spatial impact and decrease the carrying capacity of the environment, which is already exceeded for both land and water, especially in Java Island where Jabodetabek Megacity lies (Rustiadi et al., 2009). The spatial pattern in Jabodetabek Megacity is characterized by spatial inconsistencies that occur between existing land use and spatial plan, and between spatial planning and land capability (as a proxy of carrying capacity), especially in urban and surrounding areas. Previous studies state that land use inconsistencies in Jabodetabek Megacity represented 8.50% of the total area in 2001 (Nurhasanah, 2004) and 10.21% in 2010 (Rustiadi et al., 2012). These inconsistencies and unsustainable patterns of rapid urban development in Jabodetabek Megacity have caused some problems and enhanced vulnerability to environmental degradation, which may affect the occurrence of anthropogenic disasters (floods, landslides, etc.).

The environmental situation is worsening in Jabodetabek Megacity over time, a phenomenon marked by a decline in environmental carrying capacity (Rustiadi et al., 2009; Rustiadi et al., 2012). According to the Indonesian National Board for Disaster Management (BNPB), floods and landslides were the most frequent natural disaster in Indonesia during the period of 1815 – 2014, representing 20% to 40% of the total number of disasters.

A flood, defined as an overflow of water that submerges what is usually dry land, is a natural event that can have far-reaching effects on people and the environment. It is due to heavy rainfall causing rivers and/or oceans to overflow their banks and/or shores, and can happen at any time of the year. A complex mixture of geological, geomorphological, and hydrological conditions can cause a flood and its threat to destroy people and the environment (Glade, 1998; Wu and Sidle, 1995). Increasing of urban development and human activities, such as road building, settlement expansion and deforestation, can significantly increase flood risk (Chung et al., 1995; Montgomery, 1994).

The annual flooding of major cities in Southeast Asia has become predictably severe, bringing threats to health, causing great economic losses and displacing hundreds and thousands of people from their homes in the worst years (Marcotullio, 2007). As with many other metropolitan regions in the region, Jakarta as the center of Jabodetabek Megacity is also experiencing devastating annual floods. Located on an alluvial plain with 13 rivers flowing through it, the city has often been inundated during monsoon seasons throughout its history. In the past, however, widespread flooding of the city was not common, and given its relatively small size in area and population until recent decades, impacts were also substantially less than they are today. In contrast, the floods of 1996, 2002 and 2007 were the greatest and most destructive ever recorded in Jakarta (WHO, 2007). In the 2007 episode as much as 75% of the city was flooded, displacing a recorded 340,000 people from their homes with an estimated economic cost of more than US$ 450 million (BBC, 2007). Health impacts—diarrhoea, skin and respiratory problems, dengue fever—breakdown of basic urban services and loss of livelihoods lingered long after the floodwaters resided (Yuniar, 2009).

The new sources of the increasing frequency and magnitude of disastrous flooding in Jakarta, and more generally throughout Southeast Asia, are manifold. Recent research points to global climate change as the source of extreme weather events and rising oceans that breach seawalls protecting cities, a great number of which are along coastlines (Alcamo, 2009; EEPSEA, 2009). The UNEP Intergovernmental Panel on Climate Change concludes that sea rise from global warming will permanently inundate large areas of major urbanized regions of Asia, and heavy precipitation events will continue to become more frequent over of the world throughout the 21st century (Bates et al., 2008). Much of the northern coast of Jakarta and West Java is expected to be inundated by rising sea levels in the coming decades as well.

Floods have become a threat and bring increasing worse for Jakarta residents every year. In 2007, the worst floods in memory inundated about 70% of Jakarta, killed at least 57 people and sent about 450,000 fleeing their houses. In 2008, floods inundated most parts of Jakarta including the Sedyatmo toll road and nearly 1,000 flights in the Soekarno-Hatta International Airport were delayed or diverted with 259 were cancelled. In 2012, floods inundated hundreds of homes along major Jakarta waterways including rhe Ciliwung, Pesanggarahan, Angke and Krukut Rivers and displaced 2,430 people (The Jakarta Globe, April 5, 2012). In January 2013, many parts of Jakarta were inundated following heavy rain and killed at least 20 people and sent at least 33,502 fleeing their houses as reported by the National Disaster Mitigation Agency (BNPB) (The Jakarta Globe, January 22, 2013) (Figure 4-15).

(Source: http://upload.wikimedia.org/)

(Source: http://cdn.klimg.com/)

Figure 4 - 38. Floods in Jakarta, January 2013

While landslide is a slide of a large mass of dirt and rock down a mountain or cliff. Landslides are also defined as the movement of a mass of rock, debris, or earth down a slope, under the influence of gravity (Cruden, 1991; Cruden and Varnes, 1996). They are one of the major natural hazards, and account each year for enormous property damage in terms of both direct and indirect costs. Landslides can be triggered by a variety of external stimuli, such as intense rainfall, earthquakes, water level change, storm waves, or rapid stream erosion that causes a swift increase in shear stress or a decrease in shear strength of slope-forming materials (Cruden and Varnes, 1996). Prediction of potential landslide areas has been very difficult because of the complexilty of the factors involved and the relationship to each other, which is wide ranging. The factors that are usually related to landslides are geology, soil type, land surface temperature, land cover, underground water level, slope aspect, slope inclination, elevation, etc. Normally, the causes of landslide are determined by carrying out sampling of the soil, rock, slope inclination, land cover, underground water level, geology, etc. at the site. In addition, as development expands into unstable hillslopes under the pressures of increasing population and urbanization, human activities such as deforestation or excavation of slopes for road cuts and building sites have become important landslide triggers.

(Source: http://www.jpnn.com/)

(Source: http://beritadaerah.co.id/)

(Source: http://beritadaerah.co.id/)

Figure 4 - 39. Landslides in Bogor Regency, Jabodetabek, 2012

The large landslides create loss of both human life and property. Landslides killing hundreds of people have become an severe phenomenon in Indonesia as well as in Jabodetabek Megacity, especially in the mountainous areas. High rainfall events on wet soil on hill slopes can trigger 'failure' in planes of weakness in the soil profile which leads to movement of soil. Forest vegetation and trees can play an important role in holding a soil profile together through their root systems, and the removal of trees and subsequent decay of tree roots may be part of the explanation of specific landslides. Ironically, however, the risk of landslides after removal of trees is partially because the trees prevented landslides to happen earlier, and contributed to the build-up of soil until this is too heavy for the existing slope steepness. Landslides, or slope instability, can also be due to construction of roads and other structures that interfere with the flow paths of water through a hill-slope.

Bogor Regency is one of the area in Jabodetabek Megacity with high landslide potential due to rainfall. High population growth and inappropriate spatial planning in Bogor Regency were factors which led to increase risk of landslide. This risk would be more aggravated when community was completely unaware of and not responsive to the potential for landslides in the area. Based on the prediction model from Indonesian Center for Agricultural Land Resources Research and Development (ICALRD, 2009), 31.7% area of Bogor Regency (94,991 ha) are classified as low vulnerability area for landslide; 57.8% are area with middle/moderate vulnerability (173,309 ha) and 10.4% (31,127 ha) are area with high vulnerability of landslide. Results of the evaluation of spatial pattern (Yunianto, 2011) indicated that some designated residential areas were located in areas with high vulnerability to landslides, which was not appropriate for uses as residential area. In addition, the evaluation also found utilization of areas which violated the designated spatial plan of Bogor Regency, in which conservation and protected forest areas with the function to protect the surrounding environment from landslide had been converted to residential area, plantations, ricefield and farm.

The rapid urban development and increase of environmental degradation since the beginning of the 1990s, which cause disasters such as floods and landslides, has been a very important issue in terms of sustainable management of the urban environment. The objectives of this study are to identify the spatio-temporal distribution patterns and spatial clustering of floods and landslide-prone areas in Jabodetabek Megacity. Further, the susceptibility of a given area to floods and landslides can be determined and depicted using hazard zonation. A flood and landslide hazard map can be prepared early in the planning study and developed in more detail as the study progresses. It can be used as a tool to help identify land areas best suited for development by examining the potential risk of floods and landsliding. Furthermore, once floods or landslide susceptibility is identified, investment projects can be developed which avoid, prevent, or substantially mitigate the hazard.

4.3.2 Data and Methodology

The data used in this study include the total area that experienced floods and landslides, as well as the number of floods and landslide events. They were collected from PODES (village potential statistics), provided by the Central Bureau of Statistics (BPS) for the years 1996, 2000, 2003, 2008, and 2011, and from GIS datasets based on administrative units. Spatial distribution pattern maps of floods and landslides were generated based on the total area that experienced floods and landslides in 1996, 2000, 2003 and 2008. LISA was applied along with the Local Moran Index using the number of flood and landslide events dataset in 2011. The unit of analysis in this study is kecamatan (district) level.

In this study, GIS analysis and Local Moran Index were employed based on LISA statistics to investigate spatio-temporal distribution patterns and identify spatial clustering of flood- and landslide-prone areas in Jabodetabek Megacity. The Local Moran's (Local Moran's I) Index was calculated based on LISA statistics using the Geographically Data Analysis (GeoDa) software.

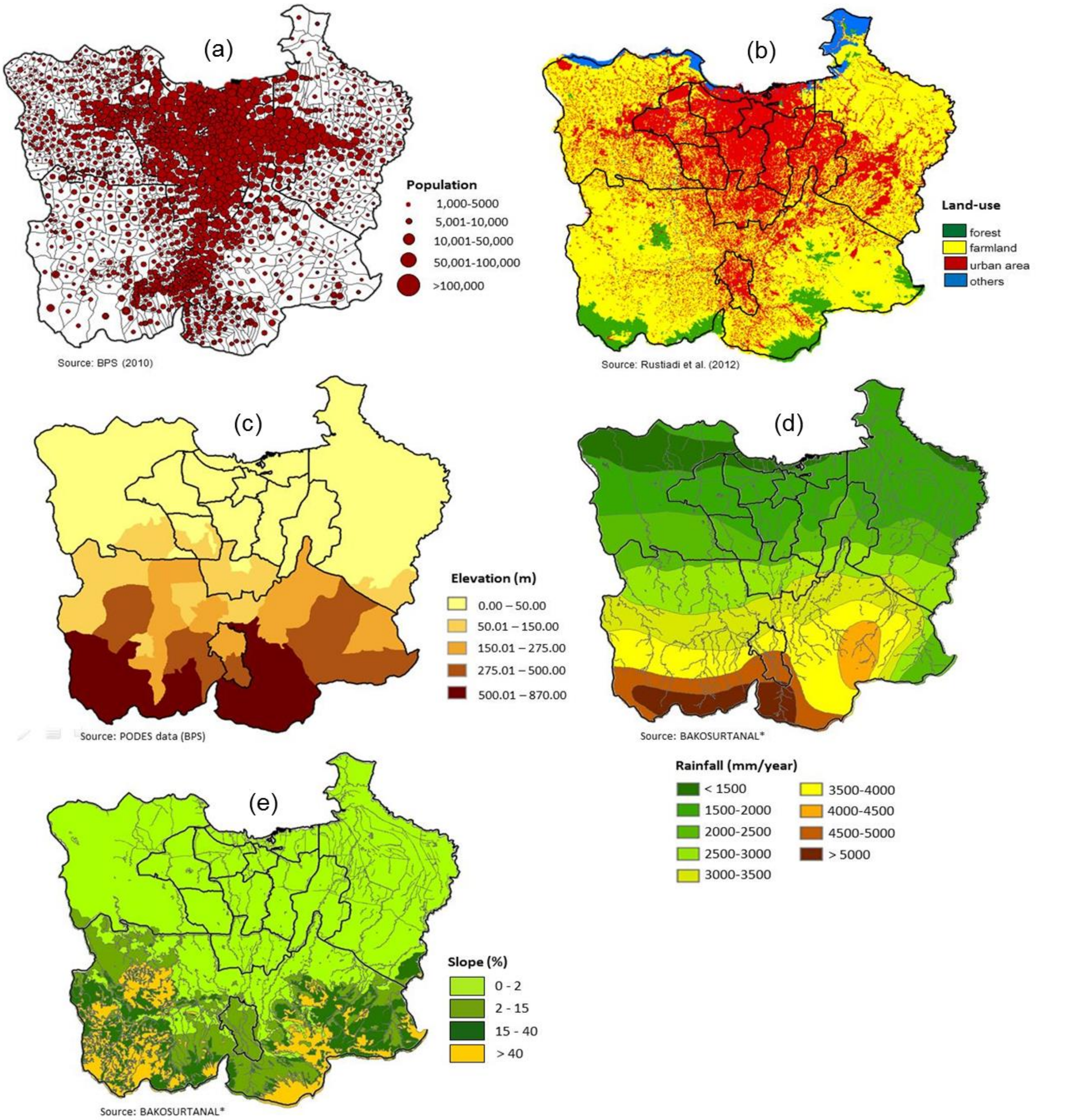

Figure 4 - 40. Thematic Maps of Jabodetabek Megacity: (a) Population; (b) Land cover; (c) Elevation; (d) Rainfall; and (e) Slope

This analusis identified spatial clusters of flood and landslide prone areas by applying this analysis. Spatial clusters of flood and landslide prone areas will appear when the spatial association (SA) of its data has a positive value (it can be high-high (HH) type or low-low (LL) type). On the other hand, SA also has a negative value (we called it "spatial outliers" for high-low (HL) type or low-high (LH) type). Positive SA exists when high values correlate with high neighboring values or when low values correlate with low neighboring values. Positive SA operationalizes Tobler's First Law of Geography whereby closer areas are more similar in value than distant ones. In contrast, negative SA exists when high values correlate with low neighboring values and vice versa (Anselin, 1995). In this study, queen contiguity as spatial weighting methods was chosen to detect the spatial association of floods and landslides in Jabodetabek Megacity. Under the queen criterion, areas are neighbors if they share either a border or point (e.g., on a grid, in addition to the four cells included under rook, the four cells sharing a corner with the central location are also counted as neighbors) (Anselin, 2005).

4.3.3 Results and Discussion

Several previous studies on the relationship between urban and economic growth and environmental conditions have argued that the degree of environmental degradation and economic growth follows an inverted U-shaped relationship. This U-shaped relationship is known as the 'Environmental Kuznets Curve' (Dinda, 2004; Stern et al., 1996; Stern, 2004). This relationship has been investigated since the 1990s after Grossman and Krueger (1995) and Selden and Song (1994) provided empirical evidence that the economic growth leads to a gradual degradation of the environment in its initial stages and, once a certain level of growth is reached, it leads to an improvement in the environmental conditions.

This analysis investigated the relationship between the urban development and environmental degradation that occurred in the Jabodetabek Megacity. Floods and landslides were chosen as representative examples of natural hazards and proxies of environmental degradation. Figure 4-18 shows the population trend and total area affected by floods and landslides in Jabodetabek Megacity between 1993 and 2011. A fast growth of the total population, as well as rapid urban development and urban expansion can be observed, as previously reported by Rustiadi et al. (2012). However, the rapid urban development and population growth were also followed by a decline in environmental conditions. Figure 4-18 indicates an annual increase in the total area affected by floods and landslides. This means that the rapid urban development contributes strongly to environmental degradation.

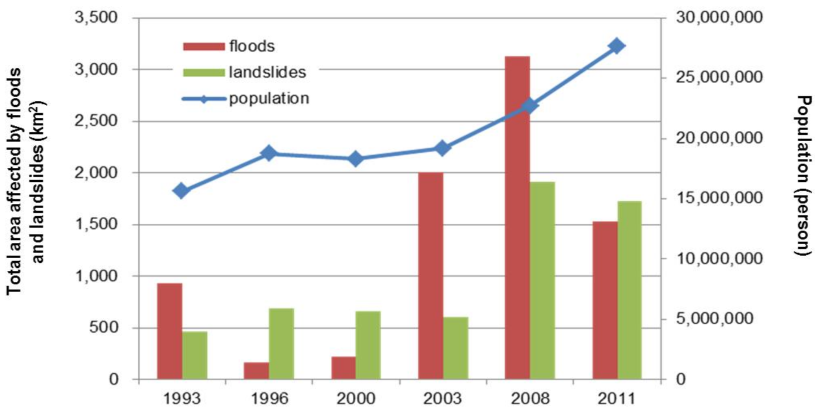

Figure 4 - 41. Population and Total Area Affected by Floods and Landslides in Jabodetabek Megacity between 1993 and 2011

Spatio-temporal Distribution Patterns of Floods and Landslides

Natural disasters are complex and detrimental events that occur completely beyond people's control and are often indirectly aggravated by human intervention. Floods and landslides are the most widespread disasters that cause serious losses to life and livelihood. The increase of human intervention in nature and environment exacerbates the effect of triggering factors. Therefore, the frequency and intensity of flood and landslide occurrence will rise and lead to an increase in human and environmental loss rates. Preparing flood and landslide maps is important to document the extent of flood and landslide phenomena in a region and to investigate the spatial distribution patterns of those occurrences. Furthermore, these maps can be developed to establish flood and landslide zoning as well as flood and landslide susceptibility and risk by including additional supporting data. Therefore, these maps and all supporting databases will be very useful tools for spatial planning. Spatial distribution patterns of floods and landslides in Jabodetabek Megacity in the years of 1996, 2000, 2003, and 2008 are shown in Figure 4-19 and Figure 4-20.

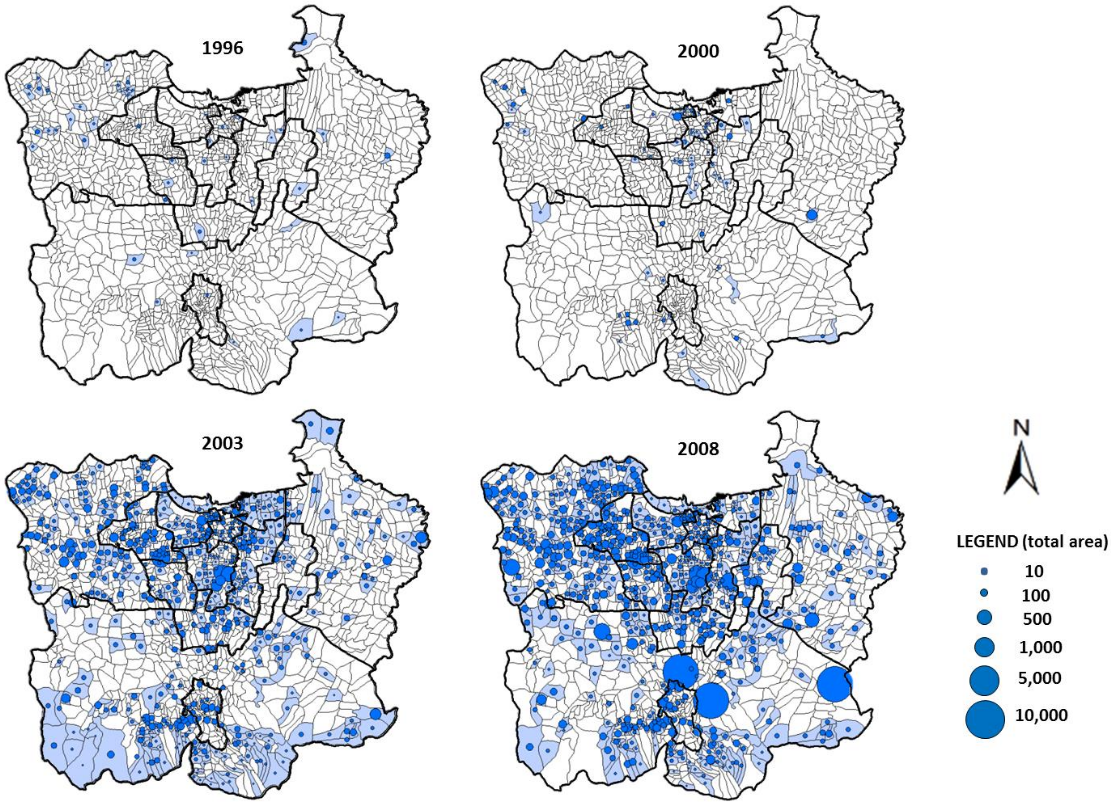

Figure 4 - 42. Distribution Patterns of Floods in 1996, 2000, 2003, and 2008

Figure 4-19 indicates that the number of villages and the total area that experienced floods increased and spread widely from 1996 to 2008 . In 2008, most of the floods occurred in Tangerang, Jakarta, and Depok, and some of them in the Bogor and Bekasi regions (Figure 4-19). In 2007, the floods were more widespread in Jakarta and surrounding areas and caused more human casualties than similar disasters that struck in 2003 and 1996. One of the floods (which occurred in Jakarta and surrounding areas on February 1, 2007 and lasted ten days), resulted in at least 80 casualties (who were either swept away, electrocuted, or otherwise harmed). Material loss due to the destruction of businesses reached an estimated 430 million dollars. Up to 320,000 people were displaced for several days after the flood. All activities in the flooded region were paralyzed, telephone and internet networks were disrupted, and electricity shortages occurred in some submerged areas. Tens of thousands of people in Jakarta and surrounding areas were forced to evacuate. Most of the remaining population was trapped inside houses flooded to a depth of ~ 2 – 3 meters and could not be saved as rescue boats did not arrive. In the city, many areas were congested, including urban toll roads. Piddles up to four feet deep in the roads also disrupted access to a number of regions.

Floodwater eroded the streets of Jakarta and caused damage that aggravated the congestion. As much as 82,150 m2 of roads across Jakarta suffered mild to severe damage, ranging from small holes and flaking asphalt to large pits. The most severe damage occurred in West Jakarta, where the total area of affected roads reached 22,650 m^2, followed by North Jakarta (22,520 m^2), Central Jakarta (16,670 m^2), and East Jakarta (11,090 m^2) while the smallest was experienced by South Jakarta (only 9,220 m^2 affected). The budget required to rehabilitate the roads is estimated as Rp 12 billion (US $1.04 million). Flooding also negatively impacted the railway lines. The trains to Tanah Abang Station did not work because the tracks around the station were inundated by ~ 50 cm of water overflowing from the Ciliwung

River. About 1,500 homes in East Jakarta were damaged by the floods and washed away. Losses in Bekasi were estimated as ~ Rp 551 billion (US$ 48 million). The biggest issue was the destruction of buildings, both houses and government offices. Moreover, 98 kilometers of district roads were also damaged and at least 7,400 hectares of rice fields dried up. After the flood, respiratory infections, diarrhea, and skin diseases affected the citizens of Jakarta, particularly those who had been evacuated, because of the poor state of sanitation and bad weather conditions. Some cases of dengue fever and leptospirosis, consequences of waterlogging after the flood, were also identified.

Severe floods not only ruin homes and businesses and destroy personal property, but the water left behind also causes further deterioration of properties and belongings. The environment and wildlife are also at risk when damage to industries causes the accidental release of toxic materials. In addition, flooding not only disrupts many people's lives each year, but it frequently creates personal tragedies when people are swept away and drowned.

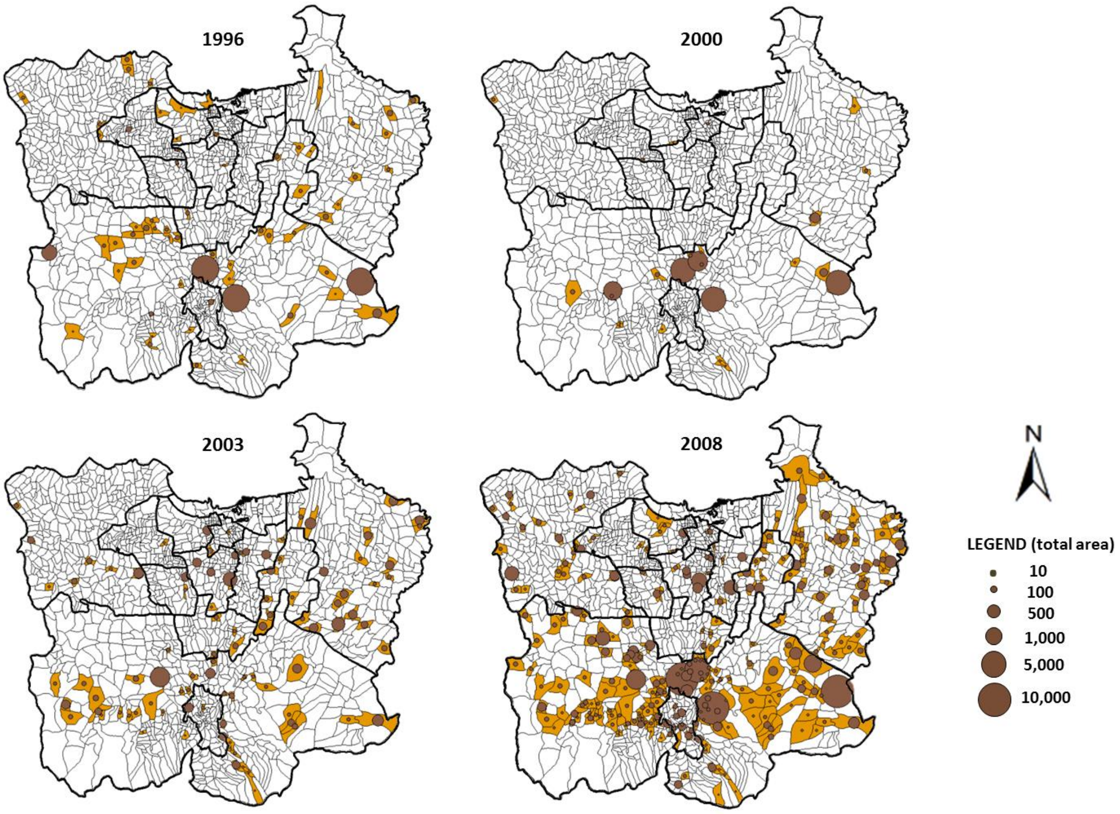

Figure 4 - 43. Distribution Patterns of Landslides in 1996, 2000, 2003, and 2008

Figure 4-20 shows that the number of villages (desa) and the total area that experienced landslides also increased and spread widely from 1996 to 2008. In 2008, most of the landslides occurred in Bogor and some in Bekasi, whereas only a few occurred in Tangerang and Jakarta. Bogor is the only region of Jabodetabek Megacity that is located on a plateau. Most of the districts in the Bogor region are situated at high elevation (>275 meters) with slopes steeper than 15%, especially in the southern part of Jabodetabek Megacity. About 30% of Bogor's total area is located on very steep slopes (> 40%) and the highest elevation of the region is 870 meters above sea level (Figure 4-17 (c) and (e)). This is why most of the villages that experienced landslides are located in Bogor. In addition, the average precipitation in Bogor is 3,000-4,500 mm/year (see rainfall map in Figure 4-17 (d)), with some areas in the southern part of the region receiving more than 5,000 mm/year of rain. In contrast, Jakarta, Depok, Tangerang and Bekasi are located in a flat area (lowland) with an average elevation less than 50 meters, shallow slopes (2%), and low rainfall (<2,000 mm/year).

These observations indicate that rainfall is the primary factor of landslide initiation, particularly in Bogor. Landslides often occur when sloping areas become completely saturated by heavy rainfall, since, without the aid of mechanical root support, the water-saturated soil simply erodes away. In this case, Bogor was identified as the highest landslide risk area in Jabodetabek Megacity due to receive intensity of precipitation. This result showed that anthropomorphic activities also influence and become triggering factor. Overpopulation and uncontrolled urbanization which occured in developing countries including this region sometimes result in settlement development on hillsides and on the banks of ravines, which may not be suitable for housing or other modifications (Bommer and Rodriguez, 2002). Landslides could be caused by road construction and landscape modification that weakens structural support, leading to slope failure (Alimohammadlou et al. 2013). The other problems caused by the development of the transportation system (roads and railways) in the landslide prone areas.

According to Zezere et al. (1999), the cause of more than 20% of landslides is human intervention. With regard to civilization and urbanization expansion, human activities that reform and modify the environment will increase in order to enable the development and utilization of new facilities. These activities generally include processes such as excavation on slope body or toe, overloading by installation of residential infrastructure such as pipes, dynamic impaction to obtain appropriate subgrade for various structures, construction of hydraulic structures on rivers, deforestation and land-use change for purposes of acquiring more territory, constructing or redirecting of irrigation and water transition channels, and air pollution due to industrialization. These human modifications may cause some natural phenomena that could inflict serious damage. The most serious events commonly start out as disturbance of slope balance and slope sliding, seismic stimulation and earthquake damage, which are aggravated by the intervention, drawdown of reservoirs caused by immediate inundation or intense rainfall, water leakage and heavy rainstorms due to climatic regime changes, and tsunamis. These occurrences may facilitate the increase of velocity and volume of landslides and therefore an increase in landslide intensity as measured by these two parameters (Glade et al., 2005).

In populated areas such as Jabodetabek Megacity, the occurrence of landslides would be very dangerous and may have severe impacts. Landslides that occur in vulnerable regions and civilization centers cause serious damages in various aspects of human life and natural environments. According to Herath and Wang (2009), landslides are the 7th greatest killer among natural disasters and contribute to about 17 % of mortalities (Kjekstad and Highland, 2009). The impacts of landslides have increased in past decades because of the rapid growth of urbanization in Jabodetabek Megacity and in other developing countries. According to Schuster and Highland (2004), landslide damage to natural environments can be divided into two categories: 1) impacts on the global environment, which includes effects on people, homes and possessions, farms and livestock, industrial establishments and other structures, and lifelines; 2) morphological changes, land cover type (forest or grassland), and native terrestrial and aquatic wildlife.

Spatial Clustering of Floods and Landslides Prone Areas

This analysis employed LISA using Local Moran Index to indicate spatial clustering of floods and landslide-prone areas in Jabodetabek Megacity. Anselin (1995) mentioned that the LISA statistics serve two purposes. On one hand, they may be interpreted as indicators of local pockets of non-stationary or hot spots, similar to the Gi and G, statistics introduced by Getis and Ord (1992). On the other hand, they may be used to assess the influence of individual locations on the magnitude of the global statistic and to identify “outliers”. This means that LISA maps are particularly useful to assess the hypothesis of spatial randomness and to identify local hot spots. A randomization approach is used to generate a spatially random reference distribution to assess statistical significance. The Local Moran Index implemented in GeoDa is a special case of a LISA statistic. The average of the Local Moran’s I is proportional to the Global Moran's I value.

The data chosen in the LISA statistics analysis were: 1) number of flood events and 2) number of landslide events (Figure 4-21). Both show the intensity of flood and landslide occurrences in 2011. The data collected from PODES was published by BPS in 2011. LISA cluster maps and LISA significance maps of floods and landslides in 2011 are shown in Figures 4-22 and Figure 4-23, respectively. The LISA maps in this study are formulated based on 999 permutations and a pseudo-significance level of p=0.05.

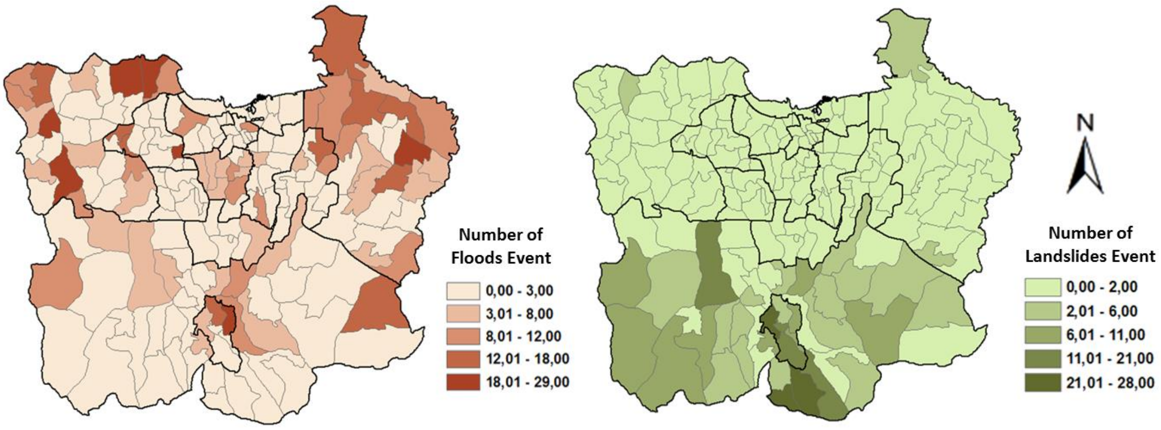

Figure 4 - 44. Spatial Distribution of Floods and Landslides in 2011

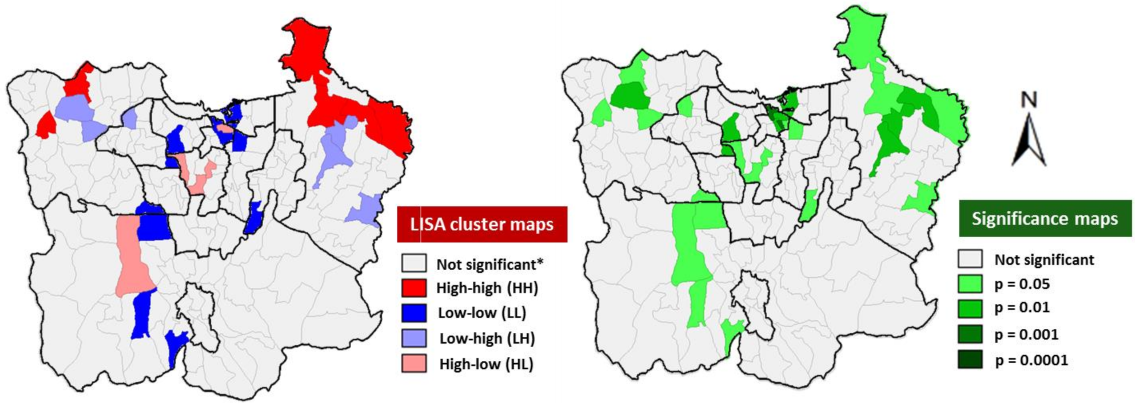

Figure 4 - 45. LISA Cluster Map and Significance Map of Floods in 2011

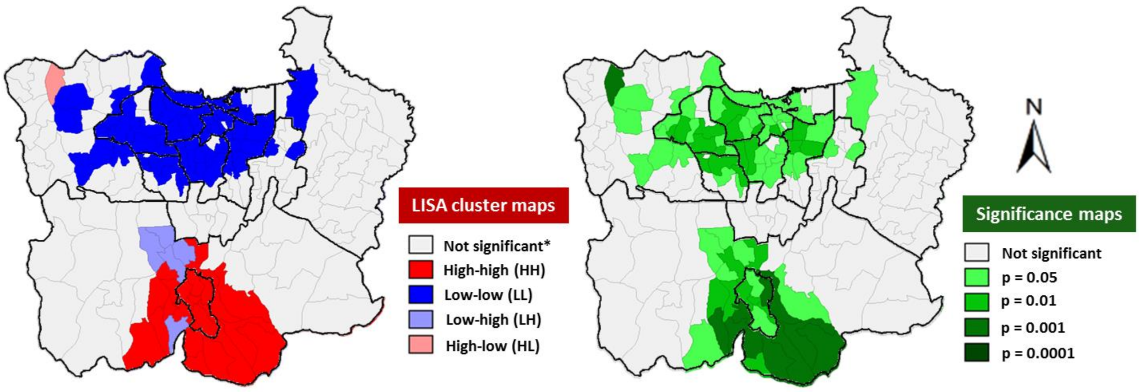

Figure 4 - 46. LISA Cluster Map and Significance Map of Landslides in 2011

The LISA cluster map is a map of significant clusters and spatial outliers, while the LISA significance map is a map of significance levels for the cluster map. The cluster map legend contains five categories: (1) Not significant (areas which are not significant at a default pseudo-significance level of 0.05); (2) High-

High (high values surrounded by high values); (3) Low-Low (low values surrounded by low values); (4) Low-High (low values surrounded by high values), and (5) High-Low (high values surrounded by low values).

The results of the LISA application using Local Moran Index can be used to identify spatial clustering of floods and landslides in Jabodetabek Megacity. Since each index has an associated test statistic, the polygons that have a statistically significant relationship with their neighbors can be mapped, and express the type of relationship. The red areas on the maps in Figures 4-22 and Figure 4-23 represent a High-High (HH) cluster, which is HH positive spatial association. This result appears when a high value representing a high total number of flood and/or landslide events is itself surrounded by other high values. It also indicates high positive spatial clustering. High positive spatial clustering of floods is observed in Bekasi and Tangerang, in the northeast and northwest part of Jabodetabek Megacity, whereas positive spatial clustering of landslides can be found in the Bogor region (southern part of Jabodetabek Megacity). Dark blue areas in those maps are Low-Low (LL) clusters, which is LL positive spatial association. LL clusters appear when a low value representing a low total number of floods and/or landslides events is surrounded by other low values. On the contrary, Low-High (LH) and High-Low (HL) types of LISA cluster maps are categorized as a negative spatial association, which means that the value representing the total number of floods and/or landslide events is different from that of its neighbors. LH type occurs when a low value is surrounded by high values, whereas HL type appears when high values are surrounded by low values. Using LISA analysis, not only the Local Moran's I, but also the Global Moran's I can be determined. In this case, the Global Moran's I values for floods and landslides are 0.0618 and 0.3815, respectively. This means that the spatial association of landslide-prone areas (based on the number of landslide events) is more clustered than the spatial association of floods (which is more random).

4.4 Conclusion

The rapid growth of urban development accelerates degradation of some environmental aspects of the study area. This analysis detected the local spatial association of floods and landslides using LISA statistics, and found that Bekasi and Tangerang have a high vulnerability to floods, with a high positive spatial association of flood occurrence and intensity, whereas Bogor is highly vulnerable to landslides owing to its topographic and climatic conditions. The LISA cluster map of floods and landslides could be used as a preliminary result of flood and landslide zoning, which is beneficial to land use or spatial planning to avoid or minimize inappropriate urban developments in flood- and landslide-prone areas.

One alternative solution to managing and controlling the environment in urban flood-prone areas is to repair and expand man-made sewer systems and storm water infrastructure. Another strategy is to reduce impervious surfaces in streets, parking lots and buildings through natural drainage channels, porous pavement, and wetlands (collectively known as green infrastructure or sustainable urban drainage systems). Areas identified as flood-prone can be converted into parks and playgrounds that can tolerate occasional flooding. Ordinances can be adopted to require developers to retain storm water on site and buildings to be elevated, protected by floodwalls and levees, or designed to withstand temporary inundation. Property owners can also themselves invest in solutions, such as re-landscaping their property to divert flows away from their buildings and installing rain barrels, sump pumps, and check valves.

Thus, in order to reduce social and economic losses due to landslides, effective planning and management can be developed. These approaches include: (a) restriction of development in landslide-prone areas, (b) use of excavation, grading, landscaping, and construction codes, (c) use of physical measures (drainage, slope-geometry modification, and structures) to prevent or control landslides, and

(d) development of warning systems (Schuster and Leighton, 1988; Schuster, 1996; Slosson and Krohn, 1982). To address the landslide problem, the local government has to achieve a better understanding of landslide hazards and make rational decisions on the allocation of funds for the management of these risks. In the case of Jabodetabek Megacity, the way to improve environmental quality is through political solutions. However, the most important measure would be the promotion of institutional change and an increase in the efforts of communities and NGOs to preserve the environment.

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CHAPTER 5. LOCAL DRIVING FORCES OF URBAN EXPANSION IN JABODETABEK MEGACITY

5.1 Introduction

Urbanization, or the concentration of people in cities, has radically transformed societies in recent years. More people tend to live in cities because they are major centers of urban development, innovation, culture, and economic activity (Angel et al., 2011). Cities play an important role as the engine of the global economy, generating 80–95% of the world's GDP (Seto et al., 2011). However, the rapid growth of cities has led to global environmental changes and emerging social costs. Many issues concerning the growth of cities such as climate change, carbon emissions, the urban heat island, urban sprawl, the loss of prime agricultural land, increasing water and air pollution, overcrowding, crime, traffic congestion, poverty, and social exclusion are often associated with urbanization (Bolay, 2012; Hasse and Lathrop, 2003; United Nations Habitat [UN Habitat], 2008; Zhao, 2010). About 75% of global energy consumption and 80% of greenhouse gas emissions occur in cities (Geng et al., 2011). In addition, wealth in cities is unequally distributed, with around 30% of the urban population living in slums or poor informal settlements that lack basic services (United Nations Water Decade Programme on Advocacy and Communication [UNW-DPAC], 2010). Such informal settlements have often emerged as a result of rapid and uncontrolled urbanization due to immigration, the incapacity of public and private institutions to provide low-income housing, and inappropriate land administration and planning (Davis, 2008; Zhu, 2010). Moreover, they will continue to grow to accommodate population growth since they constitute an important source of urban housing in low and middle-income countries (Fernandes, 2011), where recent population growth and urban expansion has been concentrated (Angel et al., 2011; World Bank, 2011). By 2050, 95% of urban expansion is expected to take place in such countries (UNW-DPAC, 2010).

In some countries, urban areas have grown so rapidly they have become "megacities" (i.e., urban areas with a population of more than 10 million). Today, there are 18 megacities in the world with very diverse characteristics, and most of these are located in developing countries, especially in tropical or temperate zones (Research Institute of Human and Nature [RIHN], 2014). These megacities have created unprecedented intricate patterns of human–environment interactions, each having a massive influence on the other cities and on the global environment. Because Asian megacities typically sprout from several urban centers (Ng and Hills, 2003), their urbanization patterns differ from the city growth experienced in Western countries. Urbanization and growth in Asian megacities, while showing some of the characteristics of Western urbanization, also exhibit features unique to Asian countries (Murakami et al., 2005). Several studies have pointed out land-use mixture as a major feature of Asian urbanization. McGee (1991), for example, indicated that rapid urban growth creates a chaotic mixture of urban and rural land use that results in serious environmental problems and a lack of adequate urban infrastructure. Living wisely in a megacity could thus become one of the most important dimensions of sustainability in the global environment, because megacity residents are the first to be impacted by both global and local environmental problems, even though they receive significant social and economic benefits from urban life.

Controlling and managing megacities in a sustainable way is needed to encourage the future prosperity of humanity and its coexistence with the global environment. To mitigate global environmental problems while improving the quality of local people's lives, it is important to identify the characteristics of megacities. Understanding the spatial characteristics of urbanized areas in all megacities is therefore highly recommended because of their diverse characteristics, which can be analyzed by exploring the driving forces of their urban expansion patterns.

Jabodetabek Megacity is considered as the second largest megacity in the world after the Tokyo metropolitan area (RIHN, 2014). It consists of *Daerah Khusus Ibukota* Jakarta or the Jakarta Capital Special Province surrounded by peripheral areas called Bodetabek, the acronym for Bogor, Depok, Tangerang, and Bekasi (Figure 5-1(A)). The Jabodetabek Megacity covers 6,392 km^2. It comprises only 0.3% of Indonesia's total area but is home to about 11.3% of the national population, with an annual growth rate of 2.6% over the period 2000–2010. Jabodetabek Megacity contributed 24.8% of national GDP in 2010.

Jabodetabek Megacity has been experiencing high pressure urban expansion (Figure 5-1(B)). The urban area in Jabodetabek Megacity increased by about 2,096 km^2 between 1972 and 2010 owing to urbanization and suburbanization processes (Rustiadi et al., 2013). This expansion is characterized by the outward spreading of the city and its suburbs, which increases the density of built-up areas, population, economic development, and urban activities. Such a trend is driven by economic expansion, fuelled by industrial estates and new satellite towns and resulting in extended areas of mixed land uses at the peripheral areas (Rustiadi and Kitamura, 1998; Rustiadi et al., 1999; Rustiadi and Panuju, 2002). The suburban region tends to expand faster than its real growth because of less controlled and disordered urban expansion with a low urban population density (Rustiadi et al., 2013).

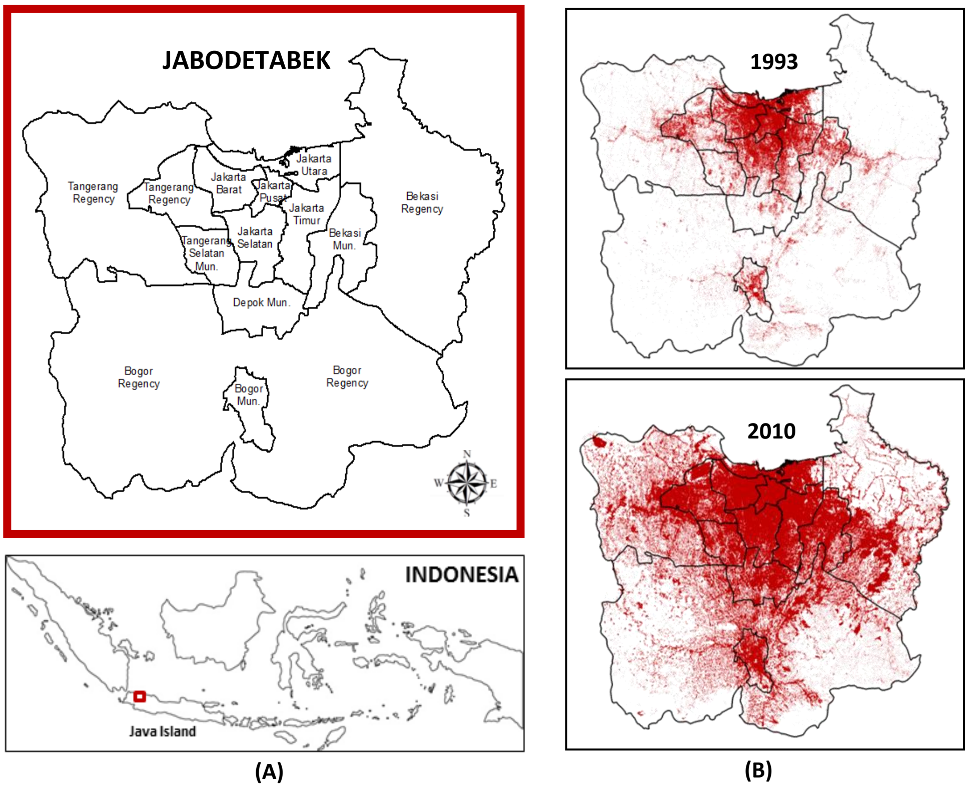


Figure 5 - 10 (A). Administrative Map of Jabodetabek Megacity; (B) Urban Expansion in Jabodetabek Megacity (1993 and 2010)

By 2010, the increasing population growth in Jabodetabek Megacity had led to 27 new town projects in peripheral areas, ranging from 5 km^2 to more than 80 km^2 in size (Herlambang, 2011). Indeed, urban areas are still expanding, especially in Bogor, Tangerang, and Bekasi. Based on land-use/cover change analysis, agricultural areas (especially irrigated rice fields) in Jabodetabek Megacity covered approximately 1,700 km^2 in 2010, spreading widely across most of the Bekasi Regency (12% of the total area of Jabodetabek Megacity), Tangerang Regency (7.5%), and Bogor Regency (5%) (Rustiadi et al., 2013). Irrigated rice fields are spread throughout Bekasi and Tangerang, and the rivers that flow through those areas help irrigate rice fields. However, rapid urban development in this area may fuel the shrinking of agricultural lands.

Rising population growth, the emergence of new town projects and large manufacturing centers, greater job opportunities, and the availability of easy transportation might all be factors that encourage urbanization and suburbanization. However, one negative impact of rapidly growing development or urbanization/suburbanization processes has been the emergence of slums. Higher land prices in the center of urban areas prohibit people from affording modern/high-class residences built by private housing companies. Although many of Jabodetabek Megacity's slums are illegal, poor families or individuals who do not earn sufficiently are forced to live in them (Zorbaugh, 1976). Slum areas can be found in several spots in Jabodetabek Megacity, notably along the river. Reports by the UN Human Settlements Program (2003) estimate that 26% of Indonesia's urban population lives in slums, with more than 5 million slum dwellers in Jabodetabek Megacity alone. The constant threat of demolition and eviction leaves little incentive for these citizens to invest in infrastructure. Rapid urbanization has created problems of land and housing scarcity, and as these scarcities increase and housing prices rise, economic constraints force the poor to inhabit land that no one else wants.

Like other emerging Asian megacities, the urban expansion in Jabodetabek Megacity has a significant impact on the local and global environment. Efforts to control urban expansion must start from a clear understanding of their various local, regional, and global driving forces. Studies of the interdependencies between the driving forces in the local spatial relationship in emerging Asian megacities are still limited. This study hypothesize that the local driving forces that affect urban expansion in the Jabodetabek Megacity vary spatially. However, the city of Jakarta is the area least affected by these local driving forces. Jakarta city has become more characterized as a global city and it has tended to have more linkages with regional as well as global economic centers. It was supposed that the local variation of demographic, infrastructural, and natural elements driving forces in the region are significantly affecting the urban expansion process in Jabodetabek Megacity and are not spatially uniform. A clear picture and more specific about the existence of spatial variation of local elements driving-forces can facilitate planners and policy makers to manage and control urban expansion in the region.

The objectives of this study are thus to explore the driving forces of urban expansion in Jabodetabek Megacity by considering the local spatial dependency and to analyze the spatial characteristics of the urbanized area as well as to identify spatial variation in the relationship between urban expansion and its driving forces. To support these goals, GWR is considered as an appropriate model for this analysis. In recent years, numerous studies have applied GWR to explore spatial variations in the relationship between environmental and socioeconomic indicators (Ogneva-Himmelbrger et al. 2009), regional development (Yu, 2006), population segregation (Yu and Wu, 2004), ecology (Su et al., 2012), natural resources management (Jaimes et al, 2010; Clement et al., 2009), and social studies (Farrow et al., 2005; Malczewski and Poetz, 2005). GWR's ability to show the local spatial dependency of each location can describe the characteristics of spatial relationships among the variables in order to explain urban expansion in Jabodetabek Megacity.

5.2 Data and Variables

To identify the driving forces that are affecting rapid urban expansion in Jabodetabek Megacity, several variables were included in the GWR analysis. The change ratio of the urban area (URB) was selected as the dependent variable (Y). This variable was chosen as a proxy of increasing urban expansion since the rapid growth of built-up or urban areas significantly affects global environmental change by producing greenhouse gas emissions. Based on the literature review, several variables were considered as having relationships with urban expansion, such as population growth (Bilsborrow and Okoth-Ogendo, 1992; Van, 2008), agricultural activities (Lopez et al., 2001; Njungbwen and Njungbwen, 2011), development level and increasing urban infrastructure (Gillham, 2001), distance to the central business district or city center (Rustiadi et al., 2013), distance to the river (Aguayo et al., 2007; Brown et al., 2002; Pijanowski et al., 2002), and distance from access roads or highways (Aquayo et al., 2007; Azócar et al., 2007; Newman et al., 1992).

The independent variables (X) in our GWR model represented three types of driving forces, namely demographic, infrastructural, and natural elements. In the GWR model, population growth (POPGRO) and percentage of agricultural households (AGRHH) were selected as proxies of demographic driving forces. For infrastructural driving forces, three independent variables were employed, namely a district settlement facilities index (DFINDEX), distance to the capital regency/municipality (D_CAPREG), and distance to the toll road (D_TOLL). Finally, a variable for distance to the river (D_RIVER) was selected as the proxy of natural elements. The Y and X variables used in the GWR model are described in Table 5-1.

URB data were taken from land-use/cover change analysis for 1993–2010 (Rustiadi et al. 2013). POPGRO, AGRHH, DFINDEX, and D_CAPREG data were collected from the PODES datasets on village-level statistics provided by the Central Bureau of Statistics (BPS) for 1993 and 2010. D_RIVER and D_TOLL data were extracted from topography map provided from BAKOSURTANAL (National Coordinator for Surveys and Mapping Agency) in 2010. For these variables, both the distances to the river and the toll road were calculated by using the proximity tools in ArcGIS. The data for each independent variable (X) and for the dependent variable (Y) used in the GWR model can be seen in Figure 5-2. This analysis used data in year of 1993 and 2010 as a representative year to capture the phenomenon 'before' and 'after' monetary crisis.

Table 5 - 3. The dependent (Y) and independent variables (X) used in the GWR model

Variable	Variable Code	Detail Explanation
Y	URB	Change ratio of the urban area from 1993 to 2010 (%) Y (%) = [(urban area in 2010 – urban area in 1993)/total area] × 100
X_1	POPGRO	Population growth from 1993 to 2010 (%)
X_2	AGRHH	Agricultural households or households that are involved in agricultural activities in 1993 (%)
X_3	DFINDEX*	District settlement facilities index in 1993
X_4	D_CAPREG	Distance to the capital of regency/municipality in 1993 (m)
X_5	D_TOLL	Distance to the toll road in 1993 (m)
X_6	D_RIVER	Distance to the river in 1993 (m)

Note:

Y: proxy of increasing of urban expansion; X_1, X_2: proxy of demographic driving forces; X_3, X_4, X_5: proxy of infrastructural driving forces; X_6: proxy of natural elements driving forces.

*DFINDEX: an index that measures the development level of regions, especially related to urban infrastructure/ facilities such as education, health, the economy, social services, and other public facilities.

Maps of the parameter estimates (β coefficient), local R^2, and standardized residuals obtained from the GWR models provide a simple way in which to detect spatially varying relationships between urbanization and related factors. R^2 alone is simply a measure of the error in the regression over the total regression. Local R^2 indicates how well the local regression model fits the observations (local models with low values perform poorly). Residuals are the differences between the observed and predicted y values, while standardized residuals have a mean of zero and a standard deviation of one.

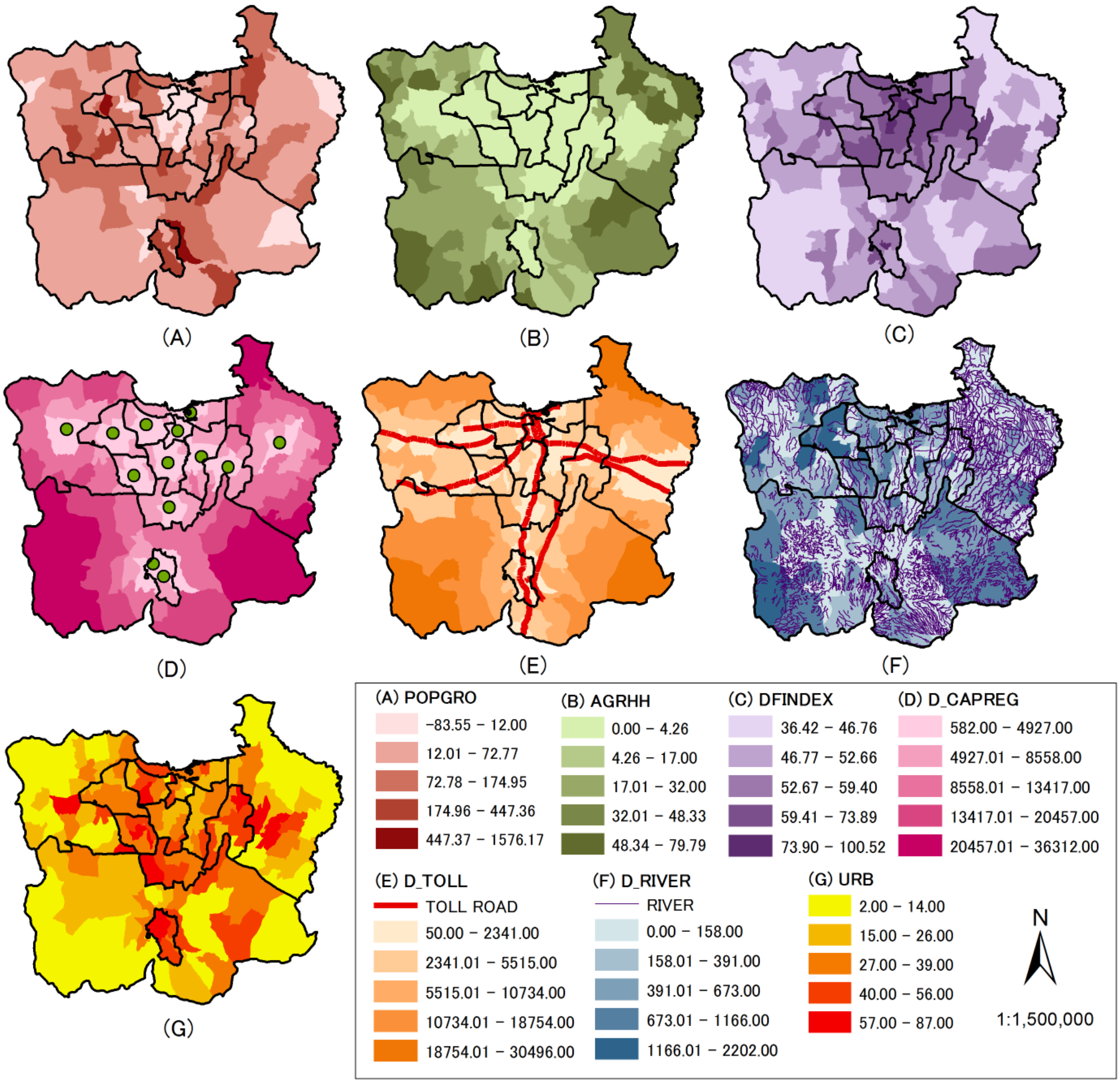
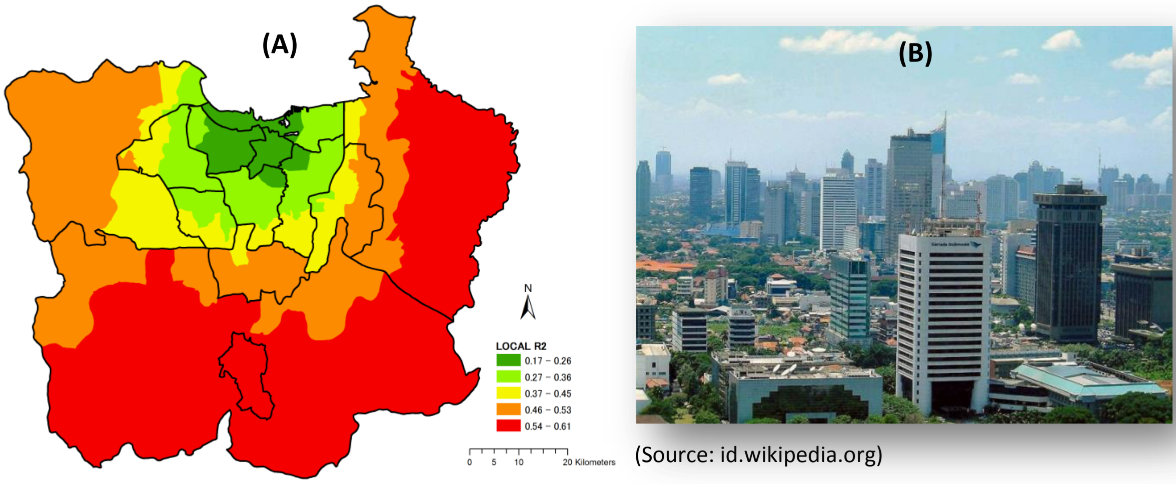


Figure 5 - 11. Maps of the independent and dependent variables

5.3 Results and Discussion

The local R^2 of the GWR model was found to range from 0.174 to 0.612 (Figure 5-3(A)). In this model, a higher value of local R^2 corresponded not to Jakarta (i.e., the core of Jabodetabek Megacity), but to the suburban/periphery areas (Bodetabek). This result shows that the core of Jabodetabek Megacity seems likely to become more and more independent from the influence of the surrounding areas. The core of megacity, especially the Central Business District (CBD) of Jakarta city has become characterized as a globalized city, which tends to have more linkages with the world market, a global urban system, global diasporic networks, and global cultural flows (Brenner and Roger, 2006). Hajer and Reijndorp (2001) considered this character as “an archipelago of an enclave”.

Jakarta city grew rapidly during the period of the New Order Regime (1967-1998). The investment in the property sector, including offices, commercial buildings, new town development, and highrise apartments and hotels grew substantially. Firman (1998; 1999) argued that Jakarta, by the mid-1990s, was heading towards global city status. Jakarta was the largest concentration of foreign and investment in Indonesia and received 32.5 billion USD and 68,500 billion rupiahs from foreign and domestic investment respectively during the period of January 1967 – March 1998 (Firman, 1999). During the thirty-two years of the New Order Regime, Jakarta changed considerably. A generally rapid economic growth during this period allowed Jakarta to expand its modern constructions and develop into a modern city. Firman (1998) noted that the physical development of Jakarta resulted from its functioning as a 'global city' in Asia. Tokyo, Seoul, Taipei, Hongkong, Manila, Bangkok, Kuala Lumpur, Singapura and Jakarta are included as the 'global cities' in Asia, whereas hundreds of new office towers, hotels and high-rise condominiums were built in many parts of the city (Figure 5-3(B)). Jakarta is linked with other 'global cities' in a functional system built around telecommunications, transportation, services and finance. A parade of tall buildings, one after the other fill the major streets on both sides. They house the offices of Indonesian and multi-national corporations. Firman (1999) reported that total area of commercial space in Jakarta in 1978 was only 0.1 million square meters and in 1997 it reached 2.7 million square meters with nearly 90% occupancy rates. In every part of the city, modern shopping malls along with family enterprises were also built (Rukmana, 2014).



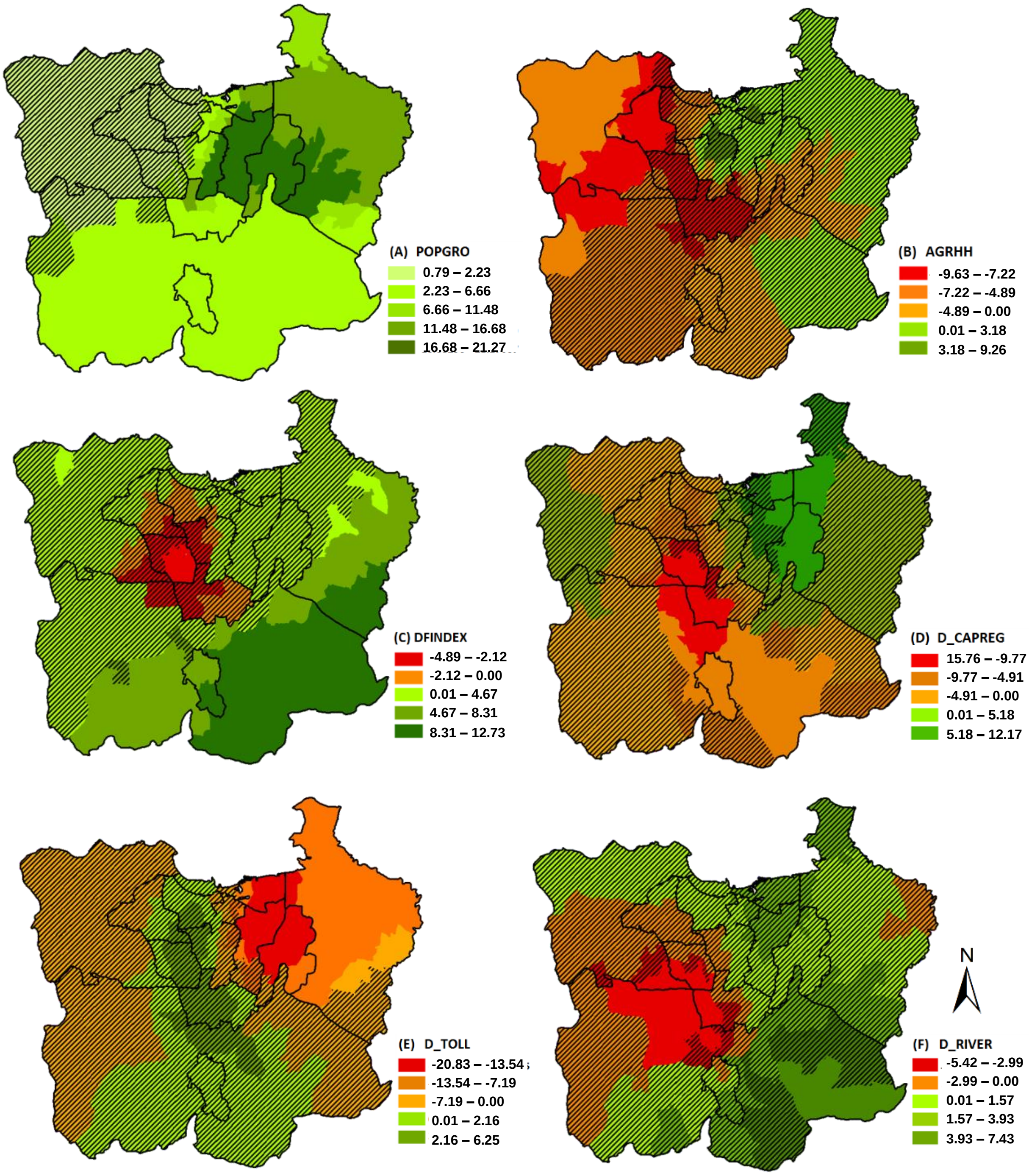
(Source: id.wikipedia.org)

Figure 5 - 12. (A) The local R^2 of the GWR model; and (B) Jakarta as one of 'global city' in Asia

The spatial distribution maps of the parameter estimates (β coefficient) for each independent variable including the significance of the t-test values of these parameter estimates from the GWR model are shown in Figure 5-4. Based on the study area, demographic driving forces seem to be the most dominant influence on urban expansion. The total area in which demographic factors (POPGRO and AGRHH) are significantly causing urban expansion covers most of the Jabodetabek Megacity except some areas of Jakarta city (Figures 5-4(A) and 5-4(B)).

Based on the result, population growth (POPGRO) is one of driving force that affecting urban expansion in Jabodetabek Megacity. The population of Jakarta in 1900 was about 115,000. In the first nationwide census of the Dutch colonial administration (1930), Jakarta's population increased to 409,475. In the next ten years, the population increased to 544,823 with an annual growth rate of 3.30%. After independence, Jakarta's population increased by nearly three times to 1.43 million by 1950. It increased to 2.91 million in 1960 and 4.47 million in 1970. The annual growth rates of Jakarta's population are 10.35% in period 1950-1960 and 5.36% in period 1960-1970 (Rukmana, 2014). Table 5-2 shows the population of the Jabodetabek Megacity including Jakarta, the inner and outer peripheries of Jakarta, from 1980 to 2010. The population of Jabodetabek Megacity increased from 11.91 million in 1980, 17.14 million in 1990, and 20.63 million in 2000 to 28.01 million in 2010. The megacity in 2010 was 11.79% of

Indonesia's total population but this population resides in less than 0.3% of Indonesia's total area. The proportions of Jabodetabek Megacity's population to the total population of Indonesia have steadily increased from 8.07%, 9.56%, to 10.0% in 1980, 1990 and 2000 respectively.



Note: ▨ not significant at p<0.05

Figure 5 - 13. Spatial distribution of the parameter estimates of each independent variable

Table 5 - 4. Population of Jabodetabek Megacity in 1980-2010 (in millions)

Area	1980	1990	2000	2010
Core:	**6,50**	**8,26**	**8,39**	**9,60**
Jakarta	6,50	8,26	8,39	9,60
Inner peripheries:	**n.a**	**n.a**	**4,93**	**7,22**
Tangerang Municipality	n.a	n.a	1,33	1,80
South Tangerang Municipality	n.a	n.a	0,80	1,29
Depok Municipality	n.a	n.a	1,14	1,75
Bekasi Municipality	n.a	n.a	1,66	2,38
Outer peripheries:	**5,41**	**8,88**	**7,31**	**11,20**
Bogor Municipality	0,25	0,27	0,75	0,95
Tangerang Regency	1,53	2,77	2,02	2,84
Bekasi Regency	1,14	2,10	1,62	2,63
Bogor Regency	2,49	3,74	2,92	4,78
Jabodetabek Megacity	**11,91**	**17,14**	**20,63**	**28,02**

(Source: Central Bureau of Statistics, Firman (1997) and Cox (2011)

POPGRO has a significant positive effect on urban expansion across most of the area, excluding only the Tangerang region and the western part of Jakarta city. The high population growth in this suburban area is mainly due to the continuing excessive in-migration from outside the Jabodetabek Megacity as well as migration from the core of the megacity (Jakarta city) to its peripheries. The in-migration into the Jabodetabek Megacity is affecting both the central and suburban areas, but the latter are absorbing more migrants. In 2010, 1,427,933 migrants migrated to Jakarta city compared with 2,630,119 to the suburbs (Bodetabek), which represented 14.6% of the total population (Rustiadi et al., 2014). In many industrial centers of Jabodetabek Megacity, most migrants work in the manufacturing industry. There are now more than 35 industrial centers in Jabodetabek Megacity accounting for an area of over 18,000 hectares (Hudalah et al., 2013). Since the end of the 1980s, no new industrial land has been developed in Jakarta city, as the available industrial land across Jakarta has declined. In Jakarta, employment zones can only be found in the northern part, although a considerable number of new zones are present in the suburbs and suburban employment zones now comprise the majority of the total area. By contrast, during the 1990s, the widescale development of private industrial land took place in the suburbs, notably concentrated in Cikarang (Bekasi District). In fact, Cikarang, with a total industrial land area of nearly 6,000 hectares, has in the past two decades become the largest planned industrial center in Southeast Asia (Hudalah and Firman, 2012). Hence, urban expansion in Bekasi and the surrounding areas is significantly affected by population growth (Figure 5-4(A)), since the eastern suburbs have received a significant influx of employment, filling in the planned industrial centers along the highway. Therefore, those areas are characterized by not only industrial estates, but also new town projects. Many new town developers envision building *kota mandiri* (autonomous towns), complete with major urban facilities and employment centers (Hudalah and Firman, 2012).

According to Rustiadi et al., (2014), built-up areas were still concentrated within the established boundaries of Jakarta city until the beginning of the 1980s. However, since the late 1980s, property development has boomed in the suburbs. During the peak period of 1992–2000, about 90,760 ha of agricultural land was converted into built-up areas, mostly transformed into land for housing, roads, and industrial and commercial areas because of housing demand and other growing economic activities (E. Njungbwen and A. Njungbwen, 2011; Lopez et al., 2001). In this study, the local spatial relationship of demographic driving forces with urban expansion is also shown by the decreasing percentage of agricultural households (AGRHH). The GWR results show that the decreasing proportion of agricultural households in the northwestern part of Jabodetabek Megacity (Tangerang Regency and Municipality) is significantly affecting the increasing urban expansion in this region (Figure 5-4(B)). Decreasing proportion of agricultural households in Jabodetabek Megacity is caused by land conversion – the process by which land is converted from agricultural to urban uses. Land conversion is a phenomenon that is almost unavoidable during economic development and population growth periods (Tan et al., 2009). According to Pierce (1981), it may involve both the internal reorganization and the outward expansion of the physical structure of urban areas, but clearly, the primary economic reason for the conversion of agricultural land is that under urban uses a much higher rent is recovered (Grigg, 1995). However, uncontrolled land conversion has great impacts on environment in general and agricultural products in particular (Figure 5-5).

Figure 5 - 14. Land conversion from agricultural to settlement/housing, industrial area, and new toll road

Conversion of agricultural land to non-agricultural uses is more intense in the periphery area of Jabodetabek Megacity because of migration of people and expanding industrial areas. To accomodate the natural population growth of the region and the influx of people and industries from other areas, more and more agricultural land is being converted to non agricultural uses. The problem is that most of agricultural land which converted to non-agicultural land are prime agricultural land. By definition, prime agricultural land is land of the highest quality for food and fiber production. These prime agricultural land are converted to accomodate the land demand for urban expansion and related activities such as highways, airports, parks, and industrial sites.

Azadi et al. (2010) mentioned that in developing countries, the increase of urban population causes intensive agricultural land conversion. The increase of urban population to more than 7 million would lead to a loss in agricultural land around 0.233 km2 per capita. People’s migration to urban areas needs more land. The increase need for job, housing, recreasion, commercial area, parking sites, road infrastructure, educational and other facilities that create social welfare, increase demand for land. On the other hand, land in urban areas becomes scarce and expensive, so the development sprawls to peripheral areas and grabs fertile agricultural lands. Consequently, the possibility of agricultural land to be converted to urban uses is getting higher and higher.

DFINDEX, D_CAPREG, and D_TOLL, which represent infrastructural driving forces, also show local spatially dependent relationships with urban expansion in certain locations (Figures 5-4(C), 5-4(D), and 5-4(E)). Based on the GWR results, most Jabodetabek Megacity have positive parameter estimates for DFINDEX. In 1993–2010, the development of public facilities and other infrastructure in the eastern and southern parts of Jabodetabek Megacity was one of the driving forces of urban expansion. Several industrial estates and new town projects are found in this area (e.g., Jababeka, Figure 5-6). In many studies, greater access to the central business district/capital city or to main roads is shown to increase the expansion of built-up/urban areas. This was the reason for including D_CAPREG and D_TOLL in this analysis. Rustiadi et al. (2013) indicated that the suburbanization of Jakarta has resulted in the expansion of housing and industries in areas that are more distant from the city. The results of their analysis, using the decay function model, indicated that housing and built-up areas in Jabodetabek Megacity moved away from the center or experienced urban sprawl during 1972–2010.

Figure 5 - 15. Jababeka: new town project, central business district and industrial estate

Leaf (1994) has identified the rapid growth of suburban enclave housing in Jakarta during early 1990s. Firman (1998) and Leaf (1994) argued that Jakarta's suburban area is characterized by the residential enclave for narrowly targeted moderate and high-income families. These residentials were built in automobile-accessible areas which located on the periphery of the city with various high-quality amenities such as modern golf courses. High-income urban dwellers in the central city also moved from the city to these settlement in the periphery area looking for better living quality (Goldblum and Wong, 2000). Leaf (1994) has argued that suburbanization in Jakarta was a direct outcome of at least two policies which have most benefited developers strongly linked with the New Order Regime: the subsidized housing finance program and the municipal permit system for land development. Based on Leaf (1994), half of the land development permits were given to 16 out of 167 development firms.

Rukmana (2014) mentioned that the periphery of Jakarta is also made up of specialized residential zones of commercial and industrial enterprises. These areas complement the other districts of Jakarta: the central business districts on Thamrin-Sudirman corridor, the government offices around Medan Merdeka, the international seaport of Tanjung Priok, and the growing network of freeways. Based on Hudalah et al. (2013), since the end of the 1980s, no new industrial parks have been developed in Jakarta. The periphery of Jakarta was also the location of several new towns, such as initiated by a collaborative project of Bumi Serpong Damai in the early 1980s. The first new town of Bumi Serpong Damai was planned for an eventual population of 600,000 in a total area of 6,000 hectares. This project developed by several private developers and led by the largest private developer in Indonesia, namely the Ciputra Group. Firman (1998) and Silver (2008) also mentioned the other new towns in the peripheries of Jakarta include Bukit Jonggol Asri, Lippo City, Tigaraksa, Pembangunan Jaya, Cikarang Baru, Kota Legenda, Kota Cileungsi, Royal Sentul, Bintaro Jaya, Lido Lakes Resort, Modernland, Kota Citra Raya, Alam Sutera, Kedaton, and Gading Serpong (Figure 5-7).

Figure 5 - 16. Residential area and urban facilities in some new towns located in Bumi Serpong Damai (Tangerang Municipality), Alam Sutera (South Tangerang Municipality), and Cikarang (Bekasi)

During the emergence of several number of new towns, the State Housing Provider Agency (Perumnas) joined with private developers to assure some housing was targeted for low and moderate-income families (Cybriwsky and Ford, 2001). Most of the new towns concept was to create self-contained communities but this was barely implemented. Instead, Cybriwsky and Ford (2001) argued that the new towns became “bedroom suburbs for city-bound commuters”. Based on Firman (1999) and Silver (2008), the new towns were still strongly dependent on the central city and the development of large-scale housing projects intensified the daily interaction between the peripheral areas and the central city of Jakarta. This situation worsened the traffic congestion problems in Jakarta metropolitan area. The development of industrial zones in the peripheries area of Jakarta also indicated a spatial restructuring that shifted manufacturing from the central city to the periphery. Firman (1998) reported that the central city attracted disproportionate investment in service industries, trade and hotel, and restaurant construction. The peripheries attracted most of the industrial construction; these include textiles, plastics, apparel, footwear, electronics, chemicals, metal products and foods (Cybriwsky and Ford, 2001). Based on Firman (1999) and Silver (2007), agricultural and forests areas in the peripheries of Jabodetabek Megacity, were massively converted into industrial estates, large-scale subdivisions and new towns. Winarso and Firman (2002) reported that within 10 years, 20 new towns emerged in the megacity of Jakarta and converted 16.6 thousand hectares of rural land.

As the center of national socioeconomic activities, Jabodetabek Megacity requires developed urban services and transportation systems. Transportation infrastructure development has also promoted urban sprawl in Jabodetabek Megacity, with several highways and toll roads constructed (Susantono, 1998). The development of three highways stretching from Jakarta to the peripheries - the Jagorawi toll road, the Jakarta-Cikampek toll road, and the Jakarta-Merak toll road contribute to the suburbanization process in the outskirt of Jakarta (Henderson and Kuncoro, 1996) (Figure 5-8). Hudalah et al. (2013) mentioned that the development of these highways triggered the emerging of 50 to 1,800 hectares of private industrial parks in the peripheries of Jabodetabek Megacity, with the average size is about 500 hectares. The major industrial centers are located in Cikupa-Balaraja of Tangerang Regency and Cikarang of Bekasi Regency. Based on Hudalah and Firman (2012), Cikarang industrial center which located in Bekasi Regency with 6000 hectares total industrial land area is the largest planned industrial center in Southeast Asia.

Recent developments in the region such as the establishment of the new toll road that directly connects Jakarta and Bandung (Cipularang toll road) in 2005 and the process of industrial agglomeration along the corridor between Jakarta and Bandung have been driving forces of rapid urban expansion in this area (Dorodjatoen, 2009). Manaf (1998) identified the implications of commuting activities between Jakarta and Bandung in relation to the role of the toll road that connects both metropolitan areas. The toll roads located in those areas have become important for networking and mobility. Rapid urban development in this area has also encouraged the emergence of new town projects or residential areas.

The areas with high positive values of D_RIVER, the proxy of natural elements, are located in the southeastern part of Jabodetabek Megacity, especially in Bogor Regency. This finding implies that urban expansion tends to occur far from the river in those areas, because people normally avoid living in flood-prone areas (Figure 5-4(F)). Floods become an important issue in Jabodetabek Megacity. Urban expansion which is physically generated by the expansion of new housing that has been developed by the property sector for upper-middle income groups tend to look for areas that are located far away from the river because they are so traumatized by the floods. The Jakarta Disaster Mitigation Agency (BPBD) reported that the number of subdistricts and victims affected by flooding had continued to increase, with incessant rain in Jabodetabek Megacity and in headwaters of the rivers, disrupting power and medical facilities, and undermining transportation and business activities.

Figure 5 - 17. Transportation infrastructure development in Jabodetabek Megacity: highways and toll roads

Figure 5 - 18. Slum's dwellers activities in the Ciliwung River

The Ciliwung River is one of the largest river systems in Indonesia, but now recognized as one of the most exploited, congested and polluted rivers in the world. Its flows along a 97 km narrow corridor from the Bogor through the Jakarta (including Depok), and terminating in the sea in Jakarta Bay. The

Ciliwung is a major water source for Bogor and Jakarta, and its waters are also utilised for agricultural irrigation and for daily needs (especially for household uses) in many small communities including slum-dwellers living in the riverside of Ciliwung (Figure 5-9). The Ciliwung river facing many problems such as flooding, declining of water quality and lost of biodiversity since it has a recent history of extensive waste dumping and silt build-up; toxic inputs from household and industrial chemicals; congested riverside dwellings; and man-made obstructions such as bridges and dams.

In 2012, the local government disbursed 190 million USD in order to sponsor river management program called PROKASIH or '*Program Kali Bersih*', especially to expand the Ciliwung river as one solution to avoid flooding. This project activities includes building more dykes, dredging canals, and overhauling four reservoirs over the next five years (The Jakarta Post, 2013). Through this project, the local government relocated 30,000 slum dwellers along the river's banks to affordable flats in various regions around Jakarta.

Based on Indonesian National Board for Disaster Management (BNPB), floods is the most frequent natural disaster happened in Indonesia during the periods 1815-2014 with the percentage of 20% to the total frequent of disasters. The areas in Jabodetabek Megacity that are not significant to urban expansion are located in the northwestern part of Bogor Regency, the southern part of Tangerang Regency and Tangerang Selatan Municipality, as well as the western part of Depok Municipality. Those locations are characterized by expanding slum areas, temporary housing, and irregular residential zones near the river. Based on BPS data (2008), 1,500 households live in 1,106 temporary houses on the riverbanks since land prices are much cheaper. However, in some areas of Jabodetabek Megacity, the local government has proposed developing 200 low-cost apartment buildings to accommodate slum inhabitants before slums develop further.

5.4 Conclusion

The spatial dimensions of the urban expansion in Jabodetabek Megacity, as in other megacities around the world, have specific characteristics. Several types of driving forces are affecting urban expansion in Jabodetabek Megacity, namely global/external, demographic, infrastructural, and natural elements. Through this study, it was found that the driving forces that affect urban expansion in the Jabodetabek Megacity vary by location. Owing to the influence of global and external economies on the Jabodetabek Megacity by employing the GWR model, it was found that local demographic, infrastructural, and natural elements driving forces spatially affect urban expansion there. However, urbanization in Jakarta city, as the core of the megacity, is least affected by local driving forces since it has become characterized as a global city. Jakarta city tends to be more connected to the world market as well as the other large cities in Indonesia (global/externally driven). Outside the core of the megacity, urban expansion in most areas of the Jabodetabek Megacity is significantly affected by local driving forces and natural elements. Demographic driving forces seem to be the most dominant influence on urban expansion, however. GWR's ability to show the local spatial dependency of each location can better describe the characteristics of the spatial relationships among the variables in order to explain urban expansion in Jabodetabek Megacity. The results derived from the GWR model show significant spatial information that would be useful for making recommendations to land-use planners and policymakers with regard to controlling urbanization as well as minimizing the negative impact of rapid urban expansion in Jabodetabek Megacity. The presented results imply the need for specific local policies. All local authorities in Jabodetabek Megacity have to use specific policies to control the widescale urban expansion since every location has a different local spatial dependency based on its individual characteristics.

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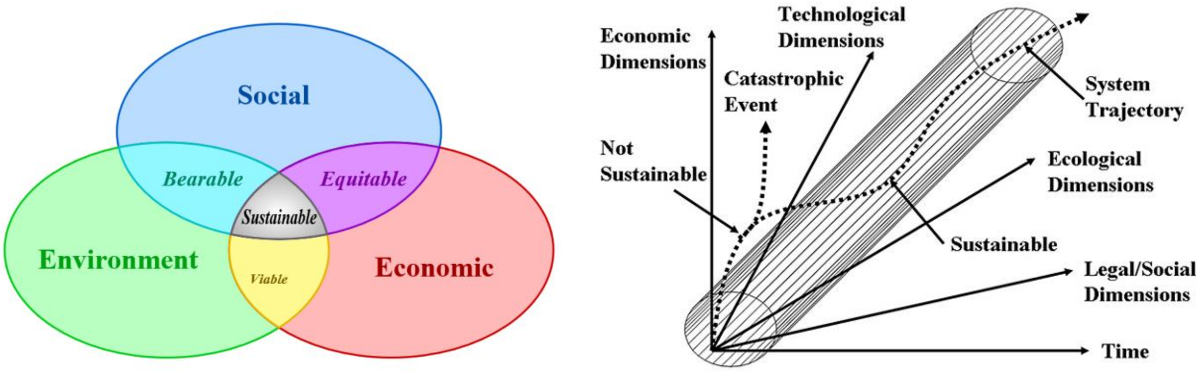
CHAPTER 6. DEVELOPING A LOCAL SUSTAINABILITY INDEX CONSIDERING LOCAL SPATIAL INTERDEPENDENCY

6.1 Introduction

6.1.1 The Concept of Sustainability and Sustainable Development

Sustainability is a global issue that requires the consolidation of the best efforts of humankind to address the goals that it is imposing on our planet and society. Sustainability has been defined as the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely (WCED, 1987). Sustainability requires the well-being of society (i.e., the combination of community livability, environmental sustainability, and economic prosperity) to be maintained or improved over time. In order to manage sustainability, society has to formulate clear and measurable sustainability goals that should be continually revised and corrected. The level at which these goals are implemented might be measured using sustainable development indicators, that is, definable and measurable parameters that show values and trends of the development of the ecological, economic, and social stability of a particular region (Ciegis et al., 2009a).

Sustainable development has been the subject of considerable discussion since the publication of The Brundtland Commission Report (WCED, 1987), which has greatly contributed to promoting the importance of sustainable development. It has played a catalytic role in the promotion of the concept of sustainable development in both the developed and the developing world. There are many versions of the definitions of sustainable development. According to the definition by the World Commission on Environment and Development (WCED), development is sustainable if the present generation can satisfy its needs without compromising the ability of future generations to meet their own. There are three pillars that support the concept of sustainable development: (1) economy, (2) society, and (3) environment (ecology) (UN, 2002; Munasinghe, 1993; Ciegis et al., 2009b) where the three should be mutually supportive and involved in the development process (Figure 6-1).



(A) (B)

Figure 6 - 8. (A) .The concept of sustainable development; (B). The trajectory of a system, and the position of the system with respect to multidimensional sustainable boundaries, are both necessary to determine system sustainability. A system which is unsustainable in one dimension is not generally sustainable. Multiple indicators are measured for each dimension, and aggregated into an index which identifies the overall position and trajectory of the system (modified from Cabezas et al., 2003).

The practical implications of this definition are diverse, ranging from the consumption of resources with respect to their rate of renewal, the efficiency of resource use, and the equity of their use across societies and generations, with different emphases according to discipline and political ideology (Ulgiati and Brown, 1998; Parris and Kates, 2003). However, recent sustainability research has become more quantitative and includes more dimensions of sustainability simultaneously (Figure 6-1(B)), which will allow for more targeted policies to be implemented and their successes tracked more closely. In urban and regional development, the sustainability concept can be included these aspects: (1) Environmental performance of developments; (2) Waste and pollution; (3) Biodiversity and the environment; (4) Protection and management of water resources; (5) Renewable energies and climate change; and (6) Modelling and environmental data (Figure 6-2).

Figure 6 - 9. Sustainability concept in urban and regional development (Source: imgsoup.com)

The term "sustainable development" has become a popular item in policy agendas worldwide. Most governments have committed themselves to sustainable development by integrating economic welfare, environmental quality, and social coherence. As a consequence, there is a strong political desire for the comprehensive assessment of changes in economic, environmental, and social conditions. An issue that cannot be clearly measured is difficult to improve. Monitoring progress toward sustainable development first requires the identification of operational indicators that provide manageable units of information on economic, environmental, and social conditions (Bohringer and Jochem, 2007). A sustainability assessment is a transparent, comprehensive, integrated, and provident decision-making approach (Gibson, 2005). Sustainability indicators are developed as simplified tools of communication that help in political decision-making concerning sustainability. In order to achieve this goal, it is necessary to set a limited number of easily understandable indicators (Spangenberg, 2002). According to the World Bank (1997), the fundamental factor of a good indicator is the estimation of relationships between measurement of environmental conditions and practical political possibilities. However, these indicators should not necessarily include all aspects of sustainability, because as Hueting and Reijinders (2004) argue, they often become very subjective and meaningless in that case.

The Earth sciences (central oval) have progressed towards Earth system science, which includes interactions of the physical components of Earth with the ecosystem. They must be broadened further to encompass the human domain to inform decisions on sustainable development (Schlosser and Pfirman, 2012).

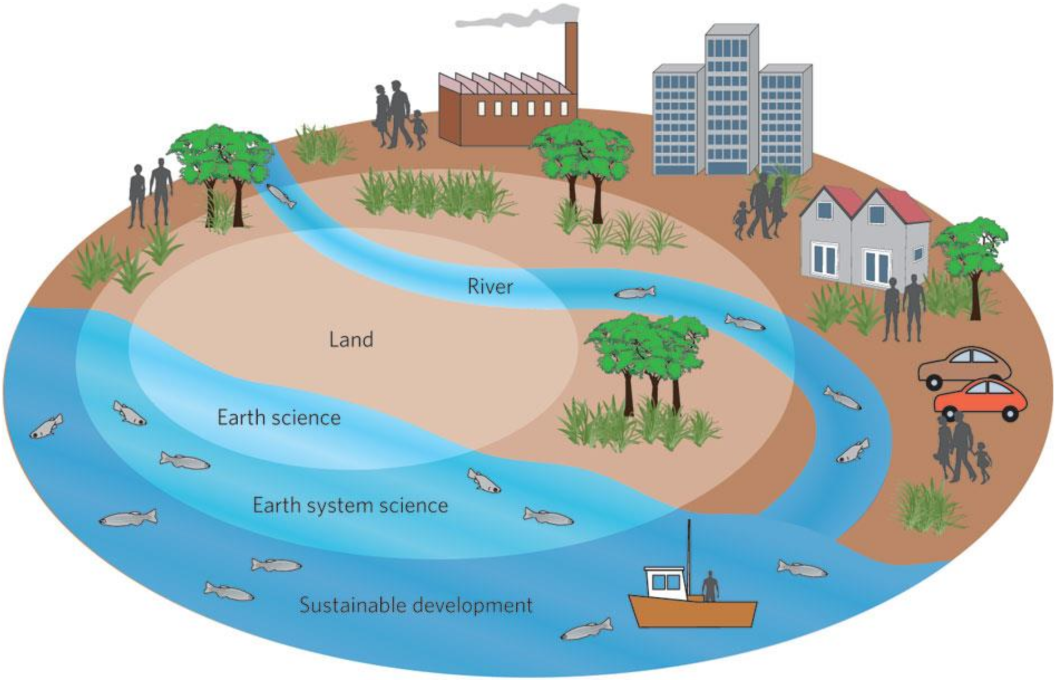


Figure 6 - 10. Towards sustainable development (Source: Schlosser and Pfirman, 2012)

6.1.2 The Concept of Indicator and Sustainability Indicators

As defined in an OECD report (2002), an "indicator" is a variable that describes one characteristic of the state of a system, usually through observed or estimated data. Some indicators may provide information about the position of the system relative to particular sustainability boundaries or goals. Harger and Meyer (1996) suggest that indicators should contain the following characteristics: (1) be simple; (2) have (wide) scope; (3) be quantifiable; (4) allow trends to be determined; (5) be tools that are sensitive to change; and (6) allow timely identification of trends. Indicators are a useful tool used to simplify, determine in quantitative terms, and summarize enormous flows of information to develop a useful feedback mechanism that highlights spheres where we act properly and where major attention is needed. Indicators are used in order to reduce the amount of complex interrelationships by converting them into simple formulations, which makes assessments easier. When many indicators are used, they are either presented in a framework of categories or aggregated into an index. An "index" is a quantitative aggregation of many indicators and can provide a simplified, coherent, and multidimensional view of a system. Indices usually provide a static overview of a system, but when calculated periodically, they can indicate whether the system is becoming more or less sustainable and can highlight the factors most responsible for driving the system. Sets of sustainability indicators and aggregation of these indicators into indices are increasingly used to make policy decisions (Oras, 2005; Hezri and Dovers, 2006). Sustainability indicators and composite index are increasingly recognised as a useful tool for policy making and public communication in conveying information on countries and corporate performance in fields such as environment, economy, society, or technological improvement (Singh et al., 2009). By visualizing phenomena and highlighting trends, sustainability indicators simplify, quantify, analyse and communicate otherwise complex and complicated information (Warhurst, 2002).

Furthermore, indicators are more helpful if they give information on the state of the system with respect to policy targets or biophysical limits. Setting sustainability policy targets can be a difficult process, although targets can be set through political choices and theoretically- and model-derived limits (Anand and Sen, 1994; Campbell, 1998; van der Perk and de Groot, 2000; Boumans et al., 2002; De Groot et al., 2003; Fath et al., 2004; Cai et al., 2006). There have been numerous attempts to move beyond the non-integrated approach and to combine different nature–society dimensions in one indicator or index, such as the Living Planet Index, Index of Sustainable Economic Welfare and General Progress Indicator, Genuine Savings, Ecological Footprint, Environmental Sustainability Index, Environmental Vulnerability Index, Environmental Policy Index, Wellbeing Index, City Development Index, and the Human Development Index.

The global biodiversity indicator Living Planet Index (LPI) was developed by WWF (1998). It measures trends in over 2000 populations of more than 1100 species of vertebrates in terrestric, freshwater, and seawater ecosystems. The LPI provides a sub-index for the three spheres: for every species within a sphere, the ratio between its populations in pairs of consecutive years is calculated. The geometric mean of these quotients of different species multiplied with the index value of the former year then delivers the biodiversity index for the respective sphere (1970 serves as a base-year with the index value for 1970 scaled to unity). The geometric mean of these indices is the LPI.

The index of sustainable and economic welfare (ISEW) is one of the most advanced attempts to create an indicator of economic welfare, developed by the Centre for Environmental Strategy (CES) and the New Economics Foundation (NEF). The main objective is to measure the portion of economic activity that delivers welfare to people. It aims further to replace GDP as an indicator of progress, because GDP is likely to lead in the wrong direction given that it does not distinguish between activities that improve or directly damage the quality of life (CES, 2000). The set of 20 sub-indicators includes seven economic activities that deliver welfare to people, such as adjusted consumer expenditure, services from domestic labour, from consumer durables, from streets and highways, public expenditure on health and education, net capital growth and net change in international position. On the other hand, the 13 indicators that ‘‘reduce’’ the welfare are: consumer durables (difference between expenditure and value of services), defensive private expenditures on health and education, costs of commuting, of personal pollution control, of automobile accidents, of water pollution, of air pollution, of noise pollution, loss of natural habitats, loss of farmlands, depletion of non-renewable resources, costs of climate change and costs of ozone depletion (Guenno and Tizzi, 1998).

Pearce and Atkinson (1993) put forward an index which is based on the Hicksian income concept. The genuine savings (GS) are thus an indicator of weak sustainable development. The societal capital stock consists of produced capital, human capital (knowledge, skills, etc.) as well as natural capital (resources, etc.). As in the ISEW all values are monetarized, such that aggregation is again achieved by simply adding up. The ecological footprint (EF) measures the demands humans place on nature. The concept of the ecological footprint was developed by Rees and Wackernagel (1996). It provides a quantitative assessment of the biologically productive area (the amount of nature) required to produce the necessary resources (food, energy, and materials) and to absorb the wastes of a given population (Rees and Wackernagel, 1996). If the human load exceeds the productive capacity of the biosphere then consumption patterns are clearly not sustainable given current circumstances. The human load can vary depending on population, technology, and eco-efficiency. The ecological footprint therefore, ultimately measures the sustainability of human consumption patterns. The ratio of required resources to available resources is interpreted as a measure of ecological sustainability: ratios exceeding one are seen as unsustainable, i.e. contemporary living standards would violate the principles of sustainable development.

Calculation of the EF is based on data from national consumption statistics. Thus, the EF primarily relies on normalisation (as any consumption is converted in land use). Weighting is rather implicit in the conversion parameter and aggregation is done by adding up all land and water requirements. There are several approaches similar to the EF, e.g. the MIPS (Material-Input-Per-Service) concept (Schmidt-Bleek, 1994; Gassner and Narodoslawsky, 2004) or the EcoindexTM (Chambers and Lewis, 2001).

The environmental sustainability index (ESI) is a composite index targeting environmental, socioeconomic, and institutional indicators as a means to assess sustainability. The ESI incorporates 20 indicators, each of which combines two to eight variables, for a total of 68 underlying datasets. The core components of the ESI include: environmental systems, reducing stresses, reducing human vulnerability, social and institutional capacity, and global stewardship (World Economic Forum et al., 2002). The environmental vulnerability index (EVI) compromises 32 indicators of hazards, 8 indicators of resistance, and 10 indicators that measure damage (SOPAC, 2005). The EVI scale for normalisation ranges between a value of 1 (indicating high resilience/low vulnerability) and 7 (indicating low resilience/high vulnerability). The 50 indicators are given equal weights and then aggregated by an arithmetic mean (EVI, 2005).

The wellbeing index (WI) is a composite index evaluating human and ecosystem wellbeing. This metric is based upon the philosophy that assessing the combination of these two elements offers insight into how close a country is to becoming sustainable. The WI is an equally weighted average of the human wellbeing index (HWI) and ecosystem wellbeing index (EWI). Both consist of five dimensions, the former comprising health and population, household and national wealth, knowledge and culture, community, and equity, while the latter consists of land, water, air, species and genes, and resource use (Prescott-Allen, 2001). The City Development Index (CDI) suggested by the United Nations Centre forHuman Settlements (HABITAT) consists of five sub-indices: (i) an infrastructure index, which builds on four (equally weighted) indicators as percentages of house-holds which are connected to clean water, canalization, electricity and a phone network (without mobiles), (ii) a twofold (equally weighted) waste index, which is composed of the percentage of untreated sewage in total wastewater and the percentage of disposal of solid waste in total solid wastes. The United Nations Human Development Index (HDI) is one of the most widely recognized measures of development, measuring three basic dimensions of human development: a long and healthy life, knowledge, and a decent standard of living (UNDP, 2004). The three base components of the HDI are: (a) life expectancy at birth, (b) adult literacy rate (with two-thirds weight) and the combined primary, secondary and tertiary gross enrolment ratio (with one-third weight) and (c) GDP per capita (PPP US$). The indices are formulated based on minimum and maximumvalues (goal posts) for each indicator and performance in each dimension is expressed as a value between 0 and 1.

These sustainable development indicators or indices can be used to (1) anticipate and assess conditions and trends; (2) provide early warning information to prevent economic, social, and environmental damage; (3) formulate strategies and communicate ideas; (4) support decision-making (Lundin, 2003; Berke and Manta, 2006).

6.1.3 Research Objectives

These explanations imply that sustainable development indicators/indices have been discussed extensively at the global, national, and regional level, but they are still very limited at the local level. However, sustainable development indicators/indices at the local level are also critical. It was supposed that there is spatial interdependency between locations at the local level. Thus, the basic idea for sustainability performance in a local situation is affected by the sustainability condition in its surrounding areas. The objectives of this study are as follows: (1) to develop the Local Sustainability Index (LSI); (2) to capture the spatial distribution of the LSI to identify the sustainability conditions in a region; and (3) to analyze the spatial association of the LSI between locations. In this research, Jabodetabek Megacity was chosen as a case study.

Cities and megacities with a population of more than 10 million are important worldwide because human social and economic activities are concentrated there. In the developing world, these cities and megacities will absorb 95% of urban growth in the next two decades and will house almost 4 billion people by 2030 (UN-Habitat, 2006). Cities and megacities play a significant role in social and economic activities, but they perform poorly in terms of environmental conservation because of externalities. The Brundtland Report (WCED, 1987) suggests that there is growing awareness that many environmental problems have a local origin while global environmental decay often manifests itself at a local level (Finco and Nijkamp, 2001). It is significant to evaluate sustainability in cities or megacities to appropriately manage human activities there. Scipioni et al. (2009) mentioned that studies on the local and urban dimensions of sustainability are becoming prevalent in international literature and that the definition of specific local urban context indicators is of great interest.

6.1.4 Study Area

Greater Jakarta or Jabodetabek Megacity was chosen as the study area of this research. Jabodetabek Megacity (i.e., Jakarta, Bogor, Depok, Tangerang, and Bekasi) consists of 13 regencies/municipalities (Figure 6-4) located in 3 provinces (DKI Jakarta, West Java, and Banten). The Jabodetabek Megacity consists of 178 subdistricts (*kecamatan*) and 1,495 villages (*desa*). The region covers 0.35% of the country's area and is inhabited by about 11.3% of the national population. The total population of Jabodetabek Megacity was 28 million in 2010 with an annual growth rate of 2.62% over the period 2000–2010.

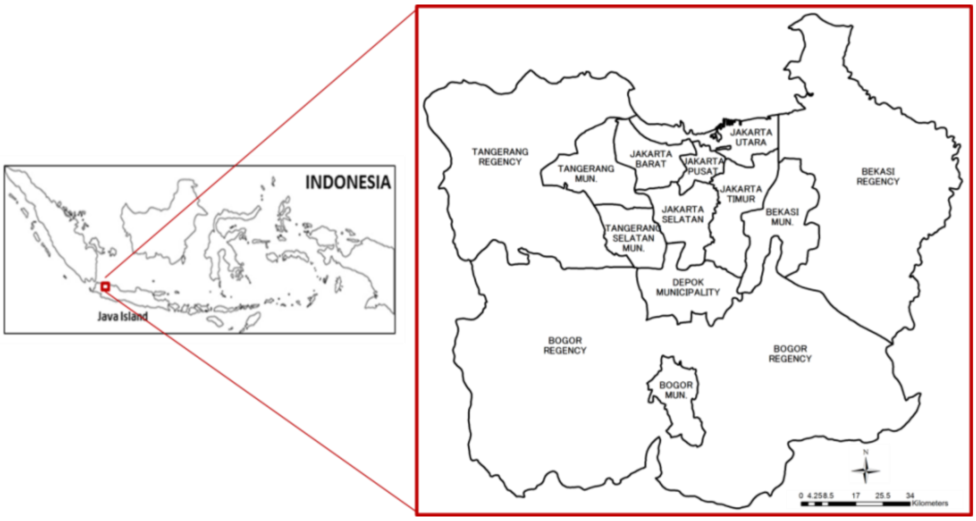


Figure 6 - 11. Location map of Jabodetabek Megacity

Jabodetabek Megacity, the world's second largest megacity after Tokyo Metropolitan Area (RIHN, 2014), has experienced serious environmental deterioration in the last two decades. Most of the recent global environmental and social problems such as loss of primary agricultural land, pollution, crises in water availability, slums (Rustiadi et al., 2014), poverty, and anthropogenic disasters have occurred in

Jabodetabek Megacity as a result of rapid urban development and increasing population growth (Rustiadi et al., 2009; 2012; 2014). McGee (1991) indicated that rapid urban growth creates a chaotic mixture of urban and rural land use that results in serious environmental problems and a lack of adequate urban infrastructure. These problems are becoming common in other parts of Asia and worldwide and spreading fast because of rapid global urbanization. Living wisely in a megacity could thus become one of the most important dimensions of sustainability in the global environment, because megacity residents are the first to be impacted by both global and local environmental problems even though they receive significant social and economic benefits from urban life. Thus, the urgency of environmental considerations is indispensable to development mainly because of rapid population growth and the urbanization rate. Thus, effort is required to maintain the balance and sustainability of resources. Recognizing the importance of economic, social, and environment considerations as important components in the concept of sustainable development, we conducted this study to evaluate and manage Jabodetabek Megacity in a sustainable way to ensure its resilience and to encourage the future prosperity of humanity and its coexistence with the global environment.

6.2 Methodology

6.2.1 Factor Analysis (FA) as the method for measuring Local Sustainability Index (LSI)

In this research, the LSI was divided into three dimensions: economy, society, and environment. The variables/indicators used to formulate the LSI were obtained from a literature review and data availability. We developed these variables using Factor Analysis (FA) for variable/indicator selection. FA could eliminate the redundancy of a set of correlated variables and transform these variables into a smaller and orthogonal set of variables, called "factors." Factors with eigenvalues (*E*) larger than 1 were selected as common factors to create the LSI. We identified key variables in each factor that have dominant/significant contributions to the LSI formation. In this study, we chose 46 variables (V_1, V_2, V_3, ..., V_{46}) to be analyzed using FA. The variables forming the LSI are listed in Table 6-1. V_1 to V_{16} are representative variables for the economic dimension, V_{17} to V_{32} are used for social dimension, and V_{33} to V_{46} represent the environmental dimension. All variable data were collected from the PODES datasets, which were village (*desa*)-level statistics provided by the Central Bureau of Statistics in 2011.

The FA model we used in this study can be written as follows:

$$LSI_{ki} = \sum_{m=1}^{n_k} E_{km}.S_{kmi} \qquad [6-1]$$

Where: LSI_{ki} = the LSI for the *k*-th dimension in the *i*-th village (desa); *k* = dimension (*k* = 1: economy; *k* = 2: society; *k* = 3: environment); E_{km} = eigenvalue for the *k*-th dimension for the *m*-th factor; S_{kmi} = factor score for the *k*-th dimension and *m*-th factor in the *i*-th village (desa); *i* = 1, 2, 3,..., 1495; n_k= the number of factors in the *k*-th dimension. To standardize the LSI value ($LSI_{ki}\,(std)$) on a scale of 0–100, we used the following equation:

$$LSI_{ki}\,(std) = \left(LSI_{ki} - LSI_{ki}\,(\min)\right) * \left(\frac{100}{LSI_{ki}\,(\max) - LSI_{ki}\,(\min)}\right) \qquad [6-2]$$

In this study, FA was conducted using principal component analysis and the varimax normalized rotation method in Statistica 8.0. To identify the spatial interdependence of the LSI between locations in Jabodetabek Megacity, we employed the Local Indicator of Spatial Association (LISA) statistic using GeoDa software.

6.2.2 Data and variables

The data and variables used in this research are listed in Tables 6-1.

Table 6 - 5. List of variables forming the LSI.

Dimension	Notation	Variables
ECONOMY (k = 1)	V_1	Percentage of households that work in the agricultural sector (%)
	V_2	Percentage of households that use electricity (%)
	V_3	Percentage of households that subscribe to cable phone (%)
	V_4	Percentage of households that live along the river (riparian) (%)
	V_5	Percentage of households that live in the slum area (%)
	V_6	Distance to the market (km)
	V_7	Distance to the bank (km)
	V_8	Distance to the central business district (CBD) (km)
	V_9	Distance to the nearest city (km)
	V_{10}	Ratio of industry per 1,000 population
	V_{11}	Ratio of markets, minimarkets, shops, and grocery shops per 1,000 population
	V_{12}	Ratio of food stalls and restaurants per 1,000 population
	V_{13}	Ratio of hotels, hostels, motels, and inns per 1,000 population
	V_{14}	Ratio of co-ops and banks per 1,000 population
	V_{15}	Percentage of built-up/urban land per total area (%)
	V_{16}	Local infrastructure index (scalogram index)
SOCIAL (k = 2)	V_{17}	Ratio of formal education institutions per 1,000 population
	V_{18}	Ratio of informal education institutions per 1,000 population
	V_{19}	Average distance to the education facilities (kindergarten to university) (km)
	V_{20}	Number of educational development facility types (school buildings and education facilities)
	V_{21}	Number of health facilities (hospitals, clinics, health centers, doctors, pharmacies)
	V_{22}	Average distance to the health facilities (hospitals, clinics, health centers, pharmacies)
	V_{23}	Ratio of medical personnel per 1,000 population
	V_{24}	Percentage of people suffering from diarrhea and vomiting (%)
	V_{25}	Percentage of people suffering from respiratory tract infection (%)
	V_{26}	Percentage of people suffering from tuberculosis (%)
	V_{27}	Percentage of people suffering from malnutrition (%)
	V_{28}	Ratio of toddler death per 1,000 population
	V_{29}	Ratio of maternal mortality per 1,000 population
	V_{30}	Number of types of residential facilities development (sanitation, clean water)
	V_{31}	Number of non-profit organization/institutions
	V_{32}	Number of criminals
ENVIRONMENT (k = 3)	V_{33}	Percentage of water body per total area (%)
	V_{34}	Percentage of forest per total area (%)
	V_{35}	Percentage of rice field per total area (%)
	V_{36}	Percentage of other greenery area per total area (%)
	V_{37}	Slope (%)
	V_{38}	Are there any irrigation canals? (1 = yes; 2 = no)
	V_{39}	Are there any reservoirs or small lakes? (1 = yes; 2 = no)
	V_{40}	Is there any water pollution? (1 = yes; 2 = no)
	V_{41}	Is there any soil pollution? (1 = yes; 2 = no)
	V_{42}	Is there any air pollution? (1 = yes; 2 = no)
	V_{43}	Have there been landslide disasters? (1 = yes; 2 = no)
	V_{44}	Have there been flood disasters? (1 = yes; 2 = no)
	V_{45}	Have there been windstorm disasters? (1 = yes; 2 = no)
	V_{46}	Have there been drought disasters? (1 = yes; 2 = no)

6.3 Results and Discussion

6.3.1 Factor loadings of economy, social, and environmental FA

We employed FA to select key performance indicators/variables forming the LSI for each dimension: economy (LSI_1), society (LSI_2), and environment (LSI_3). Table 6-2 shows 5 factors selected from 16 variables using FA that represent the LSI for the economic dimension (LSI_1). Based on factor loading values, factor 1 is represented by the percentage of households that work in the agricultural sector (V_1), percentage of households that subscribe to cable phone (V_3), and the percentage of built-up or urban land per total area (V_{15}). These indicators show the household's economic welfare. This factor is the most important/principal component that forms the LSI_1. Factor 2 is represented by the ratio of economic facilities per 1,000 population (food stalls and restaurants - V_{12}) and (co-ops and bank - V_{14}). Factor 3 is represented by the percentage of households that live along the river/riparian (V_4) and slum area (V_5). Factors 4 and 5 are represented by accessibility to the nearest city (V_9) and ratio of industry per 1,000 population (V_{10}), respectively.

Table 6 - 6. Factor loading of economic FA.

Var	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
V_1	**-0.747105**	0.006163	0.043663	-0.022716	-0.041028
V_2	0.236270	-0.055571	-0.198639	0.284321	0.467022
V_3	**0.736566**	0.036399	0.067126	0.206964	0.118745
V_4	-0.073870	-0.050240	**0.730785**	-0.105217	-0.079773
V_5	0.073016	0.020704	**0.740657**	0.107749	0.036209
V_6	-0.643296	-0.020211	0.076263	0.355313	0.048754
V_7	-0.627715	-0.032932	0.060904	0.397667	0.081137
V_8	-0.579092	0.011645	0.120268	0.135488	-0.053517
V_9	0.018501	0.013988	-0.004718	**0.779758**	-0.118860
V_{10}	0.077543	0.040465	-0.086875	0.150142	**-0.813304**
V_{11}	-0.015949	0.623959	-0.045609	0.002802	-0.012451
V_{12}	0.015787	**0.714187**	-0.002491	0.011869	-0.014362
V_{13}	0.007571	0.237685	-0.036767	-0.058966	0.342749
V_{14}	0.020722	**0.773690**	0.040579	-0.001750	0.122109
V_{15}	**0.753904**	0.030704	0.043257	0.206631	0.064308
V_{16}	0.610309	-0.034857	0.119077	0.087044	-0.074765
Expl. Var	3.258705	1.567502	1.181183	1.134080	1.071457
Prp. Totl	0.203669	0.097969	0.073824	0.070880	0.066966
Eigenvalue	3.275678	1.586854	1.202969	1.119022	1.028404
% Total	20.47298	9.91784	7.51855	6.99389	6.42753
Cumulative	20.47298	30.39082	37.90937	44.90326	51.33079

Table 6-3 shows 6 factors chosen from 16 variables using FA to represent the LSI for the social dimension (LSI_2). Factor 1 is the most important/principle component and is represented by the ratio of formal (V_{17}) and informal education facilities per 1,000 population (V_{18}) as well as by the ratio of health facilities (V_{21}). Factor 2 is represented by the percentage of people suffering from diarrhea and vomiting (V_{24}) and from respiratory tract infections (V_{25}), reflecting local community health. Educational development (V_{20}) and residential facilities development (V_{30}) are the representative indicators of Factor 3. Factors 4, 5, and 6 are represented by the ratio of toddler deaths per 1,000 population (V_{28}), the average distance to education facilities (V_{19}), and the ratio of medical personnel per 1,000 population (V_{23}), respectively. In Table 6-4, the percentage of rice fields per total area (V_{35}) and slope (V_{37}) are important indicators of Factors 1 and 2 representing the LSI for the environmental dimension (LSI_3) by showing physical conditions. In Factor 3, there is soil pollution (V_{41}) and air pollution (V_{42}), which appear as key environmental indicators. Factor 4 represents disaster resilience through flood disaster (V_{44}) and drought disaster (V_{46}) indicators. Factors 5 and 6 are represented by the existence of a reservoir or small lake (V_{39}) and windstorm disaster (V_{45}).

Table 6 - 7. Factor loading of social FA.

Var	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
V_{17}	**0.819625**	0.091724	-0.052805	-0.111258	0.215098	-0.087039
V_{18}	**0.719182**	-0.038157	0.026193	0.023913	-0.011427	0.038053
V_{19}	-0.127034	-0.032030	0.032207	0.064350	**-0.714807**	0.130482
V_{20}	0.073466	0.110626	**0.816219**	0.046911	-0.154314	0.024596
V_{21}	**0.810905**	0.054708	-0.040339	-0.076860	0.217906	0.008678
V_{22}	-0.292224	-0.005691	-0.029459	0.258488	-0.645351	0.119887
V_{23}	0.029960	-0.110230	0.015408	0.051194	-0.148800	**0.775261**
V_{24}	0.050284	**0.824527**	0.012400	-0.014370	-0.058778	0.113033
V_{25}	0.030074	**0.780156**	-0.020649	0.041163	0.039299	-0.054515
V_{26}	-0.117565	0.363966	0.003626	-0.062924	0.095007	0.621836
V_{27}	-0.354469	0.102434	0.113159	0.437929	0.234995	0.068353
V_{28}	-0.096064	0.001707	-0.024645	**0.745982**	-0.033501	0.021071
V_{29}	0.150288	-0.021105	0.017550	0.586981	-0.165069	-0.025688
V_{30}	-0.070245	-0.123041	**0.790927**	-0.011739	0.187109	0.002103
V_{31}	0.433673	0.018946	0.094410	0.133032	0.270416	-0.005012
V_{32}	0.133078	-0.066494	0.038701	0.083526	0.483908	0.316273
Expl. Var	2.339837	1.490130	1.323747	1.218128	1.507181	1.150395
Prp. Totl	0.146240	0.093133	0.082734	0.076133	0.094199	0.071900
Eigenvalue	2.803221	1.568534	1.379068	1.203211	1.042526	1.032856
% Total	17.52013	9.80334	8.61917	7.52007	6.51579	6.45535
Cumulative	17.52013	27.32347	35.94264	43.46271	49.9785	56.43385

Table 6 - 8. Factor loading of environmental FA

Var	Factor1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
V_{33}	-0.189762	-0.058590	0.098509	-0.038257	0.525849	-0.104301
V_{34}	-0.096415	0.694168	0.119313	0.054233	-0.155068	-0.094619
V_{35}	**0.855928**	-0.079357	0.003468	-0.097151	-0.052375	0.016139
V_{36}	-0.558380	0.317886	-0.003579	0.038978	0.373093	0.175369
V_{37}	-0.108106	**-0.708294**	0.054740	0.026488	-0.029923	-0.090368
V_{38}	0.687103	0.266585	0.071380	-0.044695	0.091857	0.171700
V_{39}	0.108148	-0.042890	-0.016059	0.057419	**0.727772**	0.047521
V_{40}	0.102935	0.027480	0.633451	-0.280610	-0.066083	0.092732
V_{41}	0.085013	0.067883	**0.707819**	0.105979	0.102176	-0.145784
V_{42}	-0.112721	-0.043787	**0.715953**	0.025812	0.045225	0.177995
V_{43}	-0.016078	0.463235	-0.020963	-0.082063	0.017957	0.477739
V_{44}	0.020293	-0.113484	0.105235	**-0.736725**	-0.186582	0.022833
V_{45}	0.128320	-0.193862	0.126628	-0.144926	0.133876	**0.706188**
V_{46}	0.110528	0.118808	-0.042515	**-0.726453**	0.156964	-0.015575
Expl. Var	1.645509	1.495426	1.476720	1.249906	1.131242	1.321535
Prp. Totl	0.109701	0.099695	0.098448	0.083327	0.075416	0.088102
Eigenvalue	1.912591	1.742542	1.471223	1.101151	1.075096	1.017737
% Total	12.75061	11.61694	9.80815	7.34101	7.16731	6.78491
Cumulative	12.75061	24.36755	34.1757	41.51671	48.68402	55.46893

6.3.2 The spatial distribution and spatial association of LSI on three dimensions

The distribution values of the LSI_1, LSI_2, and LSI_3 are spatially shown in Figure 6-5. Higher LSI_1 (green and yellow color areas; Figure 6-5(A)) values are concentrated in the central part of Jabodetabek Megacity (located in all municipalities dominated by urban areas, including Jakarta city, Bekasi, Tangerang, Tangerang Selatan, Depok, and Bogor municipalities). This means that these regions have better economic conditions compared with the others based on the key economic indicators. On the other hand, they have a lower local environmental index (Figure 6-5(C)).

Thus, there is a trade-off between economic growth and environmental quality (Den and Verbruggen, 1994) . However, these two topics are often pitted against each other, framing prospective policy decisions as a choice of one over the other. Some people view actions taken in order to protect the environment as constraining economic productivity, while others see some modes of economic production as particularly destructive to the environment. Compared with the LSI_1 and LSI_3, the LSI_2 have the lowest value and are mostly distributed across the entire Jabodetabek Megacity (Figure 6-5(B)), whereas areas with better social conditions have only a limited spread in several urbanized areas. Then, Figure 6-6 shows the spatial association of the local economic, social, and environmental index based on the LISA statistics. In Figure 6-6, the spatial distribution of all dimensions of the LSI values are shown by considering the influence of the neighboring villages. The local economic sustainability index (LSI_1), which has the highest Global Moran's I (0.63), tends to configure spatial clusters, whereas the social indicators (LSI_2) are more randomly distributed (low Global Moran's I (0.23)). The HH spatial associations of the LSI_1 are clustered in the central part of the region (Jakarta city), whereas Jakarta city and the surrounding urban area have LL spatial associations for the LSI_3. Then, those locations have good economic performance but low environmental quality. Applying the LISA technique to show the LSI (Figure 6-6) can better simplify and capture the spatial phenomena by considering the spatial association than by using a conventional approach (Figure 6-5).

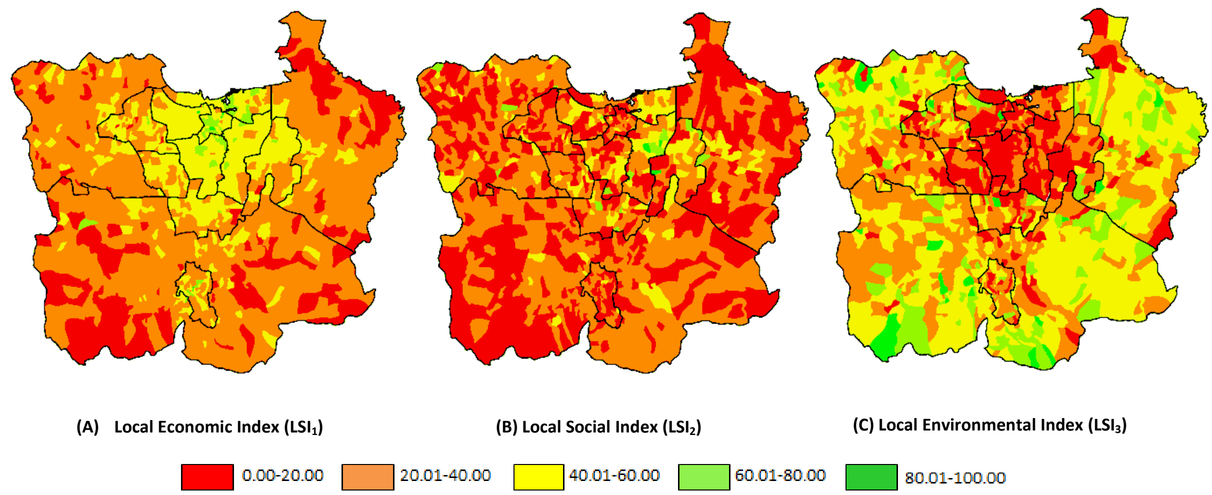


Figure 6 - 12. Spatial distributions of LSI_1, LSI_2, and LSI_3

Based on the LISA results shown in Figure 6-6, we produced a composite map that combined the HH and LL category for the LSI in all dimensions (LSI_1, LSI_2, and LSI_3) into four categories (Figure 6-7). The first (1^{st}) category shows the best local sustainability performance conditions (i.e., with an HH index value for all dimensions: economic, social, and environmental), and the last (4^{th}) category includes the worst local sustainability performance conditions (i.e., with an LL index value for all dimensions).

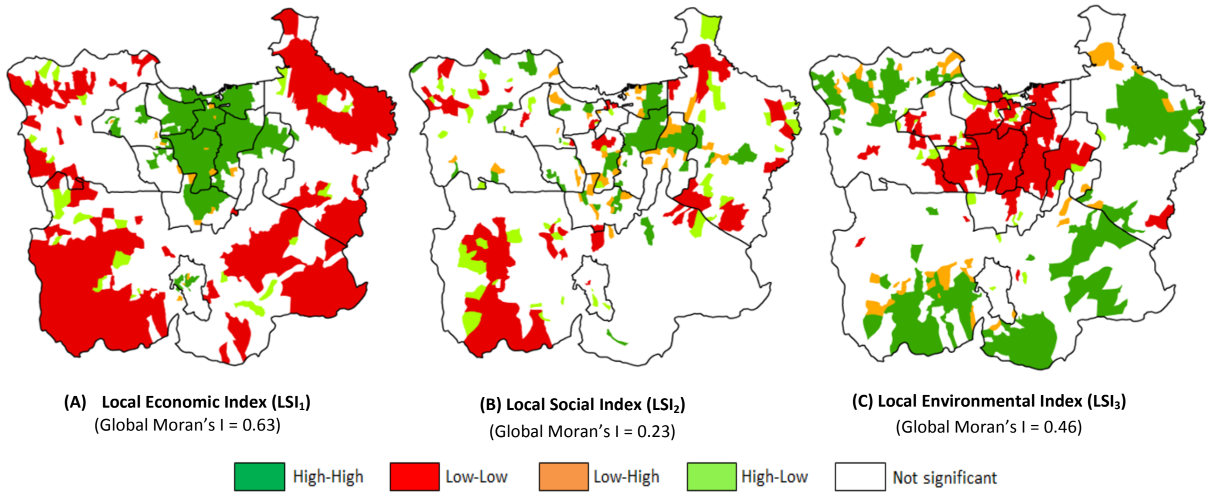


Figure 6 - 13. Spatial associations of LSI_1, LSI_2, and LSI_3 based on LISA statistics

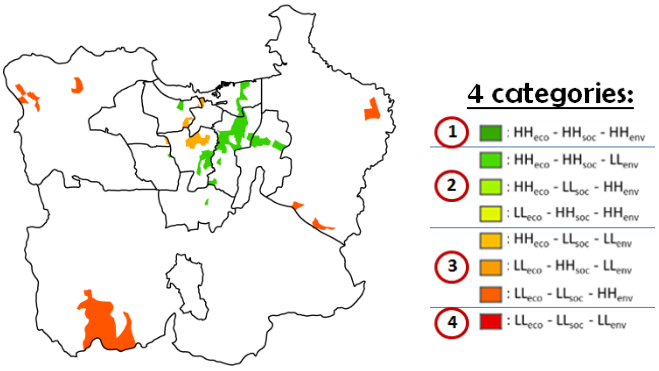


Figure 6 - 14. The combined HH and LL map categorized for LSI_1 (eco), LSI_2 (soc), and LSI_3 (env)

The areas included in first (1^{st}) (HH_{eco}-HH_{soc}-HH_{env}) and second (2^{nd}) categories (HH_{eco}-HH_{soc}-LL_{env}; HH_{eco}-LL_{soc}-HH_{env}; and LL_{eco}-HH_{soc}-HH_{env}) have better local sustainable development conditions, but the areas categorized in third (3^{rd}) category (HH_{eco}-LL_{soc}-LL_{env}; LL_{eco}-HH_{soc}-LL_{env}; and LL_{eco}-LL_{soc}-HH_{env}) and the last (4^{th}) category (LL_{eco}-LL_{soc}-LL_{env}) face severe conditions in terms of their local sustainability. The local government can use this approach to evaluate the local sustainability conditions in the region considering local spatial interdependence. Merging the LISA results into a single map as shown in Figure 4 will help decision makers take action with spatial dimensions perspectives. This study approach can show the actual condition of local sustainability performance without turning it into one composite index so that it does not eliminate the trade-off between dimensions. This is the benefit of using this approach.

6.4 Conclusion

The LSI was developed as an approach for reporting local economic, social, and environmental conditions to support the integration of the three dimensions of sustainability. Developing the LSI is a new approach to evaluating the degree of local sustainability in order to increase people's awareness about the importance of sustainable development at the local level. This index can be very powerful tools for sustainability policy if it is used appropriately. Without a clear understanding of how the indicators interact with each other and influence the index results, policy decisions could increase economic disparities and environmental damage and decrease the possibilities for long-term sustainability. Based on the spatial distribution map of LSI_1, LSI_2, and LSI_3, it was found that the areas with a higher local economic sustainability index are located in the center of Jabodetabek Megacity and are the core of economic activity, whereas the hinterland areas have a low LSI_1 value. In contrast, the local environmental sustainability index shows the opposite situation. This means that the approach developed in this study was able to show the actual conditions of local sustainability performance in all dimensions without making them into one composite index so it could include the trade-off between dimensions. Based on the LISA statistics analysis in this study, we found that local sustainability performance of the small-scale spatial units (villages/*desa*) is strongly influenced by the sustainability conditions in its surrounding areas. A high LSI value in one location is meaningless if its surrounding areas have a low index value (i.e., HL categories), because it might be affected by negative externalities from poor economic, social, or environmental quality conditions. On the other hand, a location with low values of LSI receives positive externalities only if its surrounding areas have high LSI value. LSI is a very effective method to indicate hotspot locations for sustainable development issues, and it can be used as an effective tool for spatial-based decision-making processes. The approach used in this study can be further developed by creating several policy scenarios and modeling simulations to improve the local sustainability performance toward the resilience of Jabodetabek Megacity.

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CHAPTER 7. CONCLUSION AND RECOMMENDATIONS

This study provides a broad overview of the patterns and trends of urbanization and rapid urban expansion in the developing Asian country of Indonesia. The study involves two different regional scales, namely, the island of Java (macro-scale) and Jabodetabek Megacity (micro-scale), both of which are the most urbanized areas in Indonesia. Java is the most populous island in the world and home to almost 60% of Indonesia's population. However, urbanization and rapid urban expansion in Java has been converting forest areas, green open spaces, and productive agricultural lands to non-agricultural land use and to other urban activities.

The rapid urban expansion is, of course, resulting in declining food production and is threatening the food security of Java. The rapid urbanization and urban development in Java is particularly influenced by the presence of large metropolitan cities, including Jabodetabek Megacity. There is pressure to develop the areas surrounding the larger metropolitan areas, and this suburbanization process is characterized by the spread of urban sprawl from the core to the periphery: increasingly moving from the city center towards the suburbs. Jabodetabek Megacity is one of the biggest megacities in Asia (and the world with an estimated population of 30 million as of 2014) is also experiencing rapid urbanization. Because of its function as a center of economic and government activities, and its strategic location, Jabodetabek Megacity exerts a very strong appeal that is driving the influx of both domestic and foreign investment, as well as the related rapid increase in the population. The rapid urban development of Jabodetabek Megacity, as well as in other Asian metropolitan areas, is characterized by rising socio-economic activity, including emergence of new towns, large industrial estates, residential parks, and business centers. Development of infrastructure and new highways or toll roads encourages a rapid pace of urbanization and urban development activities. This of course can have negative impacts on the sustainability of urban development in such regions.

In this study, various positive and negative impacts of urbanization and rapid urban development have been described. Among the many negative effects, most often major problems in big cities involve the emergence of traffic congestion, slum areas, and the increasing number of anthropogenic disasters (intensity and distribution). These include events such as floods and landslides due to environmental degradation.

By employing the GWR model, it was found that local demographic, social, and economic factors influence spatial effects of urbanization and rapid urban development on Java Island. The area most influenced, with the greatest potential for conversion to urban uses, is located in the western part of Java (including DKI Jakarta, Banten, and West Java Provinces). This is primarily because there are two metropolitan areas located there (Jabodetabek Megacity and Bandung Raya). Higher population and economic activities in Java, especially in both metropolitan areas, have significant impacts on demand for food and natural resources, as well as for excessive utilization of land for settlements, housing, and another urban uses. This results in land-use conversion of forest, agricultural areas, and other green areas to different uses.

The spatial dimensions of the urban expansion in Jabodetabek Megacity, as in other megacities around the world, have specific characteristics. Several types of driving force are affecting urban expansion in Jabodetabek Megacity, namely global/external, demographic, infrastructural, and natural elements. Through this study, it was found that the driving forces that affect urban expansion in Jabodetabek Megacity vary by location. Owing to the influence of global and external economies on

Jabodetabek Megacity, the GWR model revealed that driving forces related to local demographics, infrastructure, and natural elements spatially affect urban expansion there. However, urbanization in Jakarta, the core of the megacity, is least affected by local driving forces because it has become characterized as a global city. Jakarta tends to be more connected to the world market as well as to the other large cities in Indonesia (global/externally driven). Outside the core of the megacity, urban expansion in most areas of Jabodetabek Megacity is significantly affected by local driving forces and natural elements. Demographic driving forces seem to provide the dominant influence on urban expansion, however. The ability of the GWR model to show the local spatial dependency of each location can better describe the characteristics of the spatial relationships among the variables, and thus explain urban expansion in Jabodetabek Megacity.

Urbanization and rapid urban development in big cities like in Jabodetabek Megacity, as well as in other big cities in Java, often involve the emergence of many problems. The problems are not only high population density and conversion of huge amounts of land from agricultural to urban uses, but also traffic congestion; pollution of water, soil, and air; climate change; energy inadequacy; unplanned development; lack of basic services reinforcing poverty, unemployment, slums, and crime; and poor governance.

This study allowed identification of the fact that rapid growth of urban development also accelerates degradation of some environmental aspects in Jabodetabek Megacity. In addition, the local spatial associations of floods and landslides were detected using LISA statistics. It was found that Bekasi and Tangerang had high vulnerability to floods, with a high positive spatial association of flood occurrence and intensity, whereas Bogor was highly vulnerable to landslides owing to its topographic and climatic conditions. The LISA cluster map of floods and landslides could be used as a preliminary guideline of flood and landslide zoning. This would be beneficial for land-use or spatial planning to avoid or minimize inappropriate urban developments in flood- and landslide-prone areas. Those managing urban development must consider potential hazards and risks so that urban activities can go well. However, the most important measure would be the promotion of institutional change and an increase in the efforts of communities and NGOs to preserve the environment.

Many cities in Indonesia, including those on Java, appear to have problems with unclear and overlapping responsibilities amongst their institutions, leading to operational dysfunction. Even where city planning is centrally coordinated, city administrations often have little control over the implementation of their policies and plans. The influence of megacities reaches well outside their administrative boundaries to the peri-urban regions and beyond. It is important that larger regions such as megacities, be managed holistically to maximize the economic benefits of the city.

Sustainable urban expansion has become a key issue in relation to sustainable urban growth in rapidly growing megacities in developing countries. During this study, a Local Sustainability Index (LSI) was developed for Jabodetabek Megacity. The LSI was developed as an approach for reporting local economic, social, and environmental conditions to support the integration of the three dimensions of sustainability. Developing the LSI is a new approach to evaluating the degree of local sustainability, to increase public awareness about the importance of sustainable development at the local level. This index can be a very powerful tool for sustainability policy if it is used appropriately. Without a clear understanding of how the indicators interact with each other and influence the index results, policy decisions could increase economic disparities and environmental damage, and decrease the potential for long-term sustainability. Based on the spatial distribution map of LSI on each dimension, it was found that the areas with higher local economic sustainability index were located in the center of Jabodetabek Megacity, at the core of economic activity, whereas the periphery areas of Jabodetabek Megacity have low value. In contrast, the local environmental sustainability index shows the opposite situation. This means that the approach developed in this study was able to show the actual conditions of local sustainability performance in all dimensions without making them into one composite index so it could include the trade-offs between dimensions. Based on the LISA statistics analysis done in this study, it was found that local sustainability performance of small-scale spatial units (villages/*desa*) is strongly influenced by the sustainability conditions in their surrounding areas. A high LSI value in one location is meaningless if its surrounding areas have a low index value, because it might be affected by negative externalities from poor economic, social, or environmental quality conditions. On the other hand, a location with low values of LSI receives positive externalities only if its surrounding areas have high LSI value. LSI is a very effective method to indicate hotspots for sustainable development issues, and it can be used as an effective tool for spatial-based decision-making processes.

To manage both Java and Jabodetabek Megacity properly, some policy actions are needed. Jabodetabek Megacity has a core city (Jakarta) characterized as the global city. This means that Jakarta has a strong relationship with the global market. Therefore, one desirable policy action for Jabodetabek Megacity is improving its international connectivity. Large-scale investment in Jabodetabek Megacity is required for infrastructure to facilitate intra-urban links between core and periphery. The policy action for the core city should be to increase density and support rapid services sector growth; whereas the policy action for the periphery should be creating manufacturing estates to avoid industrial sprawl. The other important policy needed to manage Jabodetabek Megacity well, is to improve coordination across regencies and municipalities, as well as with central government, regarding planning and priority investments.

From the economic perspective, urbanization and rapid urban expansion in both Java and Jabodetabek Megacity causes loss of farmland and decreasing agricultural production. Thus, there should be policy provisions to maintain an appropriate amount of farmland in both regions. Therefore, it is very important to protect prime agricultural lands during the spatial planning process, using specific policy instruments to keep the most productive farmlands and use them to maintain food security.

To address urban sprawl and the urban decline caused by suburbanization, some public policies can be implemented such as: impact fees, congestion pricing, tax-base sharing, concurrency planning, reverse commuting programs, affordable housing strategies, and growth management. The suburbanization process and urban sprawl make public service and infrastructure inefficient, and force numerous workers who live in the suburbs but work in the city center, to waste a great deal of time commuting. This means that the preferred effects from policy must include more efficient public service and infrastructure, as well as decreased commuting time for those workers. To solve this problem, land policy and strategic urban planning are needed. Unplanned urban growth can result in many problems, for example, insufficient infrastructure and public services. Generally, rapid urban expansion tends to prioritize short-term land development and economic growth without considering their impacts on employment, conversion of green areas to urban uses, transportation networks, commercial trade, and delivery of public services. To address a rising population and minimize the slum areas caused by rapid urbanization, the government must provide affordable housing. National governments have a key role to play in promoting standards of housing affordability and housing quality across urban regions. To implement this policy, we have to involve local, regional, and national government to monitor housing affordability, as well as to address and improve the elasticity of the housing supply, promote affordable housing for low-income households, and address problems of social cohesion.

Managing urban growth in sustainable ways has become one of the most important challenges of the 21st century. To address many urban problems, the coordination and cooperation between local and national governments are needed, as well as encouragement of interaction between multiple local government agencies. I believe that these trends must strengthen the capacity building of local governments to solve the environmental and social service problems caused by rapid urban growth.