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# **The Declining of Rice Field and Greenery Areas in Java Island Amid Continuing Urban Expansion and Regional Disparity**

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## 1 INTRODUCTION

The urban population in Asia is growing faster than the population in other continents and as predicted that in the year 2030, there will be more than 1.1 billion Asian people living in urban areas (Asian Development Bank, 2008). Big cities in Asia have large populations and eventually experience rapid economic growth so that they become a magnet for population increase, investment inflow, business development, organization and so on (ADB, 2008). Increased urbanization rate has become the main driving factor of population growth in Asia. Urbanization and rapid urban development in several countries in Asia is marked by an increasing physical growth, beyond the boundaries of metropolis and cities (Hugo, 2006; McGee and Robinson, 1995). Urbanization process was predicted to continue in the upcoming years, so that the challenges of sustainable development will be increasingly concentrated in the cities, especially in low-middle-income countries who are currently experiencing the most rapid urbanization rate (UN, 2014).

Rapid and unplanned urban growth as well as urban expansion severely threatens sustainable development especially in areas where the necessary infrastructure are not developed or when policies are not well implemented. Unplanned or poorly managed urban expansion leads to rapid urban sprawl, pollution and environmental degradation, along with unsustainable production and consumption patterns (UN, 2014). Rapid urban growth, high population density and high level of consumption in large cities has led to a variety of socio-economic and environmental impacts that locally and globally require the attention of the global community, because it will significantly affect global sustainability and future prosperity.

The study of urbanization and the process of suburbanization in Asian countries it has been emphasized that urban expansion, from the largest metropolitan area to the surrounding region has constantly eroded the tradition of distinction between rural and urban communities. The urbanization in East and South Asian countries is characterized by blurred distinctions between 'rural' and 'urban' areas (McGee, 1991; 1994; 1995; McGee and Robinson, 1995; Brennan, 1999; Hugo, 2006). Several urban characteristics emerge in rural areas, both physically and socioeconomically. Both agricultural and

non-agricultural activities go side by side in adjacent areas of the city center, whereas the physical development of the city goes beyond the administrative boundaries of the city (McGee, 1991; Firman and Dharmaputri, 1994; Word 1997; 2003; Swerts and Denis, 2014).

High population growth and rapid development in recent years has resulted to a dynamic change in land use in most cities. Cities have been transformed from small and remote populations into large ones with interrelated economic, physical and environmental features (Avicedo, 2013). According to Kitamura and Rustiadi (1997), the most common land conversion in Indonesia is in the form of deforestation, especially outside Java and also in the form of conversion from agricultural to urban use, especially in cultivated areas around big cities in Java Island. The phenomenon of land use/cover changes of agricultural land in Indonesia is primarily due to urban expansion, and occurs mainly in Java.

Java is one of the main islands in Indonesia which occupies only 7% of the total area of Indonesia, but is currently inhabited by about 60% of the total national population (BPS, 2015). Java Island is known as a cultural center. It's also the most fertile island with abundant natural resources. In addition to natural resources, Java Island also has a high potential human resources. Various potentials and attractiveness that caused Java Island to be seen as, relatively the most developed compared to other islands in Indonesia, so this is what we called "Java Bias" (Garcia and Garcia, 2000; Anwar, 2004; Rustiadi et al., 2009). However, Java has become the center of government activities, because Jakarta as the state capital is located in Java Island. Java is not only known as center of government activities, but Java has also become a center for economic activities (contributing 60% of national GRDP) and, also the highest concentration of the national population is in Java, because 5 major metropolitan areas including Jabodetabek Metropolitan Region (Jakarta-Bogor-Depok-Tangerang-Bekasi), are located in Java island. The Jabodetabek Metropolitan Area contributed about 25.52% to the total national GRDP in 2010 (Rustiadi et al., 2015; Pravitasari et al., 2016).

Trends of urban bias and Java bias development makes Java Island more densely populated and has a high attractiveness for investments. The Dutch Indies colonization policies, as well as resettlement

programs implemented after Indonesia's independence were not sufficiently effective in reducing the population density and economic concentration in Java Island. The role of Java Island in terms of population and national economy (GDP) remained dominant, both before and after the decentralization policy since the fall of the Suharto regime in the late 1990s (Rustiadi et al., 2010; Pravitasari, 2009).

Java is also the biggest rice-producer island (*jawadwipa*) since the prehistoric era. Even today, Java remains the mainstay of rice production in Indonesia and contributes about 53% of national rice production; produces around 40 million tonnes out of a total of 75 million tonnes of national rice production (BPS, 2015). But the pressure of urbanization, threatens the role of Java as a national rice barn (Rustiadi and Wafda, 2007) and also, threatens the carrying capacity of Java (Rustiadi et al., 2009). High rate of population increase and the rapid development of economic activities in Java, has caused an increasing rate of land conversion, especially from agricultural land (mainly paddy field) to residential area. The increasing population in Java is not evenly distributed throughout the region. Highest population growth occurred around the western part of Java, especially in Jabodetabek Metropolitan Region (the Greater Jakarta). The increase in population results to an increasing demand for land, especially for residences/settlements. The increasing demand for such land encourages the land conversion from agriculture as well as greenery area into built-up areas such as settlements (Pravitasari et al., 2015). From the period of 1972 to 2012, land conversion in Jabodetabek has removed about 152,000 ha of forest cover area and about 71,000 ha of open land (Rustiadi et al., 2015). In the period of 1999-2000, conversion of paddy field was dominant in West Java which is about 0.2 million hectares (Santosa et al., 2015). The increased the rate of land conversion, especially productive agricultural land, of course, led to a decrease in paddy fields, which have also influenced the decline in rice production, which in the long term can threaten food security. The uncontrolled land conversion process, also caused a decrease in forest cover, which in turn, resulted to a decrease in environmental carrying capacity, causing various forms of anthropogenic disasters such as floods, landslides, forest fires and increasingly degraded lands (Rustiadi et al., 2015; Pravitasari, 2015; Pravitasari et al., 2018).

The spatial distribution of population and human activities in Java are very diverse, unbalanced and also very dynamics over time. Therefore, a spacial and temporal description related to the dynamics of population growth, population density, urbanization, economic growth as well their impact on the decline in rice production and greenery areas in Java, will provide a more holistic and comprehensive description of related issues and situations. A better comprehensive spatial description could be used as a foundation for optimal land use changes, control and policy; amid a continuous urbanization trend. This kind of description could facilitate the

process of effective mitigation and reduce the appearance of negative impacts which is not desirable. This study aims to: (1) Analyze spatial variety in the trend of population growth, urbanization and regional economic growth in Java Island, and (2) Analyze land use change (LUCC) to describe the declining of rice fields and greenery areas in Java Island within the last quarter century (from 1990 to 2015).

## 2 METHODOLOGY

### 2.1 Data

All data used in this study were secondary data obtained from the Central Bureau of Statistics. The following table is lists of the data types and years used in this study (Table 1).

Table 1. Type of data used in this study

Data	Year
Population of Java Island	
Population density of Java Island	1990, 1996, 2000,
Urban population of Java Island	2006, 2011 and
GDP constant price of Java Island	2015
Per capita GDP constant price of Java Island	
Population growth rate (%/year) of Java Island	1990-1996, 1996-
Average population growth rate (% / year) of Java Island	2000, 2000-2006,
Average urbanization growth rate (Urbanization Rate %/year) of Java Island	2006-2011 and
Economic growth rate of Java Island	2011 and 2015
Average economic growth rate of Java Island	2009-2015

Land cover data was derived from data information periodically provided by the Ministry of Environment and Forests (KLHK) of the Republic of Indonesia. Since 1990, KLHK used Landsat imagery for mapping land cover as part of forest monitoring activities in Indonesia. The analyzed Land cover data used in this study, were drawn from the following years; 1990, 1996, 2000, 2006, 2011 and 2015.

Based on a document of ISO standard 7645-2010 (BIG, 2010), the Indonesian land cover map is classified into 23 classes, containing 7 classes of forest cover and 16 classes of non forest cover. For simplicity and effectiveness of the this study, the 23 land cover classes were simplified into 4 classes, namely: forest, rice field, built-up areas and other areas as can be seen in the following table (Table 2).

Table 2. Reclassification of land cover types/classes

No	Reclassification	Land Cover Types/Classes
1	Forest	Primary Dryland Forest
		Secondary Dryland Forests
		Primary Mangrove Forest
		Secondary Mangrove Forest
		Primary Swamp forests
		Plantation Forest
2	Rice fields	Rice fields
3	Built-up area	Airport / Harbor
		Settlement
4	Others	Water body
		Bushes
		Dryland farming
		Dried Mixed Land Farm
		Swamps
		Plantation
		Mining
		Swamp
		Savana / Grasslands
		Ponds
		Open Ground
		Cloud

2.2. Analysis Method

2.2.1 Spatial distribution of Population, Urbanization and Regional Economy

Data on population such as population density, urban population, GDP, per capita GDP and economic growth of all districts in Java Island were obtained from the Badan Pusat Statistik (BPS-Statistics Indonesia). Population growth rate (%/year), average population growth rate in a period (%/year), urbanization per capita GDP, and average urbanization growth rate (urbanization Rate %/year) of Java Island within a certain period were calculated using the following equation [1].

$$a = \left\{ \left( \frac{X_n}{X_0} \right)^{\frac{1}{n}} - 1 \right\} * 100\% \dots\dots\dots [1]$$

where: X<sub>n</sub> = year end period  
 X<sub>0</sub> = year beginning period  
 n = number of years

2.2.2 Spatial Analysis

Land cover changes were analyzed spatially by *overlaying* land cover maps from two year points where the *overlapping* areas form a new spatial unit then, combined the information of the input data. The overlay process can be performed on two data layers that spatially

have the same geographical reference system and location (Huisman, 2009), as illustrated in Figure 1.

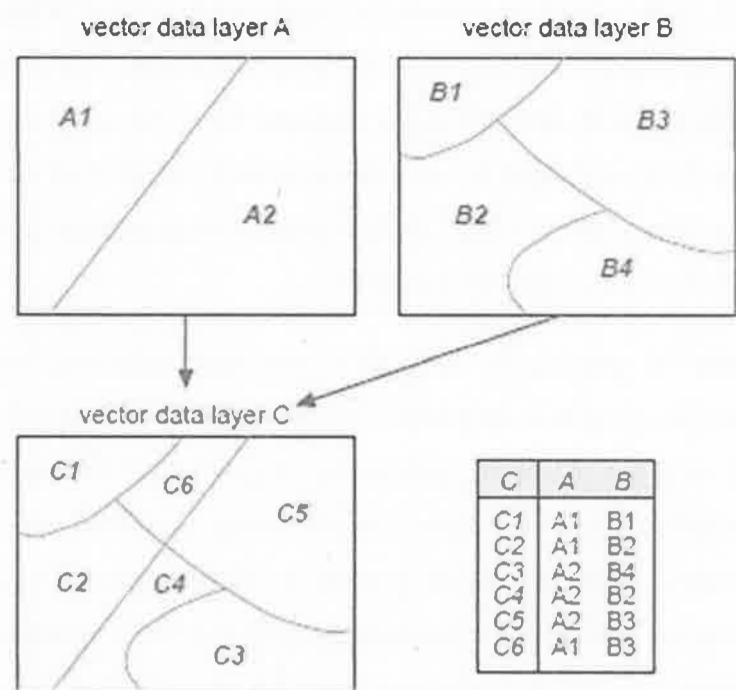


Figure 1. Overlay process based on vector data (Huisman, 2009)

The spatial land cover data obtained from KLHK were the overlay data at several points of the year (1990, 1996, 2000, 2006, 2011 and 2015) that form the new data unit, together with the combined information between the years, which became the input data. The combination of land cover classes at two different year points were used as the basis for determining the land cover changes that occurred during the period (Table 3).

Table 3. Logical Matrix of Land Cover Change

		Land Cover Year 2			
		Ht	Sw	Pk	L
Land Cover Year 1	Ht	Ht-Ht	Ht-Sw	Ht-Pk	Ht-L
	Sw	Sw-Ht	Sw-Sw	Sw-Pk	Sw-L
	Pk	Pk-Ht	Pk-Sw	Pk-Pk	Pk-L
	L	L-Ht	L-Sw	L-Pk	L-L

Notes: Ht=Forest Sw=Ricefield Pk=built-up L= others

Not change
Converted (often)
Converted (rare)

3 RESULTS AND DISCUSSION

3.1 Spatial Dynamics of Urbanization and Economics Growth in Java Island

3.1.1 Population

The population in Java from 1930-2010 shows an ever-increasing number, which is 40 million in 1930 to 130 million in 2010 (Figure 2a). The trend in the number of population is also the same with other island (outer Java) as well as the national level. Meanwhile, the population growth analysis showed fluctuating data. The highest population growth rate in Java occurred in 1971-1980 at approximately 2.2% / year, and the lowest population growth of 1.2% / year occurred in 1995-2000.

The highest population growth in Java Island was also followed by the highest population growth, both in Outer Java and at the National level. At the same time, interesting conditions were seen in the lowest population growth in Java at 1.2% / year (1995-2000), but population growth in Outer Java and at the National level was lower (0.8-1% / year). Thus, in 2000-2005 population growth rate in Java was at the lowest level (about 1.2% / year) compared to population growth in Outer Java and at the National level.

Population growth in 2005-2008 remained unsteady, with the population growth in Java Island being the highest compared to Outer Java and the National population (Figure 2b). Fluctuations in population growth in Java Island during the years 1995-2008 compared with population growth in Outer Java and National population, present an interesting phenomena for a detailed study, because it showed an opposite pattern. The complete population data for 2005, 2010 and 2015 and the projected population of 2020 and 2025 are presented in Table 4.

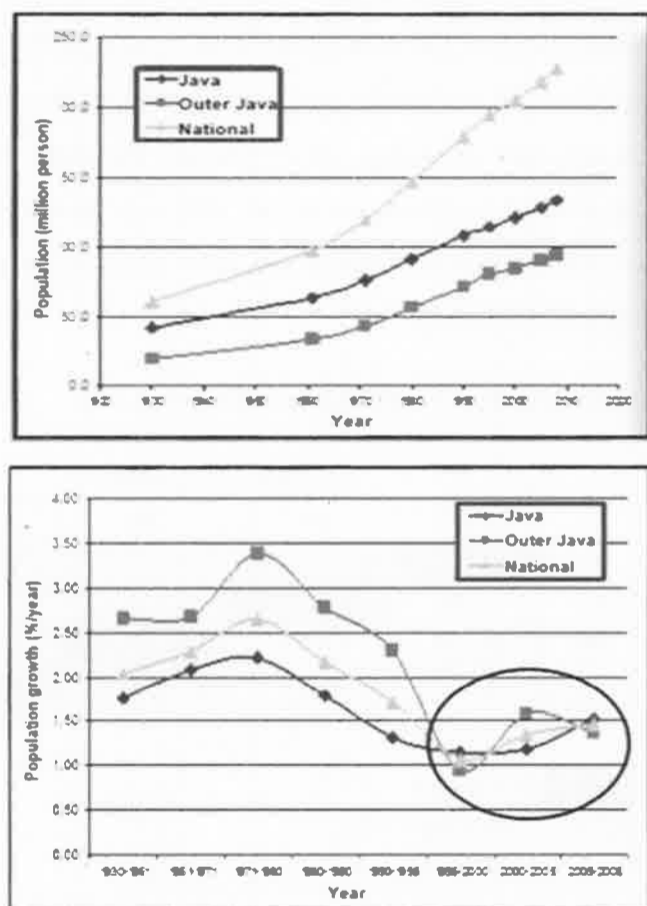


Figure 2. (a). Population of Java (1930-2010), (b). Population Growth of Java

Table 4. The population estimation of each province in Java

Province	Population				
	2005	2010	2015	2020	2025
DKI Jakarta	8,892.30	9,294.90	9,581.10	9,758.50	9,850.60
West Java	39,150.50	42,081.60	44,891.30	47,505.30	49,928.00
Central Java	31,873.50	33,094.60	34,116.40	34,891.60	35,457.00
DI Yogyakarta	3,365.50	3,534.60	3,686.90	3,814.10	3,918.60
East Java	36,481.80	37,469.70	38,258.60	38,760.10	38,962.00
Banten	9,071.10	9,964.30	10,886.70	11,803.90	12,699.80

(Source: BPS, processed)

The urbanization rate in Java in 1990-2015 showed an increase, from 106 million people in urban areas in 1990 to 146 million people in 2015 (Figure 3a). On the other hand, the urban population increased from 36 million in 1990 to 91 million by 2015. Meanwhile, judging by the average urbanization growth rate, it showed that the year 1996-

2000 presented the highest value of 7.52%/year, and the smallest occurred in periods of 2006-2011 (2.07%/year). The era of Suharto's government regime was characterized by a centralized and less democratic system of government (authoritarian system). The post-Soeharto era is characterized by a decentralized system of government, in which regency/municipality and provincial governments have much higher autonomy than the previous era.

The Soeharto regime was an era where the central government control was very strong in controlling the population through family planning programs called "Keluarga Berencana (KB)". The Soeharto regime was also characterized by a high commitment to rural development and the agricultural sector, particularly the rice production system, so as to transform Indonesia from the world's highest rice importing country in the early 1970s to a self-sufficient state of rice in the mid-1980s. By the end of the 1990s, the Soeharto regime had succeeded in reducing the national population growth through a sentimental and undemocratic population control program. The advent of democracy since the early 2000s weakened the central government controls, including the reduction of the rate of population growth through out-of-action programs. Comparison between the Soeharto regime and post-Reformation (post-Soeharto regime), shows that the average urbanization growth rate presented a lower median compared to the Soeharto regime.

In Figure 3b, the highest average population growth rate in Java Island was from 1996 to 2000 at 1.66% / year and the lowest between 2000-2006 at 1.05% / year. Comparing the average population growth rate of the Soeharto regime to that of the post-reformation, the average population growth rate during the post-reformation rate is slightly smaller than during the Soeharto regime. Meanwhile, the population density from 1990-2015 in Java shows an increasing trend.

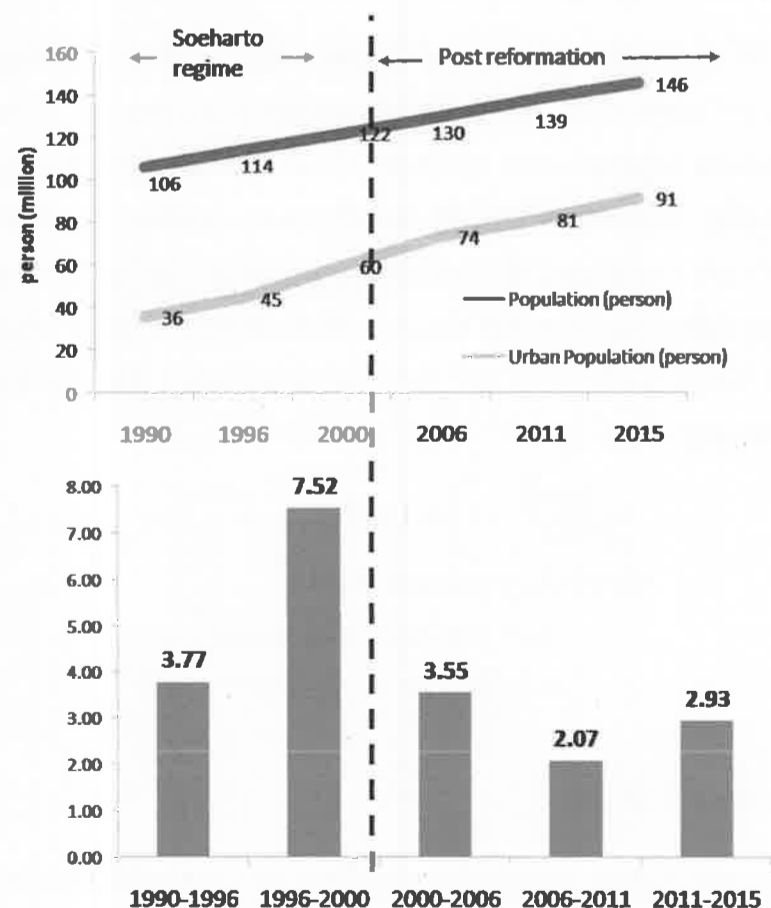


Figure 3. Population of Java Island (1990-2015): (a). Average Urbanization Growth Rate,

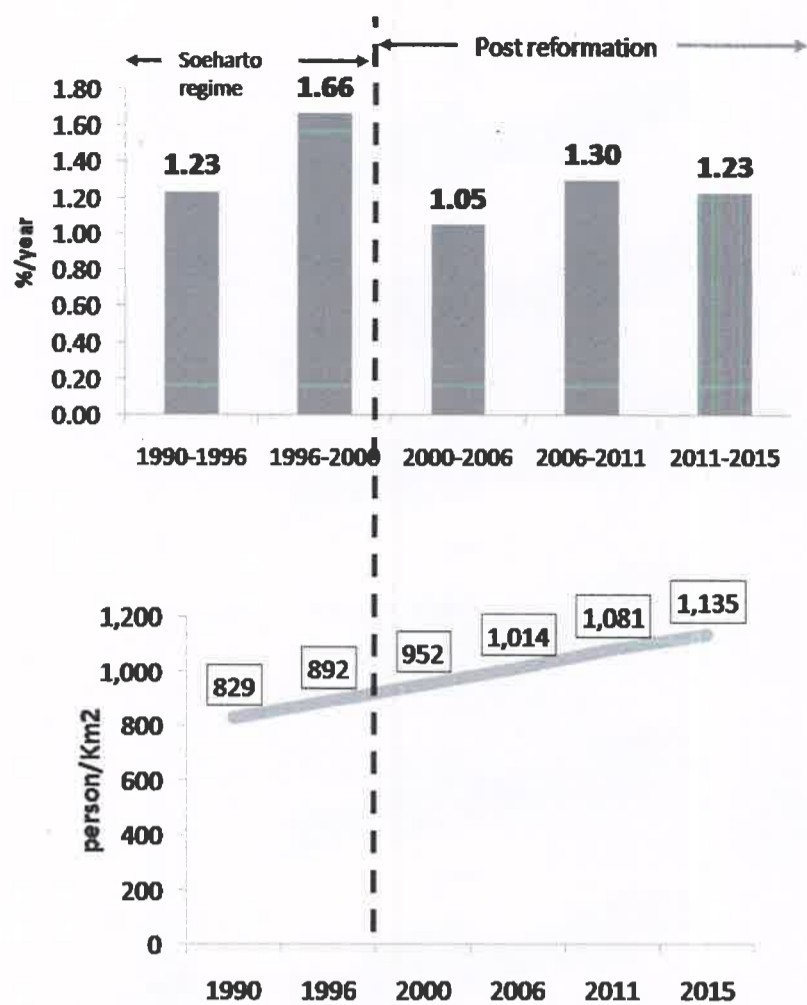


Figure 3. Population of Java Island (1990-2015): (b). Average Population Growth Rate

Based on its spatial distribution, population growth rate around the metropolitan area of Jakarta (Jabodetabek) and the Metropolitan area of Surabaya, shows a change (color) which indicates that this region has the most dynamic population growth intensity. The region around Jakarta and Surabaya are the two largest population and urban agglomerations in Indonesia, which grew to become the most important service center for other areas around and even in Indonesia. High pull and push factors of migration in these two areas causes a relatively high migration currents in and out of this region. Figure 4 presents the spatial distribution of the population growth rate over the years.

The adjacent areas of Jakarta City are experiencing the most rapid population growth process. This has led to the city's rapid physical growth on the outskirts of the city due to an increase in the number of settlements. The physical growth of the city known as suburbanization, which is the process of increasing the built-up areas such as settlements and industries on the outskirts of the urban areas, as a result of the displacement of urban population in need of residence and industrial activities (Rustiadi and Panuju, 1999).

According to Hidajat *et al.*(2013), the spatial phenomenon of suburbanization results in the shift of urban functions to the outskirts of the city, so that urban areas are physically expanding, or randomly scattered (urban sprawl) and uncontrolled. Decentralization of urban to suburban activities led to the *Post-Suburbia* phenomenon (Hudalah and Firman, 2011). In the metropolitan area of Jabodetabek, the deconcentration of high-tech industries and multinational corporations that convert suburban lands into planned suburban industrial estate was the early stage of *Post-Suburbia* (Hudalah and

Firman, 2011). *Post-Suburban* Transformation in the Jabodetabek metropolitan area can be seen as a spatial impact on the structural change of the economy, prioritizing the agricultural sector into a part of the economy that supports the manufacturing sector.

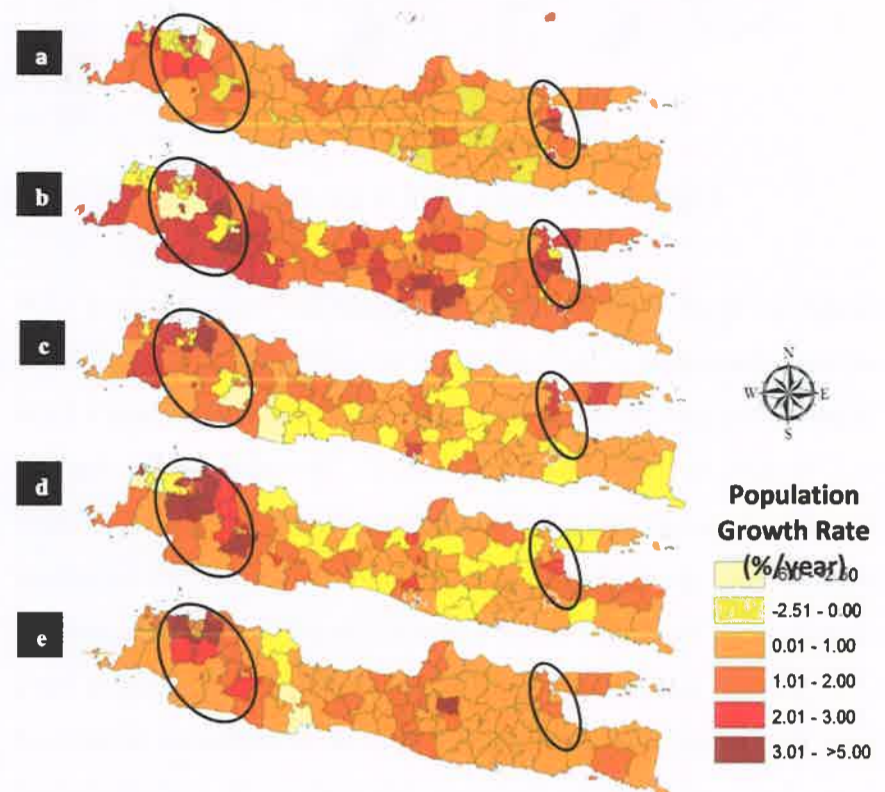


Figure 4. Population Growth Rate Distribution of Java Island: (a). 1990-1996, (b). 1996-2000, (c). 2000-2006, (d). 2006-2011, (e). 2011-2015

### 3.1.2 Economy

In general, GDP and per capita GDP in Java from 1990 to 2015 shows an increasing trend. The value of GDP in 1990 amounted to 61 trillion rupiah, which increased to 5.207 trillion rupiah in 2015, while the per capita GDP in 1990 amounted to 106 million rupiahs, which increased to 5,636 million rupiah in 2015. When compared to the GDP and per capita GDP during the Soeharto Regime and post reformation era (Post Soeharto), there is a significant increase in GDP and per capita GDP (Figure 5).

The spatial distribution of GDP per capita in Java is presented in Figure 6. Districts with high GDP per capita value are given a darker shade of gradation compared to regions with lower per capita GDP. Areas with high GDP per capita in 2011, among them are spread around Jakarta megacity, Surabaya metropolitan area, as well as some other areas in Central Java and East Java. In general, regions with highest per capita GDP are distributed mostly near the biggest cities.

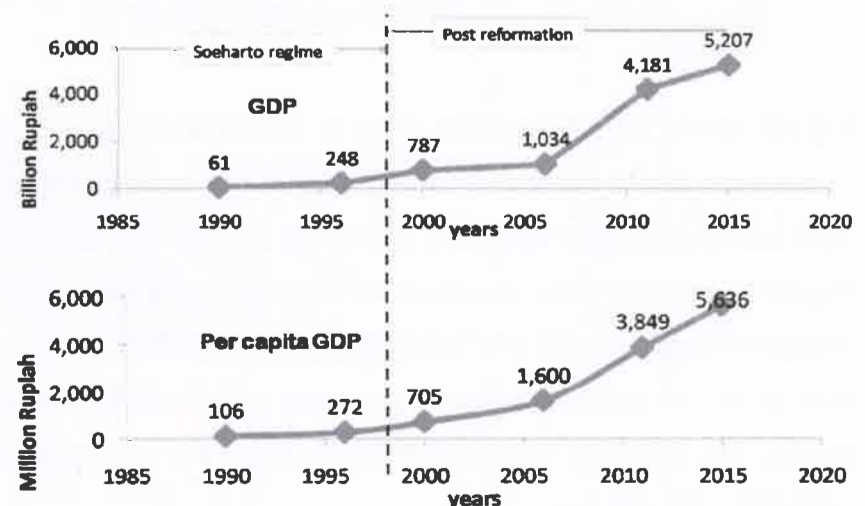


Figure 5. GDP and per capita GDP

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