# Mapping of Spatial Distribution and Spatial Autocorrelation Patterns of Poverty in All Regencies/Cities in Indonesia

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## Abstract

Poverty alleviation programs in Indonesia are the same and uniform in all regions. Of course this ignores the characteristics and causes of poverty that vary in each region. The uniformity of poverty alleviation programs affects the slow pace of decline in the poor population. Spatial influence on poverty can be identified by spatial autocorrelation; there is a relationship of poverty in one region with other regions that are closed together. This study was aimed to analyzing poverty spatial distribution in all regencies/cities in Indonesia; analyzing the spatial distribution patterns of poverty in all regencies/cities in Indonesia; and knowing local spatial autocorrelation of poverty in all regencies/cities in Indonesia. The research methods used are Moran Index analysis, Moran's scatterplot analysis, and Local Indicators of Spatial Autocorrelation (LISA) analysis. The analysis results show that the highest average of poor population percentage was in Papua and the lowest one was in Kalimantan. The results of analysis of Moran Index showed that the spatial distribution pattern of poverty in regencies/cities in Indonesia was clustered, it was called by poverty pocket. Pockets of poverty that occured do not correspond to government administrative boundaries, therefore poverty alleviation needs an integrative approach. In addition, this study also results that not all regencies/cities have significant spatial autocorrelation. This means that not all poverty conditions in a regencies/cities have a relationship with other regencies/cities. The fact that there are heterogeneity of poverty characteristics like this shows that poverty alleviation programs must vary in each regency/city.

**Keywords:** City**,** LISA, Moran, Povety, Regency, Spatial

## 1. Introduction

There are three development objectives: growth, equity, and sustainability (Rustiadi *et al.* 2011). But in reality, development has not been able to eradicate one of its main enemies in the goal of developing, namely poverty. Eradication of poverty is the main objective in the Sustainable Development Goals (SGDs). Indonesia formed Tim Nasional Percepatan Penanggulangan Kemiskinan; TNP2K (The National Team for Acceleration of Poverty Reduction) in order to accelerate poverty alleviation in Indonesia. The government places poverty eradication as one of the state agendas contained in 2005-2025 Long-Term Development Plan (Bappenas 2005), 2014-2019 National Medium-Term Development Plan (Bappenas 2004), and 3rd and 5th of nawacita. The commitment of Indonesian government to eradicate

poverty is reflected in the poverty alleviation budget which can be seen in Figure 2.

Poverty in Indonesia are calculated and reviewed by Statistics Indonesia (BPS). According to BPS, poverty is the inability from the economic side to meet food and non-food needs as measured by the Poverty Line (BPS 2017).
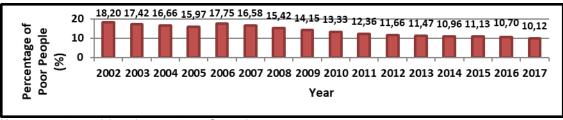
Poor people is defined by BPS as a people who in the below poverty line. Hasbullah (2012) stated that the poverty measurement used by BPS uses the United Nations (UN) measurement standards which is recommended by Food and Agriculture Organization (FAO) and World Health Organization (WHO). BPS started to calculated the poverty in 1984. Starting in 2002 BPS calculated poverty up to regency/city level. The percentage of poor people in 2002-2017 is presented in Figure 1. The average of

decline in the percentage of poor people is 0.601 %/year. However, that decreasing is not significant compared to the poverty alleviation budget which is given by Indonesian government whose value can be seen in Figure 2.

From the data in Figure 2 it can be calculated that the increasing average of poverty alleviation budget is 29.625 trillion rupiah/year or 23.36 %/year. It can be interpreted that poverty alleviation efforts in Indonesia have not been successful because there is a gap between the poverty alleviation budget disbursed and the results obtained.



Note: 2002-2010 on July and 2011-2017 on September
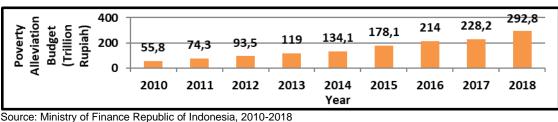Source: Statistics Indonesia, 2002-2017

Figure 1. Percentage of people who living in poverty in Indonesia 2002-2017



Source: Ministry of Finance Republic of Indonesia, 2010-2018

Figure 2. Poverty alleviation budget in Indonesia 2010-2018

Rustiadi *et al.* (2011), Hakim and Zuber (2008), Syafitri *et al.* (2008), Susila (2011), and Harmes *et al.* (2017), argue that the study of development programming, especially efforts to reduce poverty must attention to spatial elements or location so that program failure can be minimized.

At present the efforts to reduce poverty in Indonesia are still global, without attention to regional aspects. This means that these efforts are the same and uniform throughout Indonesia, althought the characteristics and causes of poverty in each region are different. This study was aimed: (1) analyzing the distribution of poverty in all regencies/cities in Indonesia; (2) analyzing the spatial distribution patterns of poverty in all regencies/cities in Indonesia; and (3) knowing local spatial autocorrelation of poverty in all regencies/cities in Indonesia.

## 2. Research Methods

### 2.1 Location and Time

This study area is located in 514 regencies/cities in Indonesia. Geographically, Indonesia located between $6^0$ 04' 30'' North Latitude to $11^0$ 00' 36'' South Latitude and $94^0$ 58' 21'' to $141^0$ 01' 10'' East Longitude and traversed by the equator is located at latitude $0^0$ (Figure 3). This study was done in May 2018-July 2019.



Figure 3. Location map of Indonesia

### 2.2 Materials and Tools

The material used in this study is secondary data from Statistics Indonesia and Ministry of Home Affairs Republic of Indonesia: Indonesian administrative map, Indonesian shape file map, and data of people who living in poverty percentage in all regencies/cities in Indonesia in 2005, 2011, and 2017. The tools which are used consists of laptop with ArcGIS 10.4.1 software, GeoDa software, Microsoft Word, and Microsoft Excel.

### 2.3 Analysis Technique

#### 2.3.1 Analysis of Poverty Spatial Distribution

Analysis of poverty spatial distribution used ArcGIS 10.4.1 software. Percentage of poverty is divided into 3 classes, namely class 1: 0 - 9.99%, class 2: 10 - 30%, and class 3:> 30%.

#### 2.3.2 Analysis of Spatial Distribution Patterns of Poverty

This analysis used data of the percentage of poor population in all regencies/cities in Indonesia in 2005, 2011, and 2017. The analysis techniques used are analysis of Moran Index, Moran's scatterplot, and Local Indicators of Spatial Autocorrelation (LISA). The Moran Index is the method most widely used to calculate spatial autocorrelation globally (Pravitasari *et al.* 2018).

The Moran test formula (Arlinghaus 1996) is formulated as follows:

$$I = \frac{n}{\sum i \sum j W_{ij}} \frac{\sum i \sum j W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum i (x_i - \bar{x})^2}$$

Where: I: Moran Index; n: Number of regency/city; $x_i$: Value of observation in regency/city i; $x_j$: Value of observation in regency/city j; $\bar{x}$: Average value of all observed variables; $W_{ij}$: Matrix elements between regency/city i and regency/city j. The value of I is in the range between -1 and 1. If I > Io, autocorrelation value is positive, it's means that spatial distribution patterns clustered, I = Io means there is no spatial autocorrelation, and I < Io means negative autocorrelation value, it's means that spatial distribution patterns spreaded. Whereas if the value of I ≠ 0 means that a positive autocorrelation occurs when I is positive, conversely there is a negative autocorrelation when I is negative.

The pattern of clustering and distribution between locations can be presented with Moran's scatterplot, which shows the relationship between the value of observation at a location (standardized) with the average observation value of locations that are adjacent to the location concerned. (Lee and Wong 2001). According to Zhukov (2010), the quadrants in Moran's scatterplot are as follows:

1. Quadrant I, HH (High-High) shows that the area that has a high observation value is surrounded by an area that has a high observation value.
2. Quadrant II, LH (Low-High) shows that the area that has a low observation value is surrounded by an area that has a high observation value.
3. Quadrant III, LL (Low-low) shows that the area that has a low observation value is surrounded by an area that has a low observation value.
4. Quadrant IV, HL (High-Low) shows that the area that has a high observation value is surrounded by an area that has a low observation value.

#### 2.3.3 Analysis of Local Spatial Autocorrelation of Poverty

According to Lee and Wong (2001), the higher the local value, the adjacent locations have almost the same value or form a clustered distribution:

$$I_i = Z_i \sum_{i=1}^{n} W_{ij} Z_j$$

Where: $I_i$: LISA Index of regency/city i; $Z_i$ dan $Z_j$: data standardization; $W_{ij}$: weighting between regency/city i and regency/city j. (1)

## 3. Result and Discussion

### 3.1 Mapping of Spatial Distribution of Percentage of Poor People in All Regencies/Cities in Indonesia in 2005, 2011, and 2017

There is an increase in clustering for poverty rate from 2005 to 2010 in Nigeria. The clusters around the North East, North West zones and three states in the South South of the countryshows high poverty level, North Central and some states in the South-South have medium poverty level.The rest of the country has low poverty level (Odeyemi *et al.* 2013). How about in Indonesia? Figure 4 provides information that the highest average of percentage of poor population in regencies/cities in 2005, 2011 and 2017 is in Papua Island and the lowest is in Kalimantan Island. This shows that during 2005-2017 poverty alleviation on Papua Island proceeded slowly. Even, the average of percentage of poor population of regencies/cities in Papua Island for the three points of the year is quite large, namely 34.17%, 33.02%, and 29.01%.
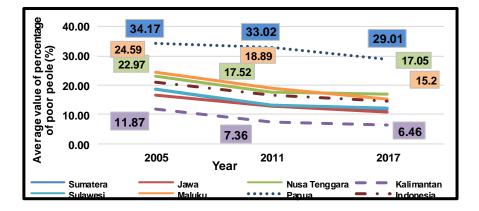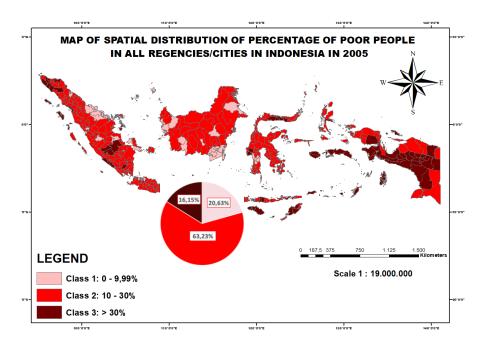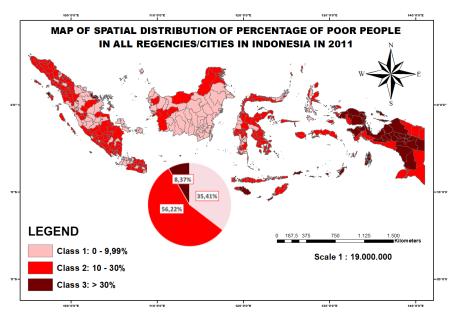


Figure 4. Graph of average value of people who living in poverty percentage in all regencies/cities of each island/islands in Indonesia in 2005, 2011, and 2017

Maps of spatial distribution of percentage of poor people in all regencies/cities in Indonesia in 2005, 2011, and 2017 are presented in Figure 5. From Figure 5 it can be seen that in 2005, 2011, and 2017 the percentage of poor population in all regencies/cities in Indonesia are mostly in the class 2: 10 - 30%. The values for the 2015, 2011 and 2017 were 63.23%, 56.22% and 51.17%.



MAP OF SPATIAL DISTRIBUTION OF PERCENTAGE OF POOR PEOPLE IN ALL REGENCIES/CITIES IN INDONESIA IN 2005

LEGEND
Class 1: 0 - 9,99%
Class 2: 10 - 30%
Class 3: > 30%

Scale 1 : 19.000.000



MAP OF SPATIAL DISTRIBUTION OF PERCENTAGE OF POOR PEOPLE IN ALL REGENCIES/CITIES IN INDONESIA IN 2011

LEGEND
Class 1: 0 - 9,99%
Class 2: 10 - 30%
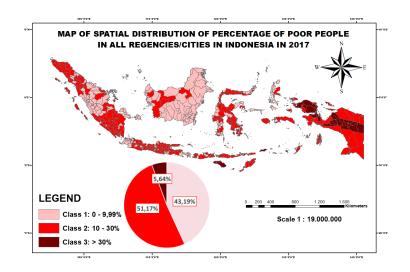Class 3: > 30%

Scale 1 : 19.000.000

Figure 5. Maps of spatial distribution of percentage of poor people in all regencies/cities in Indonesia in 2005, 2011, and 2017
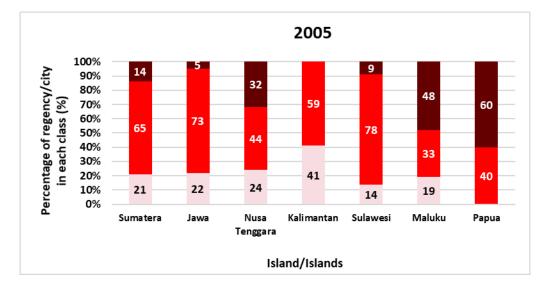
From Figure 5 it can also be seen that most of regencies/cities in Kalimantan Island have percentage of poor people in class 1. Only a few are in class 2, not even in class 3. Papua Island is the opposite. There is no regency/city in Papua Island where the percentage of poor people is in class 1. All are in class 2 and class 3.

Percentage of regency/city in each class in each island/islands of Indonesia in 2005, 2011, and 2017 can be seen in Figure 6. From figure 6 we can get information that there is no regency/city in Kalimantan Island that the percentage of poor people is in class 1 in 2005, 2011, and 2017. Even in 2017, 91% of regencies/cities in Kalimantan Island are in class 1. This means that the percentage of poor people of regencies/cities on Kalimantan Island are mostly below 10%.
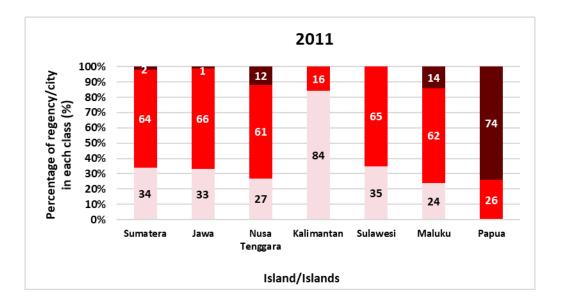
The situation in Papua Island is the opposite to Kalimantan. There is no regency/city in Papua Island that the percentage of poor population is in class 1 in 2005, 2011 and 2017. This means that the percentage of poor people in regencies/cities in Papua Island are above 10%. Even more than 30%.
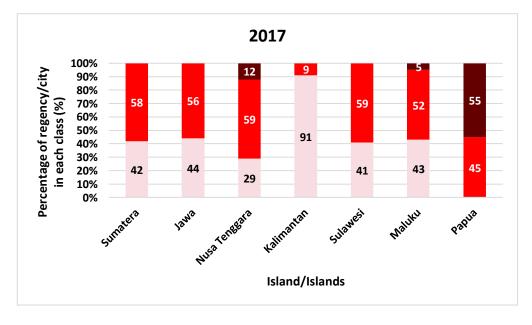
In 2017, there were no regencies/cities on Sumatra Island, Java Island, and Sulawesi Island that the percentage of poor people were in class 3. The percentage of poor people of regencies/cities in that three islands were majority in class 2.

Still in 2017, the percentage of poor people of regencies/cities in Maluku Islands and Nusa Tenggara Islands still exist in class 3, as many as 12% and 5%. Similar to Sumatra Island, Java Island, and Sulawesi Island, the percentage of poor people in the Maluku Islands and Nusa Tenggara Islands are mostly in class 2.

Figure 6. Percentage of regency/city in each class in island/islands of Indonesia in 2005, 2011, dan 2017

## 3.2 Spatial Distribution Patterns of Percentage of Poor People in All Regencies/Cities in Indonesia in 2005, 2011, and 2017

Moran Index analysis results in 2005, 2011, and 2017 can be seen in Figure 7. Based on analysis of ArcGIS software 10.4.1, spatial distribution pattern of percentage of poor people in regencies/cities in Indonesia in 2005, 2011, and 2017 is clustered or forming pockets of poverty. The Moran index values for 2005, 2011, and 2017 are 0.633924, 0.751350, and 0.721028. This value is in the range $0 < I < 1$ so that it shows a positive spatial autocorrelation.

This means that there is a grouping of poor people in regencies/cities which the observed values that are almost the same as regencies/cities that are

located close to one another or neighbours. These results are in line with research conducted by Bekti (2012) in East Java. Poverty grouping like this is an opportunity that can be used to alleviate poverty because poverty is concentrated in certain regions so as to facilitate its alleviation. Like in Indonesia, In Nigeria in 2010, The Moran Index value obtained is strongly positive; 0.6657 (Sowunmi *et al.* 2012). Same in China, the Moran Index is positive too (Chen *et al.* 2015).
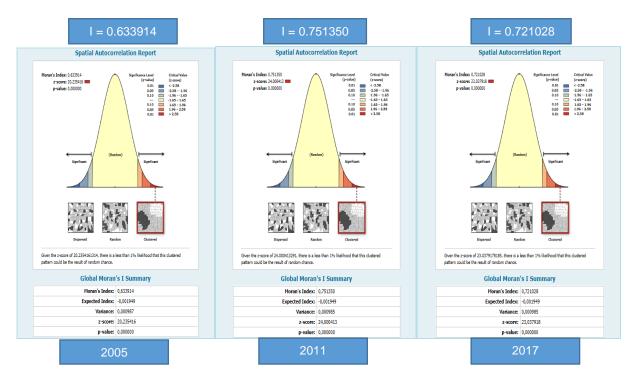
Figure 7. Moran index analysis results in 2005, 2011, and 2017

The results of Moran's scatterplot can be seen in Figure 8. From Figure 8, it can be obtained information that Moran's Index from Moran's scatterplot in 2005, 2011, and 2017 are 0.60848, 0.691349, and 0.677135. This model is good to use because in Figure 8 we can see that the percentage of poor people in regencies/cities in Indonesia is divided into 4 quadrants, namely quadrant I, quadrant II, quadrant III, and quadrant IV.
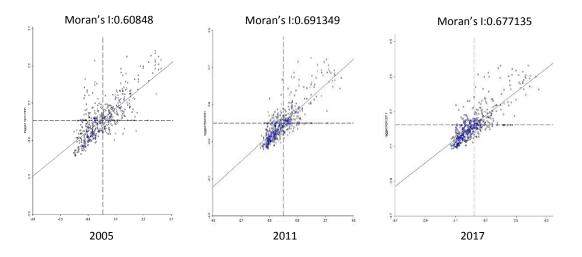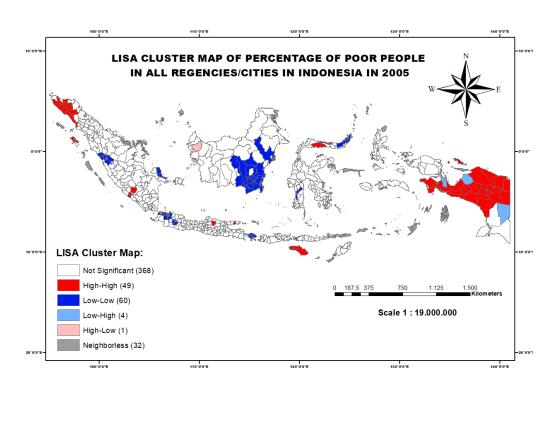


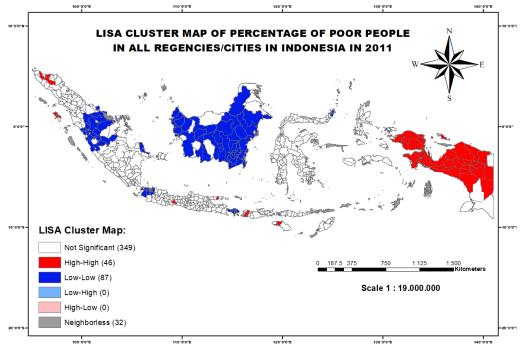Figure 8. *Moran's scatterplot* analysis results in 2005, 2011, and 2017

Furthermore, the Moran Index results are locally mapped into 4 quadrants. The results can be seen in Figure 9. In 2005 there were 49 regencies/cities that were in quadrant 1 (High-High), quadrant II (Low-High) there were 4 regencies/cities, quadrant III (Low-Low) there were 60 regencies/cities, and in quadrant IV (High-Low) there is 1 regency. In 2011, in quadrant I (High-High) there were 46 regencies/cities and quadrant III (Low-Low) there were 87 regencies/cities. There are no regencies/cities that are in quadrant II (Low-High) and quadrant IV (High-Low). For 2017, there are 48 regencies/cities that are in quadrant I (High-High), quadrant III (Low-Low) there are 85 regencies/cities. Same as in 2011 there were no regencies/cities that were in quadrant II (Low-High) and quadrant IV (High-Low).

For comparation, In Nigeria in 2010 there were 23 senatorial districts that were in quadrant 1 (High-High), quadrant II (Low-High) there were 4 senatorial districts, quadrant III (Low-Low) there were 28 senatorial districts, and in quadrant IV (High-Low) there is no senatorial districts (Sowunmi *et al.* 2012).
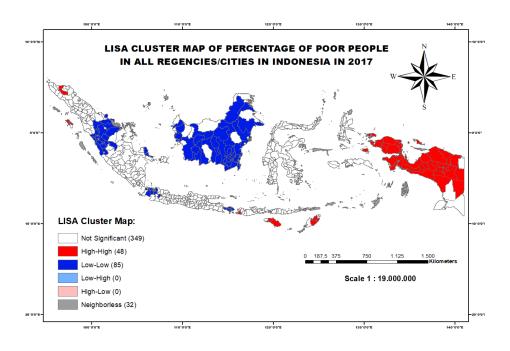
Figure 9. LISA cluster map in 2005, 2011, and 2017

Pocket poverty based on quadrants I, II, III, and IV in Figure 9 explain that a poor region tends to follow the condition of its neighbours. Regency/city with high poverty levels surrounded by regency/city with high poverty level must be prioritized to get the government's attention in alleviating poverty. In 2017, there were 36 regencies/cities in Papua Island which were in quadrant 1. Nusa Tenggara Islands accounted for 5 regencies that were in quadrant 1 and in Sumatra Island there were 5 regencies that were in quadrant 1. Thus locus of poverty reduction targets increasingly approaching the actual situation in each regency/city. Poverty pockets that occur do not correspond to the administrative limits of government, so poverty reduction needs an integrative approach. The results of this study are in line with the results of Irawan (2013) study in Central Java Province that the pockets of poverty that occur do not correspond to government administrative boundaries.
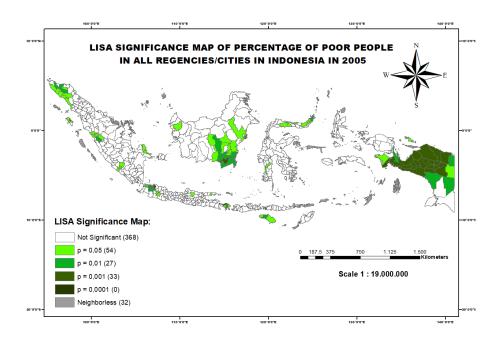
### 3.3 Local Spatial Autocorrelation of Percentage of Poor People in All Regencies/Cities in Indonesia in 2005, 2011, dan 2017

The results of Local Indicators of Spatial Autocorrelation (LISA) analysis in 2005, 2011 and 2017 show that not all regencies/cities have significant spatial autocorrelation. In Figure 10 it can be seen that in 2005 there were 368 regencies/cities that did not have significant spatial autocorrelation. At the 0.05 significance level there are 54 regencies/cities that have local spatial autocorrelation. At the 0.01 significance level there are 27 regencies/cities that have local spatial autocorrelation and 33 regencies/cities that have local spatial autocorrelation at a significance level of 0.001. Figure 10 also shows that in 2011 there were 349 regencies/cities that did not have significant spatial autocorrelation. At the 0.05 significance level there are 53 regencies/cities that have local spatial autocorrelation and at the 0.01 significance level there are 34 regencies/cities that have local spatial autocorrelation. There are 46 regencies/cities that have local spatial autocorrelation at a significance level of 0.001. In Figure 10 it can also be seen that in 2017 there were 349 regencies/cities that did not have significant spatial autocorrelation. At the 0.05 significance level there were 52 regencies/cities that had local spatial autocorrelation. At the 0.01 significance level there are 34 regencies/cities that have local spatial autocorrelation and there are 47 regencies/cities that have local spatial autocorrelation at a significance level of 0.001.

LISA SIGNIFICANCE MAP OF PERCENTAGE OF POOR PEOPLE
IN ALL REGENCIES/CITIES IN INDONESIA IN 2005

LISA Significance Map:
- Not Significant (368)
- p = 0,05 (54)
- p = 0,01 (27)
- p = 0,001 (33)
- p = 0,0001 (0)
- Neighborless (32)

Scale 1 : 19.000.000



LISA SIGNIFICANCE MAP OF PERCENTAGE OF POOR PEOPLE
IN ALL REGENCIES/CITIES IN INDONESIA IN 2011

LISA Significance Map:
- Not Significant (349)
- p = 0,05 (53)
- p = 0,01 (34)
- p = 0,001 (46)
- p = 0,0001 (0)
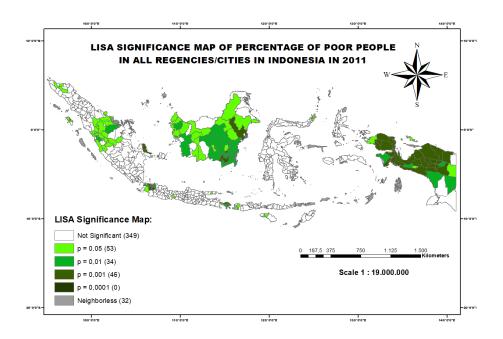- Neighborless (32)

Scale 1 : 19.000.000

Figure 10. LISA Significance Map in 2005, 2011, and 2017

From this spatial autocorrelation analysis it can be concluded that not all poverty conditions in one regency/city have a relationship with other regency/city. The linkage only occurs at locations where the observed values are almost the same or have similarities. The fact that there are heterogeneity characteristics of poverty like this shows that the approach to poverty alleviation programs must vary according to the characteristics and causes of each regency/city. This results in line in Malaysia (Majid *et al.* 2016).

## Conclusion

The spatial distribution of people living in poverty percentage in all regencies/cities in Indonesia in 2005, 2011, and 2017 provides information that the highest of the average of people living in poverty percentage are in Papua Island (34,17% for 2005, 33,02% for 2011, and 29,01% for 2017) and the lowest is in Kalimantan Island (11,87% for 2005, 7,36% for 2011, and 6,46% for 2017). The Moran Index value of people living in poverty percentage in all regencies/cities in Indonesia in 2005 is 0,633914, in 2011 is 0,751350, and in 2017 is 0,721078. It shows positive spatial autocorrelation so that the spatial pattern of poverty in regencies/cities in Indonesia is clustered or formed pockets of poverty.

The results analysis showed that the pattern of spatial distribution of poverty in regencies/cities in Indonesia from 2005 to 2017 increasingly clustered or formed pockets of poverty. The poverty pockets experienced a shift from 2005 to 2017. Pockets of poverty High-High conditions in Sumatra Island in 2017 changed to five regencies and Low-Low conditions to 21 regencies/cities. In the same year the poverty pockets in Java shifted so that the poverty pocket of Low-Low conditions amounted to 15 regencies/cities. The situation in Nusa Tenggara Islands was different. Pockets of poverty High-High conditions in Nusa Tenggara Islands changed to eight regencies and Low-Low conditions to nine regencies/cities. In 2017 the pockets of poverty with Low-Low condition in Kalimantan Island increased to 40 regencies/cities. Another with Sulawesi Island and Maluku Islands. There are no pockets of poverty formed either in the High-High, Low-High, Low-Low or High-Low conditions. Still in the same year, the poverty pockets in Papua Island where the most numerous. In 2017 the poverty pockets of High-High conditions increased to 36 regencies/cities.

The pockets of poverty that occur do not correspond to government administrative boundaries, therefore poverty alleviation needs an integrative approach. In addition, this study also shows that not all regencies/cities have significant spatial autocorrelation. This explains that not all poverty conditions in one regency/city have a relationship with other regency/city. The linkage only occurs at locations where the observed values are almost the same or have similarities. The fact that there are heterogeneity characteristics of poverty like this shows that the approach to poverty alleviation programs must vary according to the characteristics and causes of each regency/city.

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