

# Spatial pattern of agricultural land conversion in West Java Province

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**Abstract.** Population growth has an implication on increasing demand for land. The demand for built-up area is filled by land conversion, mostly from agricultural land. On the other hand, population growth requires an increase in food production as well as land for agriculture. Conversion of agricultural land can threaten the availability and food security. The purpose of this study is to identify the spatial pattern of changes in agricultural land in West Java Province as input to improve food security condition in this province. Descriptive statistics and spatial analysis were used to analyse the area of agricultural land, conversion of agricultural land, and spatial pattern of changes in agricultural land in West Java Province. The data used is time series data in the period of 2005-2014. The result of analysis shows that there are still areas with a high percentage of agricultural land in West Java Province. The rate of conversion of agricultural land varies widely. Cities or regions with very high land conversion rate tend to concentrate in metropolitan areas.

## 1. Introduction

Rapid population growth is a global issue faced in many countries, particularly in developing country. In the period of 2007-2025, the annual rate of urban population growth in developing countries is expected to be 2.27%, whilst its rate in developed countries is 0.49% [1]. This growth commonly occurs in urban areas as it is forecasted by 2050, 66% of the world's population is projected to be urban [2]. This phenomenon also happens in Indonesia with its increase of urban population growth of 7.5% in 1930 and 42% in 2000 [3].

The rise of population growth leads to the consequence of land demand in supporting the activities of inhabitant. One of its huge impacts is the land conversion specifically from agricultural to be non-agricultural land [4]. A large number of agricultural land continues to decline replaced by the function of non-agricultural land.

Population growth has a consequence of the demand growth of food production. On the other hand, the decrease of agricultural area causes the decrease of food production that can threaten the food availability and security. In the World Food Summit held in 1996, it was declared that food security is a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [5]. This widely accepted definition points to the following dimensions of food security which are food availability, food access, utilization, and stability [5]. Food production is the main key of food



availability related to demand side. Sufficient food production means the needs of food production will be fulfilled.

The aim of this paper is to identify the spatial pattern of land agricultural changes in the case of West Java Province. West Java Province is one of the main rice producing provinces in Java Island which is also the main rice producing island in Indonesia. In 2004 to 2013, most of the time, West Java Province has produced the largest rice production in Java Island. Not only in producing rice, this province also has a huge potential in producing other food commodities. It is one of 6 cassava production centers in Indonesia and gives high contribution (20%) to national production of sweet potato [6]. Given those backgrounds, this paper will explore the pattern of agricultural land conversion. Agricultural land in this study will be focused only on the land of rice field area.

## 2. Methods

Descriptive statistic using time series data and spatial analysis are the methods applied in this study in order to determine the spatial pattern of agricultural land changes in some period of time. According to ESRI in GIS Dictionary, "*Spatial analysis is the process of examining the locations, attributes, and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge. Spatial analysis extracts or creates new information from spatial data.*" [7]. In the other words, it is a tool to understand patterns and trend of the geographic and temporal relationships among data, phenomena, and issues by mapping where things are, how they relate and what it all means [8]. Moreover, this analysis helps the decision makers to be able to generate policy of what actions to take based on the issues arisen. In this context, agricultural land conversion which is in line with the vast growth of urban areas in the last decade has become a global issue.

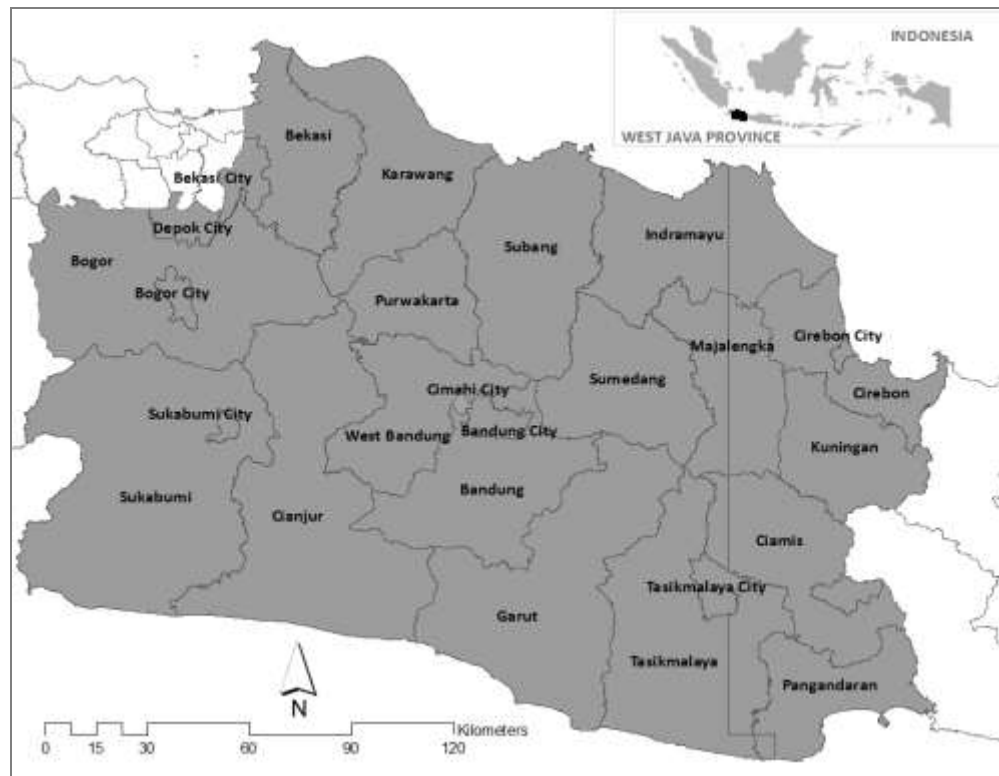
Time series data of agricultural land area were collected from Statistics Indonesia (BPS) in the period of 2005-2014. This time series data was used to be able to observe the patterns of changes occurred during 10 years. Analyses were done in the unit of regency/city in West Java Province. Besides, to be able to demonstrate the spatial pattern, analysis was also done in the context of comparing between metropolitan vs non-metropolitan areas as well as core vs peri-urban areas within 1 metropolitan area, considering the estimation of enormous urban growth in metropolitan areas.

Agricultural land conversion was calculated by using land agricultural area in each regency/city. In this study, agricultural land was assumed from the rice field area which tend to have the biggest area among all crops in West Java Province. Statistics descriptive was used to see the proportion of agricultural land area in each regency/city and was identified using the average variable condition in the period of 2005-2014. In addition to descriptive statistic, spatial analysis was also performed to translate the results of descriptive statistics in order to enrich the findings in the term of spatial context.

## 3. Study Area Context

West Java Province sits within the Island of Java which now has 18 regencies and 9 cities (see Figure 1) in the area of 35.377,76 km<sup>2</sup>. This province accommodates around 43 million populations in 2010 and is estimated to be 57 million populations in 2035. In 2015, this province is categorized as the densest province in Indonesia. Bogor Regency, Bandung Regency, and Bekasi Regency give the biggest contributions of West Java's population which respectively are 11.69%, 7.57%, and 6.95%.

The concentration of population is still clustered around Special Capital Region of Jakarta and the rest of them is mostly concentrated in the Greater Bandung (one of 3 metropolitan areas in West Java Province). Within this metropolitan area, lies the capital city of West Java Province. The Bodebek Karpur and Greater Cirebon are another two metropolitan areas in West Java Province.



**Figure 1.** The map of study area

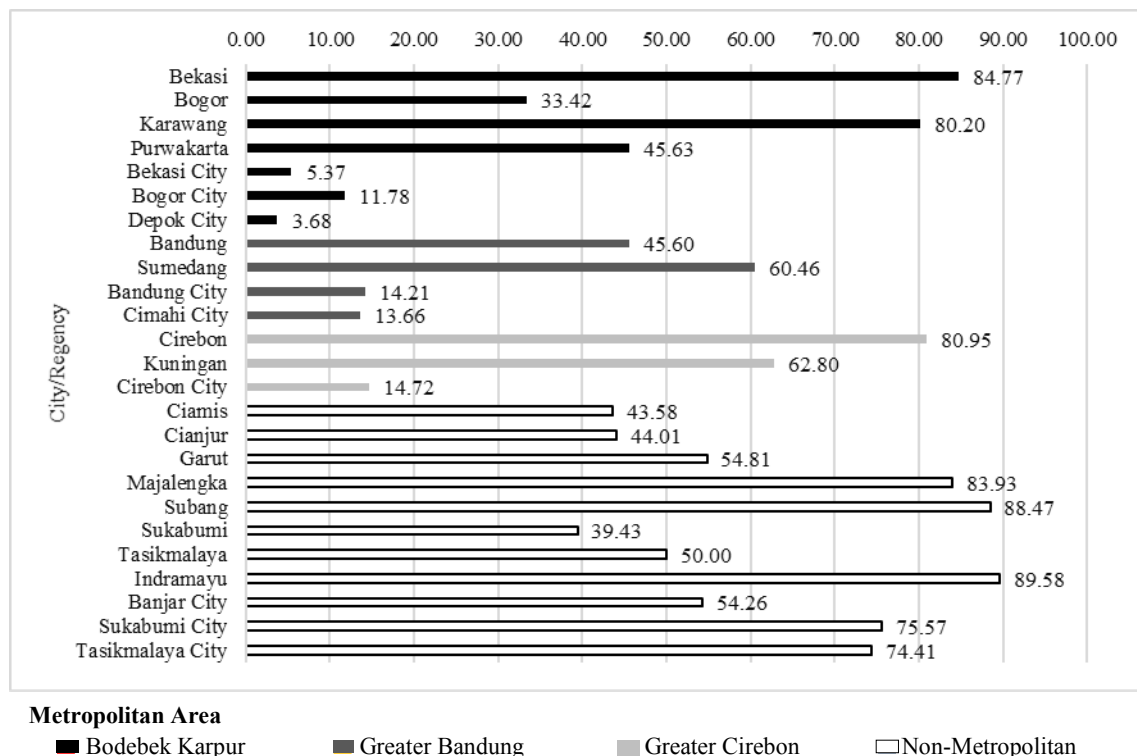
## 4. Results and Discussion

### 4.1 Proportion of agricultural land in each region

Agricultural land area in several regions of West Java Province still has a big percentage of the total area, with the percentage of more than 80% found in Bekasi Regency, Karawang Regency, Cirebon Regency, Majalengka Regency, Subang Regency, and Indramayu Regency. Some of them are the regions categorized as the peri-urban area in the metropolitan area (Bekasi, Karawang, and Cirebon Regencies) and the rest of them are not included in the metropolitan area. Indramayu is the region which has the biggest percentage of agricultural land among others and is also the only region that has legitimated LP2B in the form of its Local Regulation. LP2B (Sustainable Food Agricultural Land) is the agricultural land that has to be consistently preserved, protected, and developed in order to generate food security [9]. This policy is established by the Government of Indonesia in the Act 41/2009 regarding Protection of Sustainable Food Agricultural Land.

On the other side, the smallest percentage of agricultural land which is less than 15% is shown in all cities in West Java Province but Banjar, Tasikmalaya and Sukabumi Cities. Banjar, Tasikmalaya and Sukabumi Cities are not included in the metropolitan area, so that they still have the big percentage of its agricultural area and are still bigger compared to some regencies in the metropolitan area. Most cities in this province have been classified as the core city of its metropolitan area, therefore with its urban activity they tend to have the smallest percentage of agricultural land and also get a very small portion to pursue the mandate of LP2B policy.

Among of all, if we see it in the context of administrative region, the trend of a number of agricultural land area and its percentage to the total area always show the smaller agricultural land area in the city rather than in the regency. This proves the urban phenomenon with the nature of its activity not in the agricultural sector.



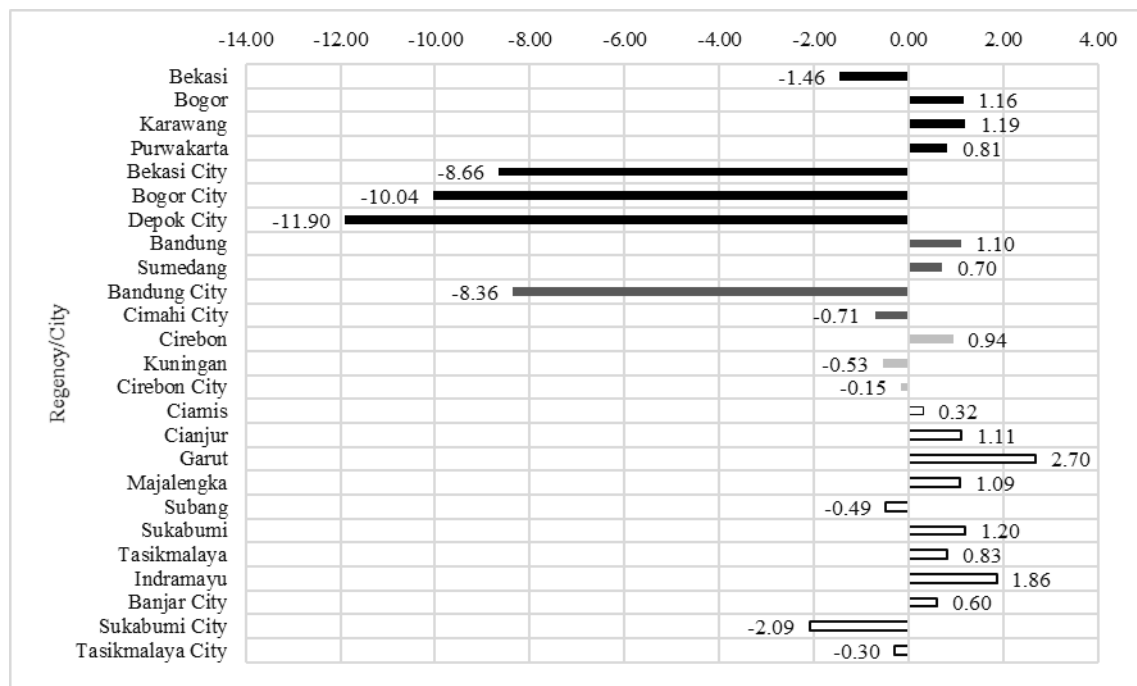
**Figure 2.** The average proportion of agricultural land and total area (%) in 2005-2014

#### 4.2 The changes of agricultural land during 10 years

As shown in Figure 3, the changes rate of agricultural land can be positive and negative. Positive value means that changes direction has increased in the last 10 years, whilst negative value shows declining changes. Overall, only 9 out of 27 regions that experience the decreasing rate of agriculture land, with 6 out of those 9 are cities or the core areas in 3 metropolitan areas of West Java Province. Depok (-11.90%), Bogor (-10.04%), Bekasi (-8.66%), and Bandung (-8.36%) are the cities with the highest declining rate. Garut Regency shows the increasing tendency of 2.70% and becomes the highest position among of all, followed by Indramayu Regency (1.86%).

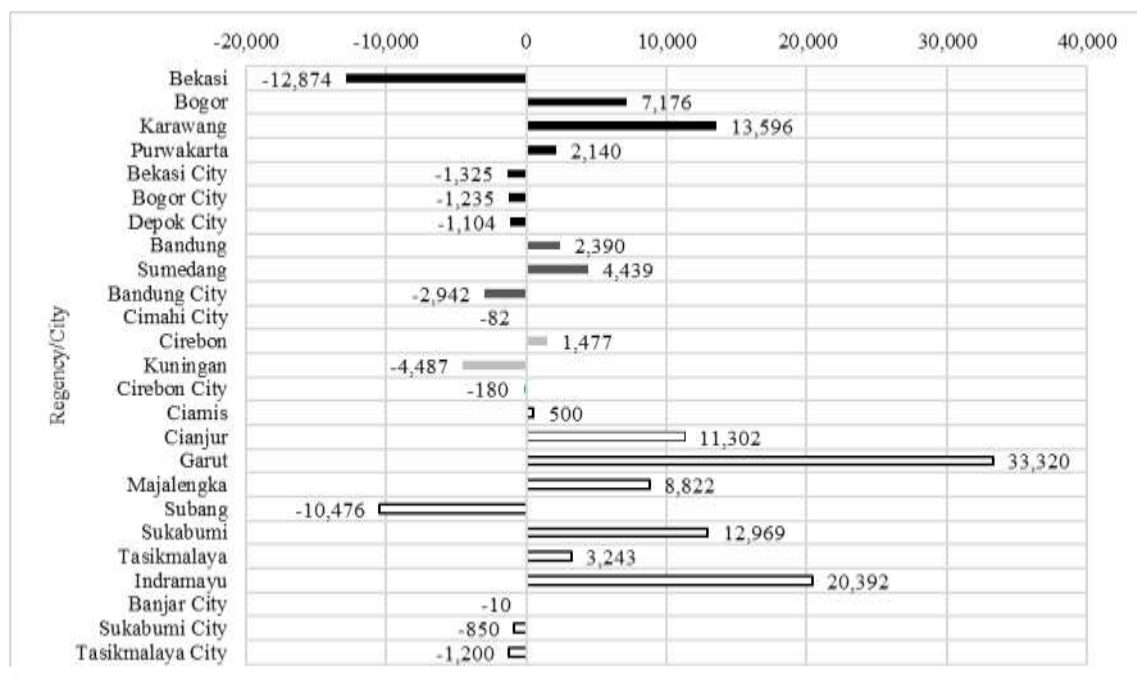
Even though Depok, Bogor, Bekasi, and Bandung are the cities with the highest declining rate of agricultural land, yet if it is seen from its area as shown in Figure 4, they are not the regions with the highest number of agricultural land conversion. The agricultural land conversion in all cities is found less than 3,000 Ha, meanwhile Subang and Bekasi Regencies have the highest conversion which respectively decrease of 10,476 Ha and 12,874 Ha. That can happen due to the trend of the total area of administrative region that tend to be smaller in city compared to regency so that the conversion in the regency is bigger than in the city as well.

It seems that the commitment of protecting LP2B has been implemented by most local government in many regencies. The rise of agricultural land during 10 years results significant numbers especially in several regencies, for instance Garut (33,320 Ha), Indramayu (20,392 Ha), Karawang (13,596 Ha), Majalengka (8,822 Ha), and Bogor (7,176 Ha).

**Metropolitan Area**

■ Bodebek Karpur    ■ Greater Bandung    ■ Greater Cirebon    □ Non-Metropolitan

**Figure 3.** The average rate of agricultural land changes (%) in 2005-2014

**Metropolitan Area**

■ Bodebek Karpur    ■ Greater Bandung    ■ Greater Cirebon    □ Non-Metropolitan

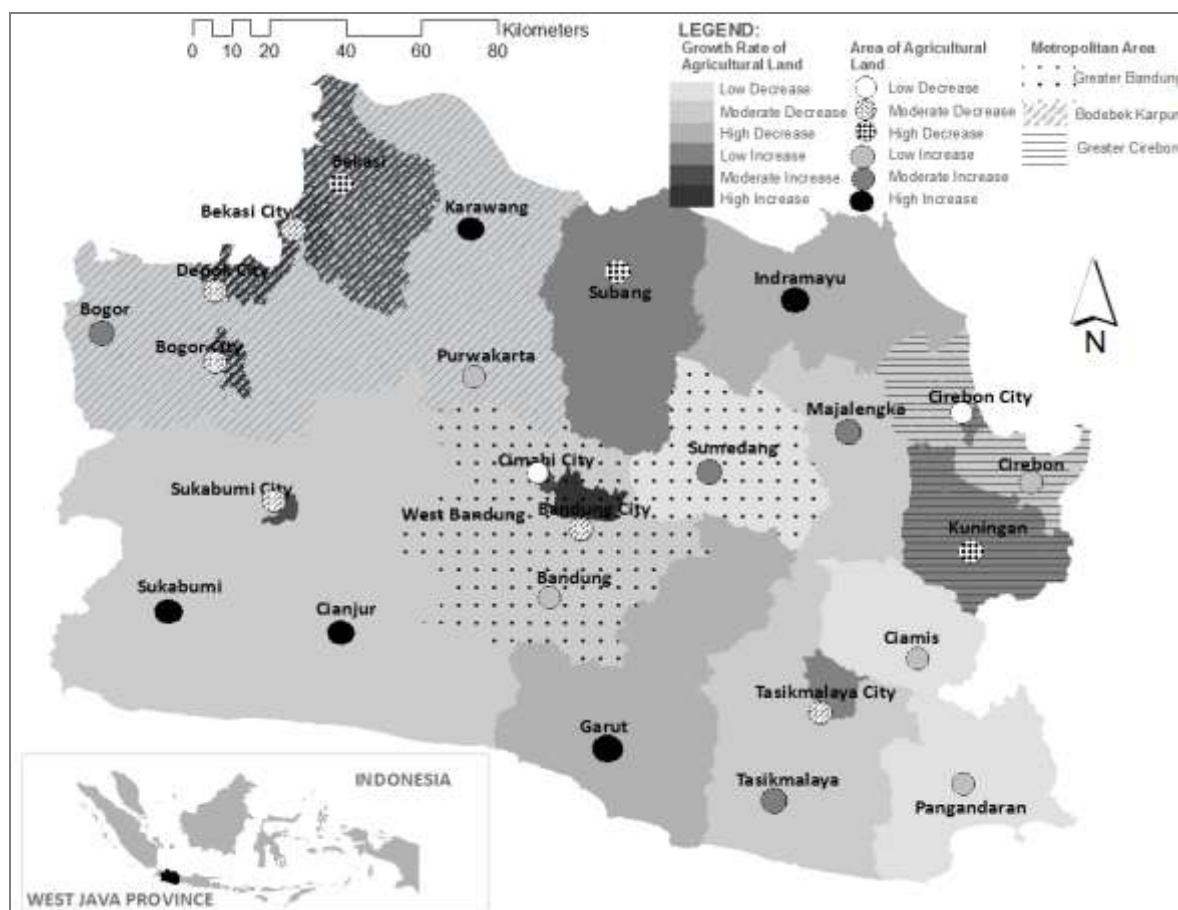
**Figure 4.** Changes of agricultural land area (Ha) from 2005 to 2014



#### 4.3 Spatial pattern of changes in agricultural land

In a spatial analysis, spatial pattern is seen in the context of distribution trend based on classification made for each variable observed. The decrease rate of agricultural land that can be seen as a replaced function from agricultural land into something different mostly occur in the core areas of metropolitan area such as Depok City, Bandung City, Cimahi City, Bogor City, and Cirebon City that is indicated by the moderate and high decrease rate. Besides, this decreasing changes are also found in some regions close to the capital city of Indonesia and West Java Province (DKI Jakarta and Bandung City).

As illustrated in Figure 5, interesting finding is also shown for the south part of this province. All regions in the south part, like Sukabumi, Cianjur, Garut, Tasikmalaya, and Pangandaran Regencies, experience the increase of agricultural land. This condition in the southern part also applies for another variable of total agricultural land conversion (Ha) from 2005 to 2014 with high increase occur in Sukabumi, Cianjur, and Garut Regencies. The decreasing conversion follows the pattern of decreasing rate which mostly happen in the area close to the capital city of Indonesia and West Java Province.



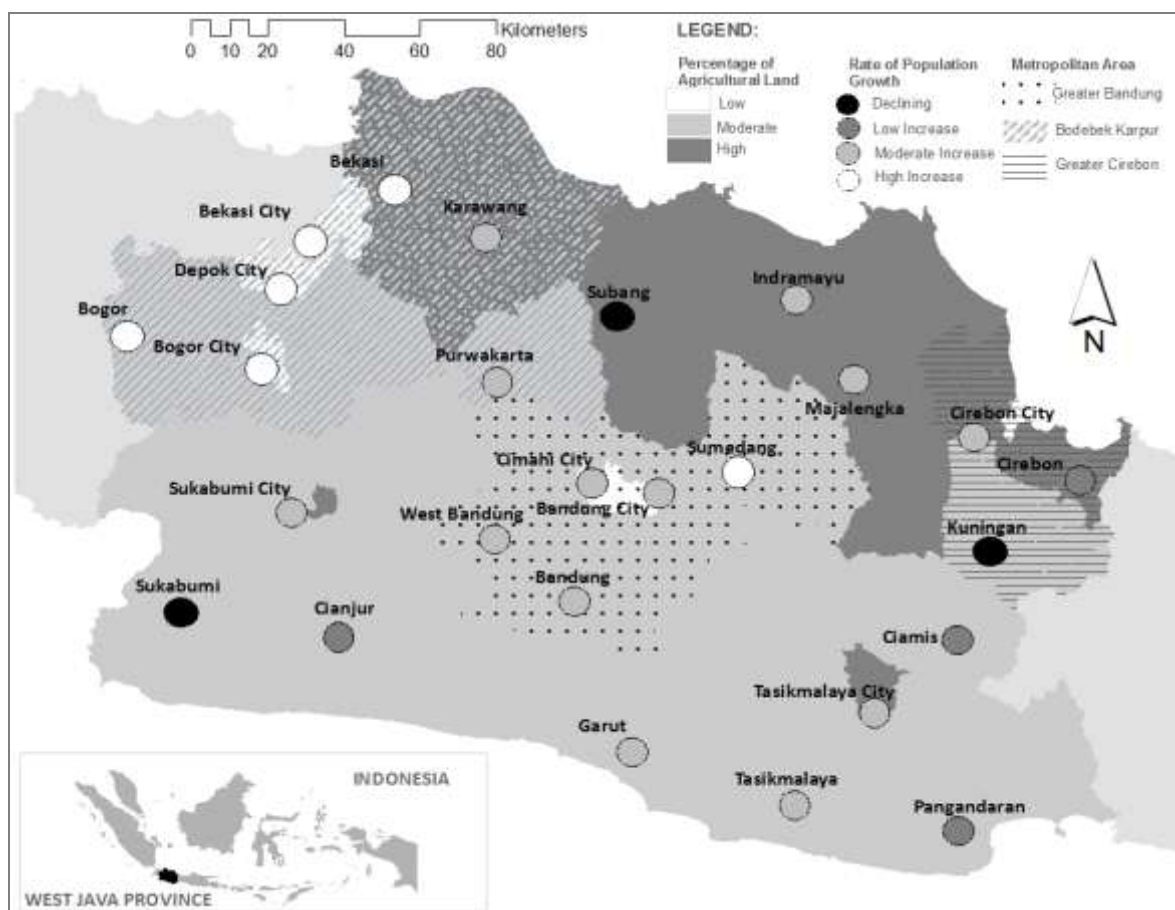
**Figure 5.** The average rate of agricultural land changes (%) and total conversion (Ha) from 2005 to 2014

If we go back to the previous discussion regarding the proportion of agricultural land and its total area, if it is plotted on the map in Figure 6, we can see clearly that there are some patterns in the spatial dimension. Firstly, most of the regions in the northern part of West Java Province, namely Bekasi, Karawang, Subang, Indramayu, Majalengka and Cirebon Regencies, are classified in the level of high proportion. This is in line with the government policy in the Spatial Plan of West Java Province to set the regions in the north coast (Pantura) to encourage preservation and protection of sustainable agricultural land and to prevent it from conversion of built up area. Secondly, it is obvious

that low proportion of agricultural land found in the cities of metropolitan area such as Bandung and Cimahi Cities in the Greater Bandung, Cirebon City in the Greater Cirebon, and Depok City, Bogor City, and Bekasi City in the Bodebek Karpur Metropolitan Area. Thirdly, the rest of the regions are categorized in the moderate level and have no pattern.

The average rate of population shows the pattern of which high increase rate of population growth is experienced mainly by the regions close to the capital city of Indonesia as well as located in the metropolitan area of Bodebek Karpur. Besides this metropolitan, another two do not show some particular pattern and tend to be random. There are also some regencies (Sukabumi, Subang, and Kuningan Regencies) that have declining growth rate, yet until now it is assumed that it happens naturally and do not show a special pattern.

The higher the rate of population growth, the higher the urban growth. Theoretically, the urban growth is supposed to be inversely proportional with the agricultural land. Yet, as it can be seen in Figure 6, that theory does not fully apply in the context of West Java Province. Some regions meet the pattern and some do not, therefore strong correlation between the rate of population growth and the percentage of agricultural land cannot be found in this study. That means, the regions with high proportion of agricultural land does not always have to have declining rate of population growth, and vice versa. There might be other factors affecting all occurrence that are still not covered in this study.



**Figure 6.** The average proportion of agricultural land and total area (%) and the average rate of population growth (%) in 2005 to 2014

## 5. Conclusion

The findings resulted from this study shows some noticeable pattern in the case of agricultural land conversion in West Java Province. First of all, agricultural land conversion in all level (varies widely) tends to be found in the core city of metropolitan area as well as around the capital city of Indonesia and West Java Province (DKI Jakarta and Bandung) such as Depok City, Bogor City, Bekasi City, Cimahi City, and Bandung City as a consequences of urban activities that also requires the land. The regions in the north coast have the highest proportion of agricultural land that is in line with the mandate of Spatial Planning of West Java Province that commit to prevent the agricultural land conversion to protect and preserve sustainable agricultural land as the rice producing centers (locally known as 'lumbung padi') of West Java Province in Pantura. In order to support LP2B policy obliged by the Act 41/2009, all regions in the southern part of West Java Province have been maintaining the agricultural land so that the area of agricultural land from 2005 to 2014 is increased significantly.

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