Map Analysis and Spatial Statistic: Assessment of Spatial Variability of Agriculture Land Conversion at Urban Fringe Area of Yogyakarta

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Abstract. Urban development has brought various effects, one of which was the marginalization of the agricultural sector. Agricultural land is gradually converted to other type of land uses which considered more profitable. Conversion of agricultural land cannot be avoided but it should be controlled. Early identification on spatial distribution and intensity of agricultural land conversion as well as its related factor is necessary. Objective of the research were (1) to assess the spatial variability of agricultural land conversion, (2) to identify factors that affecting the spatial variability of agricultural land conversion. Research was conducted at urban fringe area of Yogyakarta. Spatial variability of agricultural land conversion was analysed using an index called Relative Conversion Index (RCI). Combined of map analysis and spatial statistical were used to determine the center of agricultural land conversion. Simple regression analysis was used to determine the factors associated with the conversion of agricultural land. The result shows that intensity of agricultural land conversion in the study area varies spatially as well as temporally. Intensity of agricultural land conversion in the period 1993-2000, involves three categorie which are high, moderate and low. In the period of 2000-2007, the intensity of agricultural land conversion involves two categories which are high and low. Spatial variability of agricultural land conversion in the study area has a significant correlation with three factors: population growth, fragmentation of agricultural land and distance of agricultural land to the city.

1. Introduction

Urban development has brought various effects, one of which was the marginalization of the agricultural sector (Mazzocchi et al, 2013). The main cause of the marginalization is inequality of profit between sectors. Agricultural sector is deemed unable to give more profit, compared with other economic sectors. The marginalization process occurs gradually, especially in urban fringe or suburban areas. Agricultural land gradually converted to other land uses, which are considered more profitable.

The intensity of agricultural land conversion varies from one location to another. Such variation is thought to have a relationship with several factors. Mazzocchi et al (2013), mentions three factors related to the conversion of agricultural land, particularly in the suburb area. The first factor is the growth of the urban population. According to population projections by ONU Population Division (2009, in Mazzocchi et al, 2013), by 2015 half of the population in developing countries will live in urban areas. The second factor is the spatial factors, especially the distance of agriculture lands to...
The closer the agricultural land to the city, the higher the pressure on the land and so the greater the possibility of land conversion. The third factor is the economic mechanism that controls the value of agricultural land. Agricultural land located in suburban areas, more economically valuable for the development of housing and commercial buildings.

Yogyakarta is widely known as a city with distinct characteristics, so it attracts people from various regions in Indonesia and even foreign countries to come. They stayed for a while, or in a considerable period of time, even permanently. Educational activities and tourism, directly or indirectly, will trigger demand of land for development of facilities and supporting infrastructure. Conversion of agricultural land, particularly in urban fringe area of Yogyakarta, is inevitable. However, the policy makers need to control it. To do this, information on the distribution and spatial patterns of agricultural land conversion is needed. Based on this information, land conversion that occurs intensely in certain areas can be detected earlier, so that the right policy can be formulated. This study attempt to assess the spatial variability of agricultural land conversion at urban fringe area of Yogyakarta and identify its affecting factors.

2. Study Area
The study area was located at urban fringe area of Yogyakarta. According to administrative divisions, the study area are a part of Sleman district and Bantul district. Study area within Sleman district consist of 3 sub-district namely Gamping, Mlati and Depok. Study area within Bantul district also consist of 3 sub-district namely Kasihan, Sewon and Banguntapan. The study area totally covers 28 villages. The location of the study area is shown in Figure 1.

![Figure 1. Location of Study Area](image)

3. Methodology
Spatial variability of agricultural land conversion, in this study was assessed trough map and spatial statistical analysis. The analysis was applied against different type of data, which obtained from various sources. Results of analyses were presented as maps to provide understanding about spatial distribution of agricultural land conversion and spatial clustering as well.
3.1. Data

The data used in this study were area and location of agricultural land conversion, number of population, population growth and distance of agricultural land to the city. Area and location of agriculture land conversion were derived from multi temporal land use maps. Those maps were obtained from 1: 25,000 Indonesian topographic map (RBI) and interpretation of satellite imagaries. Statistical data published by Central Bureau of Statistics (BPS) were used to acquire number of population. The population data is then used to calculate population density as well as annual population growth. Distance of agricultural lands to the City of Yogyakarta were obtained through spatial analysis the so-called proximity analysis.

3.2. Spatial Variability Analysis of Agricultural Land Conversion

Variability of agricultural land conversions were analyzed based on the intensity of such conversion within each village. Intensity of agricultural land conversions was quantified using an index called Relative Conversion Index (RCI). The calculations principle of RCI referring to the Location Quotients LQ analysis techniques, commonly applied in the analysis to determine the level of industrial agglomeration. Formula or equation to calculate the RCI can be written as follows:

\[
\text{RCI} = \frac{R_{Dk}}{R_{Tk}} \quad (1)
\]

\[
R_{Dk} = \frac{A_{Dk}}{A_D} \quad (2)
\]

\[
R_{Tk} = \frac{A_{Tk}}{A_T} \quad (3)
\]

Relative Conversion Index (RCI), is the ratio between the proportion of conversion of agricultural land in each village \(R_{Dk}\), with the proportion of agricultural land conversion in the entire study area \(R_{Tk}\). The proportion of agricultural land conversion in each village \(R_{Dk}\) is the ratio between area of converted agricultural land \(A_{Dk}\) with total area of agricultural land in the village \(A_D\). The proportion of agricultural land conversion in the entire study area \(R_{Tk}\) is the ratio between area of converted agricultural land with total area of agricultural land in the entire study area. RCI values indicate the intensity of agricultural land conversion in a village, relative to other villages in the entire study area. If the RCI value is 1, it indicates that the intensity of the of agricultural land conversion in a village is equal to the intensity of the entire study area. The higher the value of RCI, the higher the intensity of agricultural land conversion.

3.3. Spatial Cluster Analysis of Agricultural Land Conversion

Spatial cluster analysis was performed to identify the spatial center of agricultural land conversion. The spatial statistic technique so-called hot spot analysis was used. The cornerstone of technique is Getis-Ord \(G_i^*\) statistic. Areas of agricultural land conversions for each village were used as input of the analysis. Through this analysis, the existence of hot spots was identified based on area of agricultural land conversion in a village and its surrounding. Getis-Ord statistics are calculated based on the equation or the following formula:
Where $G_i^*$ (pronounced G-i-star) is Getis-Ord statistics, $x_j$ denote area of agricultural land conversion in village $j$, $w_{ij}$ is spatial weight between village $i$ and village $j$, $n$ is total number of villages in study area.

Hot spot analysis provide information about spatial cluster and spatial center of agricultural land conversion in study area. In spatial statistic, a village which has a vast land conversion not necessarily the center of land conversion. The spatial center of land conversion will be the village with a vast land conversion and is surrounded by villages with similar conditions.

3.4. Correlation Analysis

Factors affecting the agricultural land conversion were analyzed using regression techniques. Previous studies were used as reference to identify presumably factors related to the intensity of agricultural land conversion. The intensity of agricultural land conversion, serves as the dependent variable. The number and population growth as well as the distance to the city serves as the independent variable. Simple regression equation can be written as follows:

$$Y = \alpha + \beta X$$  \hspace{1cm} (8)

Where $Y$ denote the intensity of agricultural land conversion, $\alpha$ is a regression constant, $\beta_1$ denote regression coefficients of independent variable $X$.

4. Result and Discussion

4.1. Agricultural Land Conversion at Urban Fringe Area of Yogyakarta

Spatial analysis against maps of agricultural land for years 1993, 2000 and 2007, generate new map referred to as agricultural land conversion maps. There were two agricultural land conversion maps i.e. 1993-2000 map and 2000-2007 map, as shown in Figure 2. Those maps provide an overview about spatial distribution of such land conversions in the study area. Further analysis against those maps, by means of map overlay with administrative division, provide more detail information in terms of area (ha) and proportion (%) of agricultural land conversion for each village. Those information are shown in Table 1.
Figure 2. Spatial distribution of agricultural land conversions 1993-2000 and 2000-2007

Table 1. Area and proportion of agricultural land conversion for each village in the study area

| District | Sub-District | Village       | Agricultural Land Conversion | 1993-2000 (Ha) | (%)  | 2000-2007 (Ha) | (%)  |
|----------|--------------|---------------|-----------------------------|----------------|------|----------------|------|
| Bantul   | Banguntapan  | Banguntapan   |                             | 52.43          | 12.70| 55.07          | 15.49|
|          |              | Baturetno     |                             | 18.79          | 7.03 | 25.98          | 10.45|
|          |              | Jambidan      |                             | 0.00           | 0.00 | 5.5            | 2.25 |
|          |              | Potorono      |                             | 0.52           | 0.19 | 11.78          | 4.38 |
|          |              | Singsosaren   |                             | 3.13           | 10.03| 4.7            | 16.73|
|          |              | Tamanan       |                             | 10.25          | 4.12 | 8.26           | 3.47 |
|          |              | Wirokerten    |                             | 3.14           | 1.03 | 28.87          | 9.65 |
| Kasihan  | Bangunjjwo   |               |                             | 14.96          | 3.48 | 6.4            | 1.54 |
|          | Ngestiharjo  |               |                             | 14.18          | 8.81 | 21.37          | 15.15|
|          | Tamantirto   |               |                             | 16.47          | 5.81 | 6.22           | 2.42 |
|          | Tirtonirmolo |               |                             | 6.28           | 2.42 | 11.36          | 4.56 |
| Sewon    | Bangunharjo  |               |                             | 30.37          | 6.62 | 30.01          | 7.09 |
|          | Panggungharjo|               |                             | 21.58          | 6.96 | 28.78          | 10.09|
|          | Pendowoharjo |               |                             | 10.4           | 2.67 | 6.92           | 1.86 |
|          | Timbulharjo  |               |                             | 5.76           | 0.95 | 34.72          | 5.79 |
| Sleman   | Depok        | Catur Tunggal |                             | 27.28          | 12.41| 39.07          | 20.34|
|          |              | CondongCatur  |                             | 51.59          | 14.21| 50.38          | 16.72|
|          |              | Maguwoharjo   |                             | 43.87          | 6.35 | 57.27          | 9.11 |
| Gamping  |              | Ambarketawang |                             | 10.15          | 3.45 | 6.15           | 2.17 |
|          |              | Balecatur     |                             | 13.17          | 2.97 | 19.38          | 4.55 |
|          |              | Banyuraden    |                             | 8.24           | 3.91 | 19.09          | 9.49 |
|          |              | Nogotirto     |                             | 7.1            | 3.88 | 14.56          | 8.38 |
4.1.1. Relative Conversion Index (RCI). In this study, RCI was used as indicator to assess intensity of agricultural land conversion. The higher the value of RCI, the higher the intensity of agricultural land conversion. RCI values were calculated using several parameters, as already explained in the methodology. Area and proportion of agricultural land conversion for each village, as shown in Table 1, were used as a basis for calculation of RCI. The calculations show the value of RCI in the study area ranged from 0 to 3.02. Detail calculation of the RCI for each village in the study area, are shown in Table 2. It should be noted that not all of the parameters used in calculation are shown in the table.

### Table 2. Relative conversion index (RCI) of agricultural land for each village in the study area

| District | Sub-District | Village | RCI Parameters | RCI |
|----------|--------------|---------|----------------|-----|
| Bantul   | Banguntapan  | Banguntapan | 55.07 355.55 15.49 | 2.20 |
|          |              | Baturetno   | 25.98 248.66 10.45 | 1.48 |
|          |              | Jagalan      | 0.00 0.00 0.00 | 0 |
|          |              | Jambidan     | 5.50 244.19 2.25 | 0.32 |
|          |              | Potorono     | 11.78 269.14 4.38 | 0.62 |
|          |              | Singhosaren  | 4.70 28.09 16.73 | 2.37 |
|          |              | Tamanan      | 8.26 238.30 3.47 | 0.49 |
|          |              | Wirokerten   | 28.87 299.03 9.65 | 1.37 |
| Kasihan  | Bangunjiwo   |           | 6.40 414.73 1.54 | 0.22 |
|          | Ngestiharjo  |           | 21.37 141.02 15.15 | 2.15 |
|          | Tamantirtro  |           | 6.22 257.00 2.42 | 0.34 |
|          | Tirtonirmolo |           | 11.36 249.38 4.56 | 0.65 |
| Sewon    | Bangunharjo  |           | 30.01 423.01 7.09 | 1.01 |
|          | Panggungharjo|           | 28.78 285.16 10.09 | 1.43 |
|          | Pendoowharjo |           | 6.92 372.20 1.86 | 0.26 |
|          | Timbulharjo  |           | 34.72 600.07 5.79 | 0.82 |
| Sleman   | Depok        | Catur Tunggal| 39.07 192.07 20.34 | 2.88 |
|          |              | CondongCatur | 50.38 301.36 16.72 | 2.37 |
|          |              | Maguwoharjo  | 57.27 628.57 9.11 | 1.29 |
| Gamping  | Ambarketawang |           | 6.15 283.72 2.17 | 0.31 |
|          | Balecatur    |           | 19.38 426.09 4.55 | 0.64 |
|          | Banyuraden   |           | 19.09 201.18 9.49 | 1.35 |
|          | Nogotirto    |           | 14.56 173.85 8.38 | 1.19 |
|          | Trihanggo    |           | 36.88 367.23 10.04 | 1.42 |
| Mlati    | Sendangadi   |           | 25.04 302.92 8.27 | 1.17 |
For the purpose of visualization, the RCI values then grouped or classified into three categories using equal interval method. This method was used because standard classification of RCI was not available yet. Table 3 shows the classification of intensity of agricultural land conversion based on the value of RCI. Furthermore, this classification was used to mapping or visualizes spatial distribution of the intensity. Spatial distribution of intensities of agricultural land conversion is shown in figure 3.

**Table 3. Classification of the intensity of agricultural land conversion based on RCI**

| No | RCI       | Intensity of Conversion |
|----|-----------|-------------------------|
| 1  | < 1.01    | Low                     |
| 2  | 1.01 – 2.02 | Moderate               |
| 3  | > 2.02    | High                    |

Figure 3 provide a better visual insight about spatial as well as temporal variability of agricultural land conversion in the study area. High intensity of agricultural land conversion, in the 1993-2000 periods, mostly situated at north eastern part of study area. In the 2000-2007 periods, areas of high intensity grow toward western part of study area.

4.1.2. *Center of agricultural land conversion (hot spot).* The term center of agricultural land conservation in this study was adopted from a spatial analysis method called hot spot analysis. This method is used to identify the presence of spatial clusters of agricultural land conversion. Analysis was performed using two different unit of analysis that are village and point location. Hot spot analysis
Based on Getis-OrdGi*, produce a value referred to as GiZscore (z-score) and GiPvalue (p-value). The GiZscore is the standard deviation which indicates the grouping intensity of the analysed values. In spatial pattern analysis, GiPvalue shows a probability of random spatial patterns. The smaller the value GiPvalue, the less likely random the spatial patterns of agricultural land conversion. Based on GiZscore and GiPvalue, village which significantly regarded as spatial centre of agricultural land conversion could be identified. Significance of analysis was determined using three level of confidence that are 99% (α = 0.01), 95% (α = 0.05) and 90% (α = 0.1). If a village has a GiPvalue less or equal to 0.001 then it could be significantly regarded, at 99% level of confidence, as a spatial center or hot spot agricultural land conversion. Table 4 shows the complete result of village-based hot spot analysis in the study area.

Village-based hot spot analysis revealed interesting pattern about agricultural land conversion in the study area. Hot spot of agricultural land conversion for 1993-2000 periods is slightly different from hot spot for 2000-2007 periods. It can be seen that within 1993-2000 periods, there were three villages which considered as significant hot spot at 95% level of confidence. Those villages were Caturtunggal, Condongcatur, Maguwoharjo and Banguntapan. The first three villages are located in Depok sub district and part of Sleman district, while the last village are part of Bantul District. Using the same level of confidence, there were five villages which considered as significant hot spot within 2000-2007 periods. Those two additional villages were Caturtunggal and Maguwoharjo. It also interesting to note the existence of what so-called cold spot of the conversion within 2000-2007 periods. Those cold spot were located in Bangunjiwo village, part of Kasihan sub district and within Bantul district. Comprehensive information about spatial distribution of village-based hot spots could be seen on maps shown in figure 4.

| District | Sub-District | Village            | 1993-2000 | P2000-2007 |
|----------|--------------|--------------------|-----------|------------|
|          |              |                    | GiZScore  | GiPValue   | GiZScore | GiPValue |
| Bantul   | Banguntapan  | Banguntapan        | 1.490     | 0.136      | 1.284    | 0.199     |
|          |              | Baturetno          | -0.710    | 0.478      | -0.329   | 0.743     |
|          |              | Jagalan            | -0.339    | 0.734      | -0.376   | 0.707     |
|          |              | Jambidan           | -1.967    | 0.049      | -1.607   | 0.108     |
|          |              | Potorono           | -1.942    | 0.052      | -1.343   | 0.179     |
|          |              | Singosaren         | -1.432    | 0.152      | -1.292   | 0.196     |
|          |              | Tamanan            | -0.994    | 0.320      | -1.033   | 0.302     |
|          |              | Wirokerten         | -1.432    | 0.152      | -1.292   | 0.196     |
| Kasihan  | Bangunjwo    |                    | -0.387    | 0.699      | -1.625   | 0.104     |
|          | Ngestiharjo  |                    | -0.783    | 0.434      | -1.287   | 0.198     |
|          | Tamantirtro  |                    | -0.548    | 0.584      | -1.474   | 0.141     |
|          | Tirtonirmolo |                    | 0.369     | 0.712      | -0.898   | 0.369     |
| Sewon    | Bangunharjo  |                    | -1.024    | 0.306      | -0.465   | 0.642     |
|          | Panggungharjo|                    | -0.084    | 0.933      | -0.096   | 0.924     |
|          | Pendowoarjo  |                    | -0.465    | 0.642      | -0.453   | 0.651     |
|          | Timbulharjo  |                    | 0.366     | 0.714      | 0.616    | 0.538     |
| Sleman   | Depok        | Catur Tunggal      | 4.319     | 0.000      | 3.620    | 0.000     |
|          |              | CondongCatur       | 2.544     | 0.011      | 1.757    | 0.079     |
|          |              | Maguwoharjo        | 2.115     | 0.034      | 2.547    | 0.011     |
|          |              | Ambarketawang      | -0.356    | 0.722      | -0.947   | 0.344     |
Factors related to spatial variability of agricultural land conversion

Agricultural land conversion in the study area are varies spatially and that why its referred as spatial variability. Previous researches have indicated that spatial variability of agricultural land conversion has relationship with several factors. Distance to urban area, population growth, and land fragmentation are among of these factors.

### 4.2.1. Distance of agricultural land to urban area.

Study area could be divided into several zone base on certain distance to urban area. In this research, distance to urban area is defined as a distance to Yogyakarta city. Using buffer analysis with 500 m interval, the study areas were divided into 15 zone. Area of agricultural land conversion was calculated within each zone as shown in Table 5. Based on this calculation, relationship between agricultural land conversion and distance to urban area were analysed. The analysis shows, there are strong correlation between distance of agricultural land to urban area and the intensity of conversion, i.e. area of agricultural land conversion ($R = 0.915, R^2 = 0.837$). The closer the agricultural land to urban area, i.e. Yogyakarta city, the higher the intensity of conversion. Figure 5 shows graphic correlation between distance to urban area or city and the intensity of agricultural land conversion.

| Zone | Distance to City (m) | Agr. Land Conversion (Ha) | 1993-200 | 2000-2007 |
|------|---------------------|--------------------------|----------|-----------|
| 1    | 500                 | 69.48                    | 104.08   |
| 2    | 1,000               | 70.49                    | 77.41    |
| 3    | 1,500               | 70.85                    | 73.99    |
| 4    | 2,000               | 45.05                    | 82.94    |
| 5    | 2,500               | 47.24                    | 65.75    |
| 6    | 3,000               | 66.38                    | 46.75    |
| 7    | 3,500               | 31.09                    | 45.23    |
| 8    | 4,000               | 27.37                    | 62.43    |
| 9    | 4,500               | 28.37                    | 35.79    |
| 10   | 5,000               | 44.28                    | 27.5     |
| 11   | 5,500               | 10.08                    | 9.97     |
| 12   | 6,000               | 8.64                     | 24.83    |
| 13   | 6,500               | 7.47                     | 29.42    |
| 14   | 7,000               | 1.33                     | 10.43    |
| 15   | 7,500               | 0.27                     | 0.56     |
4.2.2. Population. Demographic condition in the study area is considered dynamic in general. During 1993-2007 periods, number of population had increased significantly. Analysis against population data shows, the number of population increased by 47,039 during 1993-2000 periods while during 2000-2007 periods it’s increased by 55,094. Detail information about population in the study area are shown in Table 6. Population growth in the study area considered has relation with the intensity of agricultural land conversion. Degree of correlation between population and intensity of agricultural land conversion is considered moderate (R = 0.592, R² = 0.352). The conversion of agricultural land tends to be more intense as population increase. Graphic correlation between population and agricultural land conversion is shown in figure 5.

| District | Sub-District | Village  | Population 1993 | Year 2000 | Year 2007 | Population Growth 1993-2000 | Population Growth 2000-2007 |
|----------|--------------|---------|-----------------|-----------|-----------|-----------------------------|-----------------------------|
| Bantul   | Banguntapan  |         | 22,281          | 24,767    | 32,618    | 2,486                       | 7,851                       |
|          | Baturetno    |         | 8,571           | 9,874     | 11,863    | 1,303                       | 1,989                       |
|          | Jagalan      |         | 3,275           | 3,365     | 3,466     | 90                          | 101                         |
|          | Jambidan     |         | 7,040           | 7,508     | 7,938     | 468                         | 430                         |
|          | Potorono     |         | 7,964           | 8,872     | 9,977     | 908                         | 1,105                       |
|          | Singosaren   |         | 2,338           | 2,659     | 3,136     | 321                         | 477                         |
|          | Tamanan      |         | 7,330           | 7,876     | 8,525     | 546                         | 649                         |
|          | Wirokerten   |         | 8,059           | 9,016     | 10,713    | 957                         | 1,697                       |
| Kasihan  | Bangunjio    |         | 17,223          | 18,916    | 20,585    | 1,693                       | 1,669                       |
|          | Ngestiharjo  |         | 20,789          | 24,138    | 26,265    | 3,349                       | 2,127                       |
|          | Tamantirto   |         | 13,224          | 14,264    | 15,421    | 1,040                       | 1,157                       |
|          | Tirtonirmolo |         | 16,500          | 17,938    | 19,107    | 1,438                       | 1,169                       |

**Figure 4.** Spatial distribution of village-based hot spot of agricultural land conversions
| Village         | Area (Ha) 1 | Area (Ha) 2 | Area (Ha) 3 | Area (Ha) 4 | Area (Ha) 5 |
|-----------------|-------------|-------------|-------------|-------------|-------------|
| Sewon Bangunharjo | 17,079     | 17,631     | 18,723     | 552         | 1,092       |
| Panggungharjo    | 20,413     | 22,672     | 25,505     | 2,259       | 2,833       |
| Pendowoharjo     | 15,807     | 17,096     | 18,378     | 1,289       | 1,282       |
| Timbulharjo      | 15,833     | 16,344     | 16,718     | 511         | 374         |
| Sleman Depok Catur Tunggal | 47,411 | 53,978 | 60,045 | 6,567 | 6,067 |
| Condong Catur    | 27,586     | 31,502     | 34,574     | 3,916       | 3,072       |
| Maguwoharjo      | 20,097     | 23,612     | 26,686     | 3,515       | 3,074       |
| Gamping Amarketawang | 14,396  | 16,200     | 18,781     | 1,804       | 2,581       |
| Balecator        | 12,148     | 13,614     | 16,256     | 1,466       | 2,642       |
| Banyuraden       | 9,721      | 10,854     | 12,692     | 1,133       | 1,838       |
| Nogotirto        | 11,361     | 12,924     | 14,650     | 1,563       | 1,726       |
| Trihanggo        | 11,471     | 12,196     | 13,096     | 725         | 900         |
| Mlati Sendangadi | 10,192     | 10,722     | 11,061     | 530         | 339         |
| Sindoadi         | 23,140     | 27,381     | 31,824     | 4,241       | 4,443       |
| Sumberadi        | 10,515     | 11,272     | 11,979     | 757         | 707         |
| Tirtoadi         | 7,523      | 7,960      | 8,387      | 437         | 427         |
| Tlogoadi         | 8,527      | 9,702      | 11,078     | 1,175       | 1,376       |

4.2.3. Fragmentation of agricultural land. Agricultural land considered fragmented if separated parcel owned by single ownership. In more technical manner, fragmentation exists if there are so many small polygon with the same characteristic exist, i.e. polygon of agricultural land. This technical definition was used in this study because data of parcel ownership was not available or difficult to be obtained. This study used patch density, which is known as a measure of landscape metrics, to measure agricultural land fragmentation. Patch density was calculated using village as a basis of calculation. Further analysis shows the relationship between patch density and the intensity of agricultural land conversion. The correlation considered strong enough ($R = 0.624$, $R^2 = 0.389$). Fragmented agricultural land is more susceptible to be converted to other uses. Graphic correlation between patch density, as a measure of land fragmentation, and agricultural land conversion is shown in figure 5.
5. Conclusion

Conversion of agricultural land cannot be avoided but it should be controlled. Spatial distribution and intensity of the conversion should be identified early, so that appropriate policy could be formulated. Map analysis and spatial statistic can be utilized to obtain information related to spatial variability of agricultural land conversion. This kind of spatial analysis provides a better visual insight about spatial as well as temporal variability. During temporal framework of this study, which is 1993 to 2007, conversion of agricultural land had taken place in various locations. Instead of using absolute location as well as absolute quantity, this study use what so called relative conversion index (RCI) and spatial cluster or hot spot, to provide quick spatial understanding related to distribution of agricultural land conversion. Significant spatial cluster of agricultural land conversion were located in north eastern part of the study area. Policy maker related to land use, has to pay more attention to those area particularly in relation to fragmentation of agricultural land. Fragmented agricultural land is susceptible to be converted to other uses.

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