Urban Population Growth and Their Implication to Agricultural Land in the Process of Metropolitanization: The case of Kabupaten Sukoharjo, in Metropolitan Surakarta

F H Mardiansjah¹, A Sugiri², G P Sari³

¹²³ University of Diponegoro, Prof. Soedarto St., SH, Tembalang, Semarang, Central Java, Indonesia

*Email: fadjar.mardiansjah@pwk.undip.ac.id

Abstract. Extended urban spatial formation has been a major phenomena in many cities’ development, in Indonesia, including big, medium and smaller size of cities. Using the case which occurred in the Kabupaten Sukoharjo, an adjacent kabupaten of the City of Surakarta, this paper discusses the process of population growth, land expansion and their impact on the agricultural land outside the city’s perimeter, in the metropolitanization process of Surakarta as a secondary metropolitan growth in Java based on a medium city size as the core of the metropolitan. The analysis applies time-serial statistical data gathered from the kabupaten’s monographs. It also applies comparative analysis among the kecamatan (districts) in the kabupaten that are classified into two types of kecamatan: the adjacent and the non-adjacent. The analysis indicates a dramatic changing of urban land, which confirmed the impact of uncontrolled urbanization into agricultural land in the peripheries in terms of losing of fertile agricultural land. It also indicates that the process leads to the needs to develop other agricultural land to substitute the loss of fertile agricultural land. Therefore, the analysis indicates the double impacts of metropolitanization process into agricultural land, such as: the loss of fertile agricultural land in its peri-urban and the implication of efforts in producing fertile land in other areas.

Keywords: land conversion, metropolitanization, peri-urban, population growth, Sukoharjo, Surakarta.

1. Introduction

As happening in many developing countries, Indonesia has also experienced a tremendous urbanization process that brings many challenges and problems in the management of its cities. According to a report in CICRED Series, The Demography Institute of the University of Indonesia [1], it is predicted that urban population in Indonesia was about 14.4 million in 1961. It was about 14.8% of the total population [1]. The number has increased to 85.24 million in 2000 that represented about 41.9% of the total population [2]. Later, Indonesia has achieved the key milestone of its urban population growth by exceeding the 50 per cents of the percentage of population living in urban areas for the first time in history in 2012 [3]. Further, Indonesia is predicted to have about 135.6 million urban populations, amounting to 53.1% of Indonesian population, according to the result of Intercessal Population Survey in 2015. Higher growth of urban population occurred since 1970s, after Indonesia
entered into a new scheme of development efforts that was called as the New Order Era. The number of urban population in 2015 has become about six and half times of its number in 1971. In this identifiable time, Indonesia had nearly three million additional urban populations annually.

However, similar to the total population, urban population has not been distributed evenly in Indonesia. Java, as the smallest of the five biggest islands in Indonesia, which only has 7% of the national land area, accommodates 56.8% of the country’s population. It also becomes the home for 67% of its urban population. The huge number of population lives in Java has made the island as the most densely populated in the country. In 2015, the density of Java was 1,120 inhabitants per square kilometer. It is much denser than Bali and Nusa Tenggara, the second most densely populated region, which has density to 193 inhabitants per square kilometer, and the average density of the country covers 130 inhabitants per square kilometer.

**Table 1. Distribution of urban and total populations among regions in Indonesia, 2015**

| Regions          | Area Share | Urban Population Share | Total Population Share | Total Pop. | % Urban |
|------------------|------------|------------------------|------------------------|------------|---------|
| Java             | 7.0%       | 67.0%                  | 56.8%                  | 62.60%     |
| Sumatra          | 26.2%      | 16.8%                  | 31.6%                  | 21.6%      | 41.40%  |
| Sulawesi         | 10.3%      | 5.1%                   | 7.3%                   | 36.90%     |
| Kalimantan       | 25.5%      | 5.1%                   | 6.0%                   | 44.80%     |
| Bali & Nusa Tenggara | 4.0% | 4.4%                   | 5.5%                   | 42.60%     |
| Papua            | 22.8%      | 0.9%                   | 1.6%                   | 29.70%     |
| Maluku           | 4.3%       | 0.7%                   | 1.1%                   | 34.90%     |
| Indonesia        | 100.0%     | 100.0%                 | 100.0%                 | 53.10%     |

Sources: Calculated from SUPAS data, 2015.

With the high density of population, Java becomes a fertile land for urban population development. Two-thirds of the national population increase occurs in Java as two-thirds of the national urban population living on Java. In 1990s, urban population growth in Java in 1980-1990 was concentrated dominantly in north coast of Java [4], especially in the corridor between Jakarta to Semarang. In 2016, the distribution has become more dispersed as the occurrence of in-situ urbanization creating the gradual change of many Javanese villages from non-urban villages to urban villages [5]. The spatial distribution of urban population growth has also been characterized by the continuing process of mega-urbanization as the high growth of urban population in the outskirts of the Javanese big cities with more than one million populations such as in Jakarta, Surabaya, Bandung and Semarang [5].

The extended urban formation in the urbanization process in Java has not occurred in its big cities but also in its much smaller cities [6]. The case of Cirebon Urban Area of West Java, a metropolitan area that is formed by Municipality Cirebon, where a 300 thousand population city size as the core area, and Kabupaten Cirebon as the peripheries of the metropolitan has been one of the evidences [6]. The growth of urban population in Java has not only occurred in big city based urban regions, but also in many urban regions based on smaller cities like Malang and Tegal [7]. In fact, urban population growth has not only occurred in the Javanese cities (daerah kota or urban districts) but also in many Javanese kabupaten (non-urban districts), especially in the outskirts of big, medium and small cities in Java, including in some kabupaten that are not neighboring to any city in Java [7].

There are many studies and analyzes that have been carried out on urbanization and metropolitanization focusing on large metropolitan areas in Indonesia, such as on Metropolitan Jakarta [8] [9] [10] and [11] and Metropolitan Bandung [12] [11] and [13]. However, there are still very few
studies conducted on smaller urban regions in Indonesia. There is a study on the Cirebon Urban Region, attempting to explore the urbanization process in much smaller city in Java [6].

This article aims to discuss population growth in periurban area of medium size metropolitan in Indonesia, using the case of the periurban of Metropolitan Surakarta, a medium size metropolitan in Java. It is expected to contribute to the discourses of urbanization and metropolitanization in Java. The small-and-medium-city-size-based urbanization process in Java is very important to be understood. In addition to its condition that is still under-explored, the importance raises also because small and medium cities are the dominant type of cities in Java playing important roles in Javanese regional development as well as improving linkages to the agricultural and non-urban activities.

This article will be presented in several sections that elaborate the impact of population growth in Sukoharjo Regency, the implications of the development in built land and its effect on the availability of agricultural land. Following this introduction, an analysis of the population growth of the district will be carried out. Further, the analysis on the growth of urban land will be presented, followed by the analysis on the reduction on agricultural land, especially in paddy fields. Later, after a general discussion on the topic, the last part will be a conclusion and recommendation.

2. Data and Methods
This research utilizes the case of urban growth that occurs in Kabupaten Sukoharjo, one of three bordering kabupaten in the outskirt of Surakarta City, which has the longest border with the city compared to the other two. The kabupaten bordering on eight kecamatan (sub-districts) in the south of the city. The elaboration applies the secondary data to explain the process of population growth in the suburbs of the metropolitan as well as its relation to the growing built-up area and the conversion of agricultural land into the built-up ones. Data used in this research are compiled from monographs of the kabupaten, especially on population and land uses, such as: in built-up and agricultural land (paddy fields and farm land). Data analysis is gathered in the kecamatan (sub-district) units, classified into two groups of: the adjacent kecamatan for those are bordering to Surakarta City, and the non-adjacent kecamatan for the rest. The research employs a time serial analysis in order to perform spatial-temporal comparisons.

3. Result and Discussion
3.1. Population Growth in Kabupaten Sukoharjo
Population of the kabupaten has grown from 695,732 in 1990 to 875,917 in 2015. Meanwhile, urban population of this kabupaten has grown more rapid, from 126,811 in 1980 to 632,367 in 2010 [15]. Population growth before 2000 has been higher than after, and the period from 1995 to 2000 has the highest population growth among other periods. The more rapid urban population growth has led the kabupaten into an urbanized kabupaten in 1990s with a jump in the level of urbanization from only 21.3% in 1980 into 76.7% in 2010 [15]. Eight of its kecamatan have been classified as urbanized kecamatan in 2010. All of the kecamatan in adjacent areas have become urbanized kecamatan, and only Kecamatan Gatak that has started to be an urbanized kecamatan since 2000, while the others have been urbanized since 1990 or before. Kecamatan Sukoharjo, Bulu and Bendosari are the three kecamatan of the non-adjacent areas that also have been urbanized since 2000.

The kabupaten had about 10,755 additional populations annually in which Kecamatan Kertasura and Grogol had more than 2,500 annual additional populations each. The population growth rate has been different among areas in the kabupaten. Although they have less population, the adjacent areas faced more rapid population growth than the other areas. Kecamatan Grogol, Kertasura and Mojolaban had been always the top three kecamatan in receiving additional populations annually. Two third additional populations of the kabupaten occur in the adjacent areas, with the Kecamatan of Grogol, Kertasura and Mojolaban are the place where the growths are more concentrated. In temporal pattern, population growth in the adjacent areas has very similar pattern to the kabupaten. The different was only in the magnitude that was higher than that of the kabupaten. Even, population
growth rates of these areas have been higher than that of Kecamatan Sukoharjo, the capital of the kabupaten. The more far areas from the border with Surakarta City have lower population growth.

![Population densities in 1990 and 2015](image)

**Figure 1.** Change in population density of the kecamatan 1990 – 2015 (in pop./sq.km.).

The concentration of population growth in the adjacent areas has increased population density of all kecamatan in the areas, so their density are much higher than those of non-adjacent ones (see Figure 1). Even, Kecamatan Kertasura and Grogol have very big leap from 1990 to 2015 that has made their density double than before. Meanwhile all kecamatan in the non-adjacent areas had still less than 1500 population per square kilometer. Kecamatan Sukoharjo and Kecamatan Polokarto of these areas, which are located not too far from Surakarta, still have significant increases, but some kecamatan, like Bulu, Nguter, Weru and Tawangsari that are located more far than the others have decreasing population density along the observed period.

### 3.2. The growing built-up areas in Kabupaten Sukoharjo

The growing population in the kabupaten has also increased its built-up areas from 14.285 hectares in 1990 to 16.676 hectares in 2015, so the kabupaten had an increase of 2,391 hectares of built-up areas to accommodate 180,185 additional populations in the period. The increase was a huge since the additional built-up land was more than half of the area of Surakarta City, the core of the metropolitan area, which has about 500 thousand populations. This indicates that urban growth in the kabupaten was extensive although the average built-up land consumption per population in the kabupaten has decreased from 205 m$^2$ per person in 1990 to 190 m$^2$ per person in 2015, which still more than three times of those in Surakarta that has decreased from 65.2 m$^2$ in 1990 to 56.2 m$^2$ in 2015.

The densification process in the adjacent areas has occurred in a more intense than in the non-adjacent ones. Figure 2 shows that Kecamatan Grogol of the adjacent areas became the kecamatan that faced highest increase with 672 hectares increase along the period to accommodate 39,396 additional populations. Kecamatan Nguter of the non-adjacent areas faced the second highest increase of 409 hectares although its population increase was very little (only 96 additional population) as in 1995 to 2000 this kecamatan faced a significant decreasing population. However, it is interesting to know that most of all kecamatan in the adjacent areas have big increase of built-up land, while the kecamatan in the non-adjacent areas have much less increase. Kecamatan Grogol, Kecamatan Kertasura and...
Mojolaban have more than 250 hectares of increase each, while Baki and Gatak have 200 and 107 hectares of increase respectively. These situations indicate that the adjacent areas have become the main area of urban growth in the kabupaten.

Figure 2. Increase of built-up land in every kecamatan 1990 – 2015 (in hectares).

The highest annual increase of built-up land occurred in 2010 to 2015 with an increase of 123.6 hectares of built-up land per year, although the additional population in this period has become more moderate to less than 6000 population annually. It was different with that of the annual increase of population that was in 1995-2000, with an average of 10,755 populations per year. The two classification areas have different time of the highest average increase of built-up land. The adjacent areas had the highest increase in 1990 to 2005 when they got about 70.9 hectares additional built-up land per year with Kecamatan Grogl as the main area of the increase with an average of 35.5 hectares per year. The increase in the adjacent areas has been slowing down in the next periods, even though they were still high as they have 69.2 hectares annually in the period of 2010-2015. The non-adjacent areas had different pattern that shows an increasing annual increase according the time. Therefore the latest period, 2010-2015, was the period with the highest annual increase in the non-adjacent areas with Kecamatan Nguter has become the main area of the increase.

3.3. Reduction of paddy fields in Kabupaten Sukoharjo between 1990 into 2015
The increasing in built-up in the kabupaten has been followed by the reduction of paddy fields and farmland significantly. The kabupaten lost at least 1,732.0 hectares of paddy fields in the periods. However, since the kabupaten has also developed some new paddy fields, especially in the non-
adjacent areas, the reduction of paddy fields was ‘only’ 1,093.0 hectares. Within the loss of paddy fields, there are include the loss of 1,407.0 hectares of paddy fields with technical irrigation systems, the best agricultural land to raise paddy rice since they usually could be cultivated three times per year as they could arrange their irrigation.

Table 2. Changes of land uses in Kabupaten Sukoharjo from 1990 to 2015 (in hectares)

| Kecamatan       | A     | B      | C      | D      | E      | F      | G      |
|-----------------|-------|--------|--------|--------|--------|--------|--------|
| Kartasura       | 259.0 | -266.0 | -266.0 | 0.0    | 0.0    | 0.0    | 0.0    |
| Gatak           | 107.0 | -83.0  | -83.0  | 0.0    | 0.0    | 0.0    | -2.0   |
| Baki            | 200.0 | -190.0 | 444.0  | -616.0 | 0.0    | -2.0   | -3.0   |
| Grogol          | 672.0 | -509.0 | -476.0 | -110.0 | 273.0  | -73.0  | 21.0   |
| Mojolaban       | 252.0 | -197.0 | -153.0 | -28.0  | 0.0    | -9.0   | -16.0  |
| Adjacent Areas  | 1,490.0 | -1,245.0 | -534.0 | -754.0 | 273.0  | -84.0  | 0.0    |
| Sukoharjo       | 91.0  | -328.0 | -328.0 | 0.0    | 0.0    | 0.0    | -28.0  |
| Bendosari       | 82.0  | -124.0 | -101.0 | 294.0  | 0.0    | -317.0 | -48.0  |
| Polokarto       | 228.0 | 22.0   | 28.0   | -10.0  | 318.0  | -143.0 | -203.0 |
| Tawangsari      | 90.0  | 34.0   | 1,484.0| 0.0    | 165.0  | -1,303.0| -371.0 |
| Nguter          | 409.0 | 33.0   | 416.0  | -258.0 | 669.0  | -457.0 | -437.0 |
| Weru            | -8.0  | 550.0  | 1,082.0| -10.0  | 511.0  | -225.0 | -755.0 |
| Bulu            | 9.0   | -35.0  | 385.0  | -193.0 | 8.0    | -183.0 | -519.0 |
| Non-Adjacent Areas | 901.0 | 152.0  | 2,966.0| -177.0 | 1,671.0| -2,628.0| -2,361.0|
| Kabupaten Sukoharjo | 2,391.0 | -1,093.0 | 2,432.0| -931.0 | 1,944.0| -2,712.0| -2,361.0|

Sources: Results of the analysis, 2019.
Notes: A: built-up land.
B: paddy fields.
C: paddy fields with technical irrigation systems.
D: paddy fields with half-technical irrigation systems.
E: paddy fields with simple irrigation systems.
F: paddy fields without any irrigation systems.
G: farm land

The adjacent areas was the place where the loss of technical irrigation system of paddy fields has dominantly occurred, as the areas has not many farmland as well as other low quality paddy field anymore since 1990, so most agricultural land conversion in these areas occurred by consuming their paddy fields. It was about 978.0 hectares in the adjacent areas and another 429.0 hectares in the non-adjacent ones. However, since the kabupaten has also did some efforts in transforming other paddy fields to create 3,395 hectares of paddy fields with technical irrigation systems, mostly in the non-adjacent areas, the kabupaten has not experienced reduction in its paddy fields with technical irrigation systems. Therefore, it could be said that the kabupaten had a double impacts in these phenomena, in which it had some loss of investments with the loss of its paddy fields with the technical irrigation systems in the adjacent areas, and it has to invest a lot more again to create new paddy fields with technical irrigation systems in the non-adjacent areas to replace the previous loss.

Another land use change pattern occurred in the non-adjacent areas. The increase of built-up land in these areas was not followed by reduction in the paddy fields. Instead of deceasing, the paddy fields in these areas have also been increasing, including the paddy fields with technical irrigation systems. The big creation of new paddy fields including those with irrigation systems, especially in Kecamatan Tawangsari and Weru, and also in Kecamatan Baki, Nguter and Bulu, has replaced the loss of paddy
fields in the kabupaten, so the kabupaten does not seem to have some loss of their paddy fields, including those with the technical irrigation systems (see Table 2.).

Another interesting phenomenon occurred in the kabupaten is the facts that the increasing paddy fields with irrigation systems is not only followed by decreasing of other type of paddy fields especially those without irrigation systems, the lowest quality of paddy fields since they are highly depend on the rain water as the source of their irrigation, but also is followed by very significant decrease in their farmland. The very big decrease of paddy fields without any irrigation systems and farmland in these areas has coincided with the very significant increase in the paddy fields with technical irrigation systems and the paddy fields with simple irrigation systems. These phenomena indicate that the big loss of paddy fields with technical irrigation systems in the kabupaten has been responded by the improvements of other agricultural lands in the context of creating new paddy fields in order to maintain the rice production, the main staple food of the nation.

3.4. Implication of population growth in periurban areas in Kabupaten Sukoharjo
The phenomena occurred in Kabupaten Sukoharjo shows that population growth in a medium metropolitan’s peripheries leads to influence the availability of agricultural land in several ways. The population growth into the peripheries that could be said as an extension of the urban growth to the peri-urban areas, the extension of urban growth become a predator to agricultural land, including their best quality like the paddy fields with technical irrigation systems. The conversion patterns in the peri-urban areas occurred in two pattern. The first is the agriculture-to-urban land conversions, stimulated by urban growth that consumed agricultural land, including the best paddy fields, to create into built-up lands as the place for the growing urban activities. The second conversion is the agriculture-to-agriculture land conversion stimulated by the losses of best agricultural land (paddy fields including those with technical irrigation systems) that convert lower quality agricultural land into better ones, which occurred in two patterns: the conversion of low quality of irrigated paddy fields into the technical irrigation systems paddy fields; and the conversion of farmlands and paddy fields without irrigation systems into better quality of paddy fields including those with technical irrigation systems. If the first conversion pattern could be said as the implication of meeting the need of population growth, the second conversion is the implication of maintaining the areas’ capacities in producing food by improving their available agricultural lands to become better quality agricultural land in producing food.

4. Conclusion
In conclusion, the case of population growth in the peri-urban of metropolitan areas in Kabupaten Sukoharjo presents an interesting interaction process between urban population growths and land use conversions. The growth of population in the agricultural peri-urban areas leads to the consumption of agricultural land resources, including the most valuable agricultural land, which later leads to the situation in which the peri-urban region needs to find the way to replace the lost agricultural land resources in other parts of the region.

In the growth management point of view, these situations could be considered an indication of weak growth management system in which the peri-urban region tend to eliminate its important resources somewhere in meeting the needs of their growing population, which stimulate to increase their needs to develop their remaining important agricultural land resources in order to maintain their capacity in food production. Therefore, in this context, peri-urban growth or the urbanization process in the fringe areas needs to have better and comprehensive approaches in managing their land resources.

Acknowledgement
We thank the Faculty of Engineering, Universitas Diponegoro, for the funding of this research through the Competitive Grants on Strategic Research of RKAT Funds in the Budget Year of 2018 (Contract no. 2687/UN7.3.3/PG/2018).
References

[1] CICRED 1974 *The Population of Indonesia*: 1974 World Population Year Available from: http://www.cicred.org/Eng/Publications/pdf/c-c24.pdf

[2] BPS 2001 Population of Indonesia: Result of the 2000 Populstion Census Series: L2.2 Available from: https://www.bps.go.id/publication/download.html?nrbyfeve=YjgzZTQwODI2OGYwYmFmMDQ0ZGQ4Mjli&xzmn=aHR0cHM6Ly9vZi9zdG9yeS9saXZlLWZvY3NzLW15LWNsZXRlcy1wYXluZ3Rlci1jZG4tMjBzLW5ld3Mtd29yZ2xlLmMucGxhY2U=

[3] Jones and Mulyana 2015 Urbanization in Indonesia: UNFPA Indonesia Monograph Series No.4 Available from: https://indonesia.unfpa.org/sites/default/files/pub-pdf/FA_Isi_BUKU_Monograph_No.4_URBANIZATION_.pdf

[4] Rahayu P and Mardiansjah F.H. 2018 Characteristics of peri-urbanization of a secondary city: a challenge in recent urban development *IOP Conference Series: Earth and Environmental Science, Volume 126, conference 1*.

[5] Firman T 1992 The Spatial Pattern of Urban Population Growth in Java, 1980–1990, *Bulletin of Indonesian Economic Studies*, 28:2, pp. 95-109, DOI: 10.1080/00074919212331336234

[6] Firman T 2016 The urbanisation of Java, 2000–2010: towards ‘the island of mega-urban regions’, *Asian Population Studies*, DOI:10.1080/17441730.2016.1247587

[7] Fahmi F Z, Hudalah D, Rahayu P, and Woltjer J 2014 Extended urbanization in small and medium-sized cities: the case of Cirebon, Indonesia *Habitat International* 42, pp. 1-10 DOI: 10.1016/j.habitatint.2013.10.003

[8] Mardiansjah, F. H. (2013). *Urbanisation durable des territoires et politiques de développement urbain en Indonésie: Étude de trois kabupaten en voie d’urbanisation rapide dans l’île de Java*. University of Paris-Est.

[9] Wahyudi A, Liu Y, and Corcoran J 2018 Combining Landsat and landscape metrics to analyse large-scale urban land cover change: a case study in the Jakarta Metropolitan Area. *Journal of Spatial Science*, 1–20. doi:10.1080/14498596.2018.1443849.

[10] Firman T and Fahmi F Z 2017 The privatization of metropolitan Jakarta’s (Jabodetabek) urban fringes: The early stages of “post-suburbanization” in Indonesia. *Journal of the American Planning Association*, 83(1), 68–79. doi:10.1080/01944363.2016.1249010

[11] Winarso H, Hudalah D, and Firman T 2015 Peri-urban transformation in the Jakarta metropolitan area. *Habitat International*, 49, 221–229. doi:10.1016/j.habitatint.2015.05.024.

[12] Dorodjatoen A M H 2009 The emergence of Jakarta-Bandung mega-urban region and its future challenges. *Jurnal Perencanaan Wilayah Dan Kota*, 20(1), 15–33.

[13] Budiyantini Y and Pratiwi V 2016 Peri-urban typology of Bandung Metropolitan Area. *Procedia-Social and Behavioral Sciences*, 227(November 2015), 833–837. doi:10.1016/j.sbspro.2016.06.152.

[14] Firman T 2009 The continuity and change in mega-urbanization in Indonesia: A survey of Jakarta-Bandung Region (JBR) development. *Habitat International*, 33(4), 327–339. doi:10.1016/j.habitatint.2008.08.005

[15] Mardiansjah F. H., Hidayani W, and Setyono J.S. 2018 Pertumbuhan penduduk perkotaan dan perkembangan pola distribusinya pada Kawasan Metropolitn Surakarta. *Jurnal Wilayah dan Lingkungan*, 6(3), 215-233. doi:10.14710/jwl.6.3.215-233