

Quantification of agricultural land balance sheet of Purworejo District in 2009 and 2018

Ananda Trisakti Nugroho* and Sudrajat Sudrajat

Geography and Environmental Science, Department of Environmental Geography, Faculty of Geography, Universitas Gadjah Mada, Indonesia

Abstract. Some districts in Central Java have problems regarding the shrinkage of agricultural land area and a high decrease in the number of farm households. The increase in population and economic development is one reason for the increased demand for land to convert agricultural land. The faster rate of land use change can affect the conditions of domestic food availability in an area, so it is important to quantify the area of agricultural land to monitor changes in land area. This research aims to calculate changes in agricultural land area through the balance of agricultural land resources. This research was conducted with quantitative methods and analyzed descriptively and spatially. Agricultural land is calculated using the land resource balance through a skronto table in 2009 and 2018. The results show that a decrease in area is more dominant than an increase in land area. The largest decrease in total land area occurred in *tegal*/farm area of 21.12 % and paddy field area of 3.43 % of the previous area. Spatially, changes of land area influenced by land conversion with two factors, namely physical condition and accessibility of the area.

1 Introduction

Agricultural land is permanent even decreases due to changes in land use changes that have occurred long ago. At present, fluctuations in changes in agricultural area are faster than before [1–4], even though Indonesia has UU No. 41/2009 concerning about Protection Sustainable Food Agriculture Land, but conversion of agricultural land still occurs.

Depreciation of agricultural land area in Indonesia, occurred long ago and it was known when the Agricultural Census Results were published. At present, the area of agricultural land in Indonesia continues to decline with the growth rate showing a negative sign, especially paddy fields. The rate of decline in paddy fields in 2017 to 2018 reached 12.97 %, with the type of irrigated paddy fields being the most dominant land experiencing a decline. Paddy fields are the land that has the largest decrease in area compared to other types of agricultural land [5].

The main factor often associated with a decrease in land area is an increase in population and economic development. Conditions of decline in agricultural land area which always go hand in hand with an increase in population, is a major factor in increasing the demand for land for conversion [1, 6, 7], both in the interests of meeting food needs, settlements, and other public facilities such as airports and roads [8]. Conversion of agricultural land is also influenced by the desire of farmers to sell agricultural land due to low income from farming, so it is less able to meet the necessities of life [9, 10]. In addition, agricultural land also has an economic value 7 times lower than developed land such

as housing, which makes agricultural land easy to convert [11, 12].

Agricultural land also provides benefits from the economic and employment aspects. That is because agricultural land is arable land for farmers, so that depreciation of agricultural land that occurs, also has an impact on job loss for farmers. The results of the 2013 agriculture census, show that agricultural land use households in Java, decreased more than 10 % from the number of households in 2003, with the status of Central Java being the third largest percent age decline after Jakarta and West Java, ie 25.18 % [13].

Central Java is one of the provinces that has problems with shrinking land area and a high decrease in the number of farm households. Central Java is also the third province with the most population in Indonesia. The existence of urban development and industrialization in Central Java and its surroundings, can increase the demand for agricultural land to be converted into non-agricultural land. One of the constructions carried out since 2017 is the construction of the Airport in Kulonprogo District, which borders directly with Purworejo District. Referring to the geographical concept of interrelation between spaces, the development can affect the rate of regional accessibility so that it is increasing. Bobcock's 1932 theory asserts that high accessibility will affect the structure of urban space which will have an impact on development and land demand for conversion.

Agricultural land is a spatial resource consisting of several components such as water, climate, soil, relief and vegetation that are utilized in meeting the needs of daily life [14, 15]. Agricultural land functions as a

* Corresponding author: ananda.trisakti.nugroho@mail.ugm.ac.id

planting medium to produce food and provide employment opportunities for farmers to be used as arable land. Agricultural land is also one of the goals of the Sustainable Development Goals (SDG's) program today, which is about sustainable agricultural land. The rise of the issue of food security, agricultural land is one important aspect to note.

Agricultural land that continues to experience shrinkage, encourages the government to open new agricultural land. But this does not guarantee the realization of sustainable agricultural land, if the opening of new agricultural land has a slower growth rate than the conversion of agricultural land to non-agricultural land. This study aims to calculate changes in agricultural land area through the balance of agricultural land resources, because the balance sheet is one of the simple tools to facilitate monitoring and evaluation of land availability [16], in this case especially in Purworejo District.

2 Data and methods

The research area of Purworejo District, Central Java, is geographically located at position 109° 47' 28" - 110° 08' 20" East Longitude (EL) and 7° 32' - 7° 54" South Latitude (SL) in the northern part of the Indian Ocean, Indonesia (Figure 1). Purworejo District has 16 sub-districts with a total area of 1 034.82 Km², with agricultural land use reaching 87.52 % of the total area [17].

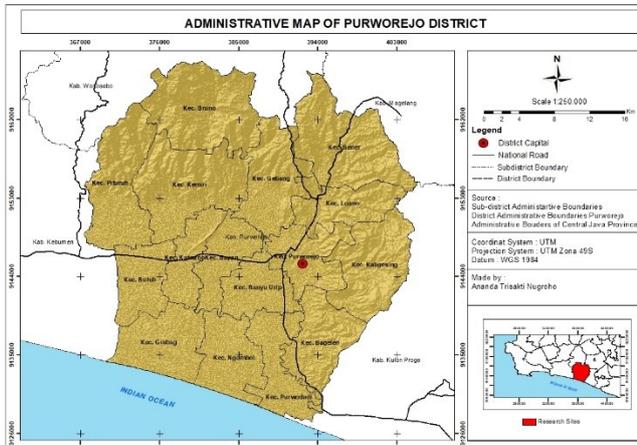


Fig. 1. Research Location

The study was conducted using quantitative methods and analyzed descriptively and spatially. Changes in agricultural land area are calculated using a balance sheet of agricultural land resources. The data used is the area of agricultural land use per district from "Purworejo District in Figure", obtained from the Central Statistics Agency (BPS) of Purworejo District. Agricultural land includes paddy fields and non-paddy fields. Paddy fields include irrigated, non-irrigated and rainfed paddy fields, while non-paddy fields include tegal/farm, fields/huma, plantations, community forests, grasslands and land not temporarily cultivated. Calculation of land area change is carried out using the discount table or the adjoining table in 2009 and 2018.

3 Results and discussion

3.1 Change of agricultural land area

Changes in land use occur gradually in accordance with the transition theory, from forests to agricultural land then to developed land [3] while food demand is increasing and land capability is decreasing [18]. Quantification of agricultural land area is one way to control land area, so that potential land can be maintained and not converted. Fluctuations of land area in Purworejo District in 2009 to 2018, occurred in every type of agricultural land. The following is a balance sheet of changes in agricultural land in Purworejo District (Table 1).

There are 2 types of changes in agricultural land area from 2009 to 2018, decreasing and increasing area. The increase in land area occurs in the types of fields/plantations, community forests, grasslands and land not temporarily cultivated. The increase in area reached more than 100 % of the previous land area, this is because the previous area was recorded 0 ha. Extensive decrease occurred in *tegal*/farm and paddy fields. Changes in the area of *tegal*/farm reached 21.12 % of the previous land area, while paddy fields were 3.43 % from the previous land area. However, the decrease in land area on paddy fields does not affect the amount of rice production produced in 2009 and 2018, even the production in 2018 is more than the production in 2009 [17, 19]. This is indicated that other factors of production influence these conditions, such as climate [20], although land is the most responsive factor [21].

Table 1. Agriculture Land Area, Change of Land Area in Purworejo District

Type of Agriculture Land Area	Land Area (ha)		Change of Land Area	% of Previous Land Area
	2009	2018		
Paddy Field	30626.9	29575	-1051.99	-3.43
Tegal/Farm	51598.1	40700	-10898.15	-21.12
Field/Huma	0	1537	1537	100.00
Plantation	12.45	4088	4075.55	32735
Forest Community	0	4752	4752	100.00
Grassland	175.66	2455	2279.34	1297.59
Not cultivated	79.85	551	471.15	590.04
Total	82493.1	83658	1164.9	1.41

Trends in agricultural land area from 2009 to 2018 show fluctuating conditions. The sharpest change in fluctuation occurs in paddy fields and tegal/farm. The following is a trend of agricultural land area by type (Fig. 2).

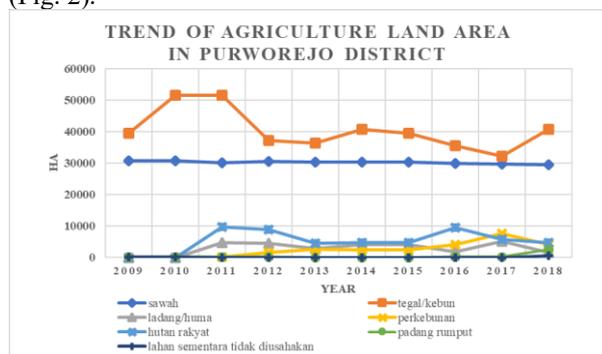


Fig. 2. Trend of Agriculture Land Area by Type in Purworejo District.

Based on data from 2011 and 2012, there was an increase in the area of rice fields by 500 ha and a decrease in the area of tegal/farm by 970 ha. In addition, also an increase in the area of land use for settlement and industry [22]. Fluctuations in land area changes between paddy field and tegal/farm, have an interrelated pattern. This is indicated that, decreasing the area of tegal/farm is carried out for the opening of new paddy fields. Increased paddy fields in 2012, not only occurred in Purworejo District, it also occurred in 4 Provinces in Java, including Central Java, DI Yogyakarta, West Java and East Java [23]. The trend also shows that, the decrease in paddy field area also occurred again in 2013, after a significant increase in area in 2012. In contrast to paddy fields, tegal/farm experienced a gradual increase in area from year to year.

3.2 Spatial analysis of changes in paddy fields and tegal/farm

3.2.1 Paddy fields

Paddy fields and tegal/farm are agricultural land types that are evenly distributed in each sub-district. Land that has the potential to be developed into agricultural land needs to be spatially known, especially paddy fields because it has high productivity producing food. The following is the balance sheet of paddy fields per sub-district in Purworejo District (Table 2).

Table 2. Balance Sheet of Paddy Fields per Sub-district in Purworejo District.

Sub-district	Paddy Fields Area (ha)		Agricultural Land Area Changes
	2009	2018	
Grabag	2651.59	2617	-34.59
Ngombol	3419.13	3425	5.87
Purwodadi	2730.9	2712	-18.9
Bagelen	509.62	510	0.38
Kaligesing	187.43	110	-77.43
Purworejo	1654.14	1534	-120.14
Banyuurip	2878.47	2777	-101.47
Bayan	1822.83	1798	-24.83
Kutoarjo	1977.23	1913	-64.23

Sub-district	Paddy Fields Area (ha)		Agricultural Land Area Changes
	2009	2018	
Butuh	2726.74	2775	48.26
Pituruh	2516.72	2454	-62.72
Kemiri	1595.89	1549	-46.89
Bruno	1621.32	1398	-223.32
Gebang	1667.77	1563	-104.77
Loano	1028.95	1029	0.05
Bener	1638.26	1411	-227.26
Total	30626.99	29575	-1051.99

The balance sheet of paddy fields area in Purworejo District shows that there is a decrease and increase in agricultural land area per sub-district. The increase in land area only occurred in 4 sub-districts which included Ngombol, Bagelen, Butuh, and Loano Sub-districts. The most extensive land increase occurred in the Butuh Sub-district that reached 48.26 ha, while other sub-districts experienced an increase of less than 6 hectares. The decrease in land area occurred in 12 other sub-districts, with the most decreases occurred in Bener and Bruno Sub-districts, respectively 227.26 ha and 223.32 ha.

Ngombol Sub-district has the largest paddy field area, while Kaligesing Sub-district has the smallest paddy field area. This can occur due to land potential differences in the sub-district. The following is a Topographic Map of Purworejo District (Fig. 2).

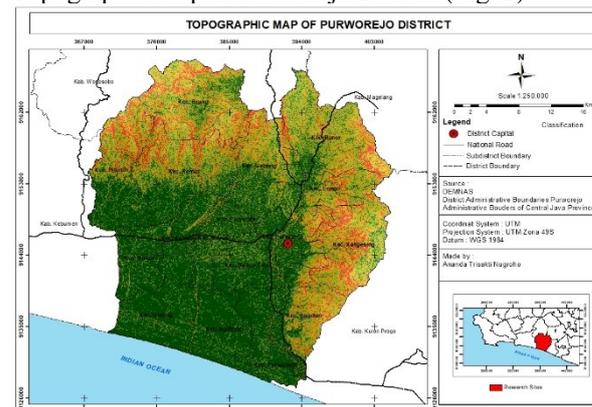


Fig. 3. Topographic Map of Purworejo District.

Spatially, agricultural land area differences in sub-districts can be influenced by physical conditions including topography, soil fertility, and water resources. Ngombol Sub-district is on a sloping to flat topography with a slope of 0 % to 2 %, while Kaligesing Sub-district is in mountain topography with a slope of >40 % (east of the Menoreh Mountains) [17]. Sloping to flat topography is a supporting factor in agricultural business because farmers do not need more effort in land management, while in steep topography requires farmers to change landforms to terracing. In addition, the presence of water resources for irrigating paddy fields in sloping to flat areas have easier access ie from rivers, compared to mountainous areas using springs or only through rainwater.

3.2.2 Tegal/Farm

Tegal/farm including agricultural land that produces food such as tubers. Tegal/farm area in Purworejo District, is one of the largest non-paddy fields in 2009

and 2018. However, spatially, tegal/farm area changes occur in almost every sub-district. The following is the balance sheet of tegal/farm area in Purworejo District.

Table 3. Balance Sheet of Tegal/Farm in Purworejo District.

Sub-district	Tegal/Farm Area (Ha)		Agricultural Land Area Changes
	2009	2018	
Grabag	2997.56	1896	-1101.56
Ngombol	1415.43	685	-730.43
Purwodadi	1983.5	1633	-350.5
Bagelen	5044.86	5045	0.14
Kaligesing	4537.88	4590	52.12
Purworejo	1064.12	615	-449.12
Banyuurip	1117.75	1096	-21.75
Bayan	1982.41	1973	-9.41
Kutoarjo	1127.89	524	-603.89
Butuh	1341.46	1177	-164.46
Pituruh	3812.19	1367	-2445.19
Kemiri	6186.51	4031	-2155.51
Bruno	4302.63	4106	-196.63
Gebang	4257.07	4346	88.93
Loano	3795.31	3353	-442.31
Bener	6631.58	4263	-2368.58
Total	51598.15	40700	-10898.15

Tegal/farm area decrease occurred in each sub-district except in 3 sub-districts, namely Bagelen, Kaligesing and Gebang. The three sub-districts experienced land area increase, with the largest area increase occurring in the Gebang Sub-district covering an area of 88.93 ha. Land area changes in 13 other sub-districts in the form of a decrease in the area of tegal/farm. The largest area decrease was in Pituruh, Kemiri and Bener Sub-districts with an area of more than 2 000 ha.

Spatially, part of Pituruh and Kemiri Sub-districts are on sloping topography and some are on bumpy topography (Figure 2). Pituruh and Kemiri Sub-districts are also the third and fourth largest areas after Bruno and Bener Sub-districts. Based on SNI 03-1733-2004 regarding Procedures for Housing Environmental Planning, population density in the sub-district is still classified as low, ie <1 000 inhabitants/ha, so that most areas with sloping topography in Pituruh and Kemiri Sub-districts have the potential to be converted, especially for new paddy fields or settlements. Data comparasions through Pituruh Sub-district on Figure 2019 and Kemiri Sub-district on Figure 2019 states that an increase in the area of building/yard land use over the area of building/yard in the previous year, while the area of tegal/farm decreased. This can indicate that the decline in the tegal/farm area in the sub-district is due to the land conversion to non-agricultural uses in the form of buildings/yards. Different from 2 sub-districts before, spatially, Bener Sub-district is in a bumpy topographical. Data of Bener Sub-district on Figure 2019 does not show an increase in land area for building/yard use from the previous year, but the existing condition of the sub-district is crossed by national roads (Figure 1). This will have an impact in the

form of high accessibility, which can increase land demand for development.

4 Conclusion

Agricultural land has increased and decreased the area of each type of agricultural land. The decrease in area occurred in paddy fields by 3.43 % and tegal/farm area by 21.12 % from the previous area. Decrease in paddy fields as productive land producing major food, does not affect the amount of production in 2009 and 2018.

Changes in paddy fields and tegal/farm are evenly distributed throughout the district, with a decrease in area being more dominant, rather than an increase in land area. Spatially, changes in agricultural land area are influenced by land conversion from agricultural land use to non-agricultural land. One of the factors considered to convert land from agriculture to non-agriculture in Purworejo District is the physical condition and accessibility of the area.

On this occasion the authors would like to thank the UGM Publisher and Publication Board (PBB) for providing RTA 2020 Grant funds, so that the authors can attend the ICST 2020 seminar and complete the thesis.

References

1. J. Chou, W. Dong, S. Wang, Y. Fu, Phys. Chem. Earth, **87–88**:3–9(2015), doi: 10.1016/j.pce.2015.08.011.
2. B. Irawan, *Konversi Lahan Sawah di Jawa dan Dampaknya Terhadap Produksi Padi*, Ekon. Padi dan Beras Indones., 295–325, (2003). [in Bahasa Indonesia].
3. C. Munteanu et al., Land use policy, **38**:685–697 (2014), doi: 10.1016/j.landusepol.2014.01.012.
4. S.J. Tomlinson, U. Dragosits, P.E. Levy, A.M. Thomson, J. Moxley, Sci. Total Environ., **628–629**: 1234–1248 (2018), doi: 10.1016/j.scitotenv.2018.02.067.
5. Kementerian Pertanian, *Statistik Lahan Pertanian 2014-2018*. Jakarta: Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderal, (2019). [in Bahasa Indonesia].
6. P. Alexander, M.D.A. Rounsevell, C. Dislich, J.R. Dodson, K. Engström, D. Moran, Glob. Environ. Chang., **35**:138–147 (2015), doi: 10.1016/j.gloenvcha.2015.08.011.
7. J. A. Foley et al., Nature, **478**,7369:337–342 (2011), doi: 10.1038/nature10452.
8. R. Harini, Indones. J. Geogr., **44**, 2:102–133 (2013), doi: 10.22146/indo.j.geog.2394.
9. I. A. Nuhung, J. Agro Ekon., **33**,1: 17 (2016), doi: 10.21082/jae.v33n1.2015.17-33. [in Bahasa Indonesia].
10. I. Pewista, R. Harini, Bumi Indones., **2**,2:98–103 (2010). [in Bahasa Indonesia].

11. M. Rondhi, P.A. Pratiwi, V.T. Handini, A.F. Sunartomo, S. A. Budiman, *Land*, **7**,4:2–19 (2018), doi: 10.3390/land7040148.
12. B. Sayaka, K. Suradisastra, B. Irawan, S.M. Pasaribu, Pemanfaatan Lahan Pertanian di Berbagai Daerah, In: *Konversi dan Fragmentasi Lahan Ancaman Terhadap Kemandirian Pangan*, Jakarta Selatan: Badan Penelitian dan Pengembangan Pertanian, 2009, 234–246. [in Bahasa Indonesia].
13. Bappenas, Analisis Rumah Tangga, Lahan, Dan Usaha Pertanian Di Indonesia : Sensus Pertanian 2013. Jakarta: Direktorat Pangan dan Pertanian Kementerian Perencanaan Pembangunan Nasional, 2014. [in Bahasa Indonesia].
14. FAO, *A Framework Of Land Evaluation*. Rome, Italy: FAO Soil Bull, (1976).
15. S. Ritohardoyo, *Penggunaan Dan Tata Guna Lahan*. Yogyakarta: Penerbit Ombak, (2013). [in Bahasa Indonesia].
16. Sumartoyo, *Globe*, **10**,2:129–135 (2008). [in Bahasa Indonesia].
17. BPS, *Kabupaten Purworejo dalam Angka*. Purworejo: BPS Kabupaten Purworejo, (2019). [in Bahasa Indonesia].
18. D. Tilman, C. Balzer, J. Hill, B.L. Befort, *Proc. Natl. Acad. Sci. U. S. A.*, **108**,50: 20260–20264, (2011), doi: 10.1073/pnas.1116437108.
19. BPS, *Kabupaten Purworejo Dalam Angka*. Purworejo: BPS, 2009. [in Bahasa Indonesia].
20. R. Harini, B. Susilo, J. Agribisnis, **1**,1:14–20 (2017). [in Bahasa Indonesia].
21. N. Kusnadi, N. Tinaprilla, S. H. Susilowati, A. Purwoto, *Agro Ekon.*, **29**,1:25–48 (2011), doi: 10.1006/gyno.2001.6534.
22. BPS, *Kabupaten Purworejo Dalam Angka*. Kabupaten Purworejo: Badan Pusat Statistik, 2013. [in Bahasa Indonesia].
23. Kementerian Pertanian, *Statistik Lahan Pertanian Tahun 2010-2014*. Jakarta: Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderal, (2019). [in Bahasa Indonesia].