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ASSESSMENT OF LAND USE CHANGE IMPACTS ON LAND CAPABILITY IN NGADIROJO, INDONESIA

SUMMARY

Since the pro-investment program was implemented in 2011, Wonogiri District including Ngadirojo Sub-district has experienced a shift in the economic sector from agriculture to industry, and land conversion has occurred. This research aims to determine the rate of land conversion in the Ngadirojo Sub-district and its effect on land capability class. The rate of conversion is determined based on the shrinkage of land use area from 2009 to 2020. The land unit for observing the land capability class is determined by overlaying the land use change map with the soil type map. Observation of land capability class is carried out on agricultural land that is experiencing conversion. As comparison data, land capability classes were observed at points that did not experience conversion. Land use change in the Ngadirojo Sub-district in 2009-2020 covering an area of 1,308.53 ha (14.03%) with a rate of conversion of agricultural land to non-agricultural areas of 264 ha (24 ha year^{-1}). Changes in land use have a very significant effect on the land capability class. Land use causes soil permeability to be slower and degrades land capability. The recommended land management efforts in the research area are the addition of organic matter to soil properties and agroforestry system implementation.

Keywords: Agricultural land, Land capability, Land conversion, Land management, Limiting factor

INTRODUCTION

Population growth and increasing economic development have led to an increase in land demand. The availability of land that is fixed but needed for all sectors causes land conversion, especially on agricultural land (Aini *et al.* 2019; Widhiyastuti *et al.* 2023). Developmental factors, either economic or demographic, have an impact on the conversion of agricultural land (Egidi *et al.*

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2020; Kumar and Agrawal 2019; Kocur-bera and Pszenny 2020). Development factors and agricultural land tend to work in opposite directions (Palšov, 2019).

Wonogiri District is one of the areas facing the problem of land conversion. The pro-investment policy since 2011 has made it easier for investors to build a business (Nugroho *et al.* 2020). Since then, there has been a shift in the economic sector, which was originally based on agriculture to become industrial. The influx of investors recruits a lot of labor but also causes land use conversion (Palšov, 2019). The construction of industrial factories causes the conversion of productive agricultural land. This will result in a reallocation of land use from less profitable activities to more profitable activities. Activities that are always threatened are agricultural activities that are considered less profitable than other economic activities (Catur and Joko 2010).

According to Dellamitha *et al.* (2018), Ngadirojo Sub-district is predicted to have the largest regional growth rate in Wonogiri District. Regional growth of the area means an increase in built-up land for residential and industrial purposes. This causes the conversion of agricultural land into settlements is also getting higher. The conversion of agricultural land to non-agriculture reduces the amount of productive land (Wardhana *et al.* 2018). The conversion of agricultural land is of particular concern because it threatens farmers to lose their land (Stanny *et al.* 2021). Changes in land use, especially in paddy fieldss that have high productivity, will have a negative impact on food availability and environmental quality (Nurliani and Rosada 2016; Wahyuti *et al*. 2023).

Land use change also includes changes in the use of agricultural land into other agricultural lands, for example, changes in paddy fields into moor or vice versa. Land use change does not only affect the decrease in land area but also changes the characteristics of land and soil (Rendana *et al.* 2022; Wardhana *et al.* 2018). (Mujiyo *et al.* 2018) mentions changes in land use causing changes in soil physical properties. Fields that turn into paddy fields experience changes in the permeability aspect, which is slower. Changes in the characteristics of land and soil will change the land carrying capacity. Land carrying capacity to be used for certain uses without causing permanent damage is the definition of land capability (FAO, 1983; Wells, 2001).

Considering that land use change affects several aspects, it is necessary to evaluate, observe, and resolve the problem of conversion that occurs (Riao *et al.* 2020). Efforts that can be made to suppress the conversion of agricultural land are by periodic identification and mapping (Mujiyo *et al.* 2008). Until now, data and information regarding land use change in Ngadirojo Sub-district are not yet available, so there is a need for an inventory of land use change data. The purpose of the study was to determine the land conversion rate and its effect on land capability, and to determine the factors causing a land conversion.

MATERIAL AND METHODS

This research was conducted from November 2020 - February 2021. Sampling and field observations were carried out in Ngadirojo Sub-district, Wonogiri District. The area of Ngadirojo Sub-district is 9,325.56 ha with dense hilly and mountainous areas, as well as inundation areas of the Waduk Serba Guna Gajah Mungkur. The largest land use is dry land which covers 50% of the total land area followed by paddy fields (26%), buildings and yards (20%), and other uses (3%) (BPS Kabupaten Wonogiri, 2018). The soil types are Alfisols which dominate on the north side and Inceptisols are on the south side.

Land use change is determined by overlaying land use maps in 2009 and 2020. The land use maps are the result of the interpretation of Google Earth images. The resulting land use change map is then inventoried for its area, type, location, and rate of land use change. The rate of land conversion is determined by calculating the rate of shrinkage of agricultural land into non-agricultural land. The total area in 2020 (L_t) is subtracted by the land area in 2009 (L_{t0}) then divided by the period 2009 (T_0) to 2020 (T). This equation produces the average rate of land conversion per year.

$$V = \frac{(Lt - L_{t0})}{(T - T_0)}$$

Remarks: V = land conversion rate (ha $year^{-1}$), L_t = land area in 2020 (ha), L_{t0} = land area in 2009 (ha), T = Year 2020, T_0 = Year 2009

Land capability class is observed on agricultural land converted into other agricultural lands. An observation made using the descriptive exploratory survey method. This method is separated into three stages: (1) pre-survey, (2) surveys, and (3) post-survey. The first stage is pre-survey, which consists of mapping the research region by constructing a working map from an overlay of thematic maps (area administration map, soil type map, and land use map) and defining the distribution of sampling locations. The survey stage is then the most important stage in the investigation. Land verification and soil samples are taken at this step. The land verification stage is required to determine whether the condition of the land in the field (actual conditions) matches what is on the map and whether the condition of the land allows it to be used as a sample point in terms of land characteristics. Farmers and local stakeholders provide detailed verification, such as evaluating soil type and land use information. Soil samples are collected after confirming the compatibility of the conditions on the map and in the field. Soil samples were gathered at various depths inside the tillage layer (1-20 cm). The final stage is post-survey, in which sample preparation and parameter analysis are performed in the laboratory.

The land unit (Figure 3) for observing the land capability class is determined by overlaying the land use change map (Figure 2) with the soil type map. Determination of sampling points was carried out purposively on agricultural land that experienced conversion during 2009-2020. As a comparison data, observations and soil samples were taken at the nearest point that did not experience any transfer of function. Land capability class classification is carried out by matching land characteristic data with land capability criteria according to (Arsyad, 2010), (Table 1). T-test analysis was conducted to determine the effect of land conversion and soil type on land capability class.

Table 1. Table of Land Capability Classification Criteria

Inhibiting Factors / Limiting	Land Capability Class							
	I	II	III	IV	V	VI	VII	VIII
Surface Slope	I_0	I_1	I_2	I_3	I_0	I_4	I_5	I_6
Erosion Sensitivity	KE_1 KE_2	KE_3	KE_4 KE_5	KE_6	(*)	(*)	(*)	(*)
Erosion Rate	e_0	e_1	e_2	e_3	(**)	e_4	e_5	(*)
Soil Depth	k_0	k_1	k_2	k_3	(*)	(*)	(*)	(*)
Upper Layer Texture	t_1,t_2,t_3	t_1,t_2,t_3	t_1,t_2,t_3,t_4	t_1,t_2,t_3,t_4	(*)	t_1,t_2,t_3,t_4	t_1,t_2,t_3,t_4	t_5
Lower Layer Texture	t_1,t_2,t_3	t_1,t_2,t_3	t_1,t_2,t_3,t_4	t_1,t_2,t_3,t_4	(*)	t_1,t_2,t_3,t_4	t_1,t_2,t_3,t_4	t_5
Permeability	P_2,P_3	P_2,P_3	P_2,P_3	P_2,P_3	P_1	(**)	(**)	P_5
Drainage	d_1	d_2	d_3	d4	d_5	(**)	(**)	d_0
Gravel/Rock	b_0	b_0	b_1	b_2	b_3	(*)	(**)	b_4
Flood Threat	O_0	O_1	O_2	O_3	O_4	(* *)	(**)	(*)

Remark: (*)= can have any properties, (**)= not applicable, (***)= generally found in dry climates

RESULTS AND DISCUSSION

Land Use Change

Land use change in Ngadirojo Sub-district in 2009-2020 covers an area of 1,308.53 ha (14.03%) and the fixed land area is 8,017.03 ha (85.97%).

Table 2. Changes in Land Use Areas in Ngadirojo Sub-district in 2009-2020

Types of Land Use	Total Area (ha)		Changes (ha)
	2009	2020	
River	33.20	32.93	-0.27
Buildings	2,155.55	2,335, 20	179.65
Dry Land	4563.24	4822.17	258.93
Forest	193.92	201.99	8.07
Open Land and Shrubs	21.75	53.50	31.75
Paddy fields	2357.90	1879.77	-478.13

The results showed that paddy fields were reduced the most (478.13 ha) among other land uses (Table 2). Many paddy fields are converted into moor. Based on the survey, the relatively easier management of dry land is one of the factors in the conversion of paddy fields to moor. Shortage of water is also one of the factors causing land conversion.

Wonogiri District's spatial planning section public housing service revealed that, generally, agricultural land conversion occurs because the certificate owner feels he has full rights to the land that will be converted for personal use without considering the regional spatial planning plan. On average, landowners have a low level of formal education. They are easily tempted by offers of high land purchase prices so that much of the land is ultimately sold to other parties to build housing, factories, and other infrastructure. Weak government policies regulating land conversion without sanctions and a lack of strict assistance to agricultural land owners are other factors in many agricultural land conversions. Local people who sold their land expressed regret because they realized that land is a non-renewable resource that can be an investment for the next generation of children and grandchildren. Dewi and Rudiarto (2013), revealed that people who were previously farmers will experience changes in socio-economic conditions because loss of agricultural land causes a decrease in income. The preventive step taken by the government as a policy maker is to provide outreach and education to the community regarding the risks and negative impacts of changing the function of agricultural land.

The cost of providing water for paddy fields becomes more expensive, so farmers choose to convert their land into dry land (Al Viandari *et al.* 2022). Landowners convert their land to expect more profits (Sianipar, 2016). Aini *et al.* (2019) stated that three factors influence the conversion of agricultural land, which is more common in paddy fields. First, the development of housing, shops, offices, and industrial areas is easier to do on flatter paddy fields. Second, past developments were more focused on efforts to increase rice production, so that more economic infrastructure was available in paddy fields. Third, paddy fields are generally closer to consumer areas or urban areas which are relatively densely populated. However, practical implementation of the Wonogiri Regency Local Regulation No. 2 of 2020 concerning the spatial planning of Wonogiri Regency from 2020 to 2040 lacks actions towards those shifting land from agriculture to non-agricultural purposes, insufficient support to encourage landowners to maintain their agricultural plots, and a lack of surveillance in ensuring the preservation of sustainable farming lands, especially for food crops. These factors make landowners susceptible to high offers for their land, leading to extensive sales for housing, industrial, and infrastructure development. The certificate owners often feel entitled to convert land for personal use without considering the regional spatial planning. Another factors besides economy is social factor. In terms of social factors and infrastructure, the most common occurrence in society is the need for residential and business spaces, leading to the conversion of agricultural land to non-agricultural use. The proximity of agricultural land to public access and transportation also contributes to its conversion. According to Hendrawan and Dewi (2016), there are three fundamental constraints in implementing land use conversion: policy coordination, policy implementation, and planning consistency.

The area of the dry land has increased by 258.93 ha. The dry land is used to cultivate corn, cassava, and peanuts. Rivers and water bodies experienced a decrease in the area of 0.27 ha. Although the area of the river is reduced, its use is still intended as a river and is not cultivated as agricultural land. In 2020 the river on the southeast side becomes less clear and sedimentation is visible. Sediment is part of the dynamics of the natural balance of the river if its presence is within a certain limit. However, if its presence is excessive, it can impact the characteristics and cause various problems in the environment and human life (Hambali and Apriyanti 2016).

Forest, open land and shrubs, buildings and infrastructure have increased in area from 2009. Forests increased by 8.07 ha. Open land and shrubs increased by 31.75 ha. Unproductive and unutilized dry land, paddy fields, and forests have turned into open land and shrubs. Open land and shrubs can be used to expand agricultural land to compensate for the conversion of functions provided that the land has potential and meets its biophysical criteria (Hidayat, 2009).

The use of building land and infrastructure which includes residential areas, business premises such as factories, offices, and buildings increased by 179.65 ha. The increase is due to the increasing need for residents both for housing and business places. In line with (Janah *et al.* 2017) that in general, the rate of land use change is associated with the rate of population growth which then increases the need for land use such as settlements and other public facilities. The construction of a factory in Ngadirojo Sub-district which has been rampant since 2014 has also caused an increase in the area of conversion of agricultural land into buildings.

Various agricultural land uses changed in the period 2009-2020 (Figure 1). Agricultural land that experienced the most conversion converted to non-agricultural land is dry land into buildings and infrastructure (15.83 ha year^{-1}) (Table 3). The characteristics of dry land that are never flooded are ideal for use as buildings (Romadhon and Aziz 2022). At a high rate of population growth, development level is one of the factors causing land use change (Iskandar *et al.* 2016).

(A) Paddy field-Moor, Alfisols (2009) (B) Paddy field-Moor, Alfisols (2020)

(C) Moor-Paddy field, Alfisols (2009) (D) Moor-Paddy field, Alfisols (2020)

(E) Moor-Forest, Inceptisols (2009)

(F) Moor-Forest, Inceptisols (2020)

(G) Forest-Open land and shrubs, Inceptisols (2009)

(H) Forest-Open land and shrubs, Inceptisols (2020)

(I) Paddy fields-Moor, Inceptisols (2009)

(J) Paddy fields-Moor, Inceptisols (2020)

(K) Moor-Open land and shrubs, Inceptisols (2009)

(L) Moor-Open land and shrubs, Inceptisols (2020)

Figure 1. Land Use Change Areas in Ngadirojo District.

Table 3. Agricultural Land Use Change Rate

Land Use Change	Area (ha)	Rate (ha year^{-1})	Percentage (%)
Paddy fields-Open and Shrub	2.21	0.20	0, 02
Dry land-Open Land and Shrub	12.18	1.11	0.13
Forest-Open Land and Shrub	21.55	1.96	0.24
Paddy fields-Building and Infrastructure	53.95	4.90	0.59
Dry land-Building and Infrastructure	174.11	15.83	1.90
Total	264.00	24.00	2.88

Figure 2. Map of Agricultural Land Use Change in Ngadirojo Sub-district

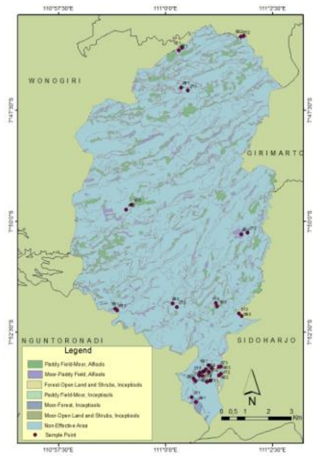

Figure 3. Land Unit Observation of land capability

The rate of conversion of paddy fields into buildings is 4.90 ha year^{-1} with a total conversion area of 53.95 ha. Forests into open land and shrubs is 1.96 ha year^{-1} with a converted area of 21.55 ha, moor into open land and shrubs of 1.11 ha year^{-1}, and paddy fields into open land and shrubs of 0.20 ha year^{-1}. The rate of conversion of agricultural to non-agricultural functions is mostly buildings and infrastructure such as industrial areas, buildings, and offices. According to (Kusumastuti *et al.* 2018), people prefer to convert the land into shops, housing, or other service sectors that generate greater profits when compared to agriculture.

The implementation of pro-investment in Wonogiri District, one of which is in Ngadirojo Sub-district, makes land demand increase and makes the conversion of agricultural land to non-agricultural land unavoidable. Land use change will increase every year because it is generally contagious. Land use change that occurs in one location will affect the surrounding locations (Nofita *et* *al.* 2016). A holistic and comprehensive strategy is needed to control the rate of land conversion (Kaputra, 2013).

Land Capability

Land capability classification is the determination of land potential to be used both as agricultural and non-agricultural land (Amelia *et al.* 2021). Land capability classification is based on the chemical and physical properties of the soil (Scopesi *et al.* 2020). Observation of land capability was carried out on six land units as a result of overlaying land use conversion maps.

Table 4. Land Capability in Land Use Change Areas

LU	Land Use	Capability of	
		Fixed Land	Changes Land
1	Paddy field-Moor, Alfisols	IV-d_4	IV-d_4
2	Moor-Paddy field, Alfisols	IV-d_4	VP_1
3	Moor-Forest, Inceptisols	IV-I_3,d_4,b_2	VP_1
4	Forest-Open land and shrubs, Inceptisols	IV-I_3,d_4,b_2	VP_1
5	Paddy fields-Moor, Inceptisols	IV-I_3,d_4	VP_1
6	Moor-Open land and shrubs, Inceptisols	VP_1	IV-I_3,d_4

Land capability at all points includes class IV-V. According to Feudis *et al.* (2021) land classes I-IV are suitable for agricultural land development, while classes V-VIII are not suitable for agricultural land but for forest areas, protected areas, and grasslands. Overall, changes in land use in Ngadirojo Sub-district cause changes in land capability class. The results of the T-test prove that on fixed land and changed land there are significant differences in land capability class ($t = 5.464$, $P = 0.025$). Land characteristics and ability class in LU 1 remain the same. Changes in land capability class occur at LU 2, 3, 4, 5, and 6.

Changes in land capability class are caused by changes in land characteristics. At LU 2, 3, 4, and 5, changes in land use cause soil permeability to be slower. Permeability value for each land use is highly correlated with land capability ($P = <0.05$). The change of dry land to paddy fields at LU 2 causes the permeability to be slower. The puddling of paddy fields destroys soil structure, resulting in a dense plow pan (Keen *et al.* 2013), increasing bulk density and ultimately causing slow permeability (Verma and Dewangan 2006). The change of forest into open land/shrub in LU 4 also causes slower permeability. Forest change causes a decrease in organic matter input, thereby increasing bulk density (Li *et al.* 2021) and slowing permeability.

Due to the conversion of the land function, LU 6 which is dry land that becomes open land and shrubs, has a better ability from class V to class IV. Soil characteristics that increase at LU 6 include erosion sensitivity and permeability, and both have a very significant correlation ($P = <0.05$) to the land capability class.

Table 5. Land Characteristics at Land Unit Observation

Sampling Point	Slope (%)	Erosion Sensitivity	Erosion Rate	Depth (cm)	Upper Layer Texture	Lower Layer Texture	Permeability (cm $hour^{-1}$)	Drainage	Rock/ Gravel	Flood	Soil Capability
1T	9.17	0.15	Low	77.33	Silty Clay	Silty Clay	1.36	Bad	Slightly	Sometimes	IV-d_4
1B	8.33	0.17	Low	67.67	Silty Clay	Clay	0.72	Bad	Slightly	Sometimes	IV-d_4
2T	6.67	0.17	Low	79.33	Silty Clay	Silty Clay	0.54	Bad	None	Sometimes	IV-d_4
2B	4.73	0.24	Low	74.67	Silty Clay	Clay	0.42	Rather Bad	None	Sometimes	VP_1
3T	19.27	0.24	Low	42.33	Silty Clay	Silty Clay	0.87	Bad	Medium	Never	IV-I_3,d4,b_2
3B	20.67	0.16	Low	35,00	Clay	Clay	0.27	Bad	Medium	Never	VP_1
4T	30.00	0.20	Low	57.67	Clay	Clay	0.63	Bad	Medium	Never	IV-I_3,d4, b_2
4B	30.00	0.18	Low	55.33	Clay	Clay	0.41	Bad	Medium	Never	VP_1
5T	15.33	0.27	Low	70.33	Clay	Clay	0.73	Bad	Slightly	Sometimes	IV- I_3,d_4
5B	24.33	0.35	Low	76.00	Silty Clay	Clay	0.26	Bad	Medium	Sometimes	VP_1
6T	28.33	0,18	Low	65.00	Silty Clay	Clay	0.28	Bad	None	Never	VP_1
6B	25.00	0.15	Low	49.67	Silty Clay	Silty Clay	1.53	Bad	None	Never	IV-I_3,d_4

Soil physical characteristics influence each other, especially soil permeability is directly influenced by soil pore size, porosity percentage, and soil texture composition, where these properties contribute to the water flow process (Abdullah *et al.* 2021). Some of the physical properties of the soil, including the structure, density, and porosity of the soil are formed from the accumulation of organic matter. Soils with low SOC content tend to be dense and have low water absorption capabilities. The results of the study (Sánchez–González *et al.* 2017) proved that dry land has a lower SOC content of up to 50% compared to the SOC content in soil under natural stands (natural forests and shrubs). This is caused by the content of SOC which in intensive agricultural land is also widely used for crops and is limited to returns/inputs to the soil so that it decreases continuously. Land conversion clearly has an impact on the physical condition of the soil.

In addition to changes in land use, the basic nature of each soil type will also affect the physical, chemical, and biological characteristics of the soil. Changes in land management have different impacts on changes in soil physical properties based on soil characteristics for each type of land use (Wardhana *et al.* 2018). The results showed that the soil type on the research land that was fixed and underwent a change of a function with different types had a very significant effect on land capability (F = 7.556, P = 0.010). From Table 5, it can be seen that the conversion of paddy fields to moor on the Alfisols soil type (LU 1) did not result in a difference in land capability, while the land use change while the land with the same conversion function on the Inceptisols soil type (LU 5) changed the land capability, namely from class IV to class V where for the ability of land V is not suitable to be used as agricultural production land including moor. Focusing solely on soil characteristics in assessments is preferred for their direct impact and specificity, simplifying analysis and enabling targeted evaluations. Soil types crucially influence fertility, water retention, and nutrient content, vital for determining land suitability in agriculture. Soil heterogeneity within an area affects its capability for diverse land uses, making consideration of soil types vital for sustainable agricultural production assessments (Ljuša et al, 2016; Zahra et al, 2023; Dingil et al, 2010). Alfisols, common in moderate to high rainfall areas, vary in land capability, impacting soil-land interactions and crop suitability. With clay-rich subsurface and high organic matter, they are suitable for a variety of crops but require specific management for optimal yields (Salari, M., & Baghernejad, 2014). Inceptisols present in similar rainfall regions have sandy subsurface that inhibits root growth and nutrient transport. This leads to lower fertility and limited crop suitability compared to other soils (Supriya et al, 2018).

Land Management Strategies

Results of land capability can be used to allocate areas of agricultural land sustainably as a basis for consideration of land use planning and policies (Bhermana *et al.* 2021). Land use capability classification is a fundamental argument that shows the suitability of agricultural production from the land. Improperly managed land will cause land degradation. Land degradation is a major threat to natural resources (Özcan, 2021). Thus, it is necessary to pay attention to the management of land that is undergoing conversion to avoid a decrease in land capability and land productivity for agriculture.

In LU 3, and LU 4 the land has been converted and has decreased land capability class, even though the type of land use with land capability class is appropriate, so it is hoped that land use can be maintained as land with natural vegetation. Land with capability classes II, III, and IV can be designated as arable land for agriculture (Amelia *et al.* 2021). Meanwhile, on land resulting from conversion (land change) LU 1, LU 2, and LU 5, the land use is not in accordance with the ability of the land, and the future impact is the emergence of serious problems, both in terms of productivity of agricultural products on the land, as well as damage to the land that has been damaged. make land critical. Inappropriate use is that LU 1, LU 2, and LU 5 are currently used as agricultural production land for upland and paddy fields, while land capability class V is not suitable for agricultural production land. Land in class V has limiting factors that inhibit plant growth so that its allocation is for forests, grasslands, and pastures (USDA, 1961). In overcoming this, land management efforts that need to be carried out in LU 1, LU 2, and LU 5 are the addition of organic matter, during land preparation and after harvest, and during rest periods. Organic materials that can be added include cow and chicken manure because they are easy to obtain, considering that most local farmers also keep cows and chickens. Organic matter in the soil can improve soil physical properties, increase soil fertility, and build biological diversity that cannot be replaced by other means of production (Sumarno *et al.* 2009; Syamsiyah *et al.* 2023). In addition, organic matter can be used to return to soil fertility and microbiological balance (Yulianti, 2020).

At LU 6, the change of land from dry land to shrubs increased the land capability class from class V to class IV. However, land capability IV is classified as suitable for use as agricultural production land. Recommendations for land management related to this discrepancy are to choose land uses that are in accordance with the capacity of the land (Mujiyo *et al.* 2020). So that later with the potential of the land in LU 6 for agricultural production, it needs to be utilized optimally. Management efforts that can be done is the agroforestry system. Agroforestry system that applies to plant woody perennials with crops in the same area. This system diversifies the land's environment, beginning with the diversity of species, agriculture methods, and socio-economic forms (Viswanath *et al.* 2018; Weldearegay *et al.* 2021). The potential challenge faced by farmers in implementing agroforestry is re-cultivating land to plant food crops and hardwood plants which require large amounts of capital and labor. Selecting the right food commodities and annual crops is also challenging because the ultimate orientation is high economic value for farmers. Planting annual crops also requires patience because new results can be used longer than food crops such as rice, corn, soybeans, etc. The adoption of agroforestry systems is influenced by the level of profit from agricultural, forestry, and carbon prices, and research results prove that agroforestry can run well with the support of financing system policies to guarantee the risks farmers face (Abdul-Salam *et al.* 2022).

Even so, the suggestion to change agricultural land use such as rice fields and moorland into grassland and forest is a good thing in terms of land capacity. Still, there will be changes in soil characteristics, such as drainage and soil microorganisms (Kurniawan *et al*. 2023). Apart from that, this conversion activity requires a feasibility assessment and precise planning, such as what methods will be used, what types of plants are suitable for planting given the soil conditions, climate and water availability around the land, as well as what form of management is appropriate. Incompatibility of plant types with soil, drainage and climate conditions can inhibit plant growth (Anshori *et al*. 2022). Drainage that is not optimal will cause the soil to experience salinity. On a larger scale it will cause plant death, decomposition of plant organic waste and cause ecosystem imbalance, up to economic losses.

CONCLUSIONS

Land conversion in 2009-2020 covering an area of 1,308.53 ha (14.03%) with the rate of conversion of agricultural land to non-agriculture is 24 ha year^{-1} (2.88%). The largest rate of conversion of functions is found in the dry land into buildings and infrastructure (15.83 ha year^{-1}). Overall, land use change in Ngadirojo Sub-district causes changes in land capability class. In addition, the type of soil on the research land that is fixed and the land converted to function with different types has a very significant influence on the ability of the land. Management efforts that can be carried out include the addition of organic matter in LU 1, LU 2, and LU 5, and agroforestry system implementation at LU 6, while at LU 3 and LU 4 it is recommended to maintain the current land use because the condition of the land and its use is appropriate. By understanding data and information related to land use changes and their impact on land capacity, the community and stakeholders can take appropriate steps in managing land while protecting the sustainability of land ecosystems. However, it is hoped that research on land use conversion mapping and analysis of its effects can be carried out with a new one, more sophisticated methods and technology. However, research on land use conversion mapping and impact analysis is expected to be carried out using new, more sophisticated techniques and technology and perfomed over a more extended period, namely more than 1 decade, to provide a more comprehensive understanding of trends and patterns.

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