The agricultural land distribution and used on various agroecosystems in Indonesia

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Abstract. The land resource is one of the mains production factors for farmer’s households and the agricultural economy. From the land use and transformation perspective, analyse the aspects related to the dynamics of land ownership and distribution, technical, socio-economy, institutional, and policy factors, and land accessibility are needed. The objectives of this study are (1) analyze diversity of agricultural land holding at the micro, region, and macro levels; (b) describe the main factors that influence the transformation of land use; and (c) formulate strategies and policies on land resources management. The approach used in this paper is to review the results of previous PATANAS research and deepening it with information from secondary data and literatures. The study shows that the transformation constraints are the high population growth and limitation of non-agricultural employment opportunities, the fragmentation and the loss of land transactions, and land conversion. This condition implies that the government needs strategies and policies to save and utilize the potential agricultural land reserves. This effort intends to create new agricultural lands and support infrastructure to increase production and income. It will enable to accelerate transformation in the agricultural sector.

1. Introduction
The land resource is one of the mains production factors for farmer's households and the agricultural economy. The land use and transformation dynamic is closely related to transformation in the agricultural sector and policy in another sector. In the agricultural sector, transformation begins with preference changing in food consumption that it is affected by shifts in commodity choices, land use, and cultivated technology on agriculture [1]. Land tenure arrangements was once way to improve the livelihoods of the rural poor [2]. The agricultural land distribution and transformation are determined by the acceleration of development in non-agriculture sector [3]. The land transformation refer to land area modified by human activities [4]. It is include land use, land holding, land degradation, and land tenure as a system. Agricultural lands encroached by urban settlements come out with extensive cost for social and economic life of local residents, particularly in urban fringes [5]. According to Pakpahan [3], in the 1970s, the size of agricultural household cultivated land in Indonesia, South Korea, and Japan is relatively equal, which is equal to 1.0 hectares. In three decades later, average agricultural household cultivated land decrease to 0.79 hectares (2003), while in South Korea increase to 1.43 hectares (2005), and in Japan (exclude Hokkaido) increase to 1.80 hectares (2005). A case in South Korea and Japan, economic transformation is determined by the performance...
of the industry and service sector to accommodate the rural and agricultural labor. Research by Hooke et al. [4] at Faisalabad city, Punjab, Pakistan showed changes in the size of landholding during the period 2006-2015 as majority of the farmers (48.9%) owned up to 5 acres, previously while now majority of farmers (53.9%) own less than 2 acres of land.

From the land use and transformation perspective, analyze the aspects related to the dynamics of land ownership and distribution, technical, socio-economy, institutional, and policy factors, and land accessibility are needed. The explanation of the statement is as follows. The dynamic spatial and temporal of land tenure (that shows farmers' ability to expand their cultivated land) will reflect the mobility and accessibility of farmers to land resources. The spatial dynamic of land tenure reflects the existence of small farmers in fairly structured land tenure. Technical, socio-economy, institutional, and policy factors have an impact on transformation land resources. Reverse various potential land and accessibility land for farmers also affect increasing land tenure area and improving the distribution of fairly land tenure.

The objectives of this study are (a) analyze diversity of agricultural land holding at the micro, region, and macro levels; (b) describe the main factors that influence the transformation of land use; and (c) formulate strategies and policies on land resources management.

2. Materials and methods

2.1. Materials
The main material of the paper is a series PATANAS research report during 2007-2018. Report from PATANAS research especially to describe the ownership distribution land in micro-level and various agroecosystems. The secondary data like SUTAS (Survei Pertanian Antar Sensus) 2018 [6] and Sensus Pertanian 2013 and other literature are used in this paper to analyze the dynamic and transformation, especially on the region and macro level.

2.2 Methods
The approach used in this paper is to review the results of previous PATANAS research and deepening it with information from secondary data. Meanwhile, information dynamic and transformation agricultural land ownership-related policies and their effects are reviewed from the results of previous studies.

The result and discussions in this paper are organized into three primary sequences. The first sequence presents the dynamic distribution of land tenure agricultural land by agroecosystem as representing dynamic in level micro. The second sequence analyzes the dynamic distribution by region, representing the dynamic in the region and macro level. The third sequence-related influential factor and land transformation policies. The analysis method used in the study was qualitative descriptive. Data will be presented in table and figure with a simple analysis. Strategies and policies on distribution and transformation of agricultural land were obtained from synthesizing the result and discussion.

3. Results and discussion

3.1. The agricultural land distribution by agroecosystem
Land tenure reflects land ownership system of land with combined the other land institutional statuses include rent land system, sharecropping, and other land acquisitions. Its existence reflects the availability and accessibility of land resources through the "transaction process" in the economy of the land market. Land markets in Indonesia are largely informal, with land transactions often lacking proper documentation and registration [7]. Land tenure as a productive asset to increase farmer's households is complemented with its distribution reflect land resources transformation.

The Gini index can be used to see the level of inequality in the distribution of land tenure and land ownership [8-10]. Gini index as parameter inequality will indicate the level of evenly distributed land resources among farmers. The discussion focused on three main agroecosystems, namely paddy-based
wetland agroecosystem, dryland-based on secondary crops and vegetable agroecosystem, and plantation commodity-based dryland agroecosystem.

### 3.1.1. Paddy-based wetland agroecosystem.

According to data in Table 1 related to the size of cultivated wetland in five provinces PATANAS research location shows some interesting information: (a) the land tenure of wetland in Java (Central Java and East Java) is lower than outside Java (South Sulawesi); (b) in the period 2007-2016, growth of land tenure of wetland was fluctuating with a decreasing trend (2010-2016), particularly in Central Java (above 1.4 % per year) and East Java (below 1.25 % per year), meanwhile in South Sulawesi there was a significant increase in wetland cultivated area (above 3.4.0%/year); (c) in 2016 the range of land tenure of wetland in Central Java and East Java was 0.40 ha–0.85 ha, North Sumatera 0.60 ha–1.00 ha, South Sulawesi 0.80 ha–1.40 ha, and West Java 1.20 ha – 1.80 ha. According to Angkoso et al. [9] with study cases in Karanganyar District-Central Java, Gini index in land tenure and ownership of agricultural land in Ngungkal and Talok Villages are high, namely 0.72 in Ngungkal and 0.52 in Talok.

**Table 1.** The dynamic of land tenure of wetland in paddy-based wetland agroecosystem in five provinces of PATANAS, 2007-2016 [11].

| Province        | Village     | Land tenure of wetland (ha) | Growth (%/year) |
|-----------------|-------------|-----------------------------|-----------------|
|                 |             | 2007  | 2010  | 2016  | 2007-2010 | 2010-2016 |
| Jawa Barat      | Sindangsari | 1.121 | 1.147 | 1.263 | 0.77      | 1.69       |
|                 | Simpar      | 2.039 | 1.438 | 1.773 | -9.83     | 3.88       |
|                 | Tugu        | 1.246 | 1.572 | 1.334 | 8.72      | -2.52      |
| Jawa Tengah     | Padangsari  | 0.449 | 0.532 | 0.437 | 6.16      | -2.98      |
|                 | Demangan    | 0.637 | 0.546 | 0.499 | -4.76     | -1.43      |
|                 | Mojorejo    | 0.799 | 0.810 | 0.736 | 0.46      | -1.52      |
|                 | Tambah Mulyo | 1.162 | 1.044 | 0.830 | -3.38     | -3.42      |
| Jawa Timur      | Sungegeneng | 0.610 | 0.718 | 0.665 | 5.90      | -1.23      |
|                 | Padomasan   | 0.617 | 0.619 | 0.587 | 0.11      | -0.86      |
|                 | Kaligondo   | 0.500 | 0.529 | 0.495 | 1.93      | -1.07      |
| Sumatera Utara  | Kwala Gunung | 0.929 | 0.629 | 0.611 | -10.76    | -0.48      |
|                 | Lidah Tanah | 0.769 | 0.926 | 0.978 | 6.81      | 0.94       |
| Sulawesi Selatan| Carawali    | 1.023 | 1.138 | 1.372 | 3.75      | 3.43       |
|                 | Salujiangbu | 0.683 | 0.634 | 0.876 | -2.39     | 6.36       |

Some of the factors that influence the decreasing wetland in Central Java and East Java are the high demand for land for a house, road infrastructure, and industry. The loss of agricultural land and skewed distribution of land is resulting from rapid urbanization which is giving rise to the large number of landless farmers [5]. Meanwhile, in North Sumatera, there is caused by incentives economic in oil palm estate [12]. The fact shows that the high growth of industry and services on Java island has not been able to guarantee the availability and accessibility for job opportunities and pressure of land resource economy in rural areas. The decreasing land tenure of wetland in Java and growth of oil palm estate outside Java will continue if there is no significant effort to accelerate the growth industry sector and technologies that increase wetland farmer profit.
Based on the same source data, analysis on the inequality of land tenure in Paddy-based wetland agroecosystem shows that according to Todaro and Smith [12] categorical (low: Gini index<0.35; medium: Gini index=0.35–0.50; high: Gini index>0.50). There are some interesting information related inequality: (a) inequality level (2007–2016) in general relatively fluctuate with a minimum growth and in medium level; (b) shifting inequality line (in the same level) maybe caused by deference’s of institutional land market [7]; (c) inequality in Java island in 2016, eight out of ten villages in the medium category and only two villages in the high category, while in two provinces outside of Java Island all of the village in medium level. In the last nine-year (2007-2016), a significant change in distribution wetland land tenure has not happened. In fact, some location level of inequality of land tenure increase.

3.1.2. Dry land-based on secondary crops and vegetable agroecosystem. A study conducted in 12 villages in 5 province point out several important features about distribution land in dry land-based on secondary crops and vegetables (Table 2): (a) growth rate of decreasing cultivated dryland in six-year (2011-2017) in secondary crops area is higher than vegetable area (6.61% per year vs 0.33% per year); (b) point (a) lead cultivated dryland in secondary crop area to be smaller than the cultivated area in the vegetable area (0.55 ha vs 0.70 ha). Without diversification of job opportunities, farmers' welfare in secondary crops area will be harder.

### Table 2. The dynamic of land tenure in dry land-based on secondary crops and vegetable agroecosystem in five province PATANAS,2007-2016 [13].

| Commodity-based province | Growth (%/year) | Village | Land tenure (ha) | 2008 | 2011 | 2017 | 2008-2011 | 2011-2017 |
|--------------------------|-----------------|---------|-----------------|------|------|------|-----------|-----------|
| **Secondary crops**      |                 |         |                 |      |      |      |           |           |
| Jawa Timur               | -6.61           | Bumiayu | 0.801           | 0.905| 0.546| 4.33 | -2.41     | 2.60      |
|                         |                 | Resongo | 0.350           | 0.270| 0.304| -7.62| -2.10     |           |
| Sulsel                   |                 | Paccaramengan | 1.670 | 1.831| 1.503| 3.21 | -2.99     |           |
| Jawa Barat               |                 | Sindang Mekar | 0.340 | 0.389| 0.330| 4.80 | -2.53     |           |
|                         |                 | Mekarsari | 0.520 | 0.816| 0.666| 18.97| -3.06     |           |
| Jawa Tengah              |                 | Ngelo | 0.630           | 0.870| 0.687| 12.70| -3.51     |           |
|                         |                 | Tlogosari | 0.670 | 0.894| 0.625| 11.14| -5.01     |           |
| Lampung                  | 0.33            | Catur Karya BJ | 1.810 | 1.509| 1.553| -5.54| 0.49      |           |
| **Vegetables**           |                 |         |                 |      |      |      |           |           |
| Jawa Timur               | -4.54           | Bendosari | 0.760 | 0.719| 0.523| -1.80| -4.54     |           |
| Sulsel                   | 0.06            | Baroko | 1.100           | 0.880| 0.883| -6.67| 0.06      |           |
| Jawa Barat               | -4.86           | Marga Mulya | 0.510 | 0.730| 0.517| 14.38| -4.86     |           |
| Jawa Tengah              | -6.41           | Karang Tengah | 0.440 | 0.551| 0.339| 8.41 | -6.41     |           |
| **Total**                | -2.61           |         | 0.761           | 0.842| 0.710| 3.55 |           |           |

Some influencing factors increasing land tenure in this agroecosystem in the early period (2008-2011) were the increasing price that implied temporary unused land use, use of PERHUTANI land, and extensification of the cultivated area through land rent and sharecropping land system. The decrease of land tenure in the later period (2011-2017) accelerate by the price of secondary crop and vegetables was drop and demography structure, especially related patrimonial system [13]. That confirms the hypothesis that rural labor force pressure has a severe impact on structure land tenure if there is have no significant effort to enhance the industry and service sector.

Analyze related distribution land tenure on 2008-2017 period in 12 villages on dry land-based on secondary crops and vegetables agroecosystem gives some information: (a) area with dry land-based on secondary crops agroecosystem, the level of inequality of land tenure in the last six year fluctuated...
with the increasing trend; (b) in 2011-2017 period, level of inequality increase 0.38 to 0.50 (in categorical high of inequality) that occurs in three of eight; (c) in village-based on vegetables, inequality decrease insignificant level, from 0.65 in 2008 to 0.50 in 2017 with growth rate 13.8 % in the last six-year. According Bauluz [8], agricultural land inequality in developing countries, South Asia and Latin America exhibit the highest inequality. The African countries display relatively less unequal land ownership patterns, while China and Vietnam is the world region with lowest inequality.

3.1.3. Plantation commodity-based dryland agroecosystem. Some important information related to the dynamic land tenure in the dryland agroecosystem based on estate crop in 2012-2018 period are as below (Table 3): (a) rate of growth size of land tenure is fluctuating with decreasing trend in the last six-year (2012-2018), even though the trend is relatively small (less than 1.50 %/year), except for cocoa commodity (+1.64%/year); (b) in 2018, the average land for four main estate commodities are sugarcane 0.82 hectare, Cocoa 1.23 hectare, rubber 3.40 hectare, and oil palm 3.87 hectares for each farmer household. The number of the average land tenure seems larger than the average land tenure in another agroecosystem.

| Commodity base | Province | Village | Land tenure (ha) | Growth (%/year) |
|----------------|----------|---------|-----------------|-----------------|
|                |          |         | 2009  | 2012  | 2018  | 2009-2012 | 2012-2018 |
| A. Rubber      | Jambi    | 1. Penerokan | 0.31  | 0.35  | 0.41  | 4.30       | 2.86       |
|                |          | 2. Semoncol | 0.19  | 0.22  | 0.25  | 5.26       | 2.27       |
| B. Cocoa       | Sulsel   | 1. Pakeng | 0.44  | 0.41  | 0.35  | -2.27      | -2.44      |
|                |          | 2. Bakti  | 0.40  | 0.45  | 0.45  | 4.17       | 0.00       |
| C. Oil Palm    | Jambi    | 1. Matra Manungal | 0.46  | 0.38  | 0.58  | -5.80      | 8.77       |
|                | Kalbar   | 2. Hibun | 0.28  | 0.32  | 0.33  | 4.76       | 0.52       |
| D. Sugarcane   | Jatim    | 1. Rejosari | 0.50  | 0.67  | 0.67  | 11.33      | 0.00       |
|                |          | 2. Kebonan | 0.44  | 0.46  | 0.52  | 1.52       | 2.17       |

Susilowati et al. [15] state that a collaboration system influenced the dynamic land sugarcane commodity among farmer and sugarcane factory, cultivated area from Perhutani, the changing sugarcane plantation to other annual commodities (“sengon”), and status of cultivated land. Meanwhile, the dynamic of other estate crop commodities (rubber, oil palm, cocoa) is influenced by high yield varieties, use of unused temporary land, and fluctuation in commodities [11]. In 2009-2018, there is no significant increasing land tenure area that indicated farmer mobility to carry out from agricultural sector and rural area deficient. So, consolidation and land transformation in the dryland agroecosystem based on estate crops has not happened in the ideal target.

Based on the same source data in Table 3, the dynamic of inequality land tenure of 8 villages sample on plantation commodity-based dryland agroecosystem are (a) level inequality relatively diverse depend on commodity variant and village infrastructure tend to increase; and (b) in villages based rubber, cocoa, oil palm in 2018, level inequality are medium, while in village-based sugar cane, the level inequality is high (Gini index 0.50-0.70). Increasing level inequality is caused by the introduction of wide variety in rubber and spread-out oil palm plantation, and at the same time, land fragmentation occurs [14].

3.2. The dynamic land size and distribution land tenure at region level

Base on Survey Usaha Tani Antar Sensus - SUTAS [6] data, in the last five years, the number of land tenure agricultural households increase from 25.75 million in 2013 to 27.22 million in 2018 (5.70%). It is at least indicate two points are rate of participated rural household on the agricultural sector is still very high and opportunities working non-agricultural sector cannot carry out the farmer to non-agricultural sector.
The increasing number of land tenure agricultural households is not followed by an increasing number of area agricultural land. At the same time, land for a house, infrastructure, factory expansion increase continuously. This fact affects the average size of land use of household land tenure agricultural to be smaller (Figure 1).

![Figure 1](image-url)  

Figure 1. Change of average area of land tenure agricultural households in Indonesia, 2013-2018 [6].

Figure 1 shows that decreasing the number of land tenure agricultural households in almost every region, except Maluku and Papua. In general, this condition indicates that there is no rationalization on the cultivated area. In other words, target economic transformation is not as well as expected. Growth of the manufacturing industry not sufficient to avoid the process of land holding decreasing.

Unfortunately, while decreasing the average land tenure of land tenure agricultural households, the distribution of land tenure also has no significant improvement. Gini index in 2013 is 0.64, while in 2018 is 0.60. Even though inequality gets to improvement, but the improvement not significant, and the inequality status of land tenure still not equal. In national scope, the proportion of farmer households with a land area less than a 0.5-hectare increase from 56% in 2013 to 58% in 2018. While the proportion of households that have a land area of more than 0.5 was decreased.

3.3. Influential factors and land resources transformation policies

Some factors and policies that influence the transformation of land resources are related (a) fragmentation and minimizing the land size of land farmer and agriculture; (b) land conversion; (c) land grabbing; (d) development of new agricultural land and irrigation; and (e) development sustainable agricultural land.

Land tenure is closely related to culture and institutional values in society. It was different with value in western culture that land's legal formal individual authority is more important [16]. Some action-related spatial land resources management consider minimizing land fragmentation and conversion. The policies to manage spatial land management through giving incentives and control community to a patrimonial system and land-use changes. Enhance sector industry in the rural area based on a collective investment of small farmers through creating farmer-owned cooperative is one strategy to minimize land fragmentation and conversion. On regulatory aspects Handayani et al. [17] say consistency of land use policy related to sustainable agricultural land protection and local government regulation on sustainable agricultural protection and land used planning are needed.

Irawan [18] study in West Java states that wetland conversion up to 110,000 hectares per annum with potential rice production losses of 6.85 % per annum. Mulyani [19] show conversion rate of wetland to non-wetland is around 96.5 thousand hectares per annum, while wetland creating only 20,000-30,000 hectare [20]. From in sociology perspective and agriculture culture, some alternative strategy that can be considered are (a) related action plan on land and environment, the legal approach must be complement with incentive and penalty system; (b) enhancing participation farmer and society
to controlling changing of land function; (c) enhance the local wisdom related mobilization on agricultural land; and (d) intensive role of traditional leader on land consolidation and providing food for the community [9].

Land grabbing may be able to make farmers get out from their cultivated land [21]. In perspective to avoid land grabbing, fundamental principles are (a) fairness water and land management as base enhancing household farmer business; (b) good government on management water and land, and (c) socio-feasibility investment on used land and water resources. Contract farming that complements local wisdom is believed an excellent operational strategy for increasing farmer welfare.

The others factor in accelerating land transformation is the development of new agricultural land and irrigation. Rice self-sufficiency is an operational strategy for achieving food security, so developing irrigation infrastructure and creating new wetlands is a great priority. In the 2015-2019 period, the government plan to create new wetland is around 1 million hectares and rehabilitate is around 3 million hectares [22].

More than 90% of staple food is rice, and more than 92% of rice is produced in the wetland. Meanwhile, a study shows that the growth rate of harvested area determines the growth rate of rice production. The condition indicated that protection on productive wetland must be concerned to guarantee sustainable food security. The regulation-related protection of agricultural land was arranged (UU No. 41/2009), but the application of the regulation is very complicated at the operational level.

4. Conclusions
The economics of land resources face the internal threat and external obstacle to obtaining land transformation, which attaches importance of fairness, availability, and accessibility for the small farmer. Threats and obstacles include high labor force and limited non-agricultural opportunities, land fragmentation, loose land transaction, land consolidation, land conversion, decreasing land tenure, and increasing inequality land tenure. This trend occurs at the micro, region, and macro level. In this condition, the structure and distribution of land tenure will not respond to transformation on economic food consumption.

At the macro and region level, need consistent policies to securing and exploiting potential food/agricultural land reserves, creating new agricultural lands and supporting infrastructure, protecting agricultural areas, strengthening local institutions, and managing communal land, are needed. Controlling land grabbing is another strategy to avoid land fragmentation and conversion. Agrarian reform, like land redistribution, transmigration program, and land consolidation, complemented supporting policy (non-land reform) such as availability and accessibility infrastructure and other aspects related to enhancing agroindustry in the rural area. Later, the government has to arranged operational policy to controlling land conversion.

At micro-level (household and rural area), fragmentation and effort made the land tenure controlled. Affirmative policy on distribution and/or redistribution which more get priority for small and landless farmers. In agrarian reform, small farmers have to support by fairness sharecropping system of land resources and another supporting policy. Farmer’s Own Company or “BUMT” as a farmer institutional can be considered to increase consolidation among farmers.

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