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The Effect of Toll Road Development on Agricultural Land Conversion in Indonesia: An Empirical Analysis

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Abstract

It is essential to undertake infrastructure development, including the construction of toll roads, due to the effects of advancing socioeconomic outcomes. Toll roads have the function of connecting and enhancing accessibility among different regions. In Indonesia, the development of toll roads has recently increased due to a national policy to boost the economic sector by developing regional infrastructure, particularly on Java Island. Although contributing to economic growth, the development of toll roads may result in a negative impact on agricultural land conversion. This paper aims to assess to what extent the effect of regional toll road development contributes to agricultural land conversion in Indonesia. Java Island was selected as a case study due to the extensive construction of the Trans-Java Toll Road, a high population, and as the primary source of agricultural products in Indonesia. A quantitative approach was applied, based on secondary data, including the farmland area and toll road development in certain regencies (*Kabupaten*) and cities (*Kota*). Statistical analysis was conducted by examining the significant differences in the growth of wetland rice fields with and without the toll road. The findings reveal that the existence of toll roads has a significant impact on the negative growth of agricultural land. However, this result needs to be verified by other influencing factors.

Keywords: *toll road development, agricultural land, land conversion, regional infrastructure, Trans-Java Toll Road, Indonesia*

1. Introduction

Rice is one of the essential foods in the world, and the 3.5 billion plus world population seriously depends on rice consumption (Ricepedia, 2020). Especially in Indonesia, although there are many kinds of substitutive foods, such as maize and cassava, rice is more critical. Rice is the leading staple food of most Indonesian people, and the majority of its people have historically and culturally depended on rice for ages. Indonesia is also the third largest rice producer in the world (Shahbandeh, 2020). Thus, rice production in the country can influence both national and global food security.

Among all of the largest islands in Indonesia, the majority of rice producers are located on Java Island (Arifin et al., 2019) because of the abundance of fertile lands and its multitude of skilled farm workers. The Island is about 6.5 percent of the total area of the country (Indonesia Statistic, 2020b), but it produces more than 50 percent of rice in Indonesia (Indonesia Statistic, 2020a). Thus, the Island is

strategically vital for the establishment of food security in Indonesia. However, rice production on Java Island has been indirectly threatened by the construction of Trans-Java Toll Road.

Currently, the Trans-Java Toll Road is one of the leading regional infrastructure developments in Indonesia. National policy has driven its development to increase the national and regional public sector. This road is in development from the edge of western Java to the side of eastern Java. The construction of the roads has encroached upon fertile rice fields, especially in the northern Java area. The development of the Trans-Java Toll Road has diminished around 4,624 hectares of rice farm fields, especially agricultural land (Studia Generalia, 2008). This impacts not only the land, but also has a multiplier effect of decreasing new farmland conversion on Java Island. This decrease in agricultural land, in the long run, is threatening to the food security. The purpose of this research was to analyze the impact of the development of the Trans-Java Toll Road on agricultural land conversion.

An infrastructure development such as a new toll road construction is expected to provide potential benefits for certain regions in the context of socioeconomic growth and inter-regional connectivity (Asian Development Bank., 2012; Kadam Ardiyono et al., 2018; Morten & Oliveira, 2018). Li et al. (2018) mentioned that road network development could promote industrial and agricultural activities by providing access to the markets and increasing job opportunities. However, the findings of Makbul's (2019) study revealed that the implications of infrastructure development in Indonesia could have indirect negative influence on regional food security in terms of agricultural land conversion. Although this study was concerned about the farmers' perceptions related to the toll road construction surrounding their farmland areas, the result indicated a tendency of free-market adoption of farmland prices due to infrastructure development. This study is supported by Handy et al. (2002), who found that highway infrastructure could result in negative externalities for those living along the roads. The land-use change from agricultural into nonagricultural land in surrounding toll road development was revealed by Putro et al. (2019), in the case of Ungaran toll road construction. From previous studies, it can be deduced that the effect of infrastructure development the highway construction would be different across the region, depending on the location and socioeconomic conditions, as described below.

Previous research on the impact road development on agricultural land conversion was engaged by Makbul et al. (2017). This research found that farmers tend to sell or convert their rice fields to the non-agriculture sector if their land is in proximity to the road. This phenomenon occurs due to the rice field being more valuable in the non-agriculture sector after the development of the toll road, especially land near the gate of the toll road. The construction of a toll road makes the land near that road more accessible and in proximity to and from the city. This phenomenon makes a good investment for real estate and industrial areas and demand for the land grows, along with the price of the land rising. The higher price of land means that farmers tend to sell their property, and the farmland is converted to the nonagricultural sector. This research focuses only on the farmers' perception of the development of the Trans-Java Toll Road and the desire of the respondent to sell or convert farmland, but not on the impact of the toll road on agricultural land conversion on Java Island as a macro finding.

Other research concludes that the development of roads for advancing transportation affects agricultural land conversion. The study of Azadi et al. (2011a) noted that road development is an agricultural land driver among less developed, developing, and developed countries, asserting that road construction development is a contributing driver of agricultural land conversion. However, in this research, road development is not a variable of analysis regarding the agricultural land conversion, but only one of the drivers of agricultural land conversion. The study of Francis et al. (2012) noted that the expansion of transportation is driving agricultural land conversion. However, the road is not the focus of analysis of this research. The research of Ho and Lin (2004) concludes that increasing investment in roads is contributing to agricultural land conversion. The study was in China; however, this research was not specific to a toll road. The analysis of Chung (2002) concludes that toll roads in rural China restricted rural people's choice to the market because the toll road blocked free movement. However, this research does not have a relationship with agricultural land conversion but road development in relation to farm market.

The previous research topic is the impact of road development on agricultural land conversion. This research provides enrichment of the above findings by analyzing the effect of toll road development on agricultural land conversion.

2. Methodology

2.1 Data collection

The data for this research is from an official publication of the Ministry of the Agriculture Republic of Indonesia. The mining data is from Indonesian Statistics Agricultural Land 2013-2017 (Ministry of Agriculture, 2018). Agricultural land is common land for agricultural crop products, like corn, yams, soybeans, etc. The area in which rice is produced is a rice field farm. In Indonesia, the sites to produce rice are dry and wet rice fields or wetlands. According to Irawan (2011), 95% of the rice fields in Indonesia are situated on wetlands, indicating that wetlands are the dominant form of rice farming in Indonesia. For this research, the chosen measure for the data is mining is the wetland rice field.

2.2. Data analysis

The analysis of the data is to calculate the increase/decrease of wetland rice fields in every regency and city on Java Island. The formula is:

$$G = \left(\frac{Y_{2017} - Y_{2013}}{Y_{2013}}\right) \times 100\%$$

G = growth of wetland rice fields in regency or city

Y_{2013} = Total wetland rice fields in this regency/city in the year 2013

Y_{2017} = Total wetland rice fields in this regency/city in the year 2017

The growth of wetland rice fields will then be compared by the regencies/cities which are passed by the Trans-Java Toll Road with the regencies/cities that do not cross the toll road. The value of the

difference is tested by t-test at 95% confidence level. If the test is significant, then it can be concluded that the toll road has a considerable impact on agricultural land conversion.

The regencies/cities that the toll road passed were given before the year 2013 to analyze the impact of the toll road. The data source is based on "*Badan Pengatur Jalan Tol*" (BPJT) or the Toll Road Regulatory Agency Republic of Indonesia.

3. Overview of the toll road and agricultural land on Java Island

The Trans-Java Toll Road is a tolled expressway network in Indonesia that runs from Merak, at the northwestern end of Java, to Banyuwangi, at the eastern end of the Island (see Figure 1). The toll road connects all major cities of the Island. The total length of the road is 1,167 kilometers (725 miles). As of December 2018, the toll road from Merak to Surabaya is fully operational, while the Probolinggo to Banyuwangi section is expected to be finished in 2020. There are also many other complementary toll networks connecting this toll road. The Trans-Java Toll Road also connects Jakarta with Surabaya, the two major cities of Java Island; the distance between the two cities is about 760 kilometers.

Figure 1. The Trans-Java Toll Road on Java Island, Indonesia

Source: (BPJT, 2020)

Figure 1. Shown the map of Trans-Java Toll Road from Merak on the west edge of Java island to Banyuwangi on the east boundary. The toll passes many regencies and cities. A list of regencies/cities that the toll road passes or to which it is connected by another toll road is below in Table 1.

Table 1. The Regencies/Cities on Java Island is Passed by the Toll Road before the Year 2013

Toll Road Name	Year Operation	Regencies/Cities Passed
Jakarta-Bogor-Ciawi	1978	Jakarta Timur city, Depok City, Bogor Regency, Bogor City
Semarang Section A, B, C	1983	Semarang city
Jakarta-Tangerang	1984	Jakarta Barat City, Tangerang City, Tangerang Regency

Prof. Dr. Ir. Soedjiatmo	1985	Jakarta Utara City
Surabaya-Gempol	1986	Surabaya City, Sidoarjo Regency, Pasuruan Regency
Jakarta-Cikampek	1988	Jakarta Timur City, Bekasi City, Bekasi Regency, Karawang Regency
Cawang-Tj. Priok-Ancol Timur	1989	Jakarta Utara City
Padalarang-Cileunyi	1991	Bandung Barat Regency, Cimahi City, Bandung City, Bandung Regency
Tangerang-Merak	1992	Tangerang Regency, Serang Regency, Serang City, Cilegon City
Surabaya-Gresik	1993	Surabaya City, Gresik Regency
JORR S	1995	Jakarta Timur City, Jakarta Utara City, Jakarta Selatan City, Jakarta Pusat City
Palimanan-Kanci	1998	Cirebon Regency
Pondok Aren-Bintaro Viaduct-Ulujami	1999	Tangerang Selatan City
Pondok Aren-Serpong	1999	Tangerang Selatan City
Cikampek-Padalarang	2005	Karawang Regency, Purwakarta Regency, Bandung Barat Regency
JORR E	2007	Jakarta Timur City, Jakarta Utara City, Jakarta Selatan City, Jakarta Pusat City
Simpang Susun Waru-Bandara Juanda	2008	Surabaya City
Kanci-Pejagan	2010	Cirebon Regency, Brebes Regency
JORR W1	2010	Jakarta Timur City, Jakarta Utara City, Jakarta Selatan City, Jakarta Pusat City
Semarang-Solo	2011	Semarang City, Semarang Regency, Salatiga City, Boyolali Regency
Surabaya-Mojokerto	2011	Surabaya City, Sidoarjo City, Gresik Regency, Mojokerto Regency, Mojokerto City
Bogor Ring Road	2011	Bogor City
Cinere-Jagorawi	2012	Depok City

Source: (BPJT, 2020)

The Table shows the regencies and cities passed by or connected to the Trans-Java Toll Road. All these regencies and cities were analyzed regarding the growth of surrounding wetland rice fields. The analysis also calculated the growth of rice fields. The result was compared and tested through statistical analysis.

Results and discussions

After the analysis, a t-test, assuming unequal variance in the growth (%) of wetland rice fields in the cities/regencies the toll road passed and those not passed by the toll road. The result is in Table 2.

Table 2. The Result of T-Test Growth the Wetland Rice Field

	Passed	*Not Passed*
Mean	-17.190986	-1.576756
Variance	490.919384	207.370074
Observations	37	85
t Stat	-3.939705	
P(T<=t) two-tail	0.000253**	
t Critical two-tail	2.008559	

**) High Significance

Table 2 reveals an overall negative growth in wetland rice fields in the cities/regencies on Java Island; however, the cities/regencies that the toll road passed showed a negative growth more than ten times higher than cities/regencies that the toll road does not cross. The difference in this growth is highly significant. From the findings of these results, it can be concluded that the toll road has a significant impact on the negative growth of the wetland rice fields. The negative growth of wetland rice fields is a signal that agricultural land conversion on Java Island is increasing.

The findings of this research support previous research (Azadi et al., 2011b; Li et al., 2018; Makbul et al., 2017) conclusions that the development of toll roads can impact agricultural land conversion. These facts indicate that food security in Indonesia is indirectly under threat. The production of rice paddies depends on agricultural land; if the farmland is shrinking, production is shrinking too. Java Island is the primary land of rice production in Indonesia. The threat to rice production Jeopardizes food security in Indonesia as well as global food security.

The development of the Trans-Java Toll Road on Java Island continues today, according to (BPJT, 2020), after 2013 to 2019. The current toll road operations are listed in Table 3.

Table 3. The Toll Road Operational on Java Island 2013-2019

Toll Road Name	Year Operation	Regencies/Cities Passed
JORR W2	2013	Jakarta Timur City, Jakarta Utara City, Jakarta Selatan City, Jakarta Pusat City
Bogor Ring Road	2014	Bogor City
Kertosono-Mojokerto	2014	Nganjuk Regency, Kediri Regency, Jombang Regency, Mojokerto City, Lamongan Regency

Cikampek-Palimanan	2015	Purwakarta Regency, Subang Regency, Indramayu Regency, Majalengka Regency,
Gempol-Pandaan	2015	Pasuruan Regency, Sidoarjo Regency, Probolinggo City,
Pejagan-Pemalang	2016	Brebes Regency, Purwokerto Regency,
Soreang-Pasir Koja	2017	Bandung City, Bandung Regency
Bekasi-Cawang-Kampung Melayu	2017	Jakarta Timur City, Bekasi City
Akses Tanjung Priuk	2017	Jakarta Utara City
Gempol-Pasuruan	2017	Pasuruan City, Pasuruan Regency
Depok-Antasari	2018	Jakarta Selatan City, Depok City
Ngawi-Kertosono	2018	Ngawi Regency, Madiun Regency, Nganjuk Regency, Jombang Regency
Pemalang-Batang	2018	Pemalang Regency, Pekalongan Regency, Batang Regency
Semarang-Batang	2018	Batang Regency, Kendal Regency, Semarang City
Solo-Ngawi	2018	Surakarta City, Karang Anyar Regency, Boyolali Regency, Sragen Regency, Ngawi Regency
Ciawi-Sukabumi	2018	Bogor Regency, Sukabumi Regency
Relokasi Porong-Gempol	2018	Surabaya City, Sidoarjo Regency, Pasuruan Regency
Pandaan-Malang	2019	Pasuruan Regency, Malang Regency, Malang City
Kunciran-Serpong	2019	Jakarta Selatan City, Tangerang Selatan City
Jakarta-Cikampek II Elevated	2019	Jakarta Timur City, Bekasi City, Bekasi Regency, Karawang Regency

Source: (BPJT, 2020)

From Table 3, the regencies/cities have been added since the year 2013 are Nganjuk Regency, Kediri Regency, Jombang Regency, Lamongan Regency, Subang Regency, Indramayu Regency, Majalengka Regency, Probolinggo City, Purwokerto Regency, Pemalang Regency, Pekalongan Regency, Batang Regency, Kendal Regency, Karang Anyar Regency, Boyolali Regency, Sragen Regency, Ngawi Regency, Malang Regency, and Malang City. Twenty more regencies/cities are to be after the initial 2013-2019 phase, which means the percentage of negative growth of wetland rice fields will increase, as it is a fact that agricultural land conversion will increase.

More toll roads will be developed on Java Island, like Ciawi-Sukabumi, Cileunyi-Sumedang-Dawuan, Probolinggo-Banyuwangi, Serang-Panimbang, Gedebage-Tasikmalaya-Cilacap, etc. This will result in

even more agricultural land conversion on Java Island because more cities/regencies will be passed by toll roads.

The increase of agricultural land conversion decreases rice production because rice production depends on land. The decrease of rice production on Java Island can have a crucial impact on food security in Indonesia because of most national rice production takes place on Java Island (Arifin et al., 2019). The decrease in rice production in Indonesia can also impact global food security, as Indonesia is the third-largest rice producer in the world (Shahbandeh, 2020).

The development of toll roads on Java Island is the proper policy for increasing economic growth in Indonesia. These policies must be supported, but food security must also be a consideration of such government policies. The government must include planning to reduce the negative impact of toll roads on agricultural land conversion, especially on Java Island.

The government policy to protect agricultural land is outlined in act 41 No. 2009, under the name of the "*Perlindungan Lahan Pertanian Berkelanjutan* (LP2B)" Act. The purpose of this act is to ensure the protection of sustainable food agricultural land (Maryati et al., 2018). Paragraph No. 1 of article No. 44 states that sustainable farmland is protected and forbidden from conversion (DPR-RI, 2020). However, in reality, the implementation of the law is unclear and has no significant effect on agricultural land conversion (Handari, 2012). The law remains unclear on the means for protecting farmland from conversion to nonagricultural use.

The law only is not enough; to decrease the impact of the Trans-Java Toll Road on agricultural land, reducing the conversion of agricultural land must be an added program. Farm groups have influenced farmers not to convert their farmland to other uses (Makbul et al., 2019), putting social pressure on farmers. So, the government can use farm groups to promote the importance of food security in Indonesia. Article 37 of Act 41 No. 2009 states that the government and local governments must control farmland production with incentives, disincentives, licensing, protecting, and promotion. Farm groups can reduce the conversion of farmland by farmers affected by the Trans-Java Toll Road.

4. Conclusion

The research finds that the growth of wetland rice fields is negative overall on Java island. This means that food security in Indonesia is threatened, as Java Island is the main producer of food in Indonesia. The research also finds that the cities/regencies that the toll road passes have significantly more negative growth compared to those not passed. The toll road has an impact on the negative growth of the wetland rice fields. While the Trans-Java Toll Road is developing and operational, agricultural land conversion on Java island is rapidly increasing. This phenomenon is very threatening to the national food security of Indonesia. The future development of the Trans-Java Toll Road must be supported, as this development will increase economic development in Indonesia. But the food security of Indonesia must be maintained as well due to its vital importance to socioeconomics in Indonesia. The program to address the negative impact of the toll road on agricultural land conversion on Java Island must be established. The implementation of the agricultural land is addressed in act 41 No. 2009. This is especially critical in

the regencies/cities that the toll road passes as an example of the need for a program to hold the negative impact of the toll road on agricultural land conversion.

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