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The Development of Industrial Agglomeration in Industrial Designation Areas and its Impact on Land Use Change (Case Study: Pringsurat Subdistrict and Kranggan Subdistrict, Temanggung Regency)

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Abstract

Industrial agglomeration refers to the clustering of industries in a specific region, where they are in close proximity and have interconnections. This phenomenon not only stimulates the growth of industrial activities, but also influences the development of other economic sectors. As industrialization expands, it gradually extends into rural areas that usually have abundant undeveloped land primarily used for agriculture. Consequently, this trend prompts a transition from agricultural to industrial land use. Pringsurat subdistrict and Kranggan subdistrict are located in Temanggung Regency, Central Java Province. Both of these subdistricts are designated as Industrial Designation Areas (KPI) according to the Temanggung Regency Spatial Plan 2011-2031. The plan has implications for the rapid development of large and medium industries. The purpose of this study is to examine the growth of industrial agglomeration in Pringsurat subdistrict and Kranggan subdistrict and their impact on agricultural land conversion. This research was conducted from 2023 to 2024 and utilizing data from 2021 and 2022. The approach of this research is descriptive quantitative and utilizes spatial analysis with Geographic Information Systems (GIS) and descriptive analysis techniques. Based on the results of the analysis, there is an agglomeration of large and medium industries in Pringsurat subdistrict and Kranggan subdistrict. The growth of agglomeration encourages the establishment of new industries and industry linkages. Furthermore, agglomeration growth has led to changes in land use, an increase in the variety of land uses, and an increase in land prices. Results of the analysis also show that there are regulatory changes in the development of industrial agglomeration that will affect to local government decision in the future.

Keywords: agglomeration; industry; land use

1. INTRODUCTION

Temanggung Regency is one of the regencies in Central Java whose economy is supported by the industrial sector. Approximately 22.41% of the district's Growth Domestic Product (GDP) comes from the processing industry sector. Industrial growth in this regency is supported by the establishment of Industrial Designation Areas (KPI) in Pringsurat subdistrict and Kranggan subdistrict. This establishment is stated in the Regional Regulation of Temanggung Regency Number 1 of 2012 on the Temanggung Regency Spatial Plan (RTRW) for 2011-2031. The establishment of Pringsurat subdistrict and Kranggan subdistrict as Industrial Designation Areas has led to rapid industrial growth in this area. According to Temanggung Regency Statistics Data, there are 13 and 46 medium-large industries located in Pringsurat subdistrict and Kranggan subdistrict in 2011 and 2022 respectively. The number of medium and large industries in these two subdistricts is greater than other subdistricts in Temanggung Regency. The growth of industries in Pringsurat subdistrict and Kranggan subdistrict is mainly concentrated along the main road network. This rapid industrial growth lead to an increased demand for space for industrial activities, as well as space for other supporting industrial activities. Additionally, the existence of industrial estates in these districts, which are located adjacent to agricultural land areas, has the potential to transform undeveloped land into built-up areas. As industrial activities continue to expand within limited land capacity, the area will become more densely populated with buildings. Furthermore, Temanggung Regency Government plans to expand the area designated as an industrial area in Pringsurat subdistrict and Kranggan subdistrict (Central Java Government, 2022).

The rapid development of the industrial sector will create a high demand for land for industrial activities and their supporting activities (Prasetyo et al., 2015). In rural areas, where agriculture dominates land use, there will be a significant

increase in the conversion of agricultural land into industrial land. Pringsurat subdistrict and Kranggan subdistrict are two subdistricts that still have a large amount of undeveloped land, mainly agricultural land. In fact, 13.2% of the agricultural land in Temanggung Regency are located in these two subdistricts. On average, each subdistrict in Temanggung Regency has 4.82% of agricultural land. This agricultural land includes Sustainable Food Agricultural Land (LP2B) and Sustainable Food Agricultural Reserve Land (LSD). According to data from the Department of Food Security, Agriculture and Fisheries (DKPPP) of Temanggung Regency (2020), the LP2B area in Pringsurat subdistrict and Kranggan subdistrict is 1,730.95 hectares, which accounts for 8.35% of the total LP2B area in Temanggung Regency. On average, the largest LP2B area in Temanggung Regency is found in the two subdistricts accounts for 9.57% of the total LP2B area. Additionally, each sudistrict has an average LP2B area of 4.50%. The medium and large industrial activities in Pringsurat subdistrict and Kranggan subdistrict are adjacent to agricultural land. Thus, it is crucial in understanding the extent of industrial growth and its impact on land use change. Industrial growth in these two subdistricts will further encourage the conversion of agricultural land to support industrial and supporting activities.

The growth of industrial sectors in these two subdistricts will encourage the conversion of agricultural land to support industrial and supporting activities. Therefore, this study aims to determine the growth of industrial agglomeration in Pringsurat subdistrict and Kranggan subdistrict in Temanggung Regency and its impact on land use change. To achieve these goals, four targets have been formulated: 1) identifying the types and distribution of medium-large scale industries; 2) analyzing the process of medium-large industrial growth; 3) analyzing the impact of industrial agglomeration growth on land-use change; and 4) analyzing the changes of regulatory about industrial agglomeration growth in Pringsurat subdistrict and Kranggan subdistrict, Temanggung Regency.

2. THEORETICAL STUDIES

2.1 INDUSTRIAL AGGLOMERATION

Industry is the term used to describe all activities involved in the production process, where raw materials are transformed into either semifinished or finished goods (Putra, 2012). According to Julianto and Suparno (2016), industry encompasses a range of activities that aim to enhance the value of a product or service through the use of labor and equipment. Fisher (1939) divides industry into three, namely primary, secondary, and tertiary industries. Furthermore, Law Number 3 of 2014 regarding Industry classifies industries based on to the number of workers involved, such as small industries (5-19 workers), medium industries (20-99 workers), and large industries (more than 100 workers). Additionally, Galbraith and Kazanjian (1986) as cited in Nicovich et al. (2007), propose another way of grouping industries based on their supply chains, specifically as upstream industries and downstream industries. In addition, industries can be grouped based on the linkage between supplier industries, core industries, and related industries.

The factors influencing industrialization processes are closely tied to the selection of industrial sites. Setiawan et al. (2018) categorized industries based on site selection into market-oriented, labor-oriented, and raw material-oriented industries. Industrial site selection can also be determined by processing requirements, site accessibility, and the absence of other specific requirements. Furthermore, land characteristics, such as land slope, play a role in determining industrial site zones. Local government policies also influence the selection of industrial sites. Government policies at local level significantly impact the extent and concentration of industrial development in a given area. Factors that influence the choice of industrial locations include the area's accessibility, topography, minimum wage for labor, availability of labor, land prices, distance from city centers, and land allocation regulations.

One theory of regional development that relates to the location of industrial development is the theory of the growth pole. The term "growth pole" was introduced by Francois Perroux in 1949, suggesting that growth does not occur simultaneously in all regions, but rather in specific centers. Hutchison (2010) points out that in the developing world, growth poles are identified as targets for focused public investment to stimulate development and then spread it to more remote areas. This is accomplished by implementing industrialization strategies within these regions.

A growth pole refers to a group of firms or industries that contribute to economic expansion (Hutchison, 2010). The growth pole theory examines how a company or leading industry can stimulate the development of other entities through the exchange of materials and information flow (Wang & Li, 2017). Typically, a growth pole is characterized by the presence of key industries, which are dominant large industries that generate direct and indirect effects. These effects include increased production output, employment, related investments, as well as the emergence of new technologies and

industrial sectors (Gavrilă-Paven & Bele, 2017). Consequently, the region where the industry develops will experience faster growth compared to other areas.

Industrial growth in certain areas leads to the formation of industrial agglomerations. An industrial agglomeration is defined as a large number of companies or industries that are located close to each other geographically (Nielsen et al., 2021). The presence of clustered medium-large industries indicates the occurrence of industrial agglomeration in a particular region (Pangarso et al., 2019). Agglomeration can also be interpreted as a set of industrial clusters (Kuncoro, 2006). Furthermore, according to Chen et al. (2021), the characteristics of spatial agglomeration include levels of spatial agglomeration, distribution of spatial agglomeration locations, and spatial agglomeration patterns. The clustering of industries that are geographically located close to each other in a region can be identified as a form of spatial agglomeration.

Interindustry relationships within a location can lead to agglomerations, such as the linkage between upstream industries that supply raw materials to downstream industries (Venables, 1996). The linkage that occurs between industries is a type of company externality resulting from the proximity of industrial locations, commonly known as economic agglomeration in the industry. The economic growth of a company or main industry that serves as a driving force will stimulate the growth of other industries or economic sectors through agglomeration, which is referred to as positive externality economy (Hutchison, 2010). In the research conducted by Pangarso et al. (2019), it is shown that agglomerated industries have an impact on labor demand, the transfer of knowledge and skills, and promote the growth of other industries. The advantages obtained from industrial locations that are geographically close to each other, such as the occurrence of inter-industrial linkages, labor absorption, and the abundance of knowledge and technology, are forms of economic agglomeration in the industry.

2.2 LAND USE CHANGE

Land use refers to the socio-economic function of a piece of land that has significant land cover (Yang et al., 2019). The development of land use is influenced by a variety of human activities (Dwiyanti & Dewi, 2013). As human activities on land continue to increase, it is important to remember that land is a finite natural resource (Rusmawan, 2007). Consequently, over time, there will be a need for land conversion to accommodate the growing number of human activities.

Land conversion refers to the process of changing land into various uses that differ from its original purpose. For instance, agricultural land may be converted into nonagricultural land. In Dwiyanti & Dewi (2013), the changes in land use involve transforming agricultural and vacant land into residential areas and other functions, as well as converting residential land into commercial areas. The changes in land use can be detected by observing the expansion of new residential areas and the presence of commercial establishments on agricultural land (Rusmawan, 2007). In rural areas, the transformation of nonagricultural land use primarily occurs in the form of residential and industrial land (Tian & Zhu, 2013). Rochadi et al. (2022) highlight that agricultural land conversion can arise from factors such as industrialization, urban development, office spaces, and infrastructure. Industrialization is one of the factors that causes the conversion of agricultural land into built-up area. This occurs due to the need for space to accommodate the industrial activities that develop in a particular region.

Economic growth tends to stimulate demand for land conversion from agricultural to nonagricultural use in a region due to its responsiveness to generated income. One of the factors contributing to this growth is industrialization activities, which are supported by infrastructure and strategic locations (Fariha et al., 2021). Industrialization promotes urbanization by attracting a large number of migrant workers, resulting in increased needs and activities (Wijaya et al., 2018). However, high interregional labor mobility can lead to transportation issues, and workers residing near industrial areas may contribute to changes in land use within the region (Pangarso et al., 2019). Furthermore, Wijaya et al. (2018) emphasize that industrial development leads to an increase in developed areas for residential, trade, and service purposes, as well as socio-economic changes for local communities.

Industrialization is driven by economic principles, particularly in terms of land prices, which are the most influential factors (Wijaya et al., 2018). The growth of the industry is influenced by factors such as proximity to major road networks and land prices when selecting a site (Fariha et al., 2021). Mahardika & Muta'ali (2018) suggest that changes in land use can be influenced by the high selling price of land due to its strategic location and designation as an industrial zone. Furthermore, industrial development significantly impacts the increase in land values (Fitriyanto, 2016). The development of industrial activities will lead to a change in land use, converting it into a developed area, which will then result in an increase in land prices. This increase can be attributed to the strategic location of the land.

Growth does not occur simultaneously in all regions. Consequently, the center of growth can be utilized as a policy for the government to equalize development, one of which is industrialization. The industrialization process will result in the development of activities within the region and encourage land use change. The spatial perspective in industrial development is one of the factors for the government in formulating industry-related policies (Damayanthi, 2008). In essence, the implementation of local government policies will also influence land use change. The industry will develop in accordance with the regulations set by the local government in a region. Therefore, the change of land use to industrial purposes will also be influenced by government policies that apply to a specific area.

3. RESEARCH METHODS

3.1 STUDY AREA

The area of this study is Pringsurat subdistrict and Kranggan subdistrict in Temanggung Regency, Central Java Province. The research location is chosen based on a Temanggung Regency Regional Regulation Number 1 of 2012 on the Temanggung Regency Spatial Plan (RTRW) for 2011–2023 that designates these two subdistricts as Industrial Designation Areas (KPI). The study was conducted in 2023–2024 using data from 2011 and 2022. This is aligned with the commencement of the KPI determination in the RTRW. To specifically study the land price, sampling of several villages in the study area is identified. The classification that is used to select the villages for sampling is shown on Table 1.

Table 1. Classification for Sampling Land Price Data in 2011

Classification	Villages
1. Hub of activity for the local district	Pringsurat, Kranggan
2. Where medium and/or large industries exist	Pingit, Ngipik, Rejosari, Pringsurat, Kebumen, Soropadan, Kupen, Nguwet, Pare, Bengkal, Badran, Klepu, Sanggrahan
3. Bypassed by arterial roads	Pingit, Ngipik, Rejosari, Pringsurat, Kebumen, Soropadan
4. Bypassed by collector roads	Kebumen, Kupen, Nguwet, Pare, Bengkal, Badran, Kranggan
Study Area	**Pingit, Klepu, Ngipik, Rejosari, Pringsurat, Kebumen, Soropadan, Kupen, Nguwet, Pare, Bengkal, Badran, Kranggan, Sanggrahan**

Source: Fariha et al. (2021); Fitriyanto (2016); Mahardika & Muta'ali (2018); Wijaya et al. (2018)

To analyze the sampling results above in a spatial manner, Figure 1 displays the study areas that have been defined using the sampling results from the study area boundary.

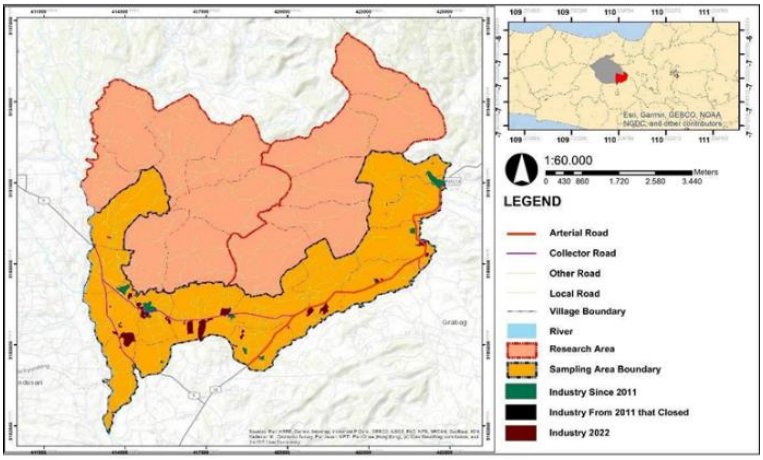

Figure 1. Study Area

3.2 RESEARCH APPROACH AND DATA COLLECTION METHOD

This research employs a deductive approach, commencing with the primary theory, namely the growth pole theory. From this, conclusions will be drawn on more specific matters, namely the extent of the industrial agglomeration growth that occurred in Pringsurat Subdistrict and Kranggan Subdistrict, Temanggung Regency, and its impact on the conversion of surrounding agricultural land. In terms of its methodology, this research can be classified as a descriptive quantitative study. In accordance with the tenets set forth by Lans & van der Voordt (2002), this descriptive research is designed to delineate the manner in which empirical phenomena manifest themselves in the real world, rather than to advance a theoretical framework.

This research employed both primary and secondary data sources. Primary data are defined as data and information collected directly by researchers in the field in accordance with their research objectives (Boaduo, 2011). The data sources for the primary data collection in this study were obtained from field observations and structured interviews. The observations made in this study were conducted with the objective of determining the distribution of medium and large industries and observing land changes in the study area. Secondary data were collected through structured interviews. Structured interviews are interviews conducted at the outset of a study, during which the researcher is already aware of the information required and the questions posed focus on the data that is truly essential. Secondary data was collected from related agencies and sources that could be accessed vial internet, document searches, and data publications. Data collected secondarily comprises data on the distribution and type of industry, data on linkages that occur between industries in the study area, as well as data on land use and land value zones. Furthermore, this study is subject to certain limitations. These include the restriction to medium and large industries and the inability to access all existing industries.

3.3 DATA ANALYSIS TECHNIQUES

3.3.1 Analysis on the Type and Distribution of Medium-Large Scale Industries Concentrated in the Study Area

To analyze the concentration of industries in the study area, the Nearest Neighbor Analysis technique was conducted using Geographic Information System (GIS). According to Bintarto & Hadisumarno (1979), the nearest neighbor parameter or T can be categorized into 3 types, namely clustered, random, and dispersed. A clustered pattern is a distribution that occurs in a specific location. This pattern is observed when the value of the nearest neighbor parameter (T) is T=0 or T close to 0. A random pattern is a distribution that occurs randomly. This pattern occurs when the value of the nearest neighbor parameter (T) shows a value of T = 1 or T close to 1.Meanwhile, dispersed pattern is a spatial distribution that shows distribution within almost the same distance. This pattern occurs when the nearest neighbor parameter value (T) shows a value of T = 2.15 or T close to 2.15. Figure 2 shows an illustration on the difference between the three patterns.

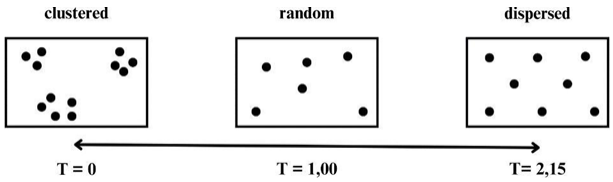

Figure 2. Continum on the Nearest Neighbor Parameter (T)
(Bintarto & Hadisumarno, 1979)

3.3.2 Analysis on the Growth Process of Medium-Large Industry in Study Area

The growth process of medium-large industry was analyzed through identification of inter-industry linkages and identification of employment in the industry sector. The identification of inter-industry linkages is carried out using descriptive analysis techniques. Economic agglomeration is determined based on the presence or absence of cooperation between industries. To obtain this data and information, interviews were conducted with industries located at the research site. Subsequently, data and information obtained will be analyzed descriptively. Identification of employment or labor absorption in the industry sector is conducted through descriptive analysis, utilizing data on the number of residents in the study area, data on residents of productive age, and data on residents employed in the industrial sector. Equation (1) is used for analyzing employment in the industrial sector, where x is employment, a is productive age population in the study area, and b is population employed in the industrial sector.

$$x = \frac{b}{a} \times 100\% \quad \text{.....(1)}$$

3.3.3 Analysis on the Impact of Industrial Agglomeration Growth on Land Use Change

The impact of industrial agglomeration growth on land use change was analyzed through identification of land use change, identification of increasing land use variation, and identification of land price change. To identify land use change, land use data from both 2011 and 2022 were obtained from Google Earth Satellite Imagery. Geographic Information Systems (GIS) are used to process the data and apply overlay analysis techniques to determine the land use changes that have occurred.Identification of increasing land use variation was conducted by comparing the diversity of land use types in 2011 with 2022 in order to observe the changes in land use over time. The identification of changes in land prices was conducted through spatial analysis, which involved mapping the changes in land prices surrounding industries in

Pringsurat Subdistrict and Kranggan Subdistrict from 2011 to 2022. The comparison of these changes in land prices was performed using equation (2), where x is percentage of land price change, a is land value in 2011, and b is land value in 2022.

$$x = \left(\frac{b-a}{a}\right) \times 100\% \quad \text{..... (2)}$$

4. RESULT AND DISCUSSION

4.1 IDENTIFICATION OF TYPES AND DISTRIBUTION OF MEDIUM-LARGE SCALE INDUSTRIES CONCENTRATED

The industry in the study area is dominated by the wood industry. As many as 30 out of 46 large and medium industries in the study area are wood industries. These industries are predominantly located along the main road network, specifically the primary collector and primary arterial roads. This distribution suggests the presence of industrial agglomeration in the study area. The first step is to identify the number of medium and large-scale industries in the study area. The data shows that in these two subdistricts, there was an increase in the number of industries by 71.73%. In 2011, there were 13 large and medium industries, and in 2022, there were 46 large and medium industries (Figure 3). After identifying the number of industries, the next step is to determine the extent of industrial land use in the study area. According to the data collected, there has been a notable increase in the industrial land area between 2011 and 2022. In 2011, the area occupied by industrial land was 57.4 hectares. However, by 2022, this figure had risen to 158.54 hectares (Table 2).

Table 2. Increasing Industrial Area in the Study Area

Subdistrict	Number of Industries		Industrial Land Use (ha)		Increase (ha)	Percentage (%)
	2011	2022	2011	2022		
Kranggan	5	21	25.2	67.07	41.87	166.15
Pringsurat	8	25	32.2	91.47	59.27	184.06
Total (Study Area)	**13**	**46**	**57.4**	**158.54**	**101.14**	**176.20**

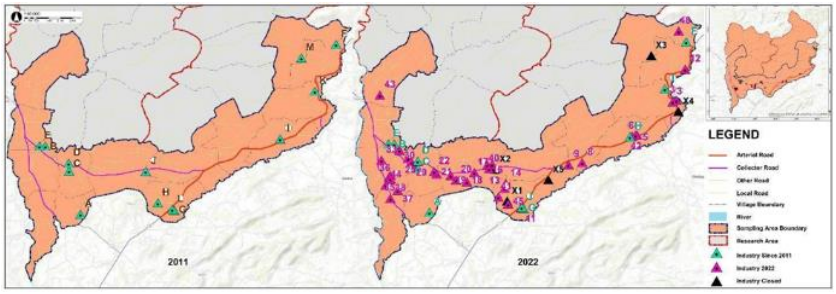

Figure 3. Maps of Industry Points in 2011 and 2022

Figure 4 shows the changes in industrial land use area that took place in the villages of Pingit, Klepu, Ngipik, Rejosari, Pringsurat, Kebumen, Soropadan, Kupen, Nguwet, Pare, Bengkal, Badran, Kranggan, and Sanggrahan in the Pringsurat Subdistrict and Kranggan Subdistrict between 2011 and 2022.

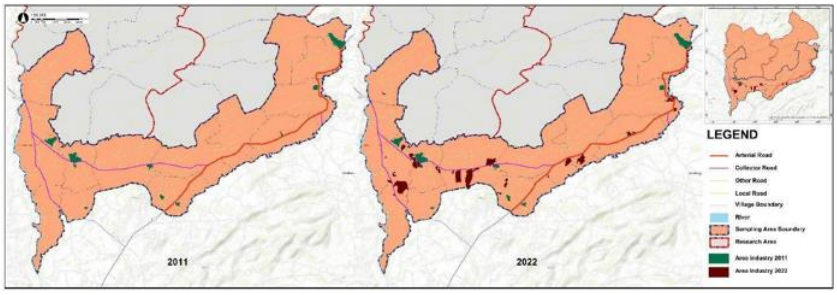

Figure 4. Industrial Land Use Map in 2011 and 2022

The next step of this study is to identify the types of industries needed in the study area, as well as determine the dominance of developing industrial types in the study area. This is based on data obtained from the Directory of Large and Medium Manufacturing Industries of Central Java Province in 2011 and 2022, as well as the Statistics Temanggung Regency in 2011 and 2023. Additionally, field observations conducted by researchers in 2023 will be taken into account. The analysis reveals that from 2011 to 2022, the wood industry consistently dominated the types of industries developed

in Pringsurat and Kranggan Subdistrict. In 2011, there were 8 woodworking industries, which increased to 30 wood industries in 2022 (Table 3). The industries in the study area are classified into primary, secondary, and tertiary industries according to Fisher's theory (1939). In the woodworking industry, primary and sundry industries include furniture, resin, construction, printing fabrics, garments, masks, footwear, frozen vegetables, and glucose. These industries are directly involved in the processing or production of goods. On the other hand, the horticultural and warehousing exporter industry in the study area is classified as a tertiary industry since it does not involve raw material processing activities.

Table 3. Number of Industries by Type in 2011 and 2022

Type of Industry	Industry	
	2011	2022
1. Wood Manufacture	8	30
2. Furniture	3	2
3. Organic fertilizer	1	0
4. Craft	1	0
5. Resin	0	1
6. Construction	0	3
7. Printing Fabrics	0	1
8. Garments	0	1
9. Mask	0	1
10. Footwear	0	1
11. Vegetables	0	1
12. Exporter Horticulture	0	2
13. Glucose	0	1
14. Warehouse	0	2
Total	**13**	**46**

According to Galbraith & Kazanjian (1986) in Nicovich et al. (2007), industries can be classified as upstream industries and downstream industries. From 2011 to 2022, the woodworking industry was the most dominant in the study area. In this type of industry, an analysis of the relationship between production inputs and outputs can be carried out. Based on the results of the analysis, it is known that there are industries that act as upstream industries because the production process starts from processing the main raw material, which is still in the form of wood. Meanwhile, industries that use semifinished wood raw materials and process them into finished goods in the form of plywood are included in the downstream industry.

After identifying the number, area, and type of medium and large industries in the study area, the next step is to analyze the grouping of industries in Pringsurat and Kranggan Subdistrict. The analysis of industry grouping in these districts was conducted using Average Nearest Neighbor in the GIS. The results indicate that the nearest neighbor ratio value of industrial points in the study area is 0.579022, suggesting the presence of industrial clustering (Figure 5).

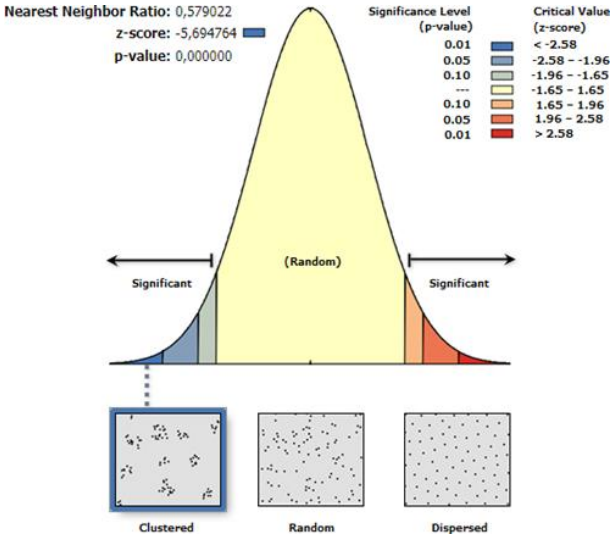

Figure 5. Results of Average Nearest Neighbor Analysis of Industry Points in 2022

According to Darwent (1969), a group of companies or industries can act as a catalyst for regional growth. This study identifies the spatial concentration of medium and large industries in Pringsurat and Kranggan Subdistrict, indicating the presence of industrial agglomeration. Notably, these industries tend to cluster around the main road in the study area, namely the Semarang-Yogyakarta arterial road that passes through Pringsurat District, as well as the collector road linking Pringsurat with Kranggan Subdistrict. The clustering of industries in this area is closely tied to various factors that influence the selection of industrial sites. The analysis reveals that the grouping of industries in the study area is strongly influenced by factors such as accessibility, availability of workers, labor wages, land conditions, land prices, distance from the city center, and existing regulations in the study area.

4.2 ANALYSIS THE PROCESS OF AGGLOMERATION GROWTH OF MEDIUM AND LARGE INDUSTRIES

The growth of industrial agglomeration in the study area is influenced by the wood industry. There is a relationship within the study area among the supplier industry (wood cutting and veneer industry), related industries (resin industry), and core industries (wood industry). This interindustry linkage also involves cooperation in the marketing process of production products. Furthermore, the growth of industrial agglomeration also results in the absorption of labor from both within and outside the study area.

The steps involved in analyzing the growth process of medium and large industrial agglomeration in the study area include identifying the relationship between production inputs and outputs, as well as identifying labor absorption in the industrial sector within the study area. The first step is to identify the relationship between inputs and production outputs. Based on data from Statistics Central Java in 2022 and field observations, the industries in the study area are dominated by the wood industry. According to the Temanggung Regency Industry Office (2023), inter-industry linkages occur within the wood industry. This industry has been the most dominant from 2011 to 2022. The linkage between production inputs and outputs within the wood industry in the study area takes the form of cooperation between industries. This cooperation involves supplying raw materials, such as resins and semi-finished materials, to other wood industries in the area. Furthermore, there is cooperation between industries in the process of distributing products. Some of smaller industries will send their products to larger industries to market their products outside of Java and internationally. The industries in the study area can be grouped based on the linkages that occur (Figure 6).

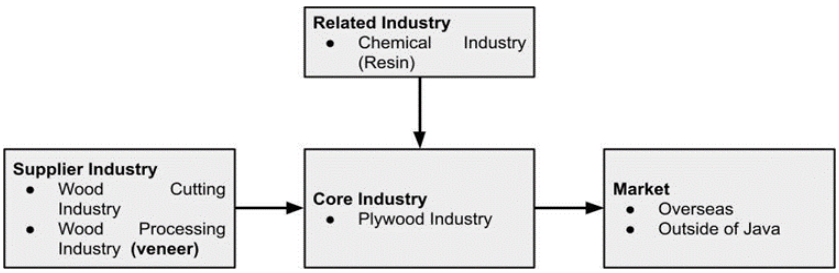

Figure 6. Industry Grouping Based on Existing Linkages

According to Zuliastri et al. (2018), industrial agglomeration refers to the grouping of core industries that are interconnected and have relationships with supporting industries, related industries, supporting services, and economic infrastructure. In the study area, inter-industry linkages can be observed in the wood industry. The wood industry, which serves as the core industry in the study area, has connections with related industries and supplier industries. The linkage between the core wood industry and related industries involves the supply of raw materials in the form of adhesive glue from the chemical industry in the study area. On the other hand, the linkage between the core industry and the supplier industry is seen in the wood cutting industry and the woodworking industry, which produce semi-finished products. Several wood industries in the study area produce these semi-finished goods, which are then distributed to other wood industries as raw materials for further production.

In addition, interindustry linkages that occur in the study area also manifest as cooperation in the distribution of goods. Various inter-industry capabilities foster collaborative efforts in the distribution of goods. Industries lacking the capacity to market their products in overseas will collaborate with larger industries to distribute their goods. The advantages derived from the spatial concentration resulting from economies of scale can be seen as a form of economic agglomeration (Zuliastri et al., 2013).

The second step of analyzing the growth process of industrial agglomeration in the study area involves identifying labor absorption in the industrial sector. According to Marshall (1895) as cited in Chen et al. (2021) and Pangarso et al. (2019), labor aspect is a key factor that indicates the occurrence of economic agglomeration in the industry. Using data from the Statistics Temanggung Regency in 2012 and 2023, the study area's population based on livelihood is shown on Table 5.

Table 5. Livelihood Structure of the Population in 2011 and 2022

Year	Subdistrict	Population Employed		Number of Employed Population	Percentage of Population Employed in the Industrial Sector (%)
		Industrial Sector	Non-Industrial Sector		
2011	Pringsurat	5,538	23,427	28,965	19.12
	Kranggan	4,459	21,992	26,451	16.85
2022	Pringsurat	7,462	34,671	42,133	17.71
	Kranggan	7,415	30,455	37,870	19.58
Total		**14,877**	**65,126**	**80,003**	**18.59**

Source: (Statistics of Temanggung Regency (2012); (Statistics of Temanggung Regency, 2023)

The industrial growth in the study area has a significant impact on the population, particularly in terms of the changing livelihood structure of the local community. This impact is evident in the increase of individuals employed in the industrial sector from 2011 to 2022. According to data from Statistics of Temanggung Regency (2012, 2023), the number of people employed in the industrial sector in the study area was 9,997 in 2011, which then rose to 14,877 by 2022 (Table 6).

Table 6. Percentage of Increase Population Employed in the Industrial Sector

Subdistrict	Population Employed in the Industrial Sector		Increase	Percentage (%)
	2011	2022		
Pringsurat	5,538	7,462	1,924	34.74
Kranggan	4,459	7,415	2,956	66.29
Total	**9,997**	**14,877**	**4,880**	**48.81**

Source: (Statistics of Temanggung Regency (2012); (Statistics of Temanggung Regency, 2023)

Based on data from Statistics of Temanggung Regency, the number of people working in the industrial sector increased by 48.81% between 2011 and 2022. In 2011, there were a total of 9,997 people employed in this sector. However, in 2022, this number has risen to 14,877 residents. Therefore, there has been an increase of 4,880 people working in the industrial sector during this time period.

The research findings on labor aspects in the study area indicate a rise in the population employed in industrial sector, which is aligned with the growth in the number of industries between 2011 and 2022. Additionally, the industrial agglomeration in the study area stimulates the recruitment of labor from neighboring areas. The analysis reveals that the workforce in medium and large industries in the study area comprises not only local residents but also individuals from nearby sub-districts and regency (Figure 7).

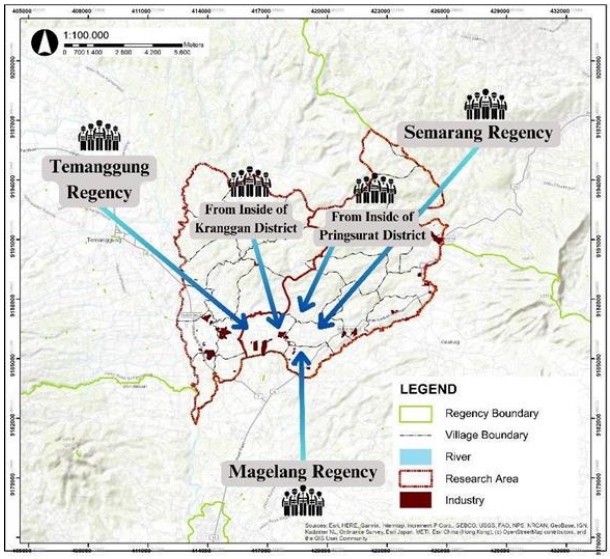

Figure 7. Map of Worker Origins

4.3 ANALYSIS THE IMPACT OF INDUSTRIAL AGGLOMERATION GROWTH ON LAND USE CONVERSION

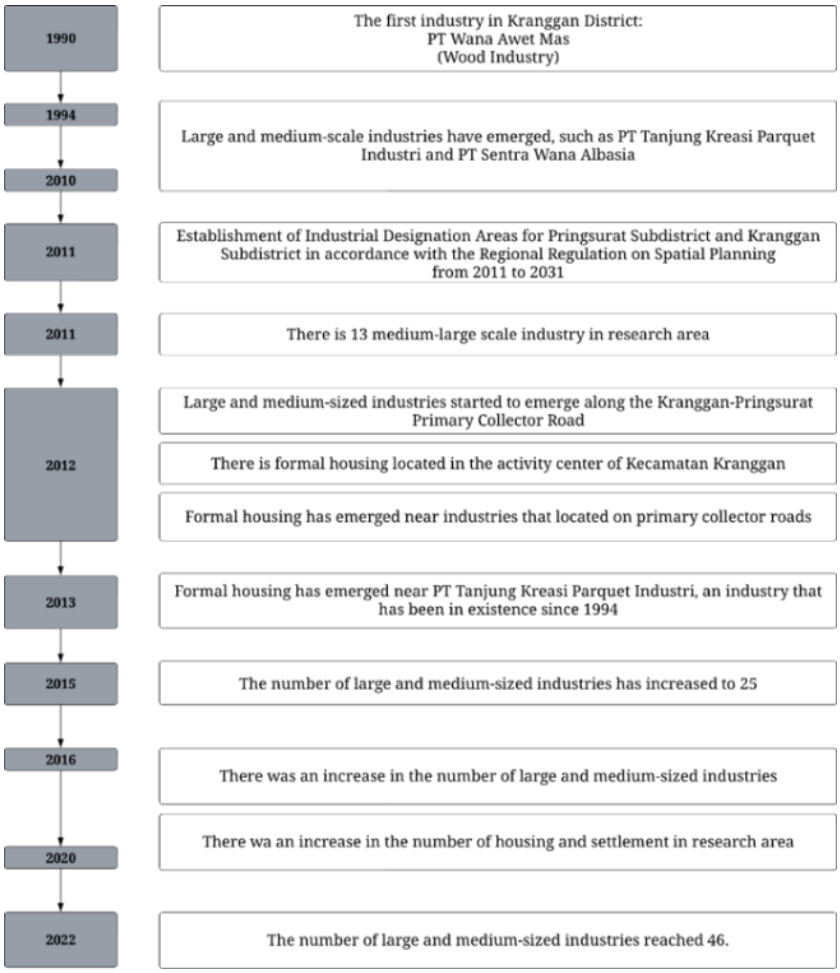

Figure 8. Chronology of Industrial Agglomeration Growth and Its Impact on Land Use Change in the Study Area from 2011 to 2022

The industrial agglomeration activities promotes the growth of new industries and other economic activities. This leads to the conversion of agricultural land into industrial land, as well as the establishment of settlements, trade and service establishments, and other facilities. These changes in land use are primarily concentrated along the main road network, resulting in a more diverse range of land utilization. Furthermore, the modifications in land use surrounding the industrial areas along the main road network have also contributed to an increase in land prices within the study area.

Industrial growth in Pringsurat and Kranggan Subdistrict has led to the conversion of agricultural land into built-up areas. This conversion has been mainly concentrated around the main road network in the study area, where industrial growths are centered. The most significant changes in land use have been observed in the industrial and residential sectors. To better understand the chronological industrial agglomeration growth and its impact on the land use change (Figure 8).

The first step in analyzing the impact of industrial agglomeration development on land use change is to identify the land use in Pringsurat and Kranggan Subdistrict. According to the analysis results, the dominant land use in the study area from 2011 to 2022 was agricultural, which includes agricultural land, agricultural fields, and rice fields. The analysis also reveals changes in certain land uses between 2011 and 2022, with increases or decreases in their areas. Area of industrial land use has grown from 57.4 hectares in 2011 to 163.12 hectares in 2022, indicating a growth of 105.72 hectares. Additionally, there have been increases in the areas of health land use (0.9 hectares), green open space (2.7 hectares), education (14.1 hectares), trade and services (18.3 hectares), worship (0.5 hectares), and settlements (55.88 hectares).

Land use changes between 2011 and 2022 in the study area have resulted in a decrease in the area of several land use types. The largest decrease occurred in agricultural land use, which includes agricultural land, agricultural fields, and rice fields. In 2011, the area of agricultural land use in the study area was 80.13%, but by 2022, it had decreased to 78.38%

of the total area. A total of 197.7 hectares of agricultural land has been lost between 2011 and 2022. Additionally, there was a 0.4 hectare decrease in the area of nongreen open space land.

Table 7. Area and Percentage of Land Use Change in 2011 and 2022

Land Use	2011		2022		Land Use Change (ha)
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)	
1. Agricultural land	5,393.1	46.95	5,254.22	45.73	-138.88
2. Agricultural field	1,765.4	15.4	1,753.5	15.35	-11.9
3. Rice field	2,038.5	17.78	1,991.58	17.3	-46.92
4. Industry	57.4	0.5	163.12	1.4	105.72
5. Health	0.9	0.008	1.8	0.02	0.9
6. Green open space	20.3	0.17	23	0.2	2.7
7. Education	33.2	0.29	47.3	0.41	14.1
8. Trade & services	65.4	0.57	83.7	0.76	18.3
9. Worship	4.2	0.038	4.7	0.04	0.5
10. Office	16	0.1	16	0.1	0
11. Settlement	1,989.8	17.3	2,045.68	17.8	55.88
12. Non green open space	6.2	0.054	5.8	0.05	-0.4
13. Shrubs	70	0.6	70	0.6	0
14. River	27.1	0.235	27.1	0.235	0
15. Transportation	0.5	0.005	0.5	0.005	0
Total	**11,488**	**100**	**11,488**	**100**	

Based on Table 7, it is evident that agricultural land experiences the largest decrease in land use area. On the other hand, industrial land use shows the most significant increase, with an increase of 105.72 hectares. While other land uses have also undergone some changes, they are relatively minor. Therefore, the most notable changes in land use from 2011 to 2022 can be observed in industrial land use, settlements, and trade & services. Figure 9 is illustrating the changes in land use between 2011 and 2022 in the study area.

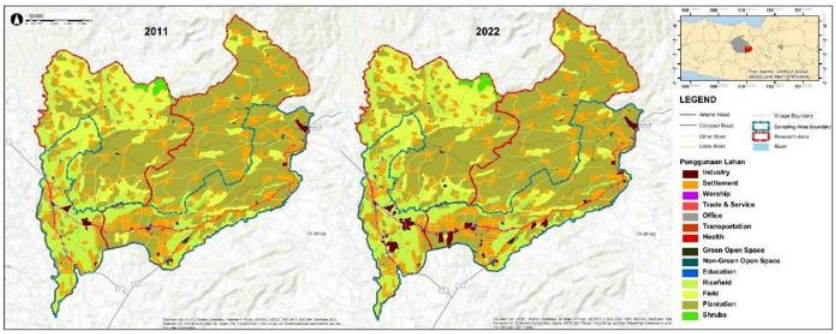

Figure 9. Land Use Map in 2011 and 2022

The development that occurs in land use change lies in the conversion of agricultural land and vacant land into settlements and other activities (Dwiyanti & Dewi, 2013). Changes in agricultural land use can occur due to various factors, such as industrialization (Rochadi et al., 2022). In Pringsurat and Kranggan Subdistrict, large and medium-sized industrial activities from 2011 to 2022 have led to land use changes in the area. These changes involve an increase in industrial, residential, and commercial areas. Land that was once used for agriculture has now been transformed into non-agricultural built-up land. The study area shows that land use change was concentrated in areas near industrial sites and along the main road network, as shown in Figure 10.

The second step involves identifying the increasing variations in land use in order to determine the diversity of land uses in Pringsurat Subdistrict and Kranggan Subdistrict. Based on the analysis of land use in the study area from 2011 to 2022, it is evident that the types of land use have remained unchanged. The land use in both 2011 and 2022 still consists of agricultural land, rice fields, industrial areas, healthcare facilities, recreational spaces, educational institutions, commercial areas, places of worship, office spaces, residential areas, green spaces, shrubs, rivers, and transportation terminals. However, there have been noticeable changes in the increasing variations of land use in the industrial sector, with an increase in the types of industries. In terms of residential land use, there has been a development of formal settlements and boarding houses around industrial estates from 2011 to 2022. Furthermore, there has been an increase

in the diversity of trade and service land use in the study area, with the emergence of various establishments such as restaurants, minimarkets, supermarkets, and freight forwarding services.

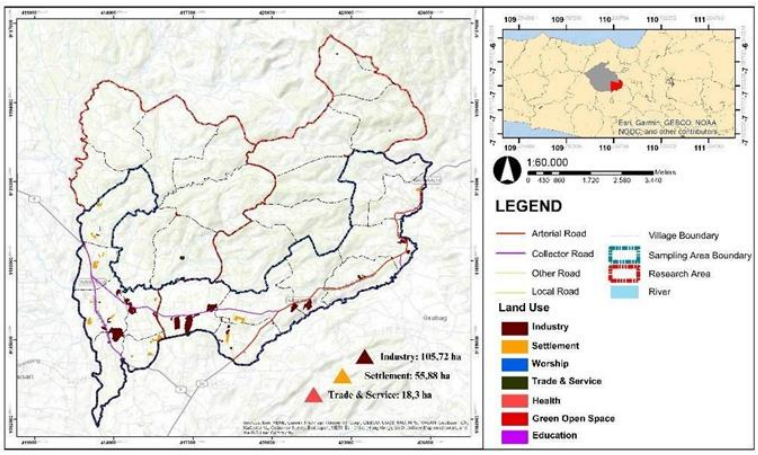

Figure 10. Map of Land Use Change in 2011-2022

The growth of industrial activities has increased the demand for surrounding land, resulting a more diverse use of land in the vicinity. Industrialization has led to the conversion of land for industrial activities, as well as for supporting activities such as settlements, commercial establishments, and infrastructure (Fariha et al., 2021). This trend is particularly noticeable in the land use surrounding industrial estates located on arterial roads and collectors. These areas showcase a wide range of land uses, including formal residential areas, trade and services, offices, healthcare facilities, educational institutions, places of worship, green spaces, and recreational areas. This demonstrates that the industrial agglomeration growth in study area has resulted in a concentration of diverse land use patterns around industrial sites and main roads.

The third step is to identify changes in land prices in the Pringsurat Subdistrict and Kranggan Subdistrict. Based on the results of interviews conducted to determine land value zones in the study area in 2011, it was found that the highest concentration of land prices was in the area around arterial roads and primary collectors, as well as on land where industries are located. The price of land around the main and industrial roads, which originally had prices ranging from IDR 500,000 to 1,000,000 in 2011, has significantly increased in 2022 to around IDR 2,000,000 to 5,000,000. The increase in land prices ranged from 4 to 5 times the previous price. In areas far from industrial sites and main roads, land in the land value zone is dominated by prices below IDR 100,000, and some of them have land prices ranging from IDR 100,000 to 500,000. The land price map and its changes in 2011 and 2022 in the study area are visualized in Figure 11, Figure 12, and Figure 13.

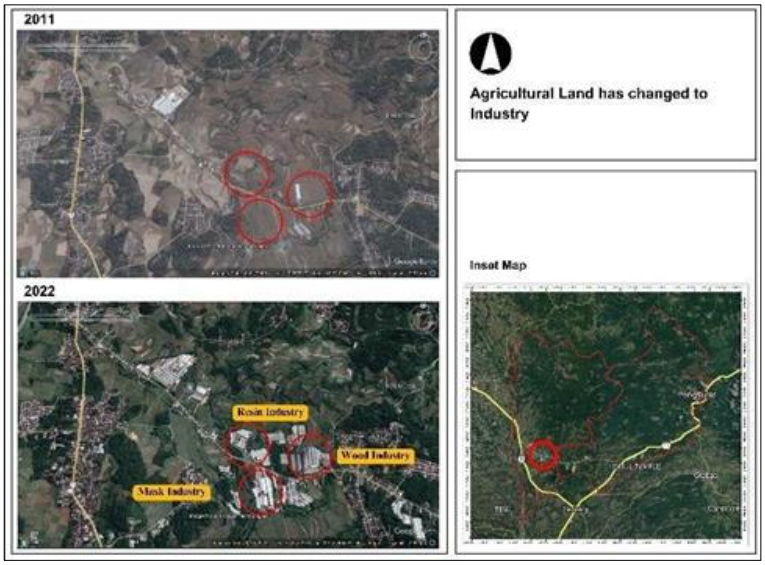

Figure 11. Sample of Agricultural Land Change into Industry

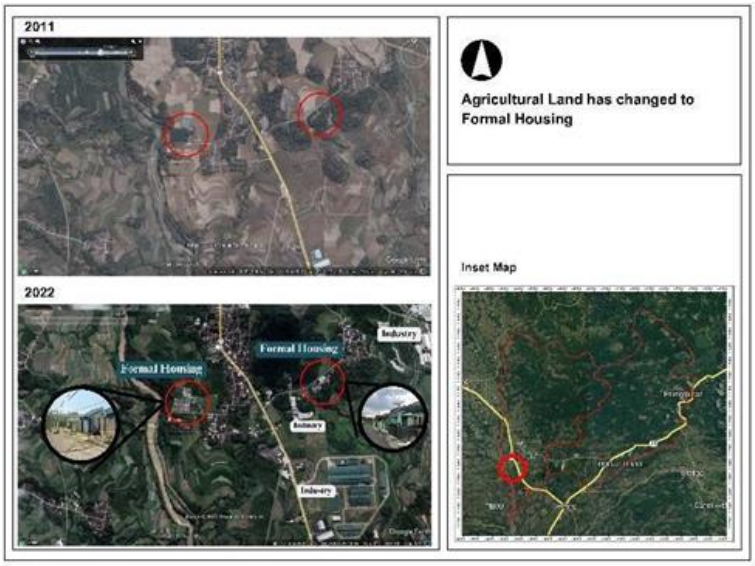

Figure 12. Sample of Agricultural Land Change into Formal Housing

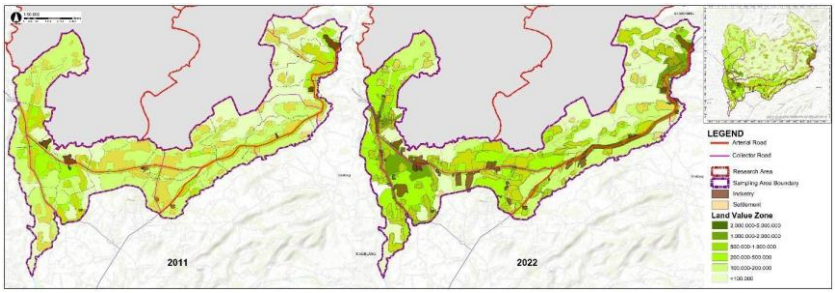

Figure 13. Maps of Land Use Value Zone of Study Area in 2011 and 2022

The strategic location, being close to the main road, is one of the factors contributing to the increase in land prices in the area. According to the analysis results, the area holds higher economic value for land compared to other areas that are located far from industrial activities. This finding supports the opinion of Fariha et al. (2021), who stated that industrial growth is influenced by the proximity to the main road network and land prices. Additionally, Mahardika & Muta'ali (2018) suggest that land use change can be affected by both land prices and strategic locations, as well as suitability with land distribution. In the study area, the development of industrial activities is determined not only by land value factors, but also by the establishment of KPIs in Pringsurat and Kranggan Subdistrict in the RTRW regional regulations.

4.4 ANALYSIS THE CHANGES OF REGULATORY ABOUT INDUSTRIAL AGGLOMERATION GROWTH

The growth of industries in the study area is regulated in Temanggung Regency Spatial Plan (RTRW) for the period 2011-2023 that designates Pringsurat Subdistrict and Kranggan Subdistrict as industrial designation areas. This led to rapid development in the research area of the industry. Industrial sites located near agricultural land prompted the government to establish regulations to protect sustainable agricultural land. Therefore, with the presence of regulations on designated industrial areas and the protection of agricultural land, the existence of industrial agglomerations does not diminish the amount of sustainable agricultural land in the research area.

Regulations governing the presence of industry in the study area are outlined in the Regional Regulation of Temanggung Regency Number 1 of 2012, which pertains to the RTRW of Temanggung Regency for 2011-2031. Initially, there were 13 large and medium-sized industries in the study area in 2011. However, the number of industries has steadily increased over the years, reaching a total of 46 by 2022. Additionally, there have been several changes to the regulations concerning industry development in the study area. The timeline provides an overview of these regulatory revisions (Figure 14).

The growth of industrial activities in the study area has prompted changes in land use to support these activities and their proponents. In 2014, the Regional Government of Temanggung Regency established Regional Regulation No. 2 of 2014, which aims to protect sustainable food agricultural land (LP2B). This regulation was implemented to prevent the

conversion of agricultural land into built-up areas. Analysis shows that the LP2B area in the study area remained unchanged from 2011 to 2022. Existing industrial activities are conducted on land that is not included in the LP2B designation. Therefore, the determination of industrial areas in the study area does not reduce the LP2B area in Pringsurat and Kranggan Subdistrict.

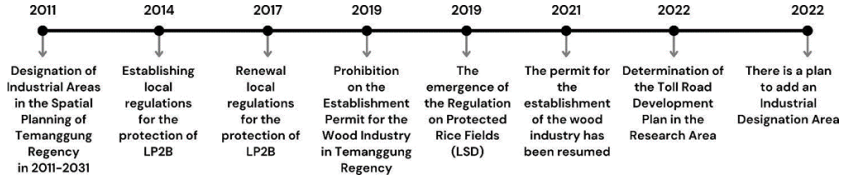

Figure 14. Chronological of Regulatory Changes from 2011 to 2022

5. CONCLUSION

The industrial agglomeration in Pringsurat Subdistrict and Kranggan Subdistrict, Temanggung Regency, has developed from 2011 to 2022. The number of industries in the region has increased significantly from 13 large and medium industries in 2011 to 46 in 2022, followed by the expansion of industrial area from 57.4 hectares in 2011 to 158.54 hectares in 2022, clustering along road network. The agglomeration is dominated by the wood industry, which has inter-industry linkage in the study aream with the resin industry. The working population in the industrial sector in the region has increased, as well as absorbtion of workers from the surrounding area. The majority of land use changes in the regioan occurred in industrial areas, settlements, and trade and services, concentrated around the main road network and leads to greater diversity in land use compared to the surrounding area. Land prices increased around industries and main road networks from 2011 to 2022. The selection of the study area as a Industrial Designatio Area (KPI) for Temanggung Regency has led to the growth of medium and large industries in this region. Local governments are not only responsible for issuing policies related to industrial growth, but they also formulate regulations aimed at protecting agricultural land, including protection against LP2B. The regulations applicable in the study area have been developed between 2011 and 2022, adjusting to the prevailing conditions.

REFERENCES

Chen, Z., Zhu, H., Zhao, W., Zhao, M., & Zhang, Y. (2021). Spatial Agglomeration of China's Forest Products Manufacturing Industry: Measurement, Characteristics and Determinants. *Forests*, *12*(8), 1–30. https://doi.org/10.3390/f12081006

Fariha, T. I., Buchori, I., & Sejati, A. W. (2021). Modelling Industrial Growth in the Coastal Area of Semarang Metropolitan Region Using GeOBIA. *IOP Conference Series: Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/887/1/012008

Fitriyanto, M. (2016). Analisis Pengaruh Perkembangan Industri Batik Terhadap Nilai Tanah di Kecamatan Tirto Kabupaten Pekalongan. *Jurnal Geodesi Undip*, *5*(1), 8–18. https://doi.org/https://doi.org/10.14710/jgundip.2016.10552

Gryshova, I., Kyzym, M., Khaustova, V., Korneev, V., & Kramarev, H. (2020). Assessment of the Industrial Structure and its Influence on Sustainable Economic Development and Quality of Life of the Population of Different World Countries. *Sustainability, 12*(5), 1-25. https://doi.org/10.3390/su12052072

Julianto, F. T., & Suparno. (2016). Analisis Pengaruh Jumlah Industri Besar dan Upah Minimum terhadap Pertumbuhan Ekonomi di Kota Surabaya. *Jurnal Ekonomi dan Bisnis*, *1*(2), 229–256. https://jurnal.untag-sby.ac.id/index.php/JEB17/article/view/914/815

Lekhanya, L. M. (2019). The Use of Modern Technology for Rural Industrialization and Its Implications on the Rural SMEs Economic Growth. *Journal of Economics and Behavioral Studies, 6*(1), 64–71. https://doi.org/10.22610/jebs.v10i6A.2662

Kuncoro, M. (2006). Aglomerasi Perkotaan di Daerah Istimewa Yogyakarta. *Unisia*, *29*(59), 3–18. https://doi.org/10.20885/unisia.vol29.iss59.art10

Mahardika, B. P., & Muta'ali, L. (2018). Dampak Alih Fungsi Lahan Pertanian Menjadi Lahan Terbangun untuk Industri terhadap Kondisi Sosial Ekonomi Masyarakat Sebagian Wilayah Kecamatan Ceper. *Jurnal Bumi Indonesia*, *7*(3), 1–12. https://www.neliti.com/id/publications/260739/dampak-alih-fungsi-lahan-pertanian-menjadi-lahan-terbangun-untuk-industri-terhad

Nielsen, B. B., Asmussen, C. G., Weatherall, C. D., & Lyngemark, D. H. (2021). Marshall Vs Jacobs Agglomeration and the Micro-Location of Foreign and Domestic Firms. *Cities*, *117*(June). https://doi.org/10.1016/j.cities.2021.103322

Pangarso, R. A., Suharyadi, R., & Rijanta, R. (2019). The Spatial Patterns and Local Economic Determinant of Industrial Agglomeration in Semarang District, Indonesia. *Geoplanning: Journal of Geomatics and Planning*, *6*(2), 99–112. https://doi.org/10.14710/geoplanning.6.2.99-112

Rochadi, A. S., Rohmah, I. Y. A., Yulyanti, A. D., & Hakim, D. H. (2022). Agricultural Land Conversion, Poverty and Adaptation Failure of Peasants in Industrial Transition in Rice Center Areas-Indonesia. *International Journal of Social, Political and Economic Research*, *9*(1), 67–79. https://doi.org/10.46291/ijospervol9iss1pp67-79

Setiawan, A. Y., & Yulianti, D. (2018). Hubungan Konsep Geografi dengan Pengembangan Usaha Konveksi serta Kesejahteraan Masyarakat di Desa Cilame Kecamatan Kutawaringin Kabupaten Bandung. *GEOAREA| Jurnal Geografi, 1*(1), 27-32.

https://ejournal.unibba.ac.id/index.php/Geoarea/article/view/89

Statistics of Temanggung Regency. (2012). *Temanggung Regency in Figures 2012*. https://temanggungkab.bps.go.id/id/publication/2012/11/20/fadb63a33131957c2938a7cd/kabupaten-temanggung-dalam-angka-2012.html

Statistics of Temanggung Regency. (2023). *Temanggung Regency in Figures 2023*. Temanggung Regency Central Bureau of Statistic. https://temanggungkab.bps.go.id/id/publication/2023/02/28/cfa802d1309732b50eb97c12/kabupaten-temanggung-dalam-angka-2023.html

Wijaya, H. B., Kurniawati, H., & Hutama, S. T. E. W. (2018). Industrialization Impact on Worker Mobility and Land Use in Peri Urban Area (Case study of Semarang District, Indonesia). *IOP Conference Series: Earth and Environmental Science*, *123*. https://doi.org/10.1088/1755-1315/123/1/012037

Wulandari, S., Sakinah, W. L., Nst, S. A., Hermayani, P., Wardani, I. T., Wahyudi, I., & Alfariqi, I. (2022). Faktor- faktor yang Memengaruhi Tenaga Kerja Industri Kayu Olahan di Kota Langsa. *Jurnal Ilmu Komputer, Ekonomi dan Manajemen (JIKEM), 2*(1), 229–237. https://ummaspul.e-journal.id/JKM/article/view/2919/839

Yang, C., Rottensteiner, F., & Heipke, C. (2019). Towards Better Classification of Land Cover and Land Use Based on Convolutional Neural Networks. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *42*(2/W13), 139–146. https://doi.org/10.5194/isprs-archives-XLII-2-W13-139-2019