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The Impact of Industrial Development on Spatial Planning: a Case Study of Klapanunggal District, Bogor Regency

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A B S T R A C T

This study examines the impact of industrial development on land use planning in Klapanunggal District, Bogor Regency West Java, which has experienced significant industrial growth over the past few decades. The transformation of agricultural and residential land into industrial zones has led to various environmental, in social, and economic implications. Unplanned spatial changes have resulted in traffic congestion, reduced green spaces, and air pollution from industrial activities. This research using a qualitative approach, this research aims to analyze the effects of industrial development on spatial planning and land use, as well as its implications on the local environment. The findings reveal the narrowing of agricultural land, air pollution, traffic congestion, role of government, and other environmental challenges in the community.

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INTRODUCTION

Klapanunggal District, located in the northern part of Bogor Regency, is strategically positioned with neighboring districts, including Gunung Putri to the north, Jonggol to the east, and Citeureup to the west and south. This district has gained prominence in recent years due to its proximity to key industrial zones, which have contributed to its rapid urbanization and transformation. The district's unique geographical location, coupled with its growing role in regional economic development, has significantly impacted its spatial planning and overall development trajectory.

The ongoing industrial growth and urban expansion in Klapanunggal have reshaped its landscape, making it a focal point for economic activities and infrastructure development. The changes in land use and the growth of industrial sectors have created both opportunities and challenges for the local population, leading to shifts in land values, agricultural practices, and the socio-economic fabric of the area. A clearer understanding of Klapanunggal's boundaries and geographical features, as shown in Figure 1 below, provides essential insights into how these transformations are influencing the region's spatial dynamics and long-term sustainability.

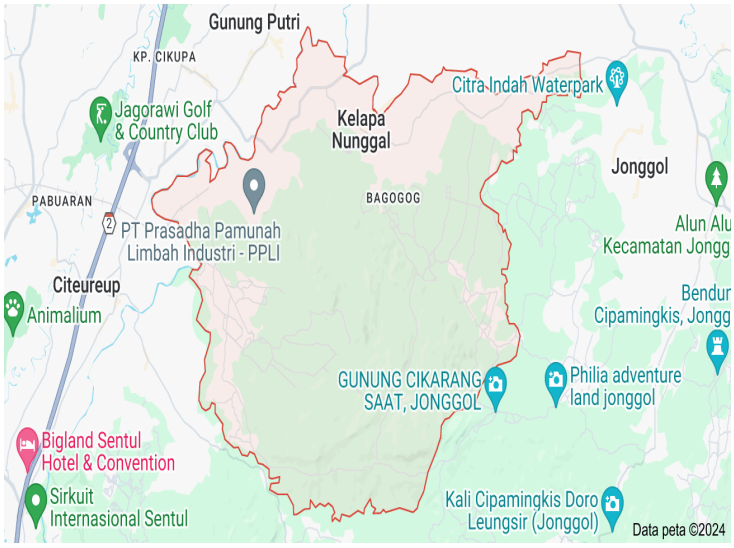

Figure 1. Map of Klapanunggal District

Source: bogorkab.go.id

The district consists of 9 villages: Leuwikaret, Lulut, Bantarjati, Nambo, Kembang Kuning, Klapanunggal, Ligarmukti, Bojong, and Cikahuripan. The area of each village within Klapanunggal District is detailed in Table.1 below.

Table.1 Area of Klapanunggal District

No	Village Name	Land area Km2	Precentage of area Klapanunggal District
1	Leuwikaret	17,10	19%
2	Lulut	22,70	25%
3	Bantar jati	3,60	4%
4	Nambo	10,40	11%
5	Kembang Kuning	5,40	6%
6	Klapanunggal	9,50	10%
7	Ligarmukti	8,00	9%
8	Bojong	8,30	9%
9	Cikahuripan	5,82	6%
	Kecamatan Klapanunggal	90,82	100%

Source: Author's Analysis

In addition to its geographical features, Klapanunggal is recognized as a rapidly developing industrial area. It serves as a key link to the Karawang industrial zone in West Java, which further integrates Klapanunggal into the broader regional industrial landscape. The expansion of industries in this area has had significant positive economic effects, particularly in terms of employment. The establishment of companies has created numerous job opportunities, contributing to the local economy and providing income for the local population.

However, the rapid industrialization has also led to several negative consequences. The conversion of agricultural land into industrial zones has resulted in a reduction of available farmland, affecting local farmers. Furthermore, environmental issues such as industrial waste odors and noise pollution from machinery in industrial areas have negatively impacted the quality of life for the surrounding communities. These challenges call for a comprehensive study to explore the relationship between industrial development and spatial planning, with a focus on its environmental, social, and economic impacts on Klapanunggal.

This study aims to explore how the rapid industrialization in Klapanunggal District has altered the region's spatial planning and land use. It investigates both the positive effects of industrial growth on employment and the local economy, as well as the negative environmental impacts that may arise from such developments. The findings of this study will provide insights into balancing industrial growth with sustainable land use planning, contributing to a better understanding of how urban and industrial development can coexist with environmental preservation.

LITERATURE REVIEW

Spatial Planning Concept

Spatial planning is a crucial aspect of regional development, serving as a guide for various sectors, including residential, commercial, industrial, and agricultural development. According to Law No. 26 of 2007 on Spatial Planning, the process should consider environmental, social, and economic aspects to achieve balanced development. Rapid industrial growth can significantly impact spatial planning, both positively and negatively. Positive effects include job creation and infrastructure development. However, negative impacts may include environmental degradation, reduction in agricultural land quality, and traffic congestion resulting from increased transportation activity (Suryani, 2015).

a. **Principles of Spatial Planning**

Spatial planning is the process of organizing and managing the use of land to ensure its optimal and sustainable utilization. This involves balancing the needs of human development with the preservation of ecosystems. The goal of spatial planning is to achieve a harmonious relationship between urban growth, resource use, and environmental conservation, while improving the quality of life for all individuals within a given region. Effective spatial planning contributes to sustainable development by considering long-term impacts, creating livable spaces, and fostering socio-economic growth without degrading the environment. By using appropriate land management techniques, spatial planning seeks to integrate various land uses in a way that minimizes conflicts, maximizes benefits, and ensures the well-being of future generations.

b. **Environmental Balance Principle**

The Environmental Balance Principle, as outlined by Budihardjo (1998), emphasizes the need for spatial planning to maintain a balance between development and environmental preservation. This principle asserts that land use should not compromise the integrity of natural ecosystems, such as forests, water bodies, or air quality. In practice, this means that urbanization and industrialization should be carefully planned to avoid overexploitation of land resources and minimize negative environmental consequences, such as deforestation, soil erosion, and air pollution. Proper spatial management ensures that development activities do not surpass the ecological capacity of an area, maintaining natural habitats and ensuring the long-term sustainability of resources. This principle is essential for fostering resilience against environmental degradation while promoting development that respects natural limits.

c. Social Justice Principle

The social justice principle emphasizes equitable access to spatial resources for all members of society. This includes the provision of decent housing, public facilities, and services. Spatial planning should prevent social segregation or disparities between urban and rural areas (Sari, R. P., 2017). Social justice in spatial planning ensures that all communities, regardless of socio-economic status, have access to the benefits of urban development. This involves equitable distribution of resources such as affordable housing, healthcare facilities, schools, and public transportation, ensuring that vulnerable and marginalized populations are not excluded from these services. The principle also seeks to prevent the gentrification of urban areas or the creation of "urban ghettos" in rural spaces, where development is concentrated in a way that exacerbates inequality. In this way, social justice in spatial planning promotes a more inclusive and fair society.

d. Efficiency Principle

The efficiency principle requires effective and resource-conserving land use. Development should align with land function and avoid wasting space or resources. Inefficient planning can lead to issues such as traffic congestion, flooding, and environmental damage (Nurdin, M., & Utami, E., 2020). Efficient spatial planning maximizes the use of available resources by ensuring that land is used according to its best function. This involves organizing different land uses (e.g., residential, commercial, agricultural, industrial) in a way that minimizes conflicts and optimizes their benefits. For example, ensuring that residential areas are well-connected to commercial hubs and transportation networks reduces the need for long commutes and fosters economic activity. Efficient planning also reduces environmental impact by avoiding excessive land consumption and promoting sustainable development practices, such as the use of green building technologies and renewable energy sources.

e. Resilience and Sustainability Principle

A well-designed spatial plan should accommodate long-term changes without compromising environmental quality or human life (Hidayat, M., 2016). Sustainability in spatial planning involves meeting present needs without depleting future generations' ability to meet their needs. Planning must also address disaster mitigation and climate change impacts, such as floods and droughts. The resilience and sustainability principle focuses on designing spaces that are adaptable to both current and future challenges. This includes the integration of climate change mitigation strategies, such as flood control measures, water conservation, and the promotion of green infrastructure. Moreover, resilience ensures that urban spaces can withstand and recover from natural disasters, economic disruptions, and other shocks. By planning for sustainability, planners ensure that the environment is protected, resources are used wisely, and future generations can thrive without compromising their ability to meet their own needs.

f. Public Participation Principle

Public participation is crucial in spatial planning, ensuring decisions reflect the aspirations and needs of local communities. This principle promotes transparency and accountability throughout the planning and implementation stages (Sari, R. P., 2017). Engaging the public in the planning process allows for more informed and inclusive decision-making. Local residents often have valuable insights about the needs, challenges, and opportunities in their communities, which planners might overlook if they are not involved in the process. Public participation can take various forms, including public meetings, surveys, workshops, and collaborative planning initiatives. By incorporating community feedback, planners can create solutions that are better aligned with local priorities and that foster greater support for development projects. Additionally, this principle ensures that all voices, especially those of marginalized or vulnerable populations, are heard and considered in the decision-making process.

g. Integration Principle

Spatial planning should be coordinated across sectors and governmental levels to avoid conflicting interests. Integrated planning ensures that sectors such as agriculture, industry, transportation, and housing develop harmoniously and support one another (Kusnadi, D., 2019). The integration principle emphasizes the need for a collaborative approach to spatial planning, where different sectors work together to create a cohesive and balanced plan. For instance, industrial development should be aligned with transportation infrastructure to ensure efficient movement of goods and reduce traffic congestion. Similarly, residential areas should be planned with access to essential services like healthcare and education. Integration ensures that various sectors complement each other, leading to more effective use of resources and better outcomes for all stakeholders. Moreover, coordination between local, regional, and national levels of government is essential to ensure that planning decisions align with broader development goals and policies.

Industrial Development

Industrial growth in Indonesia, particularly in regions close to major economic centers like Bogor Regency, plays a significant role in national economic growth. The development of industries in areas such as Klapanunggal has led to substantial changes in spatial planning. Previous studies show that industrial expansion often correlates with local economic growth but also presents challenges such as spatial adjustments, environmental changes, and social shifts (Kuncoro, 2012). The main factors driving industrial growth in Bogor Regency include its strategic location near Jakarta, as well as infrastructure such as toll roads, railways, and ports. Simatupang (2016) notes that industrial regions in West Java have seen accelerated growth due to both foreign and domestic investment.

Case Study

This research focuses on Klapanunggal District, which presents an interesting case for studying industrial development and its impact on the local environment and spatial planning. The area has attracted numerous industrial investors, especially in the manufacturing sector. As a result, significant changes in spatial planning have occurred, including land-use conversion, infrastructure development, and shifts in the local economy. This study highlights that industrial development in Klapanunggal has directly affected spatial planning, such as the transformation of agricultural land into industrial and residential zones.

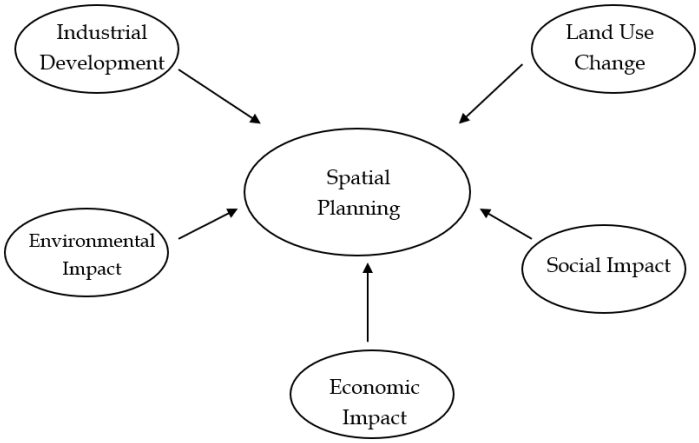

Figure 2. Conceptual Framework

Source: Researher's

This conceptual framework demonstrates how industrial development influences spatial planning in Klapanunggal District. At its core, Spatial Planning is shaped by Industrial Development, Land Use Change, Environmental Impact, Social Impact, and Economic Impact. Industrialization drives land conversion, leading to environmental degradation, social shifts, and economic growth. While it creates jobs and infrastructure, it also exacerbates inequalities, especially for those reliant on agriculture. This framework emphasizes the need for a balanced approach to development that considers both growth and environmental sustainability.

METHODOLOGY

This study adopts a qualitative approach, aiming to understand the social phenomena occurring in a broader context. The qualitative methodology allows for an in-depth exploration of the effects of industrial development on spatial planning in Klapanunggal District. This approach enables the researcher to capture meanings and interpretations from respondents based on their experiences with industrial development.

Research Design

The research design for this study is a case study, chosen due to the specific focus on the impacts of industrial development in Klapanunggal District. A case study design provides a detailed examination of the social, economic, and environmental conditions within the district and allows for a deep understanding of the specific effects of industrialization on spatial planning.

Study Location

The research was conducted in Klapanunggal District, Bogor Regency. This location was selected due to its significant industrial development potential and rapid changes in spatial planning over recent years. The researcher conducted direct observations in the field and engaged in interviews with various stakeholders from the area.

Research Subjects

The subjects of this research include informants who are directly related to industrial development and spatial planning in the district, specifically:

a. Local Residents:
   Individuals living near industrial areas who are affected by industrial activities and development.
b. Government Officials:
   Officials from relevant government agencies responsible for permitting and spatial planning in Bogor Regency.

Data Collection Techniques

Data was collected through various techniques, including:

a. Interviews
Interviews were conducted with informants to gather insights regarding their views, experiences, and opinions on industrial development and its impact on spatial planning.

b. Observation
Field observations were conducted to document physical, social, and environmental changes occurring as a result of industrial development.

c. Documentation
Secondary data was collected in the form of photographic documentation of the actual impacts of industrial development observed during fieldwork.

Data Analysis Techniques

The data collected was analyzed using thematic analysis. The analysis process involved the following stages:

a. Transcription:
   Interviews were transcribed, developed, and initial conclusions were drawn.
b. Analysis of Research Objectives:
   Survey responses were examined to ensure alignment with the research objectives. Themes were organized, and relationships between themes were analyzed.
c. Conclusion:
   The results from the interviews and surveys were analyzed to draw conclusions on the impact of industrial development on spatial planning.

RESEARCH RESULT

Klapanunggal District in Bogor Regency has undergone significant spatial changes over the last decade. The rapid industrial development has transformed the area from a rural, green space into a densely industrialized region. Agricultural land has shrunk due to conversion into industrial areas, warehouses, and infrastructure supporting industrial activities. Interviews with local residents reveal both positive and negative impacts of this transformation. Positive effects include job creation and increased income for some families. However, negative consequences such as environmental degradation, reduced quality of life, and significant social-cultural changes have also been noted. As a strategically located area in West Java, Klapanunggal now faces major challenges in balancing development with environmental and social sustainability.

Interview Results

Interviews conducted on November 17, 2024, with local residents highlighted the substantial effects of industrial development on spatial planning, the environment, and socio-economic life. The majority of respondents mentioned that land-use changes, particularly from agricultural land to industrial factories, had drastically altered their lifestyles. While industrial growth has created new job opportunities, particularly for younger generations, not all community members have benefited equally. Those with farming skills, in particular, face difficulty adapting to the industrialization. This disparity in benefits indicates an unequal distribution of industrial development's effects at the community level.

a) Land-use Change

The majority of the interviewees acknowledged that green land, which once characterized Klapanunggal, has been nearly eradicated. Many agricultural lands have been converted into factories or warehouses. As Mr. Ade expressed, "*There used to be a lot of rice fields here, but now it's all factories. That land over there used to be rice fields, but now it's part of the industrial area*." Similarly, Mr. Iron added, "*The agricultural yield was much better in the past, but now the land is gone, replaced by factories and housing*." Some residents with land in strategic locations chose to sell their property for industrial use. This

sale was often driven by economic needs or the unfeasibility of continuing agriculture. For instance, Mr. Amir shared, "*I sold my land because I needed money, and because my land was within the industrial zone, I had no choice but to sell it.*"

b) Environmental Impact

Interviewees reported significant environmental changes, particularly air pollution and water contamination, caused by industrialization.

1) Air Pollution: Many respondents complained about increased dust and smoke. Mr. Amir remarked, "*Since the factories started coming, the dust has increased, so I wear a mask more often now. The pollution is getting worse*."
2) Water Contamination: The quality of water in the area has drastically declined. According to Mr. Arifin, "*The water quality has worsened, it used to be drinkable, but now it's contaminated with a chemical smell.*"

c) Infrastructure Damage

The damage to roads due to heavy vehicles has become a major issue. The roads, full of potholes, slow down travel time and increase the risk of accidents.

- Mr. Endin shared, "*The roads are damaged, full of potholes, so travel time is longer.*"
- Mr. Mulyana added, "*The roads are so bad that I can't go fast. I once even bent my motorcycle wheel from hitting a pothole*."

d) Social and Economic Impacts

Industrial development has created new jobs, but the distribution of these benefits is uneven. Some residents have adapted by opening small businesses, such as shops or rental properties. Mr. Agus explained, "*For me, it's a mix. I used to farm, but after I sold my land to make way for factories, I used the money to buy land and build rental houses. Now I have rentals for factory workers, which is enough for daily needs*." However, not all residents have experienced the same benefits. Mr. Husen noted, "*Although there are many factories, I can't work there. I'm old and don't have a degree, so I just farm small plots behind the village.*"

Observational Results

a) Spatial Transformation

Observations revealed that Klapanunggal is now dominated by industrial buildings. Green spaces have almost disappeared, particularly in villages like Nambo and Kembang Kuning. Most of the land, once agricultural or used for farming, has been replaced with factories and high concrete fences that block community access. The distribution of factories in Klapanunggal can be seen in Figure 3.

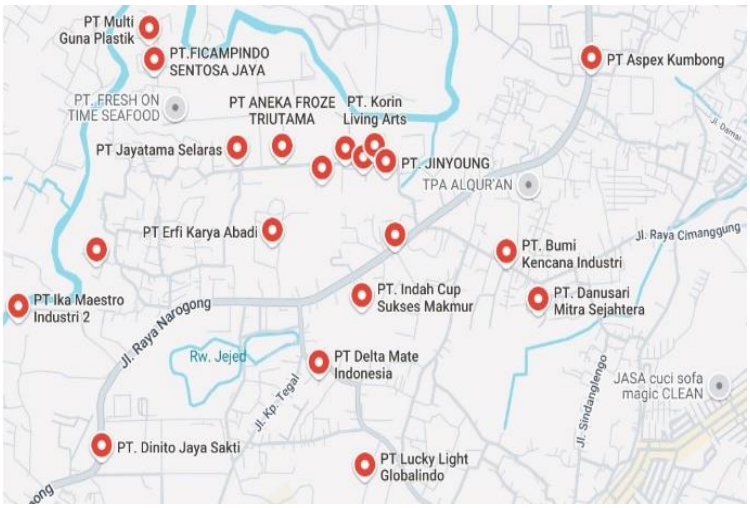

Figure 3. Factory Distribution Map in Klapanunggal District

Sumber : Google Maps

The advancement of the industrial sector has had a positive impact on investment and industry for several community groups. However, along with industrialization, the agricultural sector has nearly become extinct. The agricultural report data from Klapanunggal District can be seen in Table.1 below.

Table.1 Rice Field Agricultural Production Data

No	Village name	Land area (ha)	Results Ton	Production Ton
1	Leuwikaret	63	7.1	380,9
2	Lulut	75	6.8	435,7
3	Bantar Jati	38	6.5	211,8
4	Nambo	41	6.8	237,5
5	Kembang Kuning	32	6.5	173,9
6	Klapanunggal	167	7.4	1.061,6
7	Ligar Mukti	516	7.2	3.212,6
8	Bojong	612	7.7	4.051,0
9	Cikahuripan	501	7.4	3.184,9
	AMOUNT	2.044	63.4	12.950,0

Source: Research and Statistics Agency

From Table.1 above, it can be seen that in 2014, rice production reached 12,950.0 tons, meaning that rice farming was still quite prevalent in that year. However, in the last 10 years' report from BPS (Statistics Indonesia), there has been no mention of rice farming production; instead, the report only presents agricultural data related to vegetables and fruits.

b) Road Conditions

The road conditions in the area are concerning. The main roads, heavily used by trucks and industrial vehicles, are filled with large potholes. During the dry season, dust is pervasive, while in the rainy season, water accumulates in the potholes, posing risks to drivers. Figure 4 shows the damaged roads, primarily along Jl. Kecamatan Klapanunggal and Jl. Raya Narogong.

Figure 4. Road Damage

Source: Reasearcher's Documentation

c) Air and Water Pollution

1) Air Pollution: Air pollution is visible from the dust and smoke from factory chimneys. This air pollution is dangerous for the local community, as it poses a serious health risk. Figure 5 shows the smoke emitted by factories.

Figure 5. Smoke from Factory Chimney

Source: Researher's Documentation

2) Water Pollution: The quality of well water has deteriorated significantly. Previously drinkable water has now become contaminated, and residents only use it for bathing and washing. Figure 6 shows the polluted well water in the area.

Figure 6. Contaminated Well Water
Source: Researcher's Documentation

d) Social Activities

Many people have shifted from traditional agricultural work to new professions like trading or renting out property. Small shops and rental houses have sprung up near the industrial zones. Figure 7 shows some of the businesses operated by local residents near the industrial area.

Figure 7. Shops Around the Factory
Source: Researcher's Documentation

DISCUSSION

The findings from Klapanunggal District demonstrate the profound impacts of industrialization on spatial planning, environmental quality, and socio-economic conditions. The rapid shift from agricultural to industrial land use has not only altered the physical landscape but also disrupted the livelihoods of many residents. Land conversion has led to a significant loss of agricultural space, which in turn has affected food security and local economies.

While industrialization has provided job opportunities, these benefits have not been equally distributed, leaving certain segments of the population, particularly older farmers or those without industrial skills, at a disadvantage. Moreover, environmental impacts such as air and water pollution have significantly diminished the quality of life for local residents, highlighting the need for more sustainable industrial practices and better infrastructure management. In addition, the government's response has been insufficient, as many issues such as road damage and pollution remain unresolved. This lack of effective governance exacerbates the negative impacts of industrialization, underscoring the importance of integrated and sustainable spatial planning. The results highlight the complexity of balancing industrial development with environmental preservation and social welfare. Further research is needed to explore sustainable solutions for integrating industrial growth while ensuring the long-term well-being of the local community and the environment.

CONCLUSIONS AND RECOMMENDATIONS

This study has examined the impact of industrial development on spatial planning in Klapanunggal District, Bogor Regency, focusing on changes in land use, environmental effects, socio-economic impacts, and government responses. The analysis reveals that industrial development in Klapanunggal has led to the conversion of agricultural land into industrial zones, eliminating productive land and green open spaces. The local population faces a dilemma between short-term economic benefits from land sales and the loss of livelihoods in agriculture. Environmental impacts include air pollution from factory emissions and heavy vehicles, water contamination from industrial waste, and road damage that impedes mobility. From a socio-economic perspective, industrialization has created job opportunities for some, but it has also exacerbated inequality, particularly for those who depend on agriculture. Meanwhile, government responses are seen as inadequate, offering mostly temporary solutions that fail to address the root causes of the issues.

Based on the findings, several strategic recommendations are proposed:

1) The government should develop spatial planning policies focused on environmental sustainability, including prudent industrial zoning and land-use conversion considerations that balance social and environmental factors.
2) Stricter monitoring of industrial waste management should be implemented through collaborations with independent bodies, the construction of waste treatment facilities, and environmental education programs.
3) Road infrastructure should be upgraded with materials suitable for heavy vehicles, the construction of alternative routes, and regular maintenance to improve road quality

4) To support affected communities, skill development programs, small and medium-sized enterprise incentives, and social reintegration programs should be implemented.
5) Public participation in spatial planning should be encouraged through regular dialogues between the government, industry stakeholders, and the community to ensure long-term, effective solutions.

ADVANCED RESEARCH

This study highlights the need for a more holistic approach to addressing the impacts of industrialization in semi-urban areas like Klapanunggal. The findings can serve as a foundation for local governments to formulate more equitable and sustainable policies. Future research should delve deeper into the health impacts of industrialization and assess the effectiveness of spatial planning regulations to broaden perspectives on managing industrialization's effects.

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REFERENCES

Budihardjo, E. (1998). Tata Ruang Perkotaan. Yogyakarta: Gadjah Mada University Press.disaster and the future of energy in America. MIT Press.

Faludi, A. (2018). Planning theory. Oxford University Press.

Freudenburg, W. R., & Gramling, R. (2019). Blowout in the Gulf: The BP oil spill globalization, and the looming land scarcity. Proceedings of the National Academy of Sciences, 108(9), 3465–3472.

Hidayat, M. (2016). Prinsip-prinsip Dasar Tata Ruang dan Pembangunan Berkelanjutan. Jurnal Perencanaan Wilayah, 3(2), 45-57.

industrialization in developing countries: A review. Environmental Monitoring and Assessment, 192(12), 775.

Kuncoro, M. (2012). Industri dan Pembangunan di Indonesia. Yogyakarta: UGM Press.

Kusnadi, D. (2019). Strategi Keterpaduan dalam Perencanaan Tata Ruang Perkotaan. Jurnal Ilmu Pemerintahan, 5(1), 78-85.

Lambin, E. F., & Meyfroidt, P. (2016). Global land use change, economic.

Nurdin, M., & Utami, E. (2020). Pengaruh Aksesibilitas terhadap Pengembangan Wilayah: Studi Kasus di Provinsi Jawa Barat. Jurnal Geografi, 12(1), 12-20.

R. Gandari, A.A.F, Satriana, Y. (2023) Kecamatan Klapanunggal dalam angka.Publikasi BPS.

Sari, R. P. (2017). Partisipasi Masyarakat dalam Perencanaan Tata Ruang: Studi Kasus di Kota Bandung. Jurnal Ilmu Sosial dan Humaniora, 9(3), 34-42.

Simatupang, A. (2016). Perkembangan Kawasan Industri di Jawa Barat. Bandung: Alfabeta.

Singh, R., & Chudasama, H. (2020). Environmental implications.

Suryani, N. (2015). Dampak Ekologis dari Perkembangan Kawasan Industri. Jurnal Lingkungan, 8(3), 175-189.

Undang- undang Nomor 26 Tahun 2007 Tentang Penataan Ruang.