

THE IMPACT OF AGRICULTURAL LAND CONVERSION INTO RESIDENTIAL AREAS ON LANDSLIDE INCIDENTS IN DESA BELIK, KECAMATAN TRAWAS, KABUPATEN MOJOKERTO

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Abstract: The conversion of agricultural land into residential areas in Desa Belik, Kecamatan Trawas, Kabupaten Mojokerto, has significantly increased the risk of landslides. This research aims to examine the impact of land conversion on landslide incidents using secondary data regarding supporting variables related to the potential threat of landslides and the landscape of the area. This research uses a descriptive qualitative approach. The research results show that the conversion of agricultural land into residential areas increases both physical and non-physical vulnerability to potential landslides. The research results show that conversion of agricultural land into residential areas increases vulnerability to landslides. The conclusion is that implementing stricter disaster mitigation policies and implementing excellent spatial planning that prioritizes ecological sustainability is crucial in reducing the potential risk of landslides in the future.

Keywords: Desa Belik, Disaster Mitigation, Land Use Conversion

INTRODUCTION

Indonesia is an agrarian country rich in natural resources, including agriculture, plantations, mining, and fisheries (Ikhwanto, 2019). With this abundant wealth of natural resources, Indonesia has significant potential to achieve prosperity and well-being. The agricultural sector plays an essential role in Indonesia's economy, serving as a source of foreign exchange, providing employment opportunities, driving industrialization, and being the primary source of food supplies (Hastuty, 2017).

The national economy is anticipated to be strengthened, and the population's food requirements will be met by the abundant agricultural output. Food crop producers are

essential in guaranteeing food availability at the national level, which is consistent with the government's objective of achieving food self-sufficiency through independence. Nevertheless, the escalating conversion of productive agricultural land can have an impact on the availability of food at both the regional and national levels. (Hidayat & Rofiqoh, 2020).

Land is a natural resource that plays a critical role in the development of a nation. Agriculture, industry, commerce, and infrastructure are among the sectors that necessitate land. Land is a critical asset for agricultural development and producers in the agricultural sector. Indonesia, an agrarian nation, continues to be heavily reliant on land for agricultural purposes.

Land is essential for the production of sustenance to satisfy the demands of society. (Kurniasari & Ariastita, 2014). Agricultural land often holds lower economic value compared to non-agricultural land, making it frequently subject to conversion for non-agricultural purposes (Dewi & Rudiarto, 2013).

In fact, agricultural land provides not only economic value as a source of food supply but also ecological functions, such as water regulation, carbon absorption, and more. Converting agricultural land into areas results in a decrease in groundwater absorption capacity, as buildings or residential asphalt roads increasingly cover the soil surface (Noviyanti, 2016).

Population growth and urbanization in Desa Belik, located in Kecamatan Trawas, Kabupaten Mojokerto, have led to an increase in the conversion of agricultural land into residential areas. According to BPS data, this land conversion impacts the sustainability of the agricultural sector and reduces the availability of land for food production. Belik faces serious challenges due to land conversion. Its hilly topography and high rainfall make the area highly susceptible to landslides (Shofwan et al., 2024).

Deforestation and land use changes further contribute to the rising incidence of landslides in the region. Understanding the impact of land conversion on landslide occurrences in Desa Belik highlights the need for sustainable land management solutions. These efforts should balance residential needs with environmental protection and raise public awareness about the potential disasters resulting from land use changes.

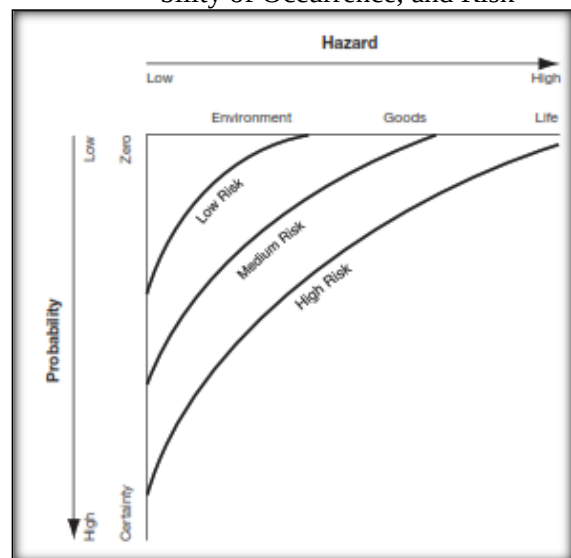
Consequently, understanding the effects of agricultural land conversion in Desa Belik is critical to formulating policies that can mitigate landslide risks while preserving the sustainability of productive agricultural land. The objective of this research was to provide important information for local governments in formulating effective and sustainable landslide disaster mitigation policies.

LITERATURE REVIEW

Forest fires, environmental degradation, and waste contamination are among the five categories into which disaster potential or hazards are classified: geological, hydro-meteorological, biological, technological, and environmental (Cui et al., 2021). Efforts to reduce disaster risk are essential to building a resilient community capable of withstanding disasters (Norris et al., 2008).

Formulating mitigation strategies is one of the obstacles in disaster risk reduction (DRR). A comprehensive catastrophe risk assessment should be the foundation for the development of these mitigation strategies and associated policies. (Gopalakrishnan & Okada, 2007). Figure 1 illustrates the relationship between hazards, the likelihood of occurrence (probability), and risk.

Figure 1. Theoretical Relationship between Environmental Hazards, Probability of Occurrence, and Risk



Source: (Smith & Petley, 2009)

The concept of disaster management has witnessed a paradigm shift from conventional to holistic approaches (Ritchie, 2004). The conventional perspective regards disasters as inevitable events or occurrences, placing a high priority on the provision of immediate assistance to victims (Sawalha, 2020). The Mitigation Paradigm aims to identify disaster-prone areas, recognize patterns that may lead to vulnerabilities, and implement mitigation activities.

Disaster management paradigms have further evolved to address societal vulnerabilities, leading to the development paradigm (Gaillard, 2019). The most recent paradigm in disaster management is the Disaster Risk Reduction Paradigm (Lavell & Maskrey, 2014). This approach integrates technical and scientific perspectives with attention to social, economic, and political factors in disaster reduction planning (Weichselgartner & Pigeon, 2015).

Disaster risk reduction involves an integrated, cross-sectoral, and cross-regional plan that encompasses social, economic, and environmental aspects (Sheehan et al., 2023). Disaster risk reduction activities at the national level align with regional and international disaster reduction plans. This framework views the community as the subject, object, and primary target of disaster risk reduction efforts (Mardiah et al., 2017). This approach emphasizes adopting and respecting local wisdom and traditional knowledge that exists and evolves within communities (Makondo & Thomas, 2018).

(Baudoin et al., 2016) encourage communities to actively access both formal and informal information channels, ensuring their direct involvement in disaster risk reduction initiatives. The government plays a crucial role in preparing the necessary infrastructure, facilities, and resources to support the implementation of disaster risk reduction activities, ensuring that the process is effective and inclusive (Izumi et al., 2019).

In response to this paradigm shift, Kobe, Japan, hosted the World Conference on Disaster Reduction in January 2005. The conference produced several fundamental principles aimed at reducing disaster-related losses, including losses of life, as well as social, economic, and environmental impacts (Selmi et al., 2015). Five priorities for action from 2005 to 2015 were established by the conference according to these principles: (1) Making disaster risk reduction a national and local priority, supported by strong institutional frameworks; (2) Identifying, assessing, and monitoring disaster risks and implementing

early warning systems; (3) Utilizing knowledge, innovation, and education to foster a culture of safety and resilience; (4) Ensuring personal safety and disaster resilience at all levels of society; (5) Reducing underlying risk factors that contribute to disaster vulnerability; and (6) Strengthening disaster preparedness at all levels to enable a more effective response.

RESEARCH METHODS

This research employed a qualitative approach with descriptive methods to analyze the impact of agricultural land conversion to residential areas on landslide occurrences in Desa Belik, Kecamatan Trawas, and Kabupaten Mojokerto.

The research is centered on a comprehensive comprehension of the phenomenon, which is derived from the available data. The data used in this study was exclusively secondary, obtained through literature evaluations from a diverse array of sources, such as:

1. **Official Reports:** The Regional Disaster Management Agency (BPBD) of Kabupaten Mojokerto provided us with the frequency, location, and impacts of landslides in Desa Belik.
2. **Land Use Maps:** Sourced from the local Department of Agriculture and the Department of Housing and Settlements, land use maps depict the transformation of agricultural land into residential areas. These maps are indispensable for comprehending the consequences of land use modifications.
3. **Related Literature:** The study drew on academic literature and prior research to examine the correlation between land conversion and catastrophe risk. The theoretical framework that underpins the spatial and mathematical analysis involved in estimating potential landslides is provided by these sources.

RESULTS AND DISCUSSION

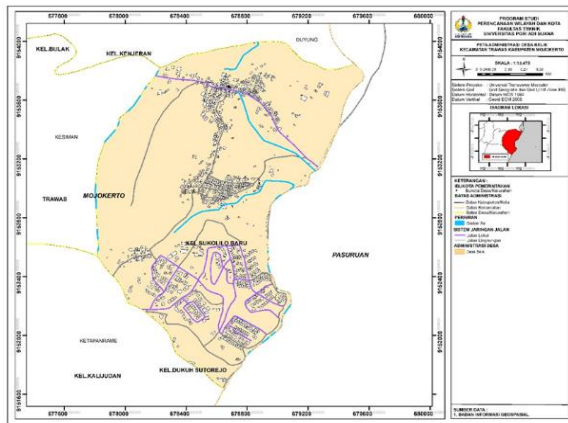
1. Geographic Scope

Desa Belik is one of the villages in Kecamatan Trawas, Kabupaten Mojokerto. It is located astronomically at approximately

7° 39' 29" S and 112° 37' 3" E. The total area of Desa Belik is 244.75 hectares. The village is located approximately 4 km from the district capital and 41 km from the regency/city capital. Geographically, the village sits at an altitude of 650 meters above sea level (masl).

The administrative boundaries of Desa Belik are as follows: South (Desa Ketapanrame); East (Desa Kebon Alas, Kabupaten Pasuruan); North (Desa Putri Duyung); and West (Desa Kesiman). Figure 2 illustrates the administrative map of Desa Belik.

Figure 2. Administrative Map of Desa Belik, Kecamatan Trawas



Desa Belik consists of 4 neighborhood units (RW) and 12 neighborhood units (RT). Located in the highlands of Jawa Tengah, the village is part of the Penanggungan Mountain range, which serves as a natural boundary between various districts and regencies. Desa Belik and Kecamatan Ngoro are separated by Mount Penanggungan to the north. To the east, it acts as a border with Kecamatan Prigen in Kabupaten Pasuruan. The scenic beauty of the mountainous area not only enhances the village's natural allure but also makes it prone to disasters like landslides, particularly during the rainy season.

Desa Belik is located in a highland area with significant agricultural potential. Most of its residents work in the agricultural sector, managing fertile farmland for various crops. According to the Central Statistics Agency (BPS) of Kabupaten Mojokerto and the Mojokerto Regency Department of

Agriculture, the majority of the population in Desa Belik relies on rice, vegetables, and secondary crops as their primary livelihoods. Additionally, many farmers in this village still use traditional farming methods. The geographic conditions of Desa Belik, at an altitude of 650 meters above sea level, provide advantages such as a cool climate and fertile soil, which support the growth of various types of crops.

2. Land Use Conversion

Landslides has multiple definitions or interpretations. The Indonesian Dictionary defines "transfer function/land conversion" as the alteration of the function of a portion or the entirety of a land area from its intended purpose to a different function, leading to adverse effects on the environment and the land's potential. (Ramadan, 2022). Desa Belik has undergone substantial alterations in land use in recent years. Agricultural land has been progressively transformed into residential neighborhoods by farmers. The chief drivers of this phenomena are local population increase and urban residents seeking homes in places with cool air and picturesque vistas. Figure 3 depicts the land conversion in Desa Belik, Kecamatan Trawas.



Figure 3. Illustrates land conversion in Desa Belik, Kecamatan Trawas

The impacts of land conversion: (1) The conversion of agricultural land directly reduces the amount of agricultural land available, leading to a decline in productive land for the agricultural sector. The impacts of this conversion cover various aspects, not only threatening the sustainability of food security but also affecting employment opportunities in the agricultural sector; (2) The effects on the environment can be either positive or negative, including potential ecosystem damage. Factors influencing whether the impact is positive or negative include the level of cooperation among the local community; (3) The economic consequences of land conversion can also vary, both positively and negatively. The outcome largely depends on the ability of farmers and the surrounding community to optimally utilize the opportunities that arise.

Agriculture still occupies a large portion of the land in Desa Belik. However, non-agricultural areas, such as residential zones and other buildings, have gradually taken over portions of this land. To understand these land use changes, periodic reviews were conducted using data from 2014, 2019, and 2024 obtained through the Google Earth application. The review results indicate an increase in the conversion of agricultural land into residential areas. In 2024, the agricultural land area measured 57.48 hectares (67%), while the residential area encompassed 28.31 hectares (33%). In 2019, the agricultural land area decreased to 37.34 hectares (55%), and the residential area increased to 30.34 hectares (45%). In 2024, agricultural land further declined to 35.03 hectares (43%), while residential areas expanded to 46.57 hectares (57%).

Table 1. Area of agricultural land conversion to residential areas in 2014, 2019, and 2024

Years	2014		2019		2024	
Land	Area	%	Area	%	Area	%
Residential	28.31	33%	30.34	45%	46.57	57%
Agriculture	57.48	67%	37.34	55%	35.03	43%

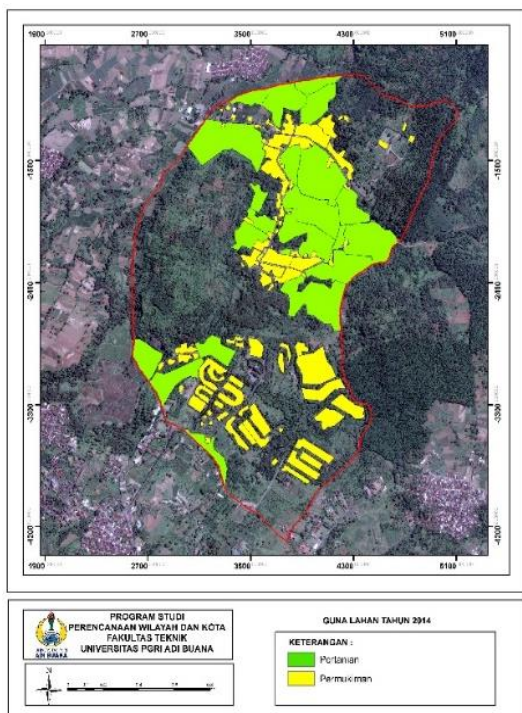


Figure 4. Area of Agricultural Land Conversion to Residential Areas in 2014

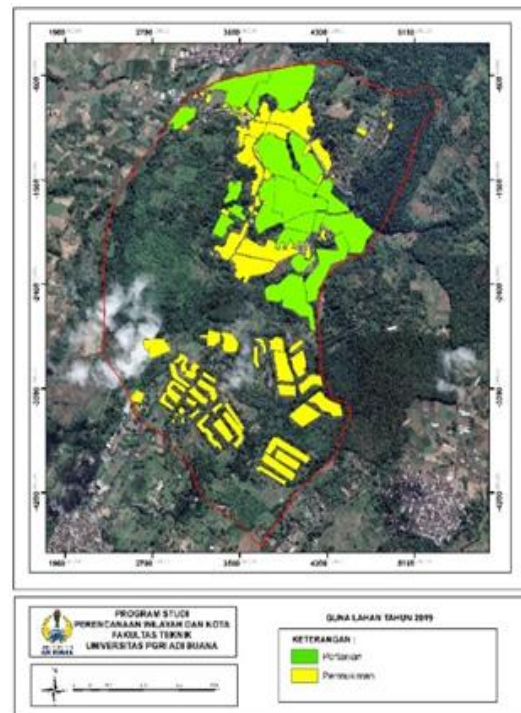


Figure 5. Area of Agricultural Land Conversion to Residential Areas in 2019

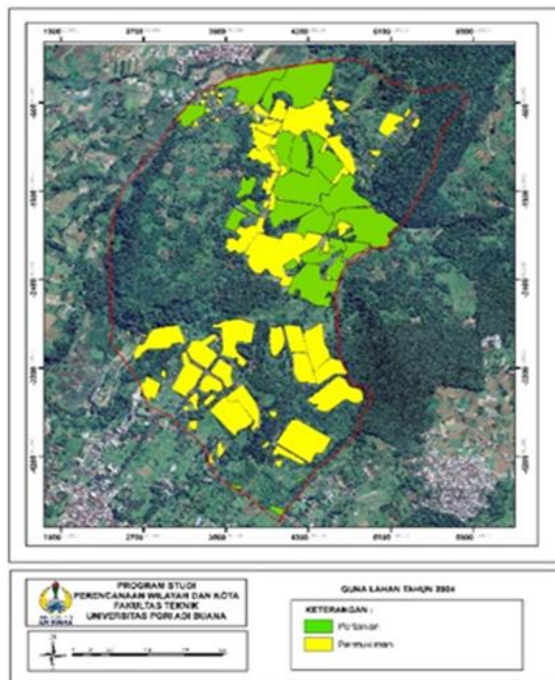


Figure 6. Area of Agricultural Land Conversion to Residential Areas in 2024

To determine the area and percentage of land that has undergone land conversion, an overlay analysis was conducted using the intersect method, which combines agricultural and residential areas from the years 2014, 2019, and 2024. The overlay analysis yielded three distinct classifications of land changes. Conversion of agricultural land to residential areas covering 4.01 Ha (4%); areas that remain residential, covering 45.59 Ha (43%); areas that remain agricultural, covering 55.30 Ha (53%).

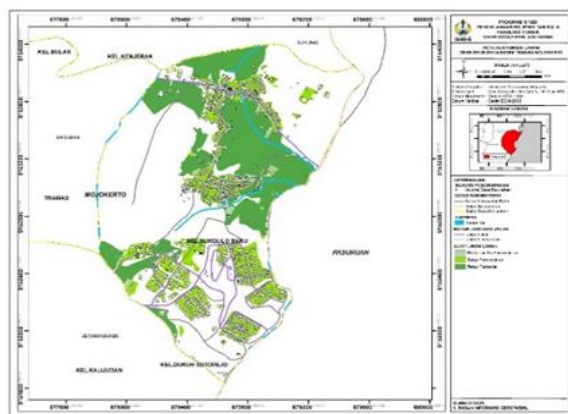


Figure 7. The Land Conversion Map of Desa Belik, 2024

Table 2. Area of Agricultural Land Conversion to Residential Areas in 2024

No	Land Conversion	Area (Ha)	Percent (%)
1	Agricultural to residential	4.01	4%
2	Residential	45.59	43%
3	Agriculture	55.30	53%
Total		104.90	100%

3. Landslide Potential

Both natural elements and human activities can trigger a landslide. When it occurs naturally, there is often a geographical component that contributes to the occurrence, such as high rainfall and other factors. Geologists often refer to this disaster as a movement of soil or rock, a geological event in which masses of rock or soil shift in a range of sizes.

When discussing landslides, there are always causes or factors that trigger the event. These factors help determine whether an area is at risk of experiencing a landslide (Firdaus et al., 2021). Two main factors influence the potential for landslides in an area: natural factors and human activities.

The physical conditions of the environment, including topography, climate, and the weathering of rocks and soil, contribute to natural factors. On the other hand, human-related factors include slope excavation, construction on slopes, and the addition of loads to those slopes. In the Kecamatan Trawas, natural factors are the primary cause of landslides (Irawan et al., 2022).

He types of landslides in Kecamatan Trawas consist of flow-type landslides /flows, slides, toppled trees, and falls. Desa Belik's geomorphology is characterized by a volcanic mountain valley (volcanic rock formations of the Upper Quaternary), with flow-type landslides being the most common type. Table 3 shows the general distribution of landslides in Kecamatan Trawas based on geomorphological units.

Table 3. Landslide Types in Kecamatan Trawas

No	Geomorphology-Cal Unit	Land Slide Type	Location
1	Fluvial Plain, Quaternary Upper Volcanic Rocks	Flows	Seloliman, Sugeng, Jatijejer, Sukosari, Penanggungan
2	Intervocalic Valley, Quaternary Upper Volcanic Rocks	Flows	Belik, Kesiman, Tamiajeng, Mermaid
3	Volcano Slopes, Quaternary Upper Volcanic Rocks	Slides	Seloliman, Kedungudi, Penanggungan
4	Volcanic Cones, Quaternary Upper Volcanic Rocks	Slides	Kedungudi, Mount Penang
5	Volcano Slopes, Arjuno-Welirang Volcanic Rocks	Slides	Trawas, Ketapanrame, Selotapak, Protected Forest area
6	Volcano, Arjuno-Welirang Volcanic Rocks	Falls and topless	Protected forest area

Source: Landslide Hazard Potential in Kecamatan Trawas, 2024

4. The correlation between land use conversion and landslide potential.

Changes in land use are one of the key triggers for landslide disasters. Transforming land in hilly areas for cultivation or residential purposes plays a significant role in accelerating soil weathering and slope instability, which significantly contributes to landslides (Ramadan, 2022). One impact of this land-use conversion is the potential for landslide disasters in slope areas, such as Desa Belik. The correlation between land-use conversion and the potential for landslides can be explained by several factors, including:

a) *Reduction of soil-stabilizing vegetation*

Plant roots stabilize the soil in agricultural and forested areas, preventing rainwater and ground movement from easily eroding it. Conversion of agricultural or forest land into residential or industrial areas replaces the existing vegetation with buildings, roads, or bare land, unable to retain water or prevent erosion. The impact is that the loss of soil-stabilizing vegetation worsens soil conditions, making it more prone to erosion and increasing the risk of landslides, especially on steep slopes.

b) *Increased Load on Slopes*

Land use conversion, such as constructing residential areas, infrastructure, or commercial zones on steep slopes, adds weight to the existing soil. Previously stable soil may become unstable due to the added

weight of buildings or other structures. The increased load exacerbates soil conditions and increases the risk of landslides, especially when drainage planning is inadequate.

c) *The disruption of water flow and drainage*

Land use Conversion from agriculture or forest to residential or infrastructure areas often alters water flow patterns in the region. Concrete, asphalt, and other structures divert more water to surface runoff than the soil could naturally absorb previously. The impact of this alteration in water flow is that it increases the risk of water pooling on slopes and exacerbates soil erosion, which can trigger landslides.

CONCLUSION

The conversion of agricultural land into residential areas in Desa Belik, Kecamatan Trawas, Kabupaten Mojokerto, has significantly increased the risk of landslides in the region. This land-use change has reduced the extent of productive agricultural land, which functions as a natural water absorber, thereby decreasing the soil's capacity to absorb and retain rainwater. As a result, surface water accumulates, triggering soil erosion, particularly in hilly areas where the soil is more prone to landslides. Analysis of land-use data from 2014 to 2024 reveals a trend of increasing residential development alongside a reduction in agricultural land. The loss of vegetation in converted land

further reduces slope stability, making Desa Belik increasingly vulnerable to landslide disasters. The village's hilly topography and significant rainfall intensify the landslide risk associated with these land-use changes.

Therefore, sustainable policies and more focused land-use control measures are required. Community awareness of the importance of maintaining environmental balance through land and vegetation conservation must support these policies. With this approach, Desa Belik can reduce landslide risk while preserving productive agricultural land for the long-term well-being of the local population. The conclusion is that implementing stricter disaster mitigation policies and great spatial planning that prioritizes ecological sustainability are crucial in reducing the potential risk of landslides in the future.

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