

## Land Subsidence in the North Coastal Semarang City for Socioeconomic Activities

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### Abstract

The city of Semarang is a coastal area that often experiences the phenomenon of land subsidence which causes sea level rise for decades. From several sub-districts directly adjacent to the Java Sea area, the worst impact of the disaster was experienced by North Semarang District, Bandarharjo Village, Semarang, Central Java, Indonesia. The impact of disaster greatly affected the lives of Bandarharjo residents, starting from the aspect of social, economic, and social activities. This makes the residents of Bandarharjo required to be able to survive to adapt to this phenomenon. This study aims to determine how the impact of the land subsidence phenomenon on the social and economic activities of the Bandarharjo Village community. This study uses a qualitative method, namely by analyzing all phenomena that occur in the field. The research data was taken by seeking information through observation, interviews, and document review. The people of the Bandarharjo Village must set aside their salaries to buy land to avoid tidal floods due to land subsidence in the Bandarharjo Village. This will impact the economic conditions of the Bandarharjo Village community, which has low-income jobs.

**Keywords:** social phenomenon, land subsidence, flooding, socioeconomic activity, community

### INTRODUCTION

Land subsidence refers to the sinking or settling of the land surface (Figueroa-Miranda et al., 2018). It can be caused by a variety of factors, including natural processes such as soil compaction, erosion, and tectonic activity (Zhu et al., 2015), as well as human activities such as groundwater pumping, oil and gas extraction, and construction (Deng et al., 2017). Groundwater pumping is one of the most common human activities that can cause land subsidence

(Rahmati et al., 2019). When groundwater is pumped out of an aquifer faster than it can be recharged, the soil and rock above it can compact and settle, causing the ground surface to sink (Erban et al., 2014). This is especially common in areas with high water demand, such as cities and agriculture (Chaussard et al., 2013). Land subsidence can cause various negative impacts, including damage to buildings, roads, and other infrastructure, increased flooding and erosion, and changes to the natural environment (Bucx et al., 2015; Solihuddin et al., 2021). It can also exacerbate the effects of sea level rise in coastal areas by lowering land elevation (Herrera-García et al., 2021). Preventing or reducing land subsidence requires a multi-pronged approach that includes sustainable management of groundwater resources, careful planning and management of infrastructure and development, and measures to protect and restore natural ecosystems (Ning et al., 2023; Olson, 2022).

The research issue is motivated by the phenomenon of land subsidence which causes a rise in sea level in the northern coastal area of Semarang City. Many factors cause land subsidence in the northern coastal area of Semarang City, the leading cause being human actions or negligence, namely the lowering of the groundwater level by the weight of the building. Floods on the north coast are related to land subsidence or land subsidence (Sarah et al., 2022). It is known that the average acceleration of land subsidence in the coastal area of the city of Semarang is currently reaching 10 to 20 cm per year. This is the fastest decline compared to other countries. Currently, the port area in Semarang is also decreasing by 2 to 9.8 cm per year (Andreas et al., 2017). This land subsidence that occurs every year is a factor causing flooding and tidal flooding on the North Coast of Semarang City, especially in the Bandarharjo Village.

Natural land subsidence without human intervention is caused by activity processes on land both from inside and outside, such as tectonic and volcanic activity. Land subsidence is caused by the burden of building structures that are too heavy in the Bandarharjo Village area itself is known to be close to several city public facility buildings such as the Ahmad Yani airport, the Semarang Harbor toll road (Semarang-Kendal) plus the Semarang-Demak sea embankment road project which seems to be a burden on coastal area buildings, many industries in the northern coastal area of Semarang City can be causing the extraction of liquid materials from the ground such as petroleum or groundwater that exceeds the limit or is carried out illegally, and land subsidence as a result of extracting solid materials from the ground such as mining can also cause the phenomenon of land subsidence to happen.

The adjustments made by the residents of the Bandarharjo Village to the phenomenon of land subsidence are by adapting their place of residence, by moving or even evacuating. The community needs to build a physical form of a house that is different from usual; these adjustments are in the form of elevating the house by blocking the house and raising the house to two floors, raising the road, raising the embankment, and making waterways, and making a few yards around the house so that at sea level rises, the water does not enter the house. The quality of residential environmental conditions is one of the factors in housing construction that influence economic conditions because it significantly contributes to the environmental quality conditions of settlements (Nazarnia et al., 2020).

This study discusses the impact of land subsidence or land subsidence on social, economic, and community activities for residents of the Bandarharjo Village. For social activities, land subsidence does not have a significant impact. The community continues to carry out social activities as usual. The people of Bandarharjo felt the impact of this phenomenon in the economic field of society, where people spent a lot of money to repair their houses due to the phenomenon and subsidence. This reduces their income.

Residents of Bandarharjo Village are not fully aware of land subsidence. Bandarharjo residents are only aware that they live under the sea so they are always required to be prepared for disasters such as floods and tidal floods. This research is expected to inform the public about the phenomenon of land subsidence or land subsidence for social, economic, and community activities for residents of the Bandarharjo Village on the North Coast of Semarang City.

## METHOD

Bandarharjo Village is a research location because the area is known as the North Coast region in Central Java, where there is a phenomenon of land subsidence or land subsidence. In addition, this location is also closer to where you live and easy to reach. This study uses a qualitative method, namely analyzing every event that occurs to produce descriptive data. This method also intends to describe and analyze phenomena, events, social activities, or people's thoughts individually or in groups. As well as in its presentation, it can raise facts and conditions or phenomena that are happening when the research is taking place. This study focuses on the phenomenon of land subsidence for the socioeconomic activities of the Bandarharjo community.

The type of data from this research is field research by analyzing events related to the phenomena and social-economic impacts of land subsidence in Bandarharjo Village, Semarang. The author uses an ethnographic

approach where this approach functions to understand every human characteristic. This approach usually focuses on specific activities in society or ways of life and so on. Primary data is data obtained directly from the field or research locations by interviewing the local community or informants who are considered to know and can be trusted to get a specific description of the phenomenon of land subsidence along with community social activities as well as documentation in the form of photos to complement the data from the research. The documentation data obtained is a photograph of the northern coastal area of Semarang City, specifically the Bandarharjo Village. Secondary data is obtained from literature studies in journals and books to understand topics related to land subsidence phenomena.

Collecting concrete data, researchers carry out several data collection techniques; data mining carried out in this study is as follows: This observation was carried out directly by going into the field at the selected research location, namely in the Bandarharjo Village, to observe and collect data directly. This observation was also carried out in several stages, the first being descriptive, where the researcher did it thoroughly, then focused observation, in which the researcher made narrow observations to focus on certain aspects. The interview used by the researcher is semi-structured, which is included in in-depth interviews. This interview was conducted directly by the researcher to the community or selected informants by conducting debriefing by asking several questions about the impact of land subsidence on the socioeconomic activities of the community. Researchers use this documentation as a supporting method to complete some of the data still lacking from this research (Silverman, 2013). The data used are photos from the Bandarharjo Village area using a camera to collect data at the research location visually. The results of data analysis from interviews, field observations, and documentation are descriptive in words, and pictures, not numbers. The data analysis used is descriptive-analytic, which describes the collected data in words, pictures, and not numbers. Data obtained from interviews, observations, and literature reviews are described to clarify the reality or reality of the phenomena of land subsidence in Bandarharjo Village.

## RESULTS AND DISCUSSION

### Land Subsidence in Bandarharjo

Land subsidence is a phenomenon that occurs in the form of land subsidence due to groundwater tectonic activity; any phenomenon that is land subsidence is categorized as land subsidence. Phenomenon Land subsidence did not happen suddenly but through a process that took so long and occurred for tens of years. One area experiencing land subsidence is the northern coastal area of Semarang City, precisely the Bandarharjo sub-district residents, an area of fine grain (swamp) or clay deposits.

Figure 1. A former Marabunta building and one of the residents' houses which its owner abandoned due to drowning and buried subsidence



Source: Private Documentation, 2022.

Land subsidence caused several existing building structures in the Bandarharjo sub-district area to be damaged. Figure 1 above is a former Marabunta building and one of the residents' houses which its owner abandoned due to drowning and buried subsidence. The damage to buildings that occurred in several places is very concerning. Damage to several building structures is the impact of the position of the land surface, which is lower than the sea level.

Figure 2. Damage to several building structures is the impact of the position of the land surface



Source: Private Documentation, 2022.

Land subsidence is a disastrous product of excessive absorption or use of groundwater, even illegally. Land subsidence cannot be fixed by returning the sea level to its original state. Land subsidence cannot be controlled unless it is necessary to carry out development or reclamation; however, reclamation also impacts the potential for short-term subsidence of the land surface. Land subsidence is challenging to detect because land subsidence is very small, which makes people less aware of this phenomenon. Development is one of the causes of land subsidence due to building loads which causes the land to be lower than sea level.

Figure 3. Impact of the position of the land surface, which is lower than the sea level



Source: Private Documentation, 2022.



The elevation of the sea wall is a form of protection so that when the sea level rises, it does not cause residents' settlements to be inundated by floods and tidal floods. Road elevation is also being carried out so that seawater does not stagnate, allowing it to happen. Raising the road, it will have an impact on the tidal water that will flow into residents' homes.

Figure 4. Road elevation is also being carried out so that seawater does not stagnate



Source: Private Documentation, 2022.

Figure 5. Village atmosphere adjacent to the port



Source: Private Documentation, 2022.

Even though the barriers and roads have been raised, however, when unpredictable climate change makes the Bandarhajo Village still inundated with tidal floods due to land subsidence. This has disrupted Bandarharjo residents' livelihoods; therefore, the government has thought of a solution to this problem: emptying the coastal areas of settlements and industries, which are then filled with reforestation through planting mangroves and also shrimp towers.

### Impact on Community Social Activities

Land subsidence caused flooding on the north coast of Semarang City, namely the Bandarharjo Village, so residents had to adapt to their environment. The residents of Bandarharjo know that they live in a coastal area prone to flooding due to land subsidence, so the residents of Bandarharjo then make several adaptations to survive in the coastal area. With the subsidence of the land surface, social activities such as Family Welfare Development and local security system are still being carried out by residents.

Adaptation to land subsidence phenomena can be used as a community adaptation to deal with tidal flood problems in the area. Some residents of Bandarharjo have fled or moved places, but many have returned to Bandarharjo Village for convenience. The people of Bandarharjo Village feel that they have the same fate as coastal communities and are used to changes in nature and the environment.

Of course, the health of the people of Bandarharjo has decreased due to the tidal flood caused by the phenomenon of land subsidence. A slum environment causes the emergence of various diseases. Stagnant water due to low soil surface causes many larvae to reproduce, causing disease. In addition to raising the house floor, the Bandarharjo community must maintain the cleanliness of the environment by holding community service and cooperation to create a healthier environment.

### Impact on Community Economic Conditions

The reason the residents of the Bandarharjo Village stay in the coastal area is that the location is close to where they work. Also, the residents are resigned to the phenomenon of flooding and tidal waves because the residents think that everything is from God. Residents in the Bandarharjo Village primarily work as fishermen, factory workers, and trade and services. Many of the Bandarharjo people have experienced a decrease in income and reduced community livelihoods.

Damage to building infrastructure due to land subsidence makes people have to repair damaged houses and roads. The community must pay for every item or house damaged due to land subsidence and tidal flooding. This dramatically reduces the economic conditions of the people who are not well-off. Communities have to set aside their money to repair or raise the floor of their house every few years.

Figure 6. Land subsidence made residents of the Bandarharjo sub-district required to fill in and elevate their houses



Source: Private Documentation, 2022.

Land subsidence made residents of the Bandarharjo sub-district required to fill in and elevate their houses. After conducting interviews with one of the residents of Bandarharjo regarding land subsidence or raising of the house floor, the residents of Bandarharjo carry out the development according to the economic capacity of each community. At least residents will raise the floor of their house every 4-5 years. Based on data taken from informants, they bought three trucks of land.

The process of raising the floor of the house adds to their economic burden, especially for low-income residents. For every truck of land, they have to buy Rp. 350,000.00. Residents must set aside their salaries to buy land to avoid tidal floods due to land subsidence in Bandarharjo Village. This will impact the economy of Bandarharjo residents who have low-income jobs, especially fishermen.

Preventing or reducing land subsidence requires a multi-pronged approach involving the sustainable management of groundwater resources, careful planning and management of infrastructure and development, and measures to protect and restore natural ecosystems (Vachaud et al., 2019). Some specific actions can be taken: sustainable groundwater management, land use planning, monitoring, self-warning systems, restoration of natural ecosystems, and infrastructure modification. Groundwater pumping is a major cause of land subsidence, so the sustainable management of groundwater resources is essential. This can involve reducing groundwater pumping rates, implementing water conservation measures, and promoting using alternative water sources such as surface or recycled water. Careful land use planning and management can help prevent or minimize land subsidence. This can include avoiding or limiting development in areas prone to subsidence, such as areas with shallow groundwater, and designing infrastructure and buildings to withstand subsidence (Azevedo de Almeida & Mostafavi, 2016). Regular monitoring of groundwater and ground levels can help detect and respond to subsidence before it becomes a significant problem (Mardian, 2022). Early warning systems can notify stakeholders about groundwater or ground-level changes (Plumpton & Cornforth, 2020). Restoring natural ecosystems such as wetlands and riparian zones can help increase water retention and infiltration, reducing the need for groundwater pumping and reducing land subsidence (Keesstra et al., 2018; Singh et al., 2021). In areas with subsidence, such as raising roads and buildings or strengthening foundations can help prevent damage and reduce the risk of future subsidence (Erkens et al., 2015; Saputra, 2020). Overall, preventing or mitigating land subsidence requires a holistic approach involving multiple stakeholders, including government agencies, water managers, land use planners, and community members.

## CONCLUSION

Phenomenon land subsidence in the Bandarharjo sub-district caused stagnant water to physically impact building construction and social, economic, and environmental activities. But in social activities, the impact is not so pronounced. As is land subsidence, the social activities of Bandarharjo residents remain normal as usual. Residents still carry out social activities such as Family Welfare Development and the local security system. It is just that people adapt the physical form of buildings to roads, which are unique forms of adaptation. The adaptations made by the residents varied according to their respective vulnerability conditions, their capacity/knowledge, and the economic conditions of the residents of Bandarharjo Village. This has an impact on the economic conditions of the community. Residents in the Bandarharjo Village are mostly low-income because most people work as fishermen, factory workers, and trading and services. Many of the Bandarharjo people have experienced a decrease in income and reduced community livelihoods. This impact is felt by people who have low incomes.

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