



## Tidal Flood Susceptibility Mapping and Community Adaptation Assesment in Semarang Utara District

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DOI: <https://doi.org/10.15294/jese.v3i1.64910>

### Article Info

Received 12 Januray 2023

Accepted 20 March 2023

Published 29 April 2023

*Keywords:*

Community adaptation,  
Flood susceptibility mapping,  
Tidal flood

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### Abstract

North Semarang District is one of the areas that is often affected by tidal floods. This study will discuss flood distribution through tidal flood susceptibility mapping and identify adaptations. The first step is to carry out flood susceptibility mapping using DEMNAS data and sea tides. The second stage is to determine the key areas based on the tidal flood susceptibility map made. Key areas are useful for identifying forms of community adaptation to tidal floods through data collection in the form of observations and interviews. The mapping results show that the flood susceptibility area reaches 582.89 Ha or around 50% of the area of North Semarang District. The key areas with high susceptibility are settlements on Jalan Tambakrejo, Tanjungmas Village and it is known that the community responds by adapting patterns to changes in physical infrastructure, economic activity, and social development.

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p-ISSN 2797-0175

e-ISSN 2775-2518

## INTRODUCTION

Climate change causes melting of polar ice caps which has an impact on sea level rise. This sea level rise threatens coastal areas, one of which is the City of Semarang (Amin et al., 2021). Rising sea levels can trigger tidal floods in coastal areas and are exacerbated by land subsidence (Bott et al., 2021; Rachman et al., 2015; Suripin & Syafrudin, 2015). Tidal floods or in the local language are called rob, have negative impacts such as damage to buildings and economic losses (Wahyudi, 2020; Syafei et al., 2017).

North Semarang District has a high tidal flood susceptibility potential (Gultom et al., 2018). This area is often hit by tidal floods both in the rainy and dry seasons. This condition can be seen throughout 2022 (Chamim, 2022; Susanto, 2022; Yasa, 2022; Yusuf, 2022). Based on this, this study will discuss the distribution of floods through tidal flood susceptibility mapping and identify their impacts.

## METHOD

The study was conducted in North Semarang District, Semarang City. Administratively, this area is bordered by East Semarang District (north side), Gayamsari District (north side), and Genuk District (west and north side) (Figure 1). Based on land use, this area mostly consists of built-up land such as settlements, industrial areas, office and commercial buildings (Nucifera & Astuti, 2021).

This study uses several data such as data on the impact of tidal floods and spatial data such as administrative maps of Semarang City, DEMNAS data. In addition, this study also uses sea tides data downloaded from [ina-sealevelmonitoring.big.go.id](http://ina-sealevelmonitoring.big.go.id). In summary some data processing and analysis consists of the following stages:

### **Making a tidal flood susceptibility map**

The activity of making a tidal flood susceptibility map in North Semarang Subdistrict was carried out using the highest high-water level (HHWL) and DEMNAS. The HHWL value is obtained from the calculation of tides data for Semarang Station. The calculation method used is the least square method and the time period used is one month starting from May 24, 2022.

The next stage is the creation of a flood inundation model from DEMNAS data and the

highest tide values which are technically similar to the study conducted by Utami et al. (2021) and Roynaldi & Maryono (2019). First, DEMNAS data is converted to DTM (Digital Terrain Model) using a slope-based filter in the SAGA 3.0 application (Fariz & Rokhayati, 2017). Second, calculate the HHWL value using the least squares method. Third, classifying the tidal flood area with the assumption that a pixel value below the HHWL value is a flood area.

### **Identification of forms of community adaptation**

The process of identifying forms of community adaptation is carried out in key areas, namely areas that have high tidal flood susceptibility based on maps that have been built. After the key areas are determined, the next step is data collection which is carried out using the triangulation method. This method is a data collection technique that uses sources from in-depth interviews with key respondents, namely the head of the KPL (Environmental Protection Group) Camar, community interviews and observation. Collecting data with this approach is expected to increase the level of accuracy and representation of data (Imfeld-Isenegger et al, 2020; Fariz et al, 2022). After the data is collected, the next step is the analysis stage with data analysis techniques in the form of descriptive qualitative.

## RESULTS AND DISCUSSION

### **Tidal flood susceptibility in North Semarang District**

North Semarang District often becomes a tidal flood. On May 23, 2022, a major tidal flood occurred around the Tanjung Emas area due to a breach in the seawater barrier (Prastiwi, 2022). Apart from that, on June 23 2022, there was also a severe tidal flood (Ariwibowo, 2022). Based on this, the tidal flood susceptibility map was built based on the elevation sea tides data at that time. HHWL calculation results using the method least square shows that the highest sea level elevation value is 1.7m. The mapping results show that almost the coastal area is a tidal flood prone area (Figure 2). For North Semarang District, the tidal flood susceptible area reaches 582.89 Ha or around 50% of the area of North Semarang District.

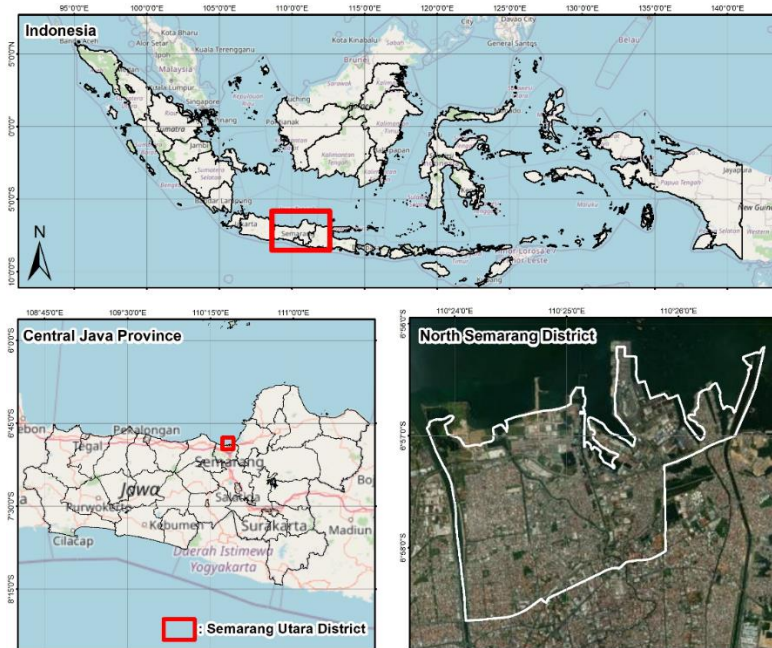


Figure 1. Study location (Source: Research results, 2022)

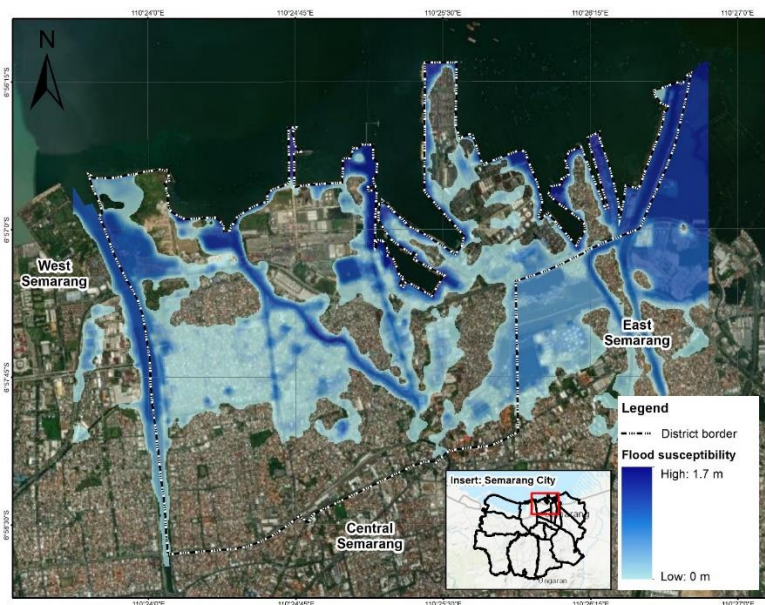


Figure 2. Map of tidal flood susceptibility in North Semarang (Source: Research results, 2022)

The resulting map has several limitations such as not considering water discharge and influence land subsidence. To build a tidal flood susceptibility map that involves influence land subsidence is to use topographic survey data and Synthetic Aperture Radar (SAR) (Zainuri et al., 2022; Tang et al, 2021). Apart from that, tidal flood mapping also uses hydrodynamic simulations

which tend to be more representative (Sagala et al., 2021). The tidal flood susceptibility mapping method that we use has the advantage of using open access data and fast data processing time, so that it can be seen that the area included in the high class is Tanjungmas Village. Therefore, the area determined as the key area for impact identification is a settlement on Jalan Tambakrejo, Tanjungmas Village (Figure 3).





Figure 3. Key areas in Tanjungmas Village (Source: Research results, 2022)

### Community adaptation to tidal floods in Tanjungmas Village, North Semarang District

Settlements on Jalan Tambakrejo, Tanjungmas Village are densely populated settlements that are often exposed to tidal floods. Tidal floods have hit this area from 1990 to 2000, one of which is the logging of mangrove forests. The logging of mangroves is because people who work as fishermen feel disadvantaged by the existence of mangroves. This is considered to reduce fish catches during the harvest period because the fish will hide in the roots of the mangroves. In recent years, there has been an increase in the area of mangrove forests due to rehabilitation carried out by the community in collaboration with NGOs, the government and campuses (Prastika & Kismartini, 2017).

Mangrove rehabilitation is a form of adaptation for coastal communities to tidal floods, besides that other adaptations can also be in the form of coastal breakwater construction. Basically, the process of adaptation to environmental changes on the coast will require large costs and a long time compared to efforts to prevent environmental damage (Akbar et al., 2017). Adaptation also aims to reduce socio-economic and environmental vulnerabilities stemming from climate change such as increasing community resilience and poverty alleviation (Gultom et al., 2020). The adaptation of the

Tambakrejo community to tidal floods includes adaptation to physical, economic and social building activities.

#### 1. Physical adaptation of buildings

Tidal floods cause damage to residential infrastructure and cause slums due to accumulation of waste (Mussadun et al., 2016). In addition, water immersion can also cause damage to household appliances and vehicles. Therefore, the Tambakrejo people responded with adaptations in the form of changes in physical buildings, be it houses, shops, places of worship, or other buildings. The physical adaptation of buildings plays an important role in the resilience of communities in disaster areas because it is related to the comfort level of the residence (Nurhidayati & Fariz, 2020).

Adaptations are made according to the economic capacity of the community. Communities with a high economy can renovate and even turn their houses into stilt houses that are relatively adaptive to flooding. However, people with a low economy usually only increase the floor height so that several low houses can be found due to the continuous elevation of the floor.



Figure 4. Physical adaptation of infrastructure buildings due to tidal floods

### 2. Economic adaptation

The impact of tidal floods is that women have a double burden, namely carrying out productive and reproductive roles (Utami et al., 2021). Uncertain family income and expenses due to tidal floods, forcing some mothers to help their husbands in earning a living. Before the tidal flood occurred, most of the women in Tambakrejo were housewives, but along with the destruction of the coastal environment, fishermen's income has also decreased. In addition, family expenses also tend to increase with more frequent tidal floods. Expenditures for upgrading buildings, health, and repairing household facilities and infrastructure after the flood, for example, have added to family expenses. These conditions make women in Tambakrejo increase their economic activities by following economic trends that have developed, for example selling agate, or other businesses such as selling daily needs. The development of the Tambakrejo area into educational tourism in recent years has also been responded to by the women's group there (the Red Delima Group) who originally sold agate to develop processed products from mangroves, such as snacks or ecoprint products.

### 3. Social adaptation

The impact of flooding on social conditions is the disruption of various community activities (Mussadun et al., 2019). Tidal floods that come suddenly often cause panic. Therefore, the community formed an early warning system based on the RT environment. Information about rising sea levels will be conveyed via loudspeakers and an evacuation coordinator will be formed in each RT. This coordinator is tasked with acting quickly

if there is an emergency, for example a flood victim who is sick needs to be taken to the hospital immediately.

Another form of social adaptation is the formation of the KPL CAMAR in 2011. This group has been dedicated to planting mangroves since its establishment and initiated the development of a mangrove edupark in 2020 (Mangrove Monitoring Team, 2021). The management of the Tambakrejo mangrove edupark is carried out with an ecotourism approach, namely by prioritizing education and empowering the local community. One form is the fishing community providing boat transportation services for visitors as well as seafood packages. Even so, community participation still needs to be increased, especially participation from youth groups (Kurniawan & Banowati, 2021). Assessing the level of community participation, especially youth in activities related to social adaptation into the future work of this study. Other future work that is important to do is to study gender role adaptation and psycho-social performance towards understanding local adaptation (Md et al, 2022; Utami et al, 2021; Drury et al, 2019; Putra et al, 2019). The hope is to create harmony between humans and nature which will eventually minimize the impact of tidal floods.

## CONCLUSIONS

The mapping results show that the tidal flood prone area reaches 582.89 Ha or around 50% of the area of North Semarang District. Based on the developed map, it is known that the key area which is a high susceptibility area is a settlement

on Jalan Tambakrejo, Tanjungmas Village. Communities on Jalan Tambakrejo, Tanjungmas Village have forms of adaptation such as physical, economic and social. This study still has many limitations, such as the susceptibility mapping that was built did not take into account land subsidence. Therefore, it is necessary to develop a tidal flood susceptibility mapping that uses SAR data and topographical surveys. In addition, it is also necessary to study gender role adaptation as well as psycho-social performance towards understanding local adaptation.

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