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The Impact of Tidal Flooding on Decreasing Land Values in the Areas of Tugu District, Semarang City

Westi Utami[1], Yuli Ardianto Wibowo[1], and Fajar Buyung Permadi[1]

[1]Sekolah Tinggi Pertanahan Nasional; e-mail: westiutami@stpn.ac.id

ABSTRACT

Semarang City as one of the areas on the north coast has a serious problem related to tidal flooding. The impact of this disaster has implications for changes in land use, a decrease in environmental quality and health, the emergence of slum settlements, a decrease in income and also a decrease in land value. This study aims to map the impact of tidal flooding on changes in land values based on the Land Value Zone Map (ZNT) and map land prices based on spatial data analysis. The study was carried out through spatial analysis by overlaying (join intersection) the 2014, 2016, 2018 and 2019 ZNT maps to determine changes in land value, while mapping land prices, especially in Mangunharjo Village, was based on land use maps, positive accessibility (road network) and negative accessibility (prone flood rob). The results of the study show that land which is permanently affected by tidal flooding and cannot be used anymore makes it a lost / destroyed land, while periodically inundated land has experienced a price decline in the range of Rp 100.000 – 200.000, -/m^2. Meanwhile, the results of the study from the ZNT map for 2014 to 2019 show a very significant difference in price between zone 1 and a price increase of ± Rp 3.500.000; zone 2 price increase ± Rp 575.000, -, zone 3 at a price range of Rp 385.000, and zone 4 as the tidal flood prone zone only experienced an increase of Rp 250.000,-. In this context, the variable of tidal flooding vulnerability greatly affects the stagnation of land prices and even decreases in land prices, while the positive accessibility variable is the location of land on national and local roads that has experienced a very high price increase.

***Keywords*:** Tidal flooding, Disaster impacts, Environmental degradation, Land assessment, Land use

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1. Research Background

Some cities and settlements in Indonesia, even in the world, are geographically located and directly face the coastal areas (Ji et al. 2010; Crowell 2010; Lin et al. 2013; Purnama et al. 2015; Menèndez 2019; Triana & Hidayah 2020), while changes on global climate in coastal areas (Ji et al. 2010; Pappone et al. 2012; Sihombing et al. 2012, Condon et.al 2012; Rao et.al 2020) has resulted in increasing losses and damages (Bhattacharya 2011; Wang 2014; McGuire 2018; Purnama et al. 2015). Semarang city, as the center of trade, industry, and government, cannot resist from the threat of climate change as well, especially the tidal flood disaster (Marfai et al. 2008; Kahar et al. 2010; Pujiastuti 2015).

Ongoing development as well as industrial and trade expansion that neglect the sustainability of natural resources and the carrying capacity of the environment (especially soil conditions and the balance of groundwater resources) cause land subsidence (Marfai, 2007; Khoirunisa et al. 2015; Pujiastuti et al. 2015; Kasfari et al. 2018, Rao 2020) and result in land below sea level (Nugraha et al. 2015; Kuehn et al. 2010). The ongoing global warming also affects sea level rise (Marfai 2007; Ward et al. 2011; Nurhendro & Marfai 2016) which has implications for the widening level of tidal flood inundation in lowland areas (Gallien et al. 2013; Astuti et al. 2020). The condition of the soil type in Semarang, which is relatively young as it is made of alluvial deposits, makes the soil compacted. Coupled with the effect of excess ground water extraction for industry, it results in a decrease in underground water level resulting in an increase in the rate of subsidence.

Data show that from 1995 to 2006 the coastline in the study area retreated to 293 m and there had been loss of some land (Nugraha 2015; Tamba 2016). Damage to natural barriers in the form of mangrove forests (Akbar et al. 2017; Sheng & Zou 2017; Syahputra, et al. 2018; Soeprobowati et al. 2020) also affects the rate of flood inundation in Semarang City (Ikhsyan 2017). While the level of mangrove vegetation density has not yet recovered and there is not enough budget allocation for infrastructure development in the form of embankments, breakwater walls and puddle water disposal pumps make the threat of flooding continues to occur, resulting in an increasing number of losses suffered by the community.

Tidal flooding has had a tremendous impact (Marfai 2008; Ballesteros 2018). As it also occurs in Semarang city, tidal flooding has resulted in people losing their settlements, livelihoods, and arable lands, damaged infrastructure, a decrease in environmental

quality, decline of healthy living standards, and quite massive changes of land use (Pratikno 2014; Gultom 2018). In addition to the above impacts, tidal flooding that occurred in Sayung Demak District, as studied by Utomo et al. (2017) also led to a decreas in land values. Several studies said the same: Ismail et al. (2016) on the impact of flooding in urban and rural areas in Malaysia; Saptutyningsih (2011) on the impact of flooding on decreasing land values in Yogyakarta; and Tanaka (2014) on the impact of the earthquake triggerring the damage to nuclear power in Fukushima which reduced the land values to an average of 3.39%.

Based on some of the studies above, it is shown that disasters have a significant effect on decreasing land values. Based on the aforementioned background, this study aims to map the impact of tidal flooding on changes in the temporal land value in the coastal areas of Semarang City, especially in Tugu District, based on the Land Value Zoning (ZNT) maps. In addition to analyzing changes in land value based on the ZNT maps, in this study was also conducted a spatial analysis related to land value using several variables: land use, road accessibility, and the threat of tidal disasters in Mangunharjo Sub-district which was affected by massive tidal flooding.

2. Research Methods

This study used a spatial approach with an overlay/superimposed method to map changes in land values due to tidal flooding. Overlay is an important operation and is often used in spatial analysis by combining spatial data and attribute data from at least two layers of map (Wang et al. 2015). To find out how land values change, this study used a Land Value Zoning (ZNT) maps obtained from the Semarang BPN Regional Office covering the 2014, 2016, 2018, and 2019 ZNT maps. Superimposed/overlay analysis (join intersection) was carried out for 2014 - 2016 ZNT map; 2016 to 2018 ZNT map, and 2018 to 2019 ZNT map. The results of the analysis then produced several maps of temporal changes in land values with a period of two years, and one year for the last analysis, linked to the availability of existing maps. The classification of changes in land values in this study is divided into eight classes based on the analysis of the distribution of changes in land values from 2014 to 2019. The classification of changes in land values is presented in Table 1 below.

The classification of changes in land value in this study is more emphasized to map the impact of tidal flooding which has experienced stagnation in prices or low changes in land values, while for other locations with the same physical condition without being disturbed by flooding, land values have increased significantly.

In this study, a mapping of the existing condition of land values in Mangunharjo sub-district which affected by tidal flooding was also carried out. The making of the land value map was carried out through spatial analysis using several variables: land use, positive accessibility (road accessability), and negative accessibility (prone to tidal flooding/coastal areas). The land use map in this study was obtained through interpretation of the google earth engine image. Image interpretation was carried out visually with a 9-key-interpretation approach (hue/color, texture, size, shape, association, pattern, height, shadow, site) to distinguish objects in the form of rice fields, embankments, and settlement/built-up lands/empty lands. In this study, an accuracy test of the results of land cover interpretation was carried out through a ground check by taking samples from 41 locations. The land use samples were determined based on the representation of the type of land use (settlements, rice fields, and embankments) with a scattered selection of locations. The survey results showed that of the 41 samples that had been tested in the field, there are only two land uses that experience errors, so the level of accuracy of land use classification in this study can be calculated using the following formula.

$$= \frac{Number\ of\ validation\ samples\ matched}{Total\ number\ of\ validation\ samples} x100\%$$

$$= \frac{39}{41} x100\%$$

= 95,122 % or 0,95

Table 1. Classification of Changes in Land Values

No.	Class	Information
1	0 - 50,000	Land values are stagnant and change is very low
2	50,000 - 100,000	Change is pretty low
3	100,000-200,000	Change is low
4	200,000 - 300,000	Change is quite moderate
5	300,000 - 400,000	Change is moderate
6	400,000 - 500,000	Change is quite high
7	500,000 - 600,000	Change in height
8	<700,000	Change has very high positive accessibility effects

The scoring of land uses in this study refer to the spatial analysis of land values conducted by Hidayati (2013) and, of course, by adjusting the results of the field conditions survey. The difference in land use classification in this study is that there are embankments whose land values are different from rice fields so that the use of embankments with a sufficiently large percentage was included in a separate class. Meanwhile, for positive accessibility, the selected road variables were classified based on field conditions, namely national roads, local roads, and the absence of road accessibility. The scoring of the road class variables also refers to the study of Hidayati (2013). For the flood variables, scoring refers to a study conducted by Saprudin (2019). Areas that are free from flooding have a positive effect on land values, and vice versa, inundated areas have a negative effect on land values. In this study, the score classification of prone areas for flooding were adjusted to the existing conditions of the areas. The scoring for determining land values is presented in Table 2.

Table 2. Variables of Land Value Classification

Land Class Variables	Score
Land Use	
Settlements/built-up lands	3
Rice fields	2
Embankments	1
Road Accessibility	
National Roads	3
Local Roads	2
No Road Access	1
Vulnerability to Tidal Flooding	
Not Prone	3
Prone	2
Very Prone	1

The overlay results of several variables as shown in Table 2 resulted in the distribution of land classes for market price surveys to map the existing land values in 2019. In this study, interviews were also conducted with several stakeholders, including the Semarang BPN Regional Office and the Semarang City BPN Land Office to determine the impact of tidal flooding as well as land value zoning map information. Interview with the Mangunharjo Sub-district Government (the head and his staffs) to obtain information on the prices of existing lands, the impact of tidal flooding and its handling; and interviews with environmental activist (Sururi) and the community to gather information related to mangrove damage and efforts to replant mangroves. The framework in this study is presented in Figure 1.

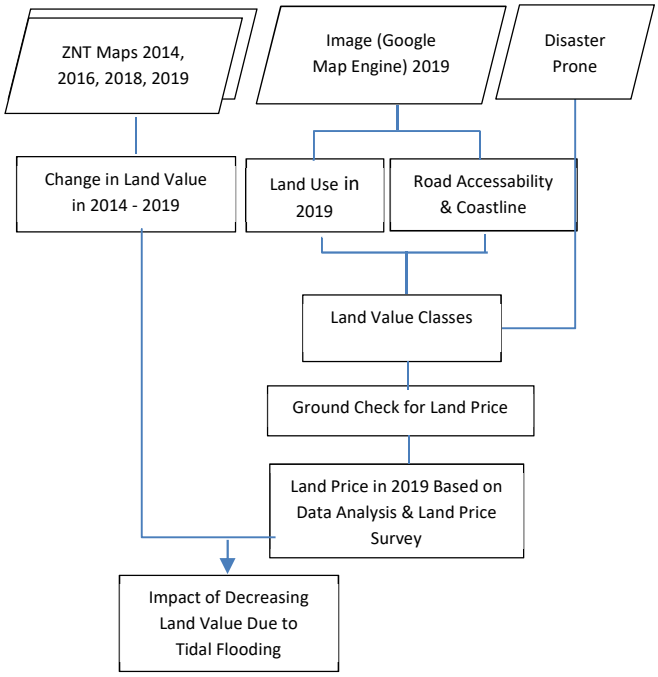

Figure 1. Research Framework

3. Results and Discussion

3.1. The Impact of Tidal Flooding

One of the triggers for tidal flooding on the north coast was the destruction of mangrove forests, especially on the coast of Semarang, which occurred in the 1980s to 1990s. One of the causes of this damage was the boom in shrimp pond cultivation, where abundant cultivation results and multiple profits have triggered the entry of large capital investors to develop shrimp farming businesses in the northern coastal areas (Interview with an Environmental Activist, Sururi, & Head of Mangunharjo Sub-district, 2019). This condition certainly resulted in a very massive conversion of mangrove forest function. In addition, the growth of industrial areas and residential areas on the north coast has also triggered the conversion of function and the destruction of mangroves in this area (Interview with Head of Mangunharjo Sub-district 2019; Wahyudi 2014). The change of function and backfilling/reclamation for embankment and mangrove areas, which were originally used as water reservoirs when there was a tidal wave, resulted in high tide crashing into lowland areas in residential areas.

Various efforts to replant mangroves have been carried out by the community and the government, but these efforts have not succeeded in returning the population and density of mangrove forest vegetation so that the problem of tidal flooding, abrasion, and sea water intrusion that disturbs the balance of life still threatens the community (Interview with an environmental activist, Sururi 2019). The widening range of tidal flood inundation has resulted in the loss of several community embankments, settlements, infrastructure, and arable land, and triggered poverty in some communities (Interview with Head of Mangunharjo Sub-district 2019; Fauzi et al. 2017).

This study was conducted in Mangunharjo Sub-district and several sub-districts in Tugu District as one of the districts apart from North Semarang and Genuk District which are categorized as very prone to tidal flooding. This district experienced quite high damage and losses, and the flood area reached 257.2 km in 2011 (Ramadhany 2011). The impact caused by the tidal flooding resulted in a decrease in the level of community income, high unemployment, high rate of urbanization, an increase in the number of poor groups, and the emergence of slum areas. The results of interviews conducted with the sud-dristrict head and an environmental activist (Sururi), coupled with the results of field surveys indicate that in addition to loss of embankments, majority of community's rice fields in this sub-district were also damaged due to sea water intrusion unidating the rice fields, causing the community to suffer from crop failure.

In addition to economic losses, the results of field studies and literature studies show that the conditions of community settlements in Mangunharjo and Mangkang Wetan sub-districts have decreased water quality due to sea water intrusion (Miswadi 2010) and increasingly degraded environmental conditions. Land subsidence is quite fast, ranging from 2,07 – 17,04 cm/year in 2013 to 2016 period (Prasetya, Yuwono, Awaluddin 2017), resulting in several houses buried in the ground. Some mitigation efforts through raising building foundations, increasing floor height, and building houses with higher construction have been attempted by the community, and of course, this effort requires self-help funds whose value is not

small, which is increasingly burdening the community's condition. Although this mitigation has been carried out, some people still feel anxious about the rate of land subsidence and the on-going impact of global warming. Tidal flooding also has an uneasy impact on community settlements close to the coastline, because when a tidal wave arrives, the water quickly inundates community's settlements and property.

A. Land Use in The Study Area

Land use maps of Mangunharjo, Mangkang Wetan, and Randu Garut sub-districts were obtained through spatial analysis of the images presented from the Google Earth Engine in 2019. Identification of land use in this study was carried out through visual interpretation using 9 interpretation keys, namely hue/color, shape, texture, size, pattern, height, site, associations, and shadows. This approach was chosen because it is based on several previous studies (Sampurno & Thoriq 2016; Kosasih et al. 2019). Visual interpretation to map land use in narrow areas (sub-districts) has higher accuracy so that it can produce more detailed large-scale maps. Based on the results of the accuracy test, it is shown that the accuracy of land use in this study has a high value of 95,12% where the results meet the minimum value accuracy requirement (>85%). In this case, the results of land use interpretation can be used as a research database. Based on the results of the accuracy test, the classification of land use in this study is acceptable, and the results are presented in Figure 2 below.

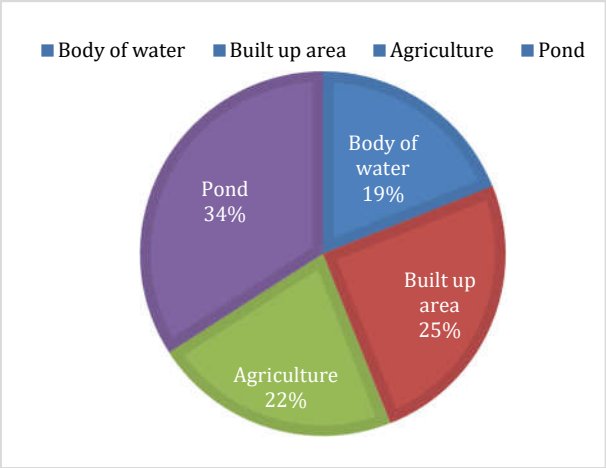

Figure 2. Percentage of Land Use in Mangunharjo, Mangkang Wetan, and Randu Garut Sub-districts

Meanwhile, the results of the land use mapping of the study area are presented in the following map.

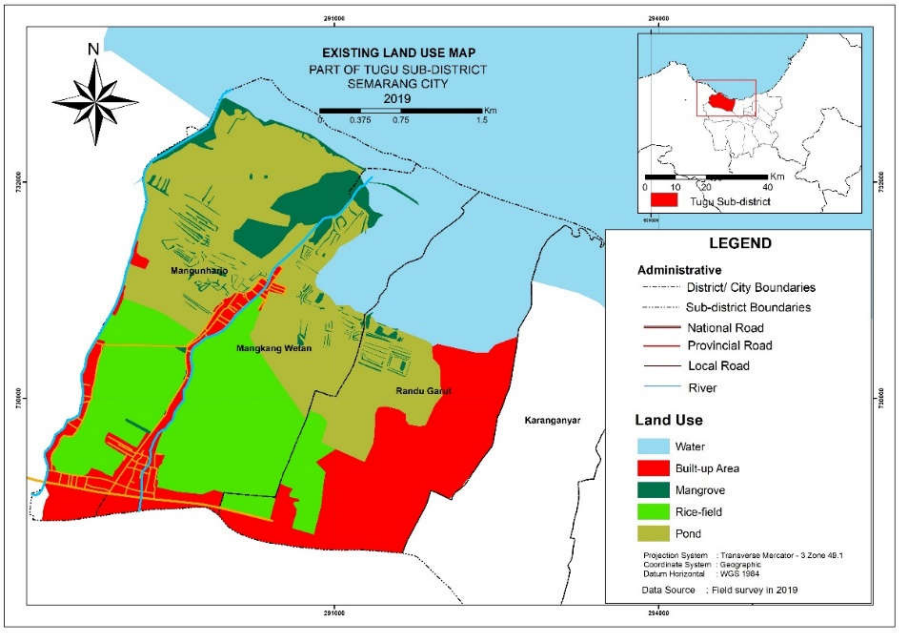

Figure 3. Land Use Map of Randu Garut, Mangkang Wetan, and Mangunharjo Sub-districts

Based on the mapping results as shown in Figure 3 and the land use diagram in Figure 2, it is shown that in the study area, there are 19% of the area that is in the form of water due to land subsidence, where within one year, the decline can occur up to ± 1 cm/year (Ismanto et al. 2009). Sururi (2019) and some people in Mangunharjo Sub-district have also felt the continuing land subsidence condition (Interview with an Environmental Activists, Sururi 2019). Mapping results show that 25% of the study area is dominated by settlements/built-up lands, considering that geographically, Mangkang Wetan, Mangunharjo, and Randu Garut sub-districts are located quite close to the center of Semarang City, ± 23 km, crossed by the Pantura (north coast) route and the toll road of Semarang – Batang.

The existence of an industrial area that is quite close to Randu Garut, the Wijaya Kusuma Industrial Area (KIW) and the Putra Wijaya Kusuma Industrial Area with an area of ± 250 hectares in Mangkang Wetan has resulted in a massive change of land function. Previously used as rice fields, the area changed its function to settlements in order to meet the housing needs of workers/employees of PT KIW.

From the data analysis, it is also shown that most of the study area, namely 34%, is currently used for shrimp and milkfish embankments by the community. This high percentage for embankments is influenced by the large number of community rice fields that are intruded by sea water and already inundated by sea water, so that farmers take advantage of former agricultural land to build embankments to fulfill their daily needs.

Changes in natural and environmental conditions also affect the social conditions and livelihoods of the population where previously they were rice farmers with two harvest times/year. This was because the soil conditions were very fertile. Yet, due to tidal flooding, people change their profession to become pond farmers. Two sub-districts, namely Mangkang Wetan and Mangunharjo, are potential agricultural/rice fields for this area is a rice-producing center with a rice field area of ± 86.583 Ha (Kecamatan Tugu Dalam Angka 2019). However, the existence of this rice field is decreasing due to pressure from sea water intrusion and land conversion for residential development and service development due to the domino effect of industrial development of PT KIW.

B. Analysis of the Impact of Tidal Flooding on Land Prices in 2019

The impact of tidal flooding which is increasingly widespread in parts of the coast of Semarang City also affects the decline in land prices. Some concepts explain that the valuation of land prices can be influenced by various parameters, including land use, land location toward the road accessability, positive accessibility (proximity to facilities and infrastructure, road accessability, trade centers, health, education, government), negative accessibility (proximity to rivers, landfills, public burial sites) (Hidayati 2010; Pratiwi 2018; Mabrur 2019), status of land rights, size and shape of land, land area, topography, level of demand or supply of land, etc. (Yuhanafia & Andreas 2017). In addition to these factors, the existence of land that is close enough to disaster-prone areas, especially the threat of tidal flood inundation, also affects the value of land in this area.

Mapping of land values in the study area was carried out through land use mapping from the results of the interpretation of images obtained from the Google Earth Engine in 2019, as presented in Figure 3, including considering the road accessability and the level of vulnerability to tidal flooding. With regard to the map overlay, the land value classification was carried out based on the scoring as in Table 2, then a land price survey and interviews with the sub-district head/officials in Mangunharjo Sub-district were conducted in the study area to find out the market price/land values in the Mangunharjo Sub-district.

Table 3. Results of Land Value Classification Based on Three Variables and Land Price Survey

No.	Land Value (Survey)	Land Use	Road Accessibility	Vulnerability to Tidal Flooding
1	Rp 5.000.000	3	3	3
2	Rp 3.500.000	3	2	3
3	Rp 3.000.000	3	2	3
4	Rp 2.500.000	3	2	3
5	Rp 2.000.000	3	2	3
6	Rp 1.500.000	3	2	2
7	Rp 500.000	2	2	3
8	Rp 400.000	2	1	2
9	Rp 300.000	1	1	1

The results of mapping land values through the overlay of several variables of land value classes of road accessabilitys, land use, and vulnerability to tidal flooding as well as the results of land market price surveys in Mangunharjo are presented in Table 3. From the overlay results, the class division shows that the highest land value (Rp 5.000.000), namely land used for settlements/built-up lands, has national road access and is not prone to tidal flooding. Meanwhile, the land class with built-up land, located on local roads and not prone to flooding, after the land price survey was conducted, had four different land prices, namely Rp 3.500.000; Rp 3.000.000; Rp 2.500.000, and Rp 2.000.000. The results of the analysis show that although the soil has three variables with the same conditions (no. 2, 3, 4, 5), its distance from the national road has an effect on differences in land values. The results of the analysis in the study also show that the result no. 6, with the same land use conditions and access as the previous one, only that it is in a disaster-prone zone (moderate level), the land value has decreased by Rp500.000/m^2. Likewise, land use also has a significant effect when compared between result no. 7 and 8 and the effect of tidal flooding has implication for the difference in value of up to Rp 1.000.000. The spatial distribution of land values based on three variables and a survey of land prices is presented in Table 3 below.

The spatial distribution of land values based on three variables and land value surveys is presented in Figure 4 below.

Based on the results of the market price survey, it is shown that the value/price of land in the study area is strongly influenced by the level of vulnerability to tidal flooding, where in areas close to the north coast, the value of land ranges from Rp 300.000. From the results of interviews with the head of Mangunharjo sub-district and the community, it was stated that the price of land in areas that are closer to the coast or land that is often/has been flooded by tidal flooding has decreased in price. With the expansion of land inundated by tidal flooding, the price of land owned by some people has also decreased. For example, one resident stated that the land he previously owned was rice fields with a price of ± Rp 400.000 to Rp 500.000/m^2, but due to the widespread impact of tidal flooding, the agricultural land was converted into a pond with a market price of ± Rp 250.000/m^2 to Rp 300.000/m^2. The decline in land prices did not only occur in one or dozens of land parcels, but also hundreds of community plots of land.

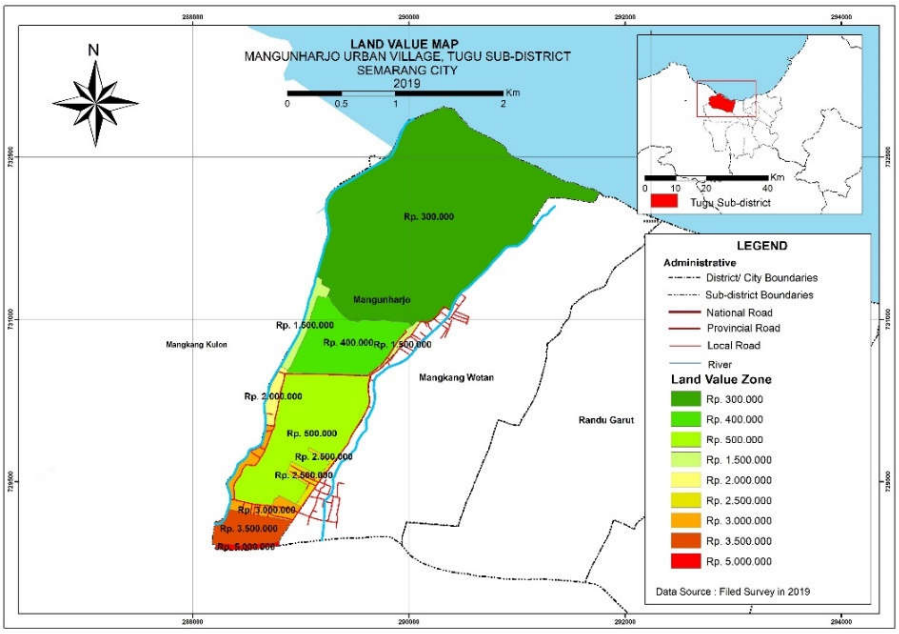

Figure 4. Land Value Map Based on Spatial Data Analysis and Field Survey

The increasingly widespread tidal flooding has also resulted in hundreds of ponds being lost due to being inundated by permanent flooding which are deep enough and can no longer be used as embankments, including in the coastal areas of Mangunharjo and Mangkang Wetan sub-districts. This has resulted in a new phenomenon, namely that some communities on the north coast still hold certificates of ownership over land but do not have a physical form of land that can be utilized. This condition is in the statutory regulations, namely the Basic Agrarian Law (UUPA) Number 5 of 1960 in Article 27, which states that land ownership rights are abolished if the land is destroyed. Further regulation of this condition is also stipulated in Government Regulation Number 24 of 1997 on Land Registration, where the land registration process can be carried out if the condition of the land is in accordance with the physical data and juridical data as strong evidence (Andawari 2017; Susiati & Setiadji 2020). Meanwhile, for land that has permanently transformed into a sea, it is certainly very difficult to measure the boundaries of land parcels and it is difficult as well to determine the area or boundary point between one plot and another.

From Figure 4, it can be observed that the land distribution which is located in the middle part is not affected by tidal flooding, where the land used for rice fields without road accessibility is in the price range of Rp 500.000/m^2. Meanwhile, land conditions in the form of empty land instead of rice fields that are traversed by local/sub-district roads show a price range of Rp 1.500.000/m^2 to Rp 2.000.000/m^2. The results of land price mapping in Mangunharjo Sub-district also show that in the study area, there is a very high difference in value, where the price of land located around the main road, namely Jalan Pantura, has a very high price, reaching Rp 3.000.000/m^2 to Rp 5.000.000/m^2, while getting closer to the coastal area, the price of land decreases further, in the range of Rp 200.000/m^2 to Rp 300.000/m^2. In this context, the three variables that greatly influence land prices in the study area are the level of vulnerability to tidal flooding, road accessibility, and land use types.

In this study, the assessment of land prices is only limited to the three variables, not based on the calculation of parcels because the research objective focuses on the study of the impact of tidal flooding on land values, so that the variables of land area, land shape, status of land rights, and land surface width are not taken into account as variables determining land prices. However, from this study, it can be formulated

that the land price for most people in the north coastal area is significantly impacted by tidal flooding.

C. Analysis of Periodic Change in Land Value Based on ZNT

In this study, determination of the impact of tidal flooding on changes in multitemporal land values was carried out through analysis of the ZNT map spatial data obtained from the Central Java BPN Regional Office. ZNT maps were not compiled on a plot basis but on a zone system where one zone contains the almost similar prices of land parcels. The preparation of the ZNT map compilation carried out by BPN began with an analysis of land parcels with similar conditions and arranged by zones. Furthermore, an analysis of several variables of the zones was carried out, namely zoning/land use, general site conditions whether they are slum areas, arranged areas, or others, consideration of infrastructure/utility conditions in the area (water, electricity, etc.), available facilities (markets, electricity, schools, etc.), physical factors (elevation, topoghraphy, etc.), and other variables relevant to the assessed zones (Technical Guidelines for the Implementation of Average Indication Value and Determination Land Value Zoning/ZNT).

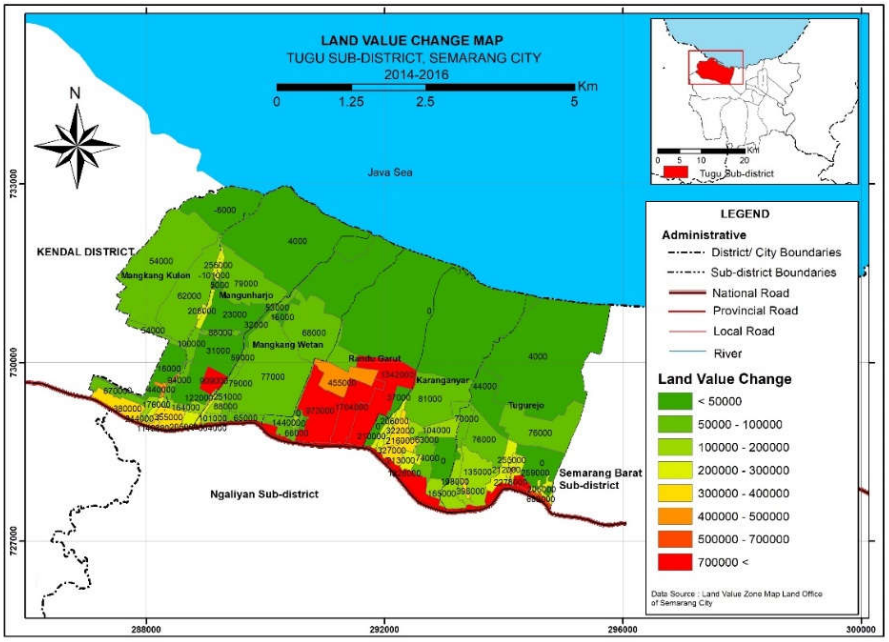

Figure 5. Land Value Change Map in 2014 – 2016

In this study, a mapping of land value changes in 2014-2016, 2016-2018, and 2018-2019 periods were carried out. Data analysis to determine changes in land values over time was carried out through an overlay (join intersection) of the ZNT maps. The results of land value/price change mapping are presented in Figure 5.

Figure 5 shows that a very high increase in land prices occurred in the area along the main road/Jalan Pantura. Besides, a high increase also occurred in the middle area. A very significant price change in the central part, the Randu Garut Sub-district, is influenced by the development and expansion of the industry of PT Putra Wijaya Kusuma Sakti as a subsidiary of the State-Owned Enterprise (BUMN) PT Wijaya Kusuma. This company is engaged in property, general trade, and services (PWS 2019). The location of this industry is very strategic because it has a complete transportation route that can be accessed by a road trip (close to the Pantura route and the Semarang-Batang Toll Road), by sea through Tanjung Mas Port, and by air travel as it is very close to Ahmad Yani International Airport. In addition to land in industrial development areas and land located around the Pantura route, the price increase in the middle zone occurred in 2014 - 2016, while price stagnation occurred for two years in coastal areas affected by the tidal flood disaster.

Based on the results of the ZNT map analysis in 2016-2018, the increase in land prices has almost spread to all regions, although the increase in the area close to the north coast is much lower than the increase in the central zone. During the two years, the highest price increase was in land located close to the main route/Pantura route. A significant increase occurred around industrial areas, namely in Tugurejo and Karanganyar sub-districts. The domino effect of the development of the industrial area of PT Putra Wijaya Kusuma had a positive impact on the increase in land prices around it.

From Figure 6, the change in land values in 2018 - 2019, the highest increase in land price still occurred in the land around the main road. Land value increases also still occurred in Tugurejo Sub-district that is quite close to industrial areas. The proliferation of housing developments to meet the needs of settlements and the strategic location of Tugurejo sub-district has resulted in the high demand for land in this suc-district.

Data related to changes in land value periodically from 2014 to 2016, 2016 to 2018 and from 2018 to 2019 are presented as shown in Figure 8.

Based on the analysis of changes in temporal value of land as depicted in Figure 8, it can be explained that the zone of the study area is divided into four categories: zone 1 is the location of land near the main road/Jalan Pantura; zone 2 is the middle zone which is close to zone 1 and is not affected by tidal flooding; zone 3 is the middle zone close to zone 4 that is slightly affected by the tidal flooding; and zone 4 is the area most affected by tidal flooding and is located close to the coastline. Figure 8 shows a very high increase in land prices in the study area between 2014 and 2016, especially in zone 1 that is on the edge of Jalan Pantura.

Figure 9 shows that the land area in zone 4 where the price decline/is stagnant/price increase is very low has the largest area (48% to 1.351,74 Ha). This condition shows that the impact of stagnation or decrease in land value has implications for the majority of society/an even wider negative impact. Meanwhile, the relatively high increase in land value only affects a small portion of community land in zone 1 because it is influenced by the accessibility of the national road (Semarang - Batang) and locations that are not exposed to tidal flooding.

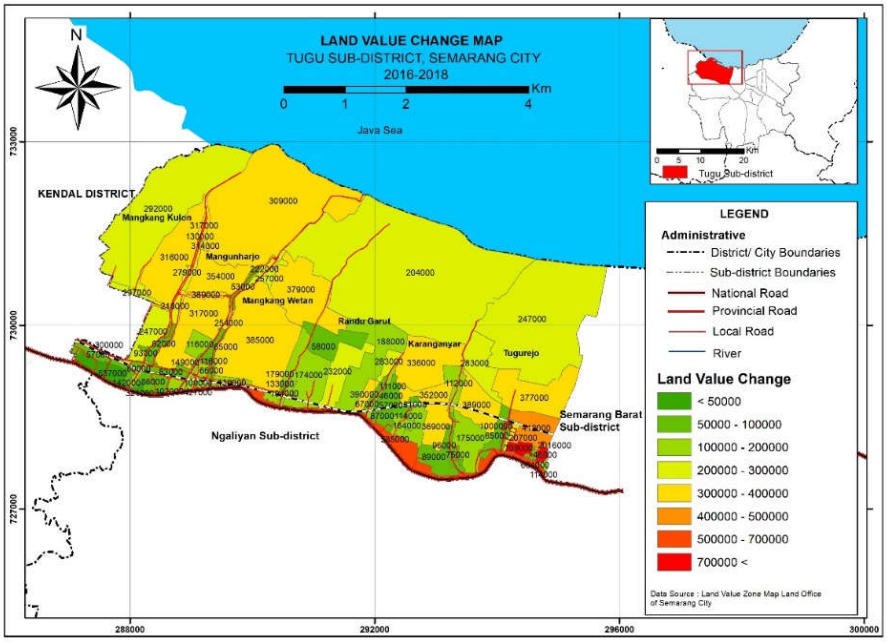

Figure 6. Land Value Change Map in 2016 - 2018

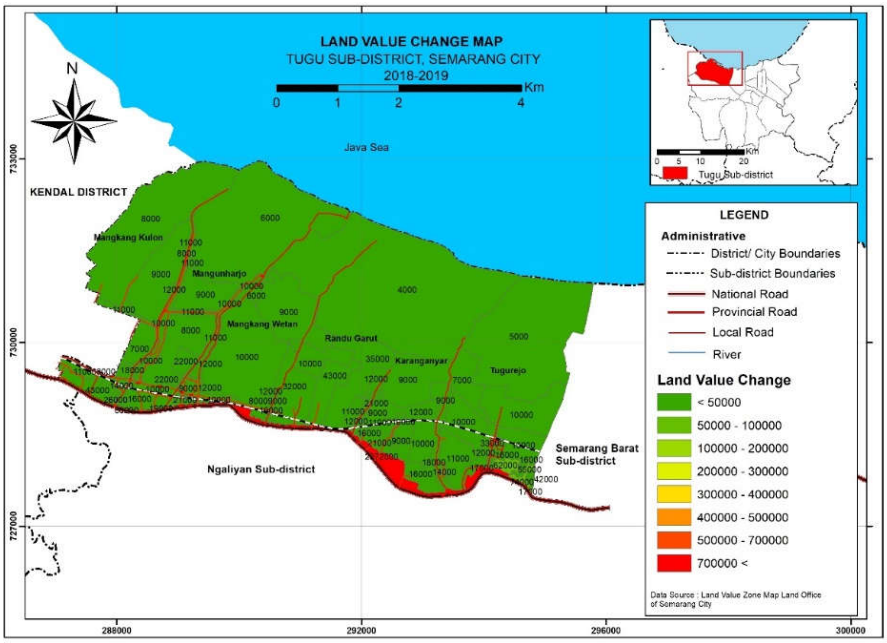

Figure 7. Land Value Change Map in 2018 - 2019

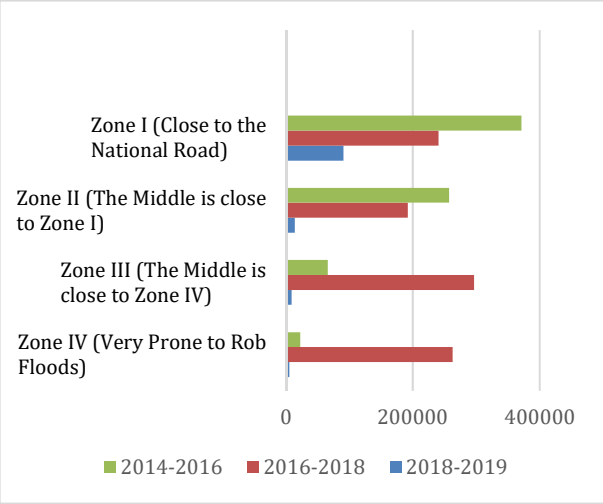

Figure 8. Graph of Periodic Changes in Land Value from 2014 to 2019

The percentage of land value area by zones in this study can be presented as shown in Figure 9 below.

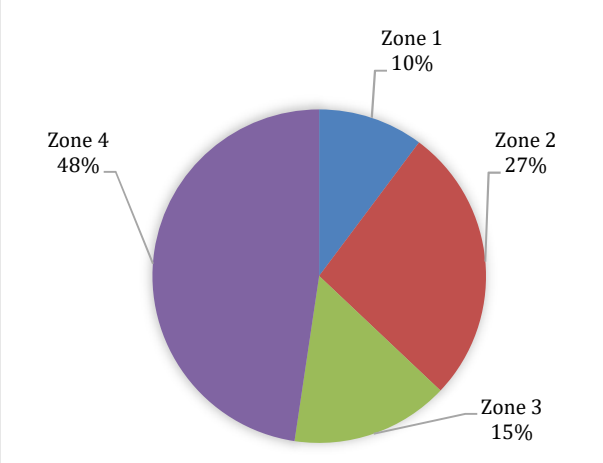

Figure 9. Percentage of Areas by Zones

Based on this study conducted using a spatial analysis approach through three variables and an analysis through a multitemporal study of ZNT maps, it shows that negative accessibility, especially disasters, in this case tidal flooding, has a significant impact on price stagnation/land value decline. The results of this study strengthen several concepts and theories as proposed by Utomo et al.'s (2017), Ismail et al.'s (2016), Saptutyningsih's (2011) and Tanaka's (2014) studies that emphasize that for areas that are prone to disasters, the disaster variable needs to be included in one of the main variables for conducting land assessments.

4. Conclusion

Tidal flooding has a negative impact on various aspects of community life on the north coast, one of which is the decline or stagnation of land values. Changes in land use from rice fields to embankments due to the expansion of tidal flood inundation induce to a decrease in land values. Changes in land values indicated through the analysis of the temporal ZNT maps divided into four zones indicate that zone 1 which is in a strategic location close to the northern coastline/national road has an increase in prices 13 times more than zone 4 in tidal flood-prone areas. The spatial analysis based on three variables (land use, road accessibility, and vulnerability to tidal flooding) and multitemporal analysis through the ZNT maps show that tidal flooding that periodically occur in the study area, covering community land up to 48% or 1.351.74 Ha, significantly results in low land value, land price stagnation, and even a decrease in land value. The status of community lands that are inundated and have transformed into sea will change to lost/annihilated land. The high decline/stagnation in prices and the loss of community land are of course a burden for the north coastal communities. The study of the calculation of land values using various variables carried out on area basis should be carried out so that the land assessment is more detailed and accurate.

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