The Impact of Rising Sea Levels on Historical Sites Old City Semarang

Kirana Anindita Parama Putri[1*], *Hayati Sari* Hasibuan[1], and *Rudy Parluhutan* Tambunan[1]

[1]Universitas Indonesia, Sekolah Ilmu Lingkungan, Jakarta Pusat, Indonesia

Abstract. The phenomenon of climate change causes cities in coastal areas to be threatened by rising sea levels. Semarang is one of the coastal cities in Indonesia which is threatened by sea level rise. One of the consequences is tidal flooding in coastal areas of Semarang. Semarang as an old city has a cultural heritage area with historic buildings. The purpose of this paper is to analyze the current condition of the Semarang Old City National Cultural Heritage Area and the impact experienced by the tidal flood. The method used in this research is to conduct a literature study and field observations which are analyzed by spatial analysis of buildings in historical areas and descriptive analysis. This study shows that tidal flooding is a threat to cultural heritage buildings. The condition of the land in the city of Semarang, which is decreasing due to land subsidence and rising sea levels, has made the potential for damage to buildings in the old city area even greater.

1 Page layout

Tidal floods are floods caused by the tidal process of seawater inundating a coastal area that is lower than the average sea level [1]. Tidal flooding is a phenomenon that often occurs in coastal areas characterized by local sea-level rise and global impacts [2]. In Indonesia, one of the coastal cities that is affected by rising sea levels is Semarang. The occurrence of flooding due to sea-level rise in Semarang City is partly due to land subsidence, as happened in the plains around the Port of Tanjung Mas, which per year has decreased by approximately 6, 5 cm [3].

The preservation of cultural heritage buildings in the Old City of Semarang is important because cultural heritage is important evidence of the history of the development of the Indonesian nation. Preservation can be carried out using protection, development and utilization of cultural heritage on land and water, which can be used for recreation, education, appreciation and/or appreciation [4]. The government has stipulated regulations regarding cultural heritage in Law no. 11/2010 concerning cultural heritage. The law states that the government and local communities are responsible for caring for cultural heritage buildings, but the reality on the ground is not yet going well [5].

The Old City of Semarang is one proof of the history of the Indonesian nation's journey. Therefore, it is important to preserve Indonesia's historical heritage. A lot of research has been done on this old city located in Semarang. One of those who researched in the Old

* Corresponding author: kirana.anindita01@ui.ac.id

City of Semarang was Murtomo (2008), Krisprantono (2009), Sari, Harani, and Wibowo (2018) saw the Old City of Semarang typology as an old city from the Dutch heritage of buildings and city forms [6–8]. In addition, there is also research conducted by Panggabean (2014), which states that the government and local communities are responsible for caring for cultural heritage buildings. However, the reality on the ground has not gone well because there is still a lot of waste out of place [5]. Factors that cause damage to cultural heritage objects can occur as a result of human or natural actions. Based on Syamsurizal et al. (2019), the sea level rise that occurs on the coast of Semarang is getting higher and has the potential to inundate the old city area [2]. The book reports on cultural heritage buildings in the Old City of Semarang compiled by the Central Java BPCB also said that one of the threats to cultural heritage buildings is tidal flooding. Therefore, this journal aims to analyze the Semarang Old City National Cultural Heritage Area and the impacts experienced due to tidal flooding.

1.1 Old City of Semarang

Based on its administrative location, the Old City of Semarang area covers the areas of Tanjung Mas Village, North Semarang District and Purwodinatan Village, Central Semarang District. Based on statements from historians, the Old City of Semarang area is a Dutch residential area. However, in its development, areas outside the city centre are more developed than the city centre, which results in a shift in the function of the city, which previously had a vital function as the city centre, becomes neglected and unproductive. The Old City of Semarang, originally a stronghold, slowly disappeared with the destruction of the fort walls that surrounded the city [7].

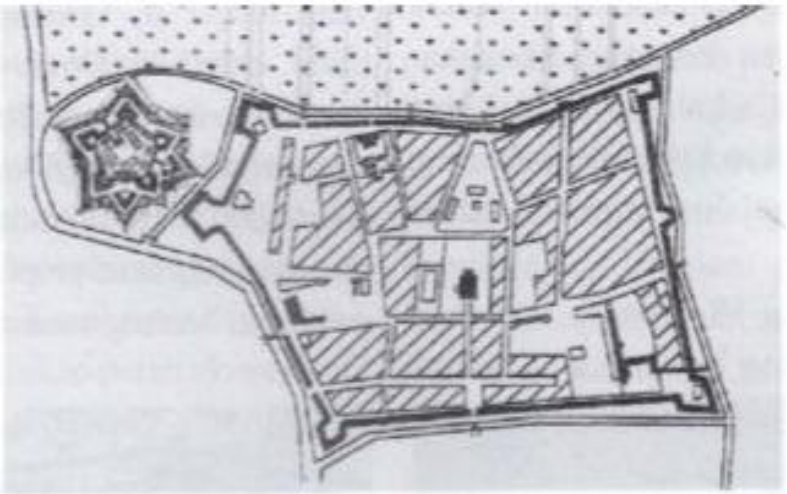

Fig. 1. Map of the Old City of Semarang in the Dutch era. Source: Krisprantono (2009).

According to Murtomo (2008), the Old City of Semarang is radial in shape so that the main roads are the roads leading to the city centre [6]. This can be seen from the placement of Blenduk Church as the centre of the old city. In addition, the main function of the Old City of Semarang in the past was for defence, so the shape of the old city area was a polygon. For defence, the polygon shape was deemed suitable to protect the city inside the fortress layer [7, 9]. This can be seen in Figure 1, where the part surrounded by a thick line is shaped like a polygon that surrounds it. The thick lines are the walls that protect the Old City of Semarang.

Meanwhile, in the northwestern part of the old town area, it is estimated that the location of the fort De Vijfhoek, a fort built during the Dutch colonial period. One of the characteristics of colonial buildings in the Old City of Semarang is classical Roman ornaments. In addition, the size of the buildings is relatively the same so that the lined buildings look neat. Another characteristic found in colonial cities was the use of tall monuments/buildings as the city's key points. Based on Sari, Harani, and Wibowo (2018), the Old City of Semarang area was designed in a European style, both structurally and aesthetically; has a centralized pattern with government buildings and Blenduk Church as its centre; the design style of the city is the same as in Europe, while the character and uniqueness of the architecture can be seen in the details of the buildings, ornaments, and decorative elements in the buildings; even though it has a European architectural style, it still presents architectural diversity in Central Java and its surroundings, and in turn, enriches the country's architectural wealth [9].

1.2 Sea Level Rise

Sea level rise is one of the consequences of climate change due to anomalous increases in global temperature of around 1ºC. The global average sea level has increased by about 20 cm since the end of the 19th century [10], both for the community, built areas, and the environment, which causes sea level also to change when there is an exchange of mass between the reservoir, ice or the terrestrial atmosphere and the ocean [11]. Several global sea-level rises (GMSL) studies using satellite altimetry data show that the rate of sea-level rise has reached 3.4 mm / year since 1993 [12]. Climate change in coastal areas such as sea-level rise, increased incidence and intensity of storms and tides is a major concern. It results in coastal erosion, flooding, saltwater intrusion, and inundation, impacting critical infrastructure, physical property production processes and wetland services [13]. This also happens in Indonesia, especially in coastal cities in Indonesia such as Jakarta. Jakarta is slowly losing its land and on the northern coast of northern Java and several areas in West Kalimantan due to rising sea levels [14]. Tidal flooding itself is a phenomenon that often occurs in coastal areas characterized by rising local sea levels and due to global impacts [2]. According to WWF Indonesia and IPCC (1999), the sea level in Indonesia is predicted to increase from 20 cm to 100 cm in 100 years due to an increase in seawater temperature from 1.30 C to 4.60 C in 2100.

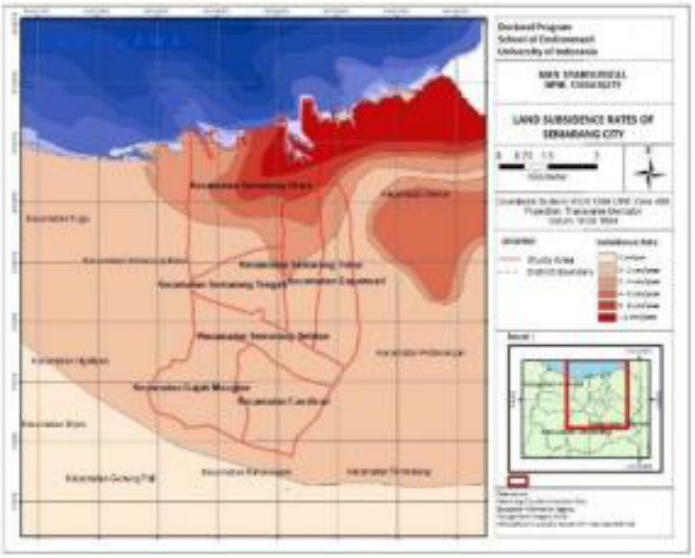

Fig. 2. Land subsidence map in Semarang.

Semarang City is a coastal city with high vulnerability, especially from tidal flooding due to sea-level rise and land subsidence [2]. Semarang is a populated urban area in a low relief area that is prone to periodic coastal flooding. The topography of the flood-prone area of Semarang has been degraded under the imaginable Sea Level Rise due to subsidence which makes the impact of coastal flooding there worse [15]. Based on research conducted by Syamsurizal et al. (2019), the land level in the Semarang area is getting lower. This can be seen from Figure 2, where it can be seen that the northern part of Semarang is getting lower and lower over time. With the lower land surface in the Semarang area, the water level inundates the Semarang coast is also getting further away. Based on the calculations that have been carried out, the SLR trend in the tide gauge records from 1997 to 2015, with a rate of about 4.4 mm / year [15], so that the water is increasing over time covering the plains of the northern area of Semarang.

2 Method

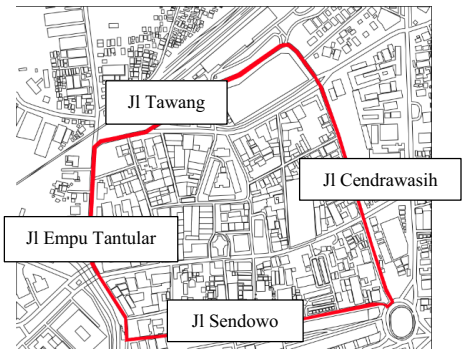

Fig. 3. Illustration Map of the Old City of Semarang in the Dutch era.

Based on Based on the Decree of the Minister of Education and Culture of the Republic of Indonesia Number 682 / P / 2020 concerning the Cultural Heritage Area of Old Semarang

City as a National Rank Cultural Heritage Area, states that the Old City of Semarang consists of four sites, namely Kauman Village, Kampung Melayu, Chinatown, and Oudestad. The place where the research was carried out was on the Oudestad site. The area of the Oudestad site is approximately 27 hectares. The boundaries of this area are within the city fort that was built during the Dutch colonial government when the Dutch expanded the residential area out of the city fortress. Jl surrounds the old town area (the site of Oudestad). Westerwalstraat and Parkhuisstraat (now Jl. Mpu Tantular) to the west, Noorderwalstraat (now Jl. Tawang) to the north, Oosterwalstraat (now Jl. Cendrawasih) to the east, and Ziderwalstraat (now Jl. Sendowo) to the south [7], like in (Fig. 3) had shown.

The method used in this research is to conduct literature studies and field observations which are analyzed with spatial analysis of buildings in the historical area and descriptive analysis. Spatial analysis is used to identify the condition of the Semarang Old City Cultural Heritage Area by zoning and observing existing land use. Field observations were carried out on 18-20 December 2020. Observations were made by walking around the outer roads by car and walking along small streets. Observations were made to see the original conditions at the Oudestad site and to see the site from a visitor's point of view. Things that can be seen are the conditions of the buildings and the environment at the Oudestad site. Descriptive analysis is data analysis by describing or describing the collected data without making any general conclusions [16]. In this research, descriptive analysis, accompanied by literature studies, is used to determine how optimal the existing activities in the Old City of Semarang and community activities as users of buildings in the cultural heritage area are. The literature study collected articles related to the sea level rise and the Old City of Semarang. In addition, the literature study also uses data related to cultural heritage buildings on the site made by the Central Java BPCB. The existing regulations are also a source of data for this article. The data that has been collected will be processed using descriptive analysis.

3 Result

Data collection on cultural heritage buildings in the Old City of Semarang has been ongoing since 2016. Existing buildings in the Old City of Semarang were recorded based on their original conditions in the year of the data collection. Data collection lasts until 2020. Data collection is carried out by the Ministry of Education and Culture in collaboration with the Central Java BPCB.

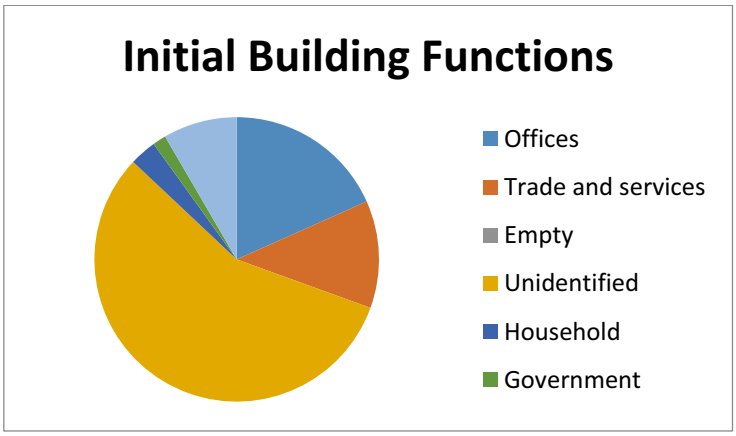

Fig. 4. Initial Building Functions Diagram.

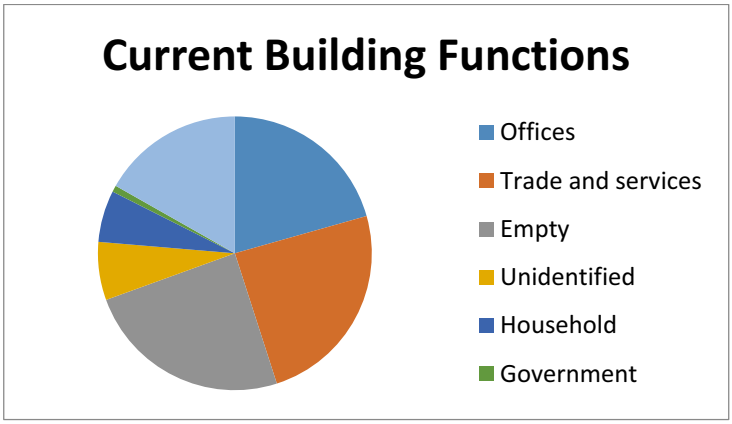

Fig. 5. Current Building Functions Diagram.

In the data obtained, most of the buildings were not identified in their previous function, as shown in Figure 4, followed by offices and trade and service buildings. However, from 2016 to 2020, it can be seen that a quarter of the buildings are empty, and the other quarter are trade and service buildings, as seen in Figure 5. Other functions in the diagram show other functions such as warehouses and building mix that are used.

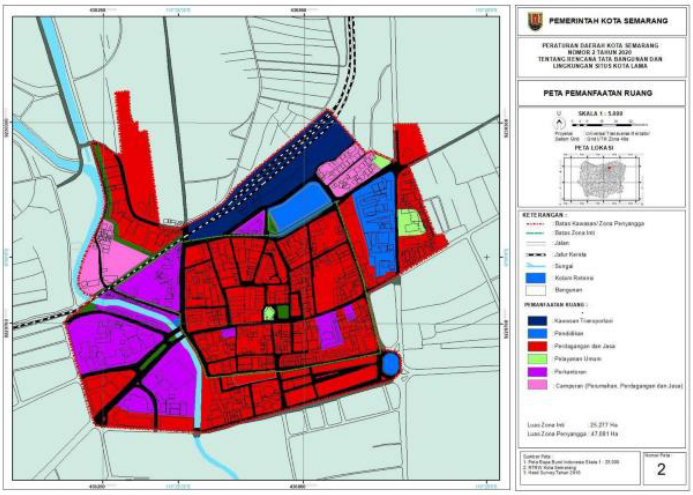

Fig. 6. Land Use Map (source: Peraturan Daerah Kota Semarang 2020).

In the planning in the Semarang City Regional Regulation in 2020, the planned use of space is as shown in Figure 6. As shown in Figure 6, most of the Oudestad site area is devoted to trade and services in the centre and the south. In the western part, part of the area is earmarked for housing. In the north and east, the designation is more diverse. In the northern part, the purpose is for transportation, offices, and mixed buildings. The northern part also has several places that function as trade and services. In the eastern part, it is devoted to education, mixed building, and trade and services.

When compared between Figure 5 and Figure 6, the red zone in Figure 5 is an area where empty buildings and buildings for trade and services are located. On the site of Oudestaad itself, Bleduk Church is the centre of the site and a landmark. The church is also still functioning as a place of worship for Christians. Around the church, the buildings have

a function as a place to trade and sell services. However, among the buildings that have been restored and are conserved, there are still buildings that are still empty because they are already badly damaged and/or not conserved.

Based on the results of data collection conducted by the Ministry of Education and Culture in collaboration with the Central Java BPCB, cultural heritage buildings in the Old City of Semarang have two threats, namely natural threats and human threats. Natural threats can be in the form of tidal flooding and land subsidence, while artificial threats can take the form of vandalism. As shown in Figure 3, the ground level in Semarang is decreasing. The Old City of Semarang is also an area affected by land subsidence. The lower ground level can cause the reach of tidal flooding to expand. Humidity can affect old building materials in the old city.

Tidal flooding can affect the condition of cultural heritage buildings because when water hits and submerges the building, tidal flood water may contain salt from seawater. In addition, the length of time the building is submerged until the water shrinks can cause the building materials to become damp and accelerate weathering and wall erosion. If a cultural heritage building ends up inundated due to higher sea levels, one way to "save" the building is to leave it inundated forever. This aims to reduce the risk of the building structure being destroyed quickly due to too much humidity. Based on the exposure of the informants, several structures are classified as cultural heritage buildings that are left submerged in water because they are considered impossible to save in dry conditions. These structures are quite common near the Tanjung Mas port area.

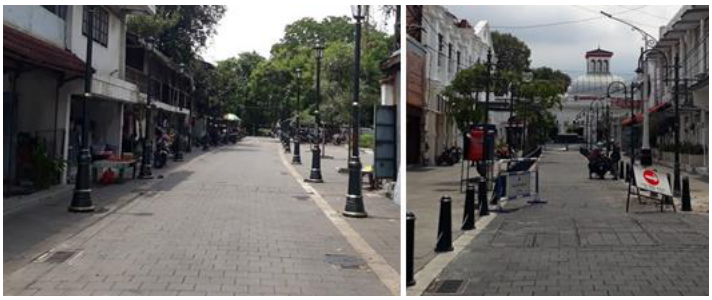

Fig. 7. Streets in the Old City of Semarang.

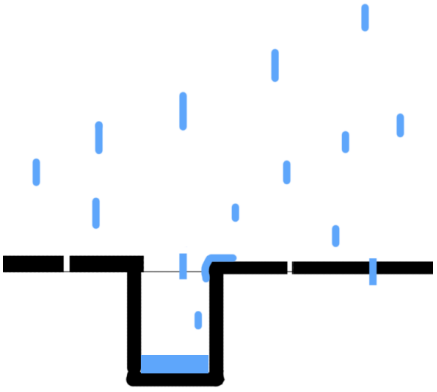

Fig. 8. Waterway illustration.

The streets in the old town area are all covered with paving blocks, as shown in (Fig. 7). This is done so that when it rains or when puddles occur, it can enter between blocks, soak into the ground, then the water is immediately flowed into the sea, like which is in (Fig. 8).

In addition, the drain hole is about two meters from one hole to the other. The water entering the hole will later enter the water channel and be discharged directly into the sea. In addition to the roads covered with paving blocks, on the roads of the Oudestaad site, there are water channel holes one meter from one hole to another.

Apart from installing paving blocks and making a water discharge hole for about two meters to make it easier for water to flow, other efforts are being made to clean the river west of the old city. The western part of the old city is directly adjacent to the East Flood Canal. Therefore, the local government cleared the East Flood Canal, which in 2010 was still filled with garbage so that the river water flow could run smoothly into the sea.

4 Conclusion

The existence of climate change makes sea levels rise. This makes cities in coastal areas threatened with inundation. One of the cities that is threatened by sea-level rise is Semarang, Central Java, Indonesia. Apart from rising sea levels, the city of Semarang is also experiencing land subsidence, which causes the land surface in Semarang to decline. With land subsidence and sea-level rise, the potential for inundation that occurs due to tidal flooding will be longer. This can affect the surrounding environment, especially historical buildings in the Old City of Semarang area.

The tidal flood that occurred on the coast of Semarang affected the condition of the cultural heritage area of the Old City of Semarang. The condition of the land in the city of Semarang, which is decreasing due to land subsidence and rising sea levels, has made the potential for damage to buildings in the old city area even greater. Therefore, the local government and the Central Java BPCB are trying to protect the old city area by cleaning waterways and rivers and making the water have plenty of space to flow by making roads around the old town using paving blocks.

References

1. M. A. Marfai, *Banjir Pesisir: Kajian Dinamika Pesisir Semarang*, (Gadjah Mada University Press Yogyakarta, 2014)
2. I. Syamsurizal, M. P. Patria, R. H. S. Koestoer, D. Harmantyo, *A Conceptual Model for Semarang City Sustainability*, ICESSD (2019)
3. S. I. Wahyudi, *Perbandingan Penanganan Banjir Rob Di La Briere (Prancis), Rotterdam (Belanda) Dan Perspektif Di Semarang (Indonesia)*, J. Riptek, **4**(2), 29–35 (2010)
4. D. G. Satrya, A. T. L. Indrianto, *CSR Untuk Cagar Budaya Surabaya*, J. Ilm. Pariwisata-STP Trisakti, **21**(1), (2016)
5. S. A. Panggabean, *Perubahan Fungsi dan Struktur Bangunan Cagar Budaya Kota Semarang Ditinjau dari Perspektif Undang-Undang Nomor 11 Tahun 2010 Abstrak*, Unnes Law J., **3**(2), 24–34 (2014)
6. B. Murtomo, *Arsitektur Kolonial Kota Lama Semarang*, J. Ilm. Peranc. Kota dan Permukim., **7**(2), 69–79 (2008)
7. Krisprantono, *Mencari jejak benteng 'De Vijfhoek' di kota lama semarang melalui pendekatan sejarah*, Amerta J. Penelit. dan Pengemb. Arkeol., 44–60 (2009)
8. S. R. Sari, A. R. Harani, H. Werdiningsih, *Pelestarian Dan Pengembangan Kawasan Kota Lama Sebagai Landasan Budaya Kota Semarang*, Modul, **17**(1), 49 (2017)
9. S. R. Sari, A. R. Harani, S. A. Wibowo, *The role of GeMaSPeKoLa in supporting the*

preservation of Semarang Old Town, Int. Rev. Spat. Plan. Sustain. Dev., **6**(4), 51–61 (2018)

10. C. Antunes, C. Rocha, C. Catita, *Coastal flood assessment due to sea level rise and extreme storm events: A case study of the atlantic coast of Portugal's mainland*, Geosci., **9**(5), 6–8 (2019)
11. I. Akbar, H. W. Poerbo, W. K. Soedarsono, *Adaptive Urban Design Principles for Land Subsidence and Sea Level Rise in Coastal Area of Tambak Lorok, Semarang*, IOP Conf. Ser. Earth Environ. Sci., **273**(1), (2019)
12. L. A. Karondia, E. Y. Handoko, H. Hapsari, *3D modelling analysis of sea-level rise impact in Semarang, Indonesia*, IOP Conf. Ser. Earth Environ. Sci., **389**(1), (2019)
13. S. Ehsan, R. A. Begum, N. G. M. Nor, and K. N. A. Maulud, *Current and potential impacts of sea level rise in the coastal areas of Malaysia*, IOP Conf. Ser. Earth Environ. Sci., **228**(1), (2019)
14. BBC Indonesia, (2020), *Pesisir Indonesia tenggelam: 'Ini bukan bencana alam, ini bencana buatan manusia*, Retrieved from: https://www.youtube.com/watch?v=jCRTFwd1O10
15. A. M. Irawan *et al.*, *Comparison between averaged and localised subsidence measurements for coastal floods projection in 2050 Semarang, Indonesia*, Urban Clim., **35**, 100760 (2021)
16. Sugiyono, *Metode Penelitian Kuantitatif Kualitatif dan R&D*, 4th ed. (Alfabet Bandung, 2008)