Measuring land subsidence of buildings in Semarang Chinatown

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Abstract. There are not many studies that discuss land subsidence and try to measure it in historic areas. This paper will take an inventory of historical areas that have existed since the early growth of cities such as Semarang Chinatown, which has existed since the 17th century. This paper is part of the results of research on land subsidence in coastal cities in Java, which have left many historical areas. Semarang City is one of the case studies because it has a high land subsidence rate of around 20 cm/year in the North Semarang area. Indeed, this area in the past was an ocean. However, due to sedimentation, on the old 1700s map, this area has become a marsh. After becoming mainland, several historical areas stood on young alluvial land. The purpose of this paper is to make an inventory of old buildings in the historic area of Chinatown. On the map from 1695 to now, after 305 years, the area has experienced land subsidence, which can be seen visually in several buildings. The research method used old photos, old maps, and field surveys by taking samples of several old residences that still exist. To strengthen the data, the use of Google street view is very helpful in seeing conditions in the field. The recommendation of this research is to provide directions for an inventory of the list of buildings that need to be conserved due to the hazard of subsidence, which is currently not being felt by the local community.

1. Introduction

In the framework of structuring and preserving the Heritage City of Semarang, the potential and existing problems can examine as a real effort to conserve historic areas in the Heritage City of Semarang. Some of the potencies and problems of Semarang City are part of the National Activity Center (NAC) transported on an international scale. Then, some of these heritage assets are now in the downtown area. The strategic value of the city center makes historical areas and old buildings prone to conversion. Besides, poor management and maintenance have the potential to reduce the historical value of heritage. The government has conducted some conservation. However, some things have not been addressed, namely because the historical area is in an area prone to natural disasters (tidal flooding, flood, land subsidence) [1].

The historic area of Semarang, which is now in the center of the city, used to be a small area with a city structure consisting of Javanese villages, Malay villages, colonial fortresses, and Chinatowns. In the 19th century, the Chinatown area became a Trade Center. Since then, Javanese settlements
around Kauman and Chinatown have developed into villages whose residents produce various products for trade in Kauman and Chinatown.

Chinatown area is a case study as a heritage city that requires identification of environmental conditions considering that the area often experiences tidal disasters. The tidal symptom indicates that the condition of the area is below sea level. Based on its history, this area was in a swampy area. Given the existing geographical conditions, and the role of Semarang River as a transportation route, it makes sense for residents to build settlements around the place. A map of 1695 shows the existence of settlements of immigrants and settlers from China forced to move from Simongan to a site that is still open land, covered by rivers. For protection and defense, a wooden fort was built in the current location, Beteng Street. Since then, a closed Chinatown area has been formed for a long time. Semarang River, at the time of closure of the area, automatically becomes a "wall" of strict separation (natural elements as a firm defense) from the area outside that can be as a threat. The condition of the location that is on swampland and an area that is nearly 300 centuries old cause changes in environmental conditions. As a result of tidal flooding, road and house elevation or construction of gutters blocking the entry of water at the house entrance were carried out. This phenomenon is temporarily interpreted by the local community as a phenomenon of road hikes to avoid the area from tidal disasters. However, this paper will uncover tidal symptoms to measure how deep the building subsidence is in the Chinatown area. This paper discusses the existence of land subsidence in Chinatown Semarang, besides that there is no research that discusses landsubsidence in Chinatown using old maps as a research method to compare the height of old buildings with buildings with current conditions.

2. Methodology

A literature study is a step to obtain the history of architecture, the Chinatown area in the historical context of the city of Semarang, and a preliminary study in the problem of building subsidence. The concept or theory of urban design and architectural theory are theories that are indispensable in research. The primary data is city designs in the past and the condition of buildings in the past obtained through archives, manuscripts, photos, and old maps. The stages of data collection include field data collection to confirm the height of the building in the past which will compare with current conditions. Through observation and measurement (if necessary) of the building and the height of the road/environment, the amount of land subsidence will be known. Interviews were also conducted with community leaders and owners of old houses. Private collection photos of the owner of the house and old photos of the house by kitlv and area are tools to reveal the magnitude of land subsidence. Google street view also helps with field observational research. All data collected through various approaches will then be measured the difference in elevation and the difference from past and present land elevations.

3. Results and discussion

Land subsidence in Semarang City in some areas has reached 8 cm every year [2]. The area that is experiencing subsidence is in Semarang City in the northern area, in which the soil consists of young alluvium rocks. This is following the historical development of Semarang City, which is in the past; Semarang was a cluster of islands. The land that is now formed is the result of sedimentation and unites several of these island clusters. Also, the result of excessive groundwater extraction is another dominant factor causing land subsidence, followed by natural soil compression and loading, both in the form of buildings and dredging. The land subsidence in Semarang City is different than that of Jakarta City. Alluvium rocks in the north Semarang area are only hundreds of years old, so they are not yet ripe and continue to experience compaction compression. This is different from alluvium rocks in Jakarta, which are 4500 years old. Alluvium rocks or deposits are composed of sand, gravel, loam, and silt. Most of them are scattered in northern Semarang, where there are many river estuaries. The rivers carry silt continuously to form new land.
For example, the coastline at the mouth of the West Flood Canal in the last 93 years has advanced 581 m or an average of 7.32 m each year. The most severe subsidence of more than 8 cm each year occurs in Tanjung Mas to the east to the coast in Demak District. Then, there are Bandarharjo area and its surroundings (6-8cm) every year, Tanah Mas, Tawang Station, Karang Tengah (4-6 cm) every year, and Marina, Tawang Mas (2-4 cm) every year. Land subsidence is a natural process to achieve a good balance caused by natural factors and changes caused by human activities. Alluvium rocks before they become ripe soil layers will continue to experience compaction naturally [2]. Land subsidence is a serious problem, even detrimental to the community when areas that have subsided land are occupied or used for human activities. Human activities worsen land subsidence and add to new problems such as the threat of tidal flooding. Landfilling to raise buildings in areas of subsidence exacerbates land subsidence.

Semarang is one of the old cities in Indonesia, not less than 464 years old. Semarang City, a city that has undergone developmental periods from a traditional, a colonial, and a modern city, shows specific characteristics, especially in the development of urban settlements or urban villages. Based on the historical development of Semarang City, Semarang has many old villages, which are the embryos of urban development along the Semarang river (see figure 1). The old villages in Semarang include Chinatown, Malay Village, Kauman Village, Batik Village, Kulitan Village, Geni Village, and so [3]. This research focuses on the study of the character of the form of shops on Layur Street in Melayu Village and Chinatown Village in Semarang. Ethnic villages such as Chinatown are traditional villages. Although they have developed in various social, economic, political, and cultural fields, Melayu Village and Chinatown Village have maintained their existence in society. In this old Chinatown village, currently not only certain ethnic groups live, but other ethnic groups have also lived for a long time, mingling and interacting harmoniously. The existence of Chinatown Village which has survived until now is an interesting study to find out the history of the economic development of the Chinatown community in Semarang during the colonial period of the 1900s until the revolution. Another thing related to the old Chinatown Village is not only from the economic aspect but also the socio-cultural aspect of the community [4]. Figure 1 describes the development of Chinatown Village in its early formation until 1892. At that time, the Dutch Colonial Fort and Chinatown were still on the east side of the river [5]. In its development, this semi-permanent fort became the western boundary of the Semarang Chinatown in the early period [6]. The Chinatown community has contributed greatly to the development of the Indonesian economy. As immigrants, the Chinatown community can survive in overseas areas. By assimilating the indigenous people, this harmony has formed a very unique and diverse culture, which contributes to our national culture [7].

As an area that was once the center of trade and services for Chinese people in the past, Semarang Chinatown has very strong economic, social, and cultural potential. At that time, the products traded in Chinatown were the products of the natives, such as pepper [8]. This area also relies on three things, namely roads, rivers, and places of worship (pagoda) [9]. This area has been confirmed by the Semarang city government to include in the list of revitalization areas through the Mayor's Decree No. 650/157 dated June 28, 2005, regulating the Revitalization of the Chinatown area, as well as a center for Chinese cultural tourism in Semarang [10,11]. Even the pattern of Semarang city cannot be analyzed properly without paying attention to the development of Chinatown [12].
3.1. Chinatown area

A Brief history of the Semarang Chinatown Area is an area that has played a role in the formation of Semarang City today. Based on the history of the development of Semarang City, the Semarang Chinatown area is a settlement in the colonial era, which is the embryo of the city's development [13]. As one of the areas in Semarang City that have existed since the early 17th century, Chinatown has a long history. The following is a brief history of Semarang Chinatown.

Early Period of Semarang Chinatown (Early 15th century): The formation of Chinatown in Semarang began with the arrival of the Chinese community in the early 15th century. At the beginning of their arrival, the Chinese community chose to settle in Gedong Batu because it was considered a strategic location. The Gedong Batu area or also known as Simongan is at the mouth of the Semarang River and Bandar Semarang. According to feng shui or hong shui, this area is considered ideal because it is close to a water source and surrounded by hills [13]. Figure 2 describes the conditions of the Chinatown settlement during the Dutch colonial period. In the figure, many houses and shops have pointed roofs that are characteristic of these settlements. The character of the area is the result of a combination of Chinese architectural characters mixed with Malay architecture. The building façade in the Chinatown area is determined by the shape and color of the building [14,15]. The structure and meaning of space in the Semarang Chinatown settlement are formed from the socio-cultural character that develops and exists in this settlement. This settlement in Simongan was formed by several important factors. The first is the existence of the Sam Poo Kong Temple as a place of worship. Second, as previously stated, this location was chosen according to the requirements of Chinese custom (according to feng shui/hong shui) [17].

During its development, Semarang Chinatown has experienced a change of location as it is today. This was the period of isolated Chinatown (1740-1742). The transfer occurred in two different periods. This was due to several factors that influenced the migration of Chinese villages. The first move was due to the availability of land in Simongan. When Sunan Pandan Arang II moved the settlement location to the west of Semarang River due to silt deposition in Kreo River, Garang River, and Semarang River, which resulted in the loss of Semarang Bay around 1547, Chinese settlements were still around Sam Poo Kong. Then the arrival of overseas Chinese to Java Island resulted in a lack of land in the Simongan area. The old map in 1741 explains that the Chinese people moved and established new settlements with simple houses to the east of the Semarang river [18].

Based on the results of the survey conducted by the researchers, 39 objects have the potential to become Cultural Heritage, except for all temples and Widayat Basuki Darmowiyono's house because they have been designated as a Cultural Heritage. In addition, the former Balekambang, the former Bee Ing Tjoe House, the former Gedong Goelo, and the Rasa Dharma Building are currently new buildings so that they cannot be designated as a Cultural Heritage. The cultural heritage potential is scattered in the Chinatown area, which consists of four villages, namely: Kranggan, Purwodinatan, Gabahan, and Kauman. The four villages are in one sub-district, Central Semarang.
3.1.1. *Current conditions in Chinatown.*

In the mid-1980s, Chinatown's position as a trading center attempted to be integrated with other economic centers. Along the main street of Semarang's Chinatown, there are banks, offices, night clubs, shops, shopping centers, cinemas, and so on. These new buildings often took the footprint of several shophouses and were dominated by glass. Meanwhile, shop names that previously used Chinese names were prohibited and replaced with Indonesian or English names with capital letters. In the same year, to solve the problem of flooding, the Semarang city government normalized Semarang River by dredging, widening, and constructing a pair of inspection roads along the river. This project knocked down many old buildings in the Chinatown area of Semarang. In Gang Warung, there were 24 shophouses with their backs to the Semarang river, and 19 shophouses are planned to demolish. After lengthy negotiations, 24 houses were not destroyed but cut down several meters [19].

In addition, there was an incident of land subsidence in Chinatown. Mr. Alwin knows this phenomenon. He used to be a community who once lived in Chinatown, but now he lives in Amsterdam. During a visit to Semarang along with a research team from Netherland on February 15th, 2020, he said that when he was little, his father was a photographer. At that time, his house was in Gang Warung No. 55. Then he showed the photo evidence of his house (see figure 3). He also said that there had been changes. He showed photo evidence of the front of his house in the past and its present condition. Besides, there are changes to the building floor. The floor is not the floor it used to be. To avoid tidal flooding, the old floor was about 20 cm below the current floor level. This discussion was held at the Banaran restaurant on February 15th, 2020, with Crista Nooy, Nila Ardiani from Amarta Institute, husband of Nila Ardiani, journalist, Alwin, and researchers.

In addition, several old buildings in the Chinatown area have also decreased by 50-60 cm (see figure 4 and 5). In figure 3 and 4 (right and left), there is a comparison of the stair traps that decreased due to tidal flooding that occurred. This results in a very significant subsidence of the building land that is visible to the naked eye. The drainage channel in the Chinatown area is in the ad category by a percentage of 38%. The drainage in this area is dominated by closed drainage and clogged with garbage so that water cannot flow [20].

![Figure 2. Chinatown in the past. (sources: kitlv)](image)

![Figure 3. Evidence of buildings in Chinatown showing land subsidence. (sources: kitlv)](image)
4. Conclusion
Global warming causes sea levels to rise. The results of the research by the Research and Development Center, Settlements and Regional Infrastructure show that seawater in the coastal area of Semarang has increased by 5 mm each year. If the land is inundated by tidal water, this means the land's height is lower than seawater. Chinatown areas often experience tidal flooding. This symptom indicates land subsidence in the area. From the results of visual measurements comparing old photos and current conditions, the amount of reduction varies between 20 cm–60 cm. By raising the floor of the building or making a water embankment at the entrance to the house, the community tries to secure the house from incoming tidal water. Meanwhile, the government is also making efforts to raise roads so that the area is protected from tidal flooding. The decline in buildings in the Chinatown area is a warning tool for the environment about a disaster that is not being realized because it happened slowly and was formed for a long time.

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