Climate Change Impact on the Coastal Settlement Quality and the Relation with the Attainment of Semarang Healthy City

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Abstract. Climate change affects the increase in air temperature, making the dry season hotter and the humidity decrease; the difficulty of obtaining clean water and high rainfall makes the frequency of tidal waves and floods higher. This situation is placed in Tanjun Mas, a coastal village in Semarang City. Tidal flood worsens the environmental quality of community settlements, coupled with poor water quality, high population density, and unhabitable housing, making the risk of transmission of both water-borne and vector-borne diseases surge. The situation above reflects that achieving healthy city efforts is challenging for the Semarang City government and the community because of climate change. Hence, this study reveals the impact of climate change on the settlement quality that influences the healthy city achievement. This study uses qualitative methods that rely on secondary data from the government agencies' websites and the internet. The analysis results showed that the quality of settlements in Tanjun Mas has decreased along with climate change. The community, especially the elderly and children, are also increasingly susceptible to exposure to diseases, as indicated by significant cases of diarrhea and pneumonia. Therefore, achieving a healthy city from the settlements and healthy infrastructure indicators is still not optimal.

Keywords: climate change, coastal settlements, healthy infrastructure, Tanjun Mas

1. Introduction
On 27-30 March 2022, Semarang hosted the 2022 Healthy Cities Summit, attended by government representatives of regencies and cities in Indonesia (https://kotasehat.semarangkota.go.id). A healthy city is a city that has cleanliness, safety, and a healthy environment so that the community feels comfort through several integrated arrangements and activities regulated by local government policies and mutual agreements (Joint Regulation of the Minister of Home Affairs 34 of 2005 and the Minister of Health Number 1138 of 2005). A healthy city is one of the outputs that signifies the success of sustainable urban development implementation. The assessment of healthy city categories refers to nine arrangements: settlement and public facilities and infrastructure areas, traffic order areas and
transportation service facilities, healthy mining areas, healthy industrial and office areas, healthy tourism areas, food and nutrition security, and independent community health, and healthy social life.

From 2019 until now, Semarang has received the highest award for a healthy city, *Swasti Saba Wistara*. This award means that the city is considered successful in organizing a healthy city implementation in several categories. Semarang achieved six urban development arrangements (out of nine), such as healthy tourist areas, healthy settlements, healthy social life, food and nutrition security, orderly traffic in transportation services, and an independent community. The achievement of Semarang City deserves appreciation and support, and primarily the government has committed to having several programs related to the healthy city since 2019.

Attaining the highest healthy city award requires effort and commitment from all parties. Moreover, several problems and challenges exist, burdening government efforts, especially in urban areas where the population increases and climate change occurs [1]. According to the Intergovernmental Panel on Climate Change-IPCC, the actual impacts of climate change include rising sea levels, air temperature, and rainfall, which generate floods and droughts. One area significantly affected by climate change is the coastal area [2]. Coastal residential areas deal with the threat of rising sea levels, flooding, rob, and the problem related to clean water supply [3]. The poor quality of the coastal settlement environment and air pollution have implications for the level of public health, such as the emergence of acute respiratory diseases, bronchial asthma, bronchitis, eye disease, skin irritation, lungs, cardiovascular disease, and mental illness [4][5].

Climate change significantly impacts residential areas for the poor who are not equipped with adequate clean water and sanitation infrastructure [6]. Residents of coastal areas are primarily fishermen with low economic capacity making the community more vulnerable to various diseases. The problem of poor environmental quality also occurs in the Semarang coastal area, especially Tanjung Mas Village. Floods and tidal waves frequently inundate the community settlement. Likewise, the community faces health threats such as various diseases. The location of coastal settlements close to the Tanjung Emas Port, an industrial area, and warehousing makes the level of air pollution very significant. This air pollution comes from industrial activities and heavy vehicles passing through the area. Moreover, the community settlement includes unhabitable housing, where the lack of air ventilation and high building density make air circulation less good.

The coastal settlements of Semarang City are increasingly vulnerable to natural disasters and health problems due to climate change [7]. Furthermore, the increase in population number creates the coastal area more vulnerable. This situation is challenging when Semarang gives the highest award for a healthy city implementation. At the same time, the problem of the quality of settlements and communities in coastal areas is still unresolved. Hence, this study aims to analyze the effect of climate change on the quality of settlements and the level of public health in Tanjung Mas as one of Semarang’s coastal villages to achieve a healthy city. Healthy city planning as part of good urban planning will significantly affect the quality of the environment, the level of health, and public welfare [8]. Therefore, the output of this study is expected to contribute to sustainable healthy city planning, especially in the city of Semarang.

2. Research Method

2.1. Study Area
This study focuses on Tanjung Mas Village, North Semarang District, where according to the housing profile and residential area of Semarang City in 2020, this village has the most expansive slum area, that is 64.77 ha (out of the total area of slum settlements in Semarang City of 120.91 ha). In addition, there is the Tanjung Emas Port and industries that choose locations close to the port in this village. The existence of these industries causes significant air pollution to the surrounding community and influences the water quality as well.
The area of Tanjung Mas Village is 323.78 ha and has the highest population in North Semarang District, which was 28,123 people in 2019 (North Semarang District in Figures, 2019). Most of the residents of this sub-district include the poor community who work as industrial workers (24.5%) and fishers (19.6%).

Figure 1. Tanjung Mas Village.

2.2. Research Method
The research method used in this study is descriptive qualitative, describing the quality of settlements in Tanjung Mas Village and then analyzing how climate change affects the community environment. The data used in this study were taken from the websites of relevant government agencies such as the Central Bureau of Statistics-BPS, Regional Disaster Management Agency-BPBD, Environmental Service, and Health Office of Semarang City. Some of the data used include dynamic population data, disaster data, and data related to implementing a healthy city indicator.

This study emphasizes the discussion on healthy urban arrangements, exceptionally healthy settlements, facilities, and infrastructure. However, not all indicators from this arrangement were analyzed, which focused on indicators related to climate change, such as air cleanliness, water quality, and availability of clean water. Meanwhile, other indicators such as waste management, market management, health services, facilities and infrastructure for sports and children's play will be described in an overview.

The analysis process is carried out by identifying the quality of the existing settlements descriptively and using statistical data, which describes physical and environmental conditions on maps. Afterward, analyze the effect of climate change on the quality of settlements. This analysis compares air cleanliness and water quality data in time series to see trends. The next stage is to analyze the effect of climate change on achieving a healthy city in terms of indicators of settlement quality. The analysis descriptively examined the government's efforts to improve the quality of the particular environmental aspect associated with Tanjung Mas Village.

3. Result and Discussion

3.1. Quality of Settlements and Existing Infrastructure
The settlements in Tanjung Mas Village are divided into slum and non-slum areas. According to data on Housing and Settlement Areas (PKP), the highest distribution of slums (92.56%) in Semarang City is in coastal areas, one of which is in Tanjung Mas. The slum area in this village reaches 20.2% or 16.95 ha in 2021, which is divided into the categories of medium slums and light slums (Semarang
Mayor Decree No.050/275 in 2021). This categorization of slums is reviewed based on slum conditions (aspects of residential conditions, clean water infrastructure, wastewater, solid waste, roads, drainage, and fire protection), population density, and land legality.

![Slums Distribution in Tanjung Mas](image)

The slum area has decreased significantly from 2018 (70% of the total slum area was improved). This decrease in the area of slum areas is the result of the Neighborhood Upgrading Shelter Program (NUSP), where there are efforts to repair uninhabitable houses, improve drainage networks, and build public toilets.

Although there have been environmental improvements, there are still problems related to the provision of clean water: this sub-district has not yet received clean water piped services from the Local water company-PDAM. Therefore, the fulfillment of clean water is obtained from artesian wells, which causes over-exploitation of groundwater and worsens the level of land subsidence. However, well water quality tends to be brackish, so it cannot be consumed, so people have to buy clean water from mobile water vendors for eating and drinking. Meanwhile, for other purposes, people continue to use artesian wells water.

A third party also manages the waste infrastructure that provides household waste transportation services to the temporary garbage dump. The community must pay the cost of transporting waste to third parties. However, the existence of the temporary garbage dump is inadequate, so it cannot accommodate waste production and make garbage pile up for several days. Moreover, the transportation of waste to the final disposal is not carried out frequently, causing the waste to accumulate in the temporary garbage dump and invite flies and smell bad.

Tanjung Mas is a village with a high-density rate and a population density rate of more than 200 people/ha. Tanjung Mas is one of the most densely populated urban villages in the coastal area of Semarang City [12]. The high population density impacts the availability of infrastructure, green open space, and the minimum space requirement for each person. High population density also correlates with a higher risk of disease transmission.

The availability of health facilities in North Semarang District, including in Tanjung Mas Village is limited. For instance, in Tanjung Mas, there is only one treatment center or clinic and two pharmacies. Meanwhile, the Community Health Center (Puskesmas) is located in Bandarharjo Village, which serves Bandarharjo, Tanjung Mas, Dadapan, and Kuningan Villages. Likewise, the availability of
sports facilities and children’s playgrounds, where the existing open space is the school yard and open space in the middle of the market. Many children play in the alley around their house or on the streetside. Meanwhile, economic facilities in Tanjung Mas consist of shops, the Tambak Mulyo Market, and a non-permanent market that resides on the streetside. Based on the health and economic facilities provision, Tanjung Mas has relied on the other villages which is not supporting the health city attainment.

3.2. The Effect of Climate Change on the Quality of Settlements

The effect of climate change on environmental quality is determined based on several criteria, including an increase in sea level, an increase in air temperature, an increase in rainfall, and a longer dry season [10]. The sea-level rise is 10 cm/year, which contributes to the occurrence of inundation. The increase in sea level makes the coastal areas of Semarang always flood every year. According to Buchori’s research (2018), climate change causes the frequency of rob to become more frequent, including in Tanjung Mas Village. In addition, the provision of drainage networks and embankments that did not integrate made the water flow process not smooth, causing tidal waves and flooding. The obvious impacts of floods and tidal waves experienced by the community include disruption of economic activities both locally and regionally [9]. Moreover, the distribution of goods and services is hampered, considering the existence of Tanjung Mas Port as a distribution center and the inundation of the North Coast of Java Highway as a national road connecting Semarang and other cities. The increase in sea level also causes the local road network to be inundated by 40-60 cm so that the quality of the roads decreases and their conditions are damaged [11]. The impact of floods and other tidal waves is that children are affected by water-borne diseases such as diarrhea, malaria, and fever; the women (housewives) also have to work extra to clean flooded houses [12]. Floods and tidal waves that occur continuously make Tanjung Mas's environmental quality decline, affecting the road network and clean water, and sanitation cannot function optimally.

Floods and tidal waves also make it the community difficult to obtain clean water supplies and damage houses [13]. When floods and tidal waves occur, people have to buy more gallons of water than when there is no flood. In addition, the community also relies on tank water assistance sent by the BPBD. The Semarang City Government, through BPBD, always allocates a budget for the purchase of tank water to help the community during droughts in drought-prone areas and flood-prone areas.

Another impact of climate change is the increase in air temperature, where based on data, it is known that air temperature has increased over the last 30 years. The increase in air temperature affects the mortality rate and public health, especially in vulnerable groups such as children and the elderly [10].

![Figure 3. Air Temperature Changes in Tanjung Mas Village, Semarang](image)

The number of children (aged under 15 years) and elderly (aged 55 years and over) in Tanjung Mas Village is almost 50% of the total population. This figure is quite prominent and needs attention, especially concerning the level of health.
One of the efforts to reduce the impact of increasing air temperature is through the provision of green open spaces. The existence of green open spaces can reduce hot air temperatures, provide coolness, and increase comfort for the community [15]. However, the utilization of built space in Tanjung Mas has increased, especially for settlements impacting the provision of green space or vegetation. The existence of unhealthy plants, which are defined as non-green space or green space but the vegetation is damaged or dead has a large percentage.

One of the responses to the increase in air temperature is to provide comfortable housing with sufficient ventilation to allow air circulation to run properly. However, 5% of community housing in Tanjung Mas Village is still considered unfit for habitation. According to the Public Works and Spatial Planning Ministry, an uninhabitable house is defined as a house whose construction is dangerous, unhealthy due to lack of sunlight and ventilation, high humidity, does not have access to clean water and sanitation network, and does not meet the minimum space requirement per person (9 m²/person).
The community living in uninhabitable houses is included in a group vulnerable to exposure to diseases due to increased air temperature.

3.3. Climate Change and Healthy Cities in terms of Settlement Quality

As previously mentioned, climate change affects the level of public health, which is triggered by the poor quality of the residential environment. Floods and tidal waves often make it difficult for people to meet their needs for clean water. Some people consume water that is not suitable for consumption and causes diarrhea, itching (skin disease), and diphtheria. The World Health Organization-WHO explained that all of these diseases are not only caused by the consumption of unfit drinking water but also due to environmental quality, such as poor sanitation networks and high population density.

Climate change that impacts weather changes results in the potential for the spread of pathogens through the air and water in food getting bigger [16]. Another impact of poor clean water quality is that activities such as hand washing and other healthy clean living practices (PHBS) are challenging to realize. According to the Chersich study, a weekly minimum air temperature increase of 5°C increased diarrhea cases by 40% a week after the temperature increase in Cape Town, Africa. This research result is in line with data from the Central Java Provincial Health Office; the most significant cause of under-five mortality is diarrhea. Diarrhea is a water-borne disease caused by the consumption of water that does not meet health standards.

![Figure 6. Diseases that Cause Under-five Deaths in Central Java Province in 2019.](image)

Diarrhea has become a threat to the community, floods and tidal waves, and environmental sanitation, which is laborious. Based on data from the Semarang City Health Office, in 2014, it was found that diarrhea was one of the top ten diseases suffered by the community (both in children and adults and the elderly) who took treatment to the hospital. More specifically, based on data from the Bandarharjo Health Center, where the service area covers Tanjung Mas Village, it is known that in 2017 the number of diseases most commonly found in children aged 5-11 years was diarrhea with 1,263 cases.
In addition, the problem of clean water and the air quality in Tanjung Mas causes by industrial activities, and vehicle fumes pollute it. Existing industrial and warehousing areas take advantage of the proximity to Tanjung Mas Port as a distribution center so that many heavy vehicles pass by, making air pollution even higher. Poor air quality causes several diseases, such as upper respiratory tract infections, pneumonia, and lungs. Patients with this disease are increasing and getting worse during the dry season; where due to climate change, the dry season is getting longer, plus the weather is hot and dusty. In addition, the quality of housing that lacks lighting and ventilation fosters these diseases. Children and the elderly are still the most vulnerable group to this disease.

Based on Semarang City Health Office data, upper respiratory tract infections are among the diseases that many people suffer from in Semarang. Although the number of respiratory tract infections sufferers in 2019 (3053 cases) decreased from 2018 (4600 cases), Semarang City is still among the top five respiratory tract infection cases in Central Java Province. As many as 5% of the 3053 cases are classified as severe pneumonia, primarily found in children. In Tanjung Mas, 75% of pneumonia sufferers are children aged 1-5 years, and the remaining 25% are children aged <1 year. More specifically, the number of pneumonia cases in Tanjung Mas Village is recorded in the following data from the Bandarharjo Health Center.

The healthy cities concept mutated; in the beginning, this concept emphasized more the social and mental aspects of the community, then developed more on efforts to mitigate disease through the provision of environmental infrastructure needed by the community, such as clean water and sanitation infrastructures. Nowadays, a healthy city concept focuses on social, economic, and environmental aspects [17] The key to the success of implementing a healthy city is the government's commitment, community participation, and empowerment [18]. The role of the community determines by the setting.
of the environment or their circumstance, which arranges settlements, healthy facilities, and infrastructure essential. Physically, the quality of settlements, as well as facilities and infrastructure in Tanjung Mas Village, have not met the requirements of a healthy area. Therefore, it will have implications for the achievement of the Semarang as a healthy city in general. A healthy area is part of a healthy city with good environmental characteristics that are clean, comfortable, and safe to ensure public health. In addition, a healthy area also means that it is economically capable of optimizing the potential of the community through empowerment activities that involve all relevant stakeholders. Likewise, all of these activities follow spatial and development plans.

3.4. Discussion
Based on the IPCC Climate Change Vulnerability, three aspects affect community vulnerability: exposure, sensitivity, and adaptive capacity. Exposure reveals the relationship between the system (both in social, economic, and environmental contexts) and climate, while sensitivity explains how the system is affected by exposure risk. While adaptive capacity describes the system's ability, both individuals and society, in general, can create resilience.

![Climate Change Vulnerability Trend](image)

**Figure 9. Climate Change Vulnerability Trend.**

Based on the picture above, the efforts made by the community toward climate change tend to be short-term and have an unfavorable impact in the long term. All the impacts that will occur in the future have occurred and are being encountered now. However, if climate change is not anticipated, the level of climate hazards will be even greater.

Several efforts that are being and will be implemented by the Semarang city government are improving uninhabitable houses and developing marine tourism, which aims to enhance the community's economic capacity. In addition, the mega projects of the toll road and sea wall construction are believed to overcome floods and tidal waves. All these efforts have been planned, and some have been carried out, whereas the other homework is on how to increase the community's awareness of a healthy lifestyle and the importance of protecting the environment.

However, marine tourism development also needs to be appropriately managed not to create many newcomers in Tanjung Mas. If this happens, the population density will be higher, and the population's health will be very vulnerable. In general, the area's vulnerability depends on geographical factors, whereas a coastal area is prone to flooding, high population and density, and minimal availability of basic infrastructure [19].
4. Conclusion
Climate change increases the vulnerability of communities and coastal areas, which also relates to the achievement of healthy cities. Based on the arrangement of residential areas, health facilities, and infrastructure, Tanjung Mas has not been able to contribute to the fulfillment of healthy area indicators. This arrangement looks at the area more physically, but the impact involves other aspects, namely social, economic, and environmental. Socio-economically, climate change makes people vulnerable to exposure to disease, thus burdening the economic aspect. Meanwhile, the limitations of the clean water and sanitation network make the quality of the environment decline, which has implications for public health.

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