COASTAL COMMUNITY'S RESPONSES TO WATER INFRASTRUCTURE UNDER CLIMATE-RELATED DISASTER IN SEMARANG CITY, INDONESIA

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Abstract

Rapid urbanization in developing countries faces the challenge of increasing demand for urban water services. This challenge can be more significant particularly in urban coastal area under climate-related disaster, which is able to obviously influence the change of socioeconomic and environmental aspects. This study investigates the affected coastal community's responses to water infrastructure under climate-related disaster in Tanjung Mas, located in the northern part of Semarang City, Central Java Province, Indonesia. Field observation, key informants interview, and structured household survey were conducted. The survey was conducted among 106 residents using random sampling method. The findings reveal that water infrastructure is mostly available in the study area and the residents typically rely on water source from the local water company by using water supply pipeline. However, the location in flood prone area has contributed enormously their vulnerability to water availability. The residents recognize the importance of water for their quality of life, and the impacts of urban development to reduce the availability of water resource, but they had not completely understood the relationship between climate change and water sector. They have perceived that climate change is not significant issue related to water resource, even though they live in prone area. The practice of their current measures is only able to cope with the impacts in the short term period, such as clearing drainage channels, adding sanitation infrastructure, and building simple embankment. Public awareness campaign and advocacy at the community level are necessary to reduce the low perception of potential risks posed by climate change and natural disasters related to water infrastructure. The specific government policy, program and practice oriented solutions on climate change and urban development issues need to be considered in order to increase resilience and sustainable urban development.

Keywords: Climate-related disaster, Coastal community, Water infrastructure

Introduction

Urban areas in developing countries have to deal with the challenge of increasing demand for urban services particularly in water resource-related infrastructure. With the growing population and economic wealth, there is an increased pressure on the available water resources [1, 2, 3, 4]. Water resource is considered as one of vital resources influencing the quality of life of the people. Urban water availability and management have recently acquired more attention in global contexts; it becomes part of the comprehensive Sustainable Development Goals on Water (SDG-6) [5]. The challenge can be further significant in urban coastal area under climate-related disasters, such as drought, high intensity of flood and extreme temperature change. Coastal zones are particularly vulnerable and risk to climate change impacts [6]. Rapid urbanization and climate change phenomenon will trigger high vulnerability and risk to urban coastal community. It obviously will influence the alteration of socioeconomic and environmental aspects. Without a sound management plan for urban development planning and climate risk

assessment, urbanization process and climate change impacts in urban coastal areas are likely to bring increasingly serious problems to people's livelihood, property, environmental quality and future prosperity. Indonesia becomes one of the most vulnerable countries in Southeast Asian region since several large cities are located in the coastal area, such as Jakarta, Surabaya, Makassar, Balikpapan, Semarang, Bandar Lampung, Banjarmasin, etc. [7]. The coastal cities in developing countries have similar characteristics in terms of physical and socio-economic settings. Many vulnerable communities are generally living in the coastal areas. The cities are relatively affected by climate-related disasters, such as coastal flooding and extreme weather events, which will influence the availability of water.

The vulnerability of coastal communities due to climate-related disaster has given attention by many scholars to study and investigate based on several research and studies [8, 9, 10, 11, 12, 13]. Coastal community has been facing problem related to tidal floods [12]. Mostly, they have adapted with structural measures. In addition, understanding coastal community's response related to the issue is important to getting real context of coastal management [14, 15, 16, 17]. For that reason, this study presents the residents' perception and assessment of their understanding on climate change, disaster, and water resource. Several studies have received consideration on disaster assessment in coastal area of Semarang [12, 18, 19], however, there are few available studies on physical infrastructure imposed by climate-related disaster at the local level [20, 21]. The infrastructural support also plays essential role in disaster management responding to the mitigation program. This study is focused on the local level to investigate the impacts of climate-related disaster to urban physical infrastructure, especially water infrastructure on the community and identifying the community response in the Semarang coastal area. The selected urban coastal community is in Tanjung Mas, located in the northern part of Semarang City, Indonesia. This area has experienced a range of climate-related disasters including coastal flooding, coastal erosion, and extreme weather events. Besides that, the city also has to deal with environmental challenges such as flash and tidal floods, land subsidence, water pollution, and water shortage.

This paper consists of six sections, namely: (1) Introduction, (2) Conceptual issues on urban coastal development, climate change and water sectors, (3) Methodology, (4) General information of the study area, (5) Discussion of study results, and (6) Conclusion and recommendation.

Conceptual Consideration

Nowadays, 54 percent of the world's population lives in cities [22]. The proportion of population in urban area is predicted to increase to 66 percent by 2050. In addition, the population growth is further compounded by megacities' extreme vulnerability to the impacts of climate change, especially in developing countries [23]. Urbanization process in the major urban coastal area makes the people who live nearby or along these areas to be exposed by climate-related disasters. Climate-related disasters [24] are classified according to disaster types that are climatic in nature or which may include a climatic component, such as drought, epidemic, extreme temperature, flood, slide, wave and surge, wild fire and windstorm. The negative effect of this process is the increase of vulnerability to disasters as a result of the concentration of people and assets in prone areas, since many urbanized areas are situated along major bodies of water such as low-lying areas near the mouths of major rivers, coastal and delta area [6]. It is predicted that roughly ten percent of the world's population resides nearby the coastal area [25]. The Fifth Assessment of Intergovernmental Panel on Climate Change (IPCC) noted the following summary with high confidence [26] that "coastal systems and low-lying areas will increasingly experience

submergence, flooding and erosion in the coming decades, due to sea level rise. The population and assets projected to be exposed to coastal risks as well as human pressures on coastal ecosystems will increase significantly due to population growth, economic development, and urbanization. In urban areas, climate change is projected to increase risks for people, assets, economies and ecosystems. These risks will be amplified for those lacking essential infrastructure and services or living in exposed areas". IPCC has confirmed that urban coastal area is increasingly getting the impacts and risks from climate change. This situation will be significantly a challenging issue for urban communities and local authorities.

Climate change has made coastal urban areas hotspots of vulnerability since they have frequently been affected by natural hazards as well as increased salinity and coastal erosion in contributing to degraded urban coastal zones [6, 27]. Climate change related to natural disasters can undermine decades of growth in urban areas in a single catastrophic event. In addition, low-lying cities are particularly vulnerable to sea level rise [28]. The impact not only damages the physical infrastructure, but also loss of life, time, and opportunity for the affected people. Although climate change is an uncertainty phenomenon, but the people who reside in the prone areas could minimize the impacts with adaptation measures. Sustainable urban risk management is becoming an important approach to deal with the challenges for urban communities and authorities. Unfortunately, many developing cities are still unable to carry on with the strengthening of such challenges.

Coastal cities in Indonesia are mainly vulnerable to disasters because of their coastlines, high density of population, and high concentration of economic activity in coastal areas [7]. The vulnerability is compounded by uncontrolled urbanization, common urban and rural gap, lack of law enforcement, and the environmental degradation. In addition, the impacts of climate change can influence the state of water resource since the changes are particularly associated with rainfall pattern, sea level rise and weather extreme, and responsible for different impacts at both surface and groundwater systems. Water resource is extremely important in view of the fact that water is really necessary for food security and economic prosperity in many countries nowadays [29]. It is also an important component in urban management.

Furthermore, urban water infrastructure systems are being affected by climate change impacts [30, 31]. Changes of precipitation patterns, frequency and intensity of storms, sea level rise, and extended heat waves are giving direct impacts on natural water sources (quality and quantity) and water infrastructure. They affect to decreasing urban functions such as the availability of water supply. In coastal areas, sea level rise will exacerbate water resource constraints due to increased sea water intrusion of groundwater supplies. Besides that, coastal communities will be affected also due to increases in storm frequency [6]. In terms of urban water management especially in developing cities, several problems, which are related to water, are discovered such as water shortage and water pollution from household and industrial activities. The main attention for the water-based resources is the sustainability of the current and even future water resource allocation including water quantity and quality.

Methodology

This study used both primary and secondary data. The primary data was obtained from a structure household questionnaire survey with the affected community in Tanjung Mas. The survey was conducted in August 2015. Questionnaire survey was selected for this study since the unit of analysis was at household level which needs direct information from

households. Interview was also conducted with local community leaders and government officials. This was carried out to obtain information from the affected communities and government officers about their strategies and responses on water related infrastructure, such as wastewater facility, water supply system and drainage system imposed by climate-related disasters. The research team also used field observation assessment to find out the communities' physical vulnerabilities.

The survey questionnaire obtained information on the respondents' socioeconomic and demographic characteristics. In addition, information was asked regarding the characteristics of residential building in which the respondents reside, and the water infrastructure condition including drainage system, wastewater facility, and water supply system. The perceptions of respondents on climate change and water resource, and the respondents' response to reduce the impacts were also asked. These are important indicators of the level of vulnerability to climate-related disasters. Relevant secondary data was obtained from published and unpublished materials, including online resources, to complement the primary data. Using an assumption that every household gets affected by climate-related disasters (95%), and a confidence interval of 95% (estimated error margin of 4%), a sample size of 102 households was computed in the study area. The survey was completed among 106 households in the study area using random sampling method. The data collected from the questionnaire survey was analyzed with the aid of Statistical Package for the Social Sciences (SPSS) using descriptive analysis statistics.

The Study Area

Semarang City, the capital city of Central Java Province, is a coastal urban area situated on Java Island in Indonesia. It covers an area of 373.7 square kilometers and located at the northern coast of Java and about 500 kilometers in the western part of Jakarta, the capital city of Indonesia. The main business activities are industrial, estate, education, commercial, and tourism. Most of commercial and industrial areas are built on the low-lying area of coastal plain. The city has a population of 1,584,068 people in 2014 and the growth of 0.83 percent per year [32]. The city has experienced in rapid urbanization, climate change and natural disaster impacts. The land use pattern and physical environment in the city have been changing rapidly followed by the increase of population. Rapid urbanization has given the challenge of the increase of urban services, especially in the water sector. In addition, the residential growth and industrial expansion contribute to the land subsidence in the affected areas. Besides that, the area is imposed by climate change impacts, such as the increase of surface temperature and rainfall intensity, the rise of sea level, and the change of extreme weather pattern. Since the last century, the evidence of the increase of surface temperature in monthly average has been revealed. It has been discovered also that sea level has risen since more than 30 years ago, and it is estimated to rise between 40 and 80 centimeters in the next century. This situation will increase the potential inundation area inland between 1.7 and 3 kilometers [33]. Changing rainfall patterns contribute to current problems with flooding, landslide, drought and water scarcity; while sea level rise and land subsidence will contribute to coastal erosion and tidal flooding.

Figure 1 is the map of Semarang showing the city's land use growth from 1972 to 2005 differentiated in terms of settlement, fish pond, and green areas. The city has a relatively large land area with a very diverse and fast-growing population. Thus, normal urbanization pressures and modern development forces have resulted in the city expanding to nearby suburbs. However, the concentration of population is still located at the northern area of Semarang City. This makes the city more vulnerable. The average population density of Semarang is approximately 4,238 populations per square kilometer in 2014 [32]. High

concentration of population in the northern part of the city has implications for coastal flood disasters in terms of the number of people who would be directly affected. Sea level rise increased dramatically from 1985 until 2008. During those periods, sea level increased by about 58.2 centimeters, with an average annual sea level rise at 4.47 centimeter per year [34]. Based on the research conducted by several research institutions, including the Research and Technology Agency (*Ristek*), University of *Diponegoro* (UNDIP), the Fishery and Marine Agency (DKP), and Bogor Agricultural University (IPB), flood prone area due to sea level rise was estimated by different simulation models in 20, 60, 80, and 100 years, which gave the result of sea level rise in 15.5, 46.5, 62.0, and 77.5 centimeters, respectively (see Figure 2). Then, it was applied by mapping the sea water level with consideration to geophysical aspects in the study area such as the land elevation, the building, the river/canal. The study revealed that the higher the sea level rise will occur the higher the chance for more inundated areas.

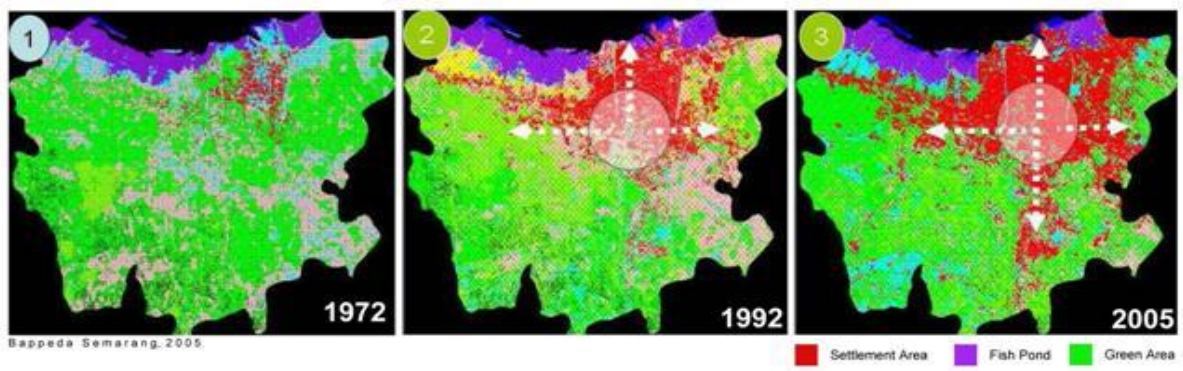

Figure 1. Land use growth of Semarang City from 1972 to 2005

In terms of water resource availability, water supply for household in Semarang City is mostly obtained from water pipeline provided by the local water company (PDAM) (70%), well groundwater (20%), and the remaining is from other sources [35]. The main raw water resources of the local water company include four water sources, which are water springs (10.84%), surface water/rivers (69.7%), mountain wells (18.79%), and urban wells (0.67%). Total raw water production of PDAM is 2,703.27 liters per second [36]. Meanwhile, as an important natural resource, groundwater provides water supply for the communities and industries in Semarang. According to the Public Works Department [37], the demand for water supply was 57.28 million cubic meters per year in 1995, and 75.89 million cubic meters per year in 2000. Surface water supply provides up to 40 million cubic meters per year. Therefore, groundwater extraction is to be expected to continue until additional surface water supplies or water management (for instance, water recycling and reuse) are made more available. Groundwater over-extraction particularly by industrial sector leads to the permanent reduction of groundwater level, which will be followed by the reduction of water pressure affecting the soil consolidation resulting subsidence.

Based on the interview with one of senior officers at the Local Planning Agency (*Badan Perencanaan Daerah*), the local municipality of Semarang can only serve 64% of the water demands through local water company. An average rate of water consumption in the city is increasing from 108 to 152 liters per day in the last 5 years. It means that surface water is still dominant for water source in Semarang City. However, this situation brings the new challenge for the city when the climate-related disasters are considered. The quantity of water in the ground surface is likely to increase when heavy precipitation

occurs. Whereas when drought happens, the quantity of water decreases. Sea water inundation and salinity also affect the quality of groundwater and surface water.

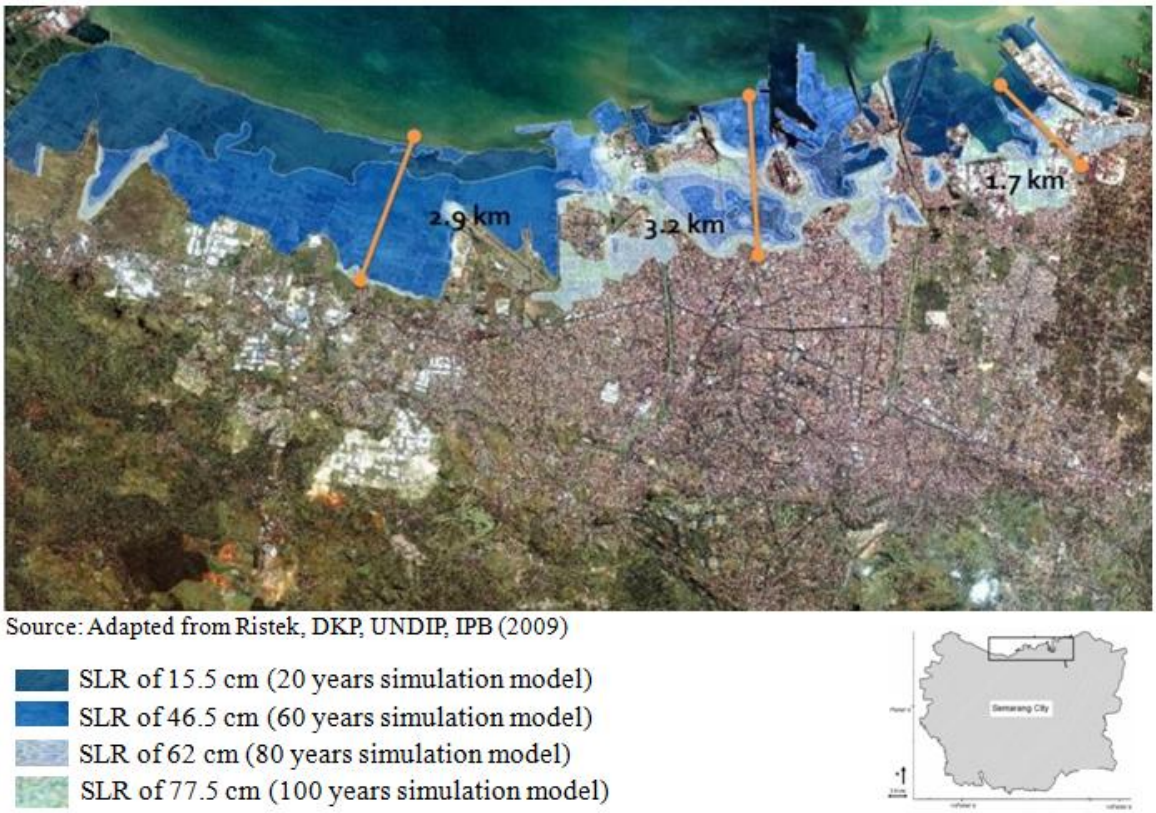

Figure 2. Flood-prone areas due to sea level rise (SLR) in the northern of Semarang City

Tanjung Mas

The selected community is in urban village (*kelurahan*) of Tanjung Mas (see Figure 3), which is located nearby the coastal area and the seaport. Tanjung Mas has the area of 3.24 square kilometer with the population of 31,072 people and the density of 9,620 people per square kilometer [32]. It is categorized as a very high-density area. The northern part of this area is the Java Sea. The community in this area has experienced the impacts of climate change and related disasters, such as tidal flood, sea level rise, heavy precipitation, drought and coastal erosion. These could affect urban environment (physical / infrastructure), social (quality of life) and economy of urban coastal community. The highest elevation in Tanjung Mas is 0.5 meter above sea level while the average inundation ranges between 0.4 and 0.6 meter above sea level. In addition, this area is sited on the land that is highly prone to subsidence because of the increase of water demand from groundwater extraction. This area has an international seaport called *Tanjung Mas* Seaport and also an industrial area. The presence of these establishments coupled with the workers who live nearby the study area contributes to the increasing demand for water resources. In addition, the current condition is that several buildings are inundated, such as office and residential buildings affecting the infrastructure condition such as road and groundwater access. Several adaptation measures have been adopted by affected community to respond the impacts and risks, such as constructing a simple embankment, taking out the water from the houses, constructing a drainage system, and purchasing of gallons of clean water for drinking and cooking usages.

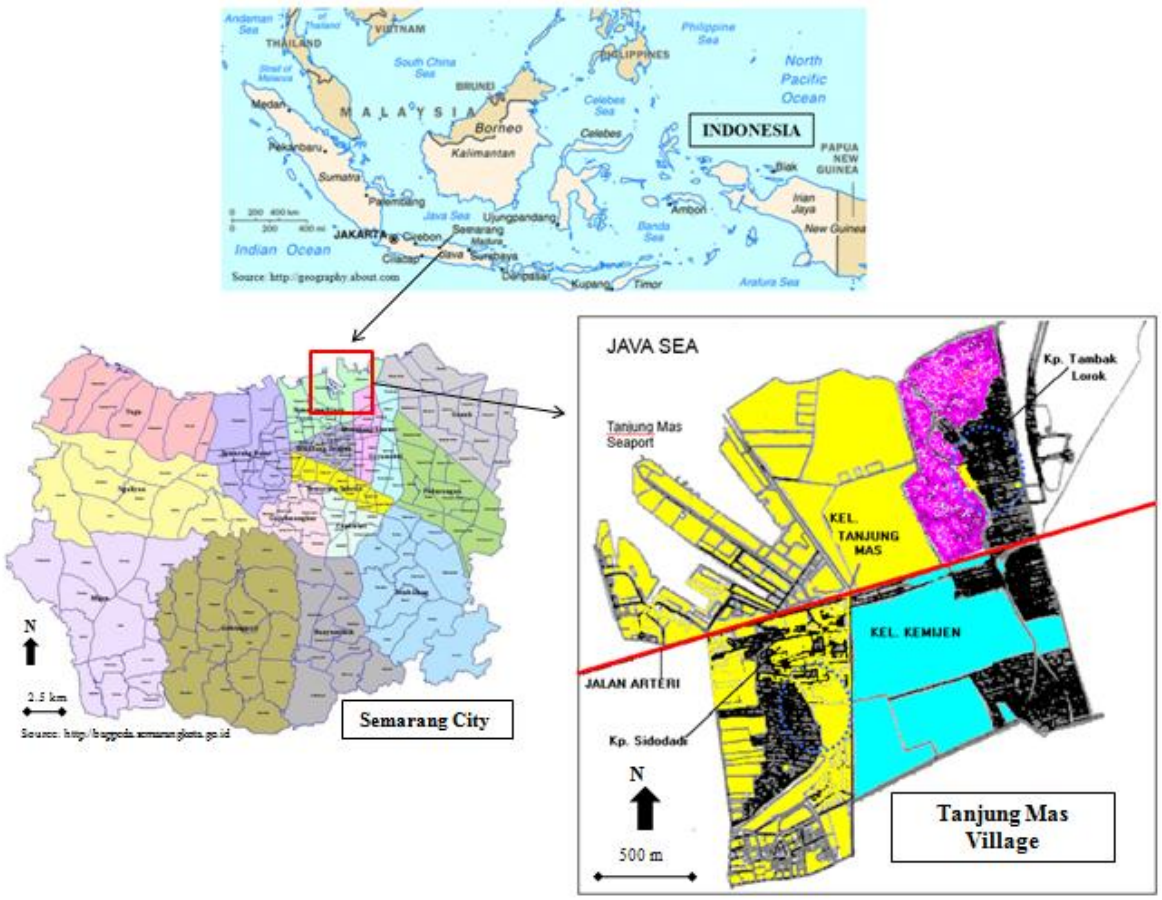

Figure 3. Location of the study area

Precipitation

Based on 100 years rainfall dataset in Semarang City, it is revealed that rainfall and number of rainy days are very unstable and fluctuating. However, generally it is known that rainfall increases in its intensity on the wet seasons, which are from September to November (SON) and from December to February (DJF). In DJF, the seasonal rainfall increases approximately from 950 to 1,000 millimeters, while in SON, it increases from 250 to 300 millimeters (see Figure 4). The upward trends of rainfall during wet seasons (SON and DJF) are associated by the increasing trends of wet days' frequency during the same seasons (SON and DJF) [38]. This trend of precipitation indicates that the increase of rainfall during twentieth century over Semarang City is caused by the rains, which come more often than normal situation, raising the probability of floods in the region if there is still no adaptation and mitigation measures to deal with this issue.

Temperature

Based on the temperature data extracted for Semarang City, it can be revealed that the increasing trend of mean temperature in each season for the last 100 years period is fluctuating [38]. In the wet season, which is from December to February (DJF), the mean temperature increases from 25.9 to 26.3 degree Celsius, while in dry season, which is from June to August (JJA), it increases from 25.3 to 26.3 degree Celsius. The increasing trend of temperature is also related to the increase of daily maximum temperature trends (see Figure 5). In the wet season (DJF), the maximum temperature increases from 31.4 to 31.9 degree

Celsius, while in the dry season (JJA), it increases from 31.2 to 32.2 degree Celsius. In addition, it is found that the daily temperature range shows a descending trend, indicating that the increase of daily minimum temperature more rapidly occurred than the maximum temperature.

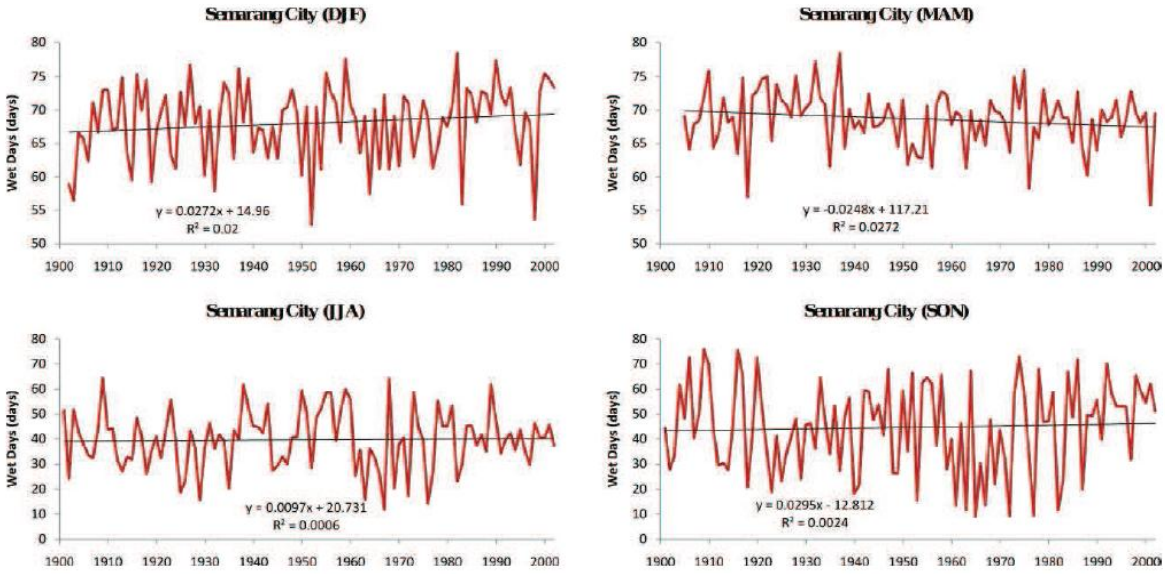

Figure 4. Average of maximum precipitation in Semarang City 1902-2002 [38]

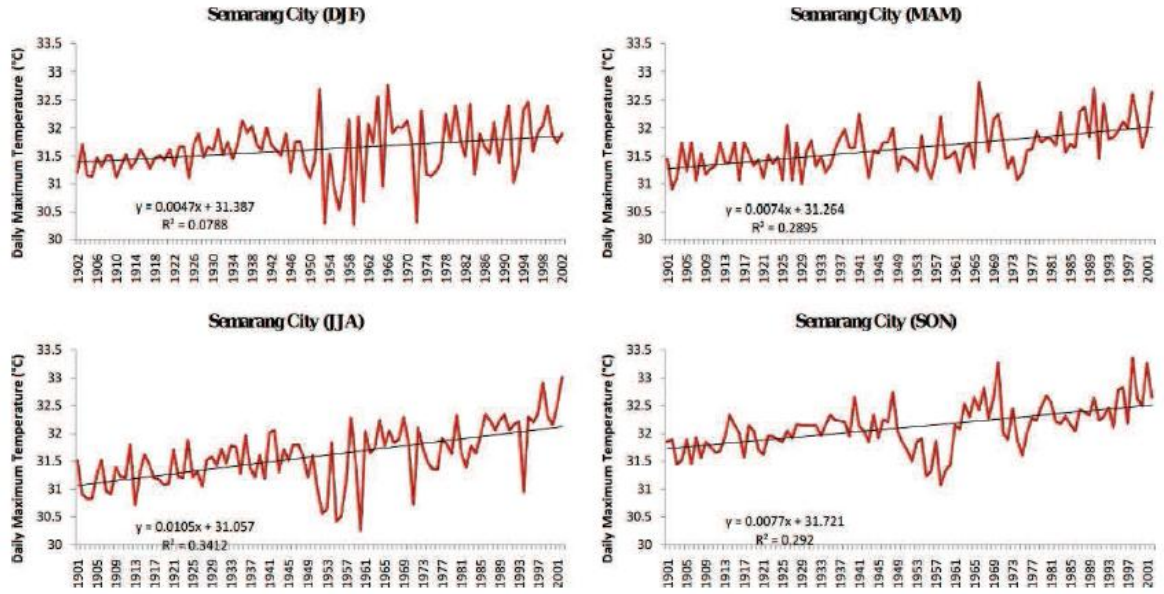

Figure 5. Average of maximum temperature in Semarang City 1902-2002 [38]

Results and Discussions

Water resource is considered as the important element for human life and ecosystem. However, due to urban development and climate-related disaster, the availability and affordability to get water resource become limited. The following section presents the study results and a discussion of the vulnerable community's characteristics in socio-economic and demographic aspects, residential building, and the water infrastructure in the study area.

Respondents' Socio-Economic and Demographic Characteristics

As shown in Table 1, 55% of the respondents were male, while the remaining 45% were females. It is indicative that although the expected interview targets were the heads of households (usually males), but actually in the study area, it did not always happen. Generally the male respondents were still dominant. In addition, the survey results further reveal that 21.7%, 25.5% and 31.1% of the respondents were between the ages 36 and 45 years, 46 and 55 years, as well as 56 and 65 years, respectively. It means that the respondents in the study area were mostly in the productive ages. Only, 6.6% and 15.1% of the respondents were above 65 years, and between the ages 16 and 35 years.

The survey also revealed that 41.6% of the respondents finished secondary and high school, and 41.5% completed primary school. Only 12.3% of the respondents had no formal education, and 3.8% had reached tertiary education in college/ university level. Generally, the education level of respondents is relatively low. From the analysis result, there is gap between the percentage of adult people (1.9% respondents were between the ages 16 and 25 years) and the percentage of respondents, which they are supposed to study in their reasonable educational attainments (45.6% respondents were in secondary, high schools and college/university level). Most of the respondents did not continue their study and merely reached secondary and high schools level. The low number of respondents who attained college/university level (3.8%) and the high number of respondents who did not have formal education (12.3%) confirmed the poor quality of respondents' education level in the study area. This finding is considered not good in terms of their acceptance and understanding on the information about the issues at hand. Therefore, in terms of their understanding on knowledge which is particularly more complex such as water resource and climate change would be limited.

Of the respondents, 35.8% were housewives, 14.2% were not having jobs, 13.2% were entrepreneurs, 12.3% were private employees, 11.3% were farmers/fishermen, and 7.5% were factory workers, while 5.4% were public servants. The survey reveals that the occupation in the affected community was varied. The high proportion of the respondents' occupation as housewives gives confidence to the high percentage of the female respondents (45%).

Large household sizes have implications for disaster impacts in the sense that when a disaster strikes, large numbers of people per household are likely to be affected. More than half of the respondents (69.8%) were between 3 and 5 household members, 22.6% more than 5 members, and 7.5% less than 3 members. Based on the survey, there is an average of 4.7 members per household. Large household size has also implications for disaster risk in that high absolute numbers of causalities during disasters may be compounded by an increased need for disaster relief for survivors. In terms of household size and educational level, large household size lacks knowledge absorption since majority of the respondents' educational level are in poor condition which influences their capacity for adaptation to climate-related disasters.

Table 1. Characteristics of Socio-Economic and Demographic

Variables		Frequency	Percentage
Sex	Male	57	55.0
	Female	49	45.0
Age (years)	16-25	2	1.9

Variables		Frequency	Percentage
	26-35	14	13.2
	36-45	23	21.7
	46-55	27	25.5
	56-65	33	31.1
	Above 65	7	6.6
Educational level	No formal education	13	12.3
	Primary school	44	41.5
	Secondary school	22	20.8
	High school	22	20.8
	College/university	4	3.8
Occupation	Civil servant	6	5.4
	Private employee	13	12.3
	Factory worker	8	7.5
	Housewife	38	35.8
	Farmer/fisherman	12	11.3
	Entrepreneur	14	13.2
	Unemployed	15	14.2
Household size	Less than 3	8	7.5
	3 – 5	74	69.8
	More than 5	24	22.6
Monthly income	Less than IDR 1 million	24	22.6
	IDR 1 – 2 million	47	44.3
	IDR 2 – 3 million	23	21.7
	More than IDR 3 million	12	11.3

Source: Demographic survey, 2015

Analysis of the respondents' incomes indicates that 44.3% of the respondents earned between IDR 1 million and 2 million per month (during the survey period, the currency exchange rate was USD 1 to IDR 13,500). Another 22.6% of the respondents earned less than IDR 1 million per month. Meanwhile, 21.7% of the respondents earned between IDR 2 million and 3 million per month. However, 11.3% of the respondents earned more than IDR 3 million per month. With absolute poverty defined globally below USD 1 per capita per day and given an average household of 4.7 people, the average family will need to earn IDR 1.9 million per month to live above that poverty line. The implication is that one of every two of the respondents lives below the absolute poverty line. An individual's income also largely determines his or her capability to cope with and recover from climate-related disasters. Poverty makes urban residents vulnerable to climate-related disasters.

Residential Building Characteristics

In Table 2, it presents and analyzes the function, condition, status, and location of the residential building of the respondents. Majority of respondents' buildings function as residence place only (86.8%), while the remaining buildings served as residence and business places (13.2%). The residential building's function gives the implication to the amount of loss and risk during the occurrence of disasters. Almost of all residential buildings (92.5%) were in permanent condition, while 5.7% semi-permanent, and 0.9% non-permanent. Generally, majority of respondents' building condition is in permanent condition. It indicates that they already maintained their houses to withstand the disaster impacts. About 81.1% of the buildings had status as the owner of the land, 17% others, while 1.9% tenant. The ownership status associates to the amount of loss to be borne by the residents, when disasters happened.

Table 2. Characteristic of Residential Building

Building Characteristics		Frequency	Percentage
Function	Residence place	92	86.8
	Residence and business places	14	13.2
Condition	Permanent	99	92.5
	Semi-permanent	6	5.7
	Non-permanent	1	0.9
Status	Landlord	86	81.1
	Tenant	2	1.9
	Others	18	17.0
Distance to the coastline (km)	Less than 1	30	28.3
	1 – 2	50	47.1
	2 – 3	26	24.5

Source: Survey analysis result, 2015

The building's location also plays an important role in increasing or decreasing its vulnerability to climate-related disasters in the coastal area. The building's location, located near coastal line and prone areas (low-lying area), is expected to be more vulnerable under climate-related disasters. An analysis of the data shows that 47.1% of the residential buildings were located between 1 and 2 kilometer from coastal line, 28.3% less than 1 kilometer, and 24.5% between 2 and 3 kilometer. The result indicates that the majority of respondents' residential building in the study area is likely vulnerable to climate-related disasters, such as coastal flood, coastal erosion, sea water intrusion, and submerged. It can be found also that because of groundwater over-exploitation, land subsidence has evidently occurred in the study area. These incidents have destroyed the structure of buildings.

Figure 6. Coastal flooding (in the left) and land subsidence (in the right) in the study area (Source: Field visit, August 2015)

Field observation analysis found that many residential buildings of the respondents and office building were submerged by coastal flood (see Figure 6). The roads and water infrastructure in the ground got affected as well. Some of the people in the community showed their coping strategies in place due to past disasters. As regards to the water infrastructure in the study area, many residents elevated the water storage tanks to higher position (see Figure 7).

Figure 7. Water infrastructure condition in the study area (Source: Field visit, August 2015)

Some of the residents elevated their housing floor to higher position or made additional storey buildings, and also build a small embankment surrounding their houses. Although in some cases, the physical construction was not built according to standards. These measures actually reinforced the residents' decision not to be relocated. Another natural disaster that should be considered in the study area is land subsidence because of high extraction of groundwater (see Figure 6).

Characteristics of Water Infrastructure

In terms of water resource condition in the study area (Table 3), the water usage was mostly for washing and bathing (30%) and cooking (28%). While, 19% and 15% of the respondents responded that they used the water for watering the garden and drinking, respectively. Only 7% of the respondents used the water for cleaning the vehicles. In this study, water resource related infrastructure is including water supply system, drainage system as well as sanitation and wastewater facilities. In terms of water supply source, the water source was mostly from the local water company (PDAM) (59.4%). While, 23.6% of

respondents responded that they obtained the water from the artesian well. Only 10.4% of the respondents obtained the water from bottled or refilled water, and 4.7% from well. It indicates that the groundwater in the study area was not adequate, and almost all the respondents depended on the water source from the local water company by using water supply pipeline. The means to store is through water storage tanks.

Table 3. State of Water Infrastructure in the Study Area

Water Infrastructure		Frequency	Percentage
Usage of water	Washing and bathing	32	30.0
	Cooking	30	28.0
	Watering the garden	20	19.0
	Drinking	16	15.0
	Cleaning the vehicles	7	7.0
Water source	Well	5	4.7
	Local water company	63	59.4
	Artesian well	27	23.6
	Bottled/refilled water	11	10.4
	Rainwater collection	1	0.9
	Others (purified water)	1	0.9
Quality of water	Very good	40	37.7
	Good	34	32.1
	Medium	29	27.4
	Poor	3	2.8
Availability of water	Very adequate	35	33.0
	Adequate	38	35.8
	Medium	33	31.1
Availability of drainage system	Yes	86	81.0
	No	20	19..0
Sanitation condition	Very Good	7	6.6
	Good	46	43.4
	Medium	38	35.8
	Poor	11	10.4
	Very poor	4	3.8
Wastewater facility in the house	Septic tank	78	73.3
	Discharge to river	23	21.9

Water Infrastructure		Frequency	Percentage
	Discharge to ground	1	1.0
	Others (public toilet)	4	3.8
Wastewater facility condition	Very good	7	6.7
	Good	48	44.8
	Medium	25	23.8
	Poor	13	12.4
	Very poor	13	12.4

Source: Survey analysis result, 2015

In this study, the respondents were also asked about the quality of water in their community area based on physical characteristics (color, odor and taste) from their qualitative self-rating measurement into five scales: very good, good, medium, poor, and very poor. Based on the results of analysis, 37.7% of the respondents indicated that water quality in the study area was in very good condition, and 32.1% indicated that it was in good condition. While, 2.8% of the respondents responded that it was in poor condition. This result can be reasonable because most of them rely on the water supply pipeline provided by the local water company. Similarly, water availability related to accessibility of groundwater and surface water is also ranked by five scales: very adequate, adequate, medium, inadequate, very inadequate. 25.8% of the respondents stated that the water availability was adequate, and 33% of them were very adequate. Generally, the water supply in this area is available and in good quality according to respondents' answers.

Condition of sanitation facility reflects the human health condition. Sanitation in good condition promotes health through prevention of human contact with sewage or wastewater disposal. The physical aspect of sanitation condition was asked to respondents including cleanliness and odor based on qualitative self-rating measurement into five scales: very good, good, medium, poor, and very poor. The response of the respondents to the condition of sanitation in the study area was mostly in good condition. 43.4% and 6.6% of the respondents were in good and very good condition, respectively. While, 10.4% and 3.8% of the respondents indicated that sanitation was in poor and very poor condition, respectively. In addition, almost all respondents stated that the drainage system was available (81%). Only 19% of the respondents were not having access to drainage system.

The facility of wastewater is really important in order to prevent diseases and to keep a healthy environment, particularly in the study area, where it is categorized as vulnerable area. It needs well maintenance and improved condition. The condition of wastewater facility was asked to respondents based on qualitative self-rating measurement into five scales: very good, good, medium, poor, and very poor. More than half the respondents noted that they used septic tank for wastewater facility in their house (73.3%) and majority in very good condition (6.7%) and good condition (44.8%). However, there is a challenge for using a septic tank system particularly in the prone area; it should be in good condition and regularly maintained. It can be concluded that even though this area is vulnerable to climate-related disasters, but the community is still not threatened with the impacts. Although the evidences of the impacts could be perceived in last decades, the community prefers to have an experience of sea level rise and flooding than lack of water resource. Some of the respondents still discharged the wastewater to the river (21.9%) and to the ground (1%). Therefore, it causes pollution to their areas and gives a more environmental challenging issue.

Respondents' Perception on Climate Change and Water Resource

While awareness on the phenomenon of climate change is actually important, individual feedback patterns and the understanding of this issue are crucial, because the action taken determines the extent to which people suffered from the impact. Thus, this study identifies the perception of respondents regarding climate change and water resource, including their understanding on the issue of climate change, the recognition of vulnerability area, the quality and quantity of water resource affected by climate change, and the willingness to relocate. Table 4 shows that more than half respondents (62.3%) claimed that they did not understand about climate change issue. Only 37.7% stated that they understood the issue. Lack of understanding of affected community to this issue makes them more susceptible to the impacts of climate-related disasters. Furthermore, 62.3% of the respondents were not aware if their area was vulnerable to the impacts while 37.7% of the respondents noted that they were aware if their location is a prone area.

Previous study and many evidences stated that climate change can affect the quality and quantity of water resource. However, the results of this study found that the majority (71.7%) of the respondents did not understand if climate change could influence the state of water resources. Only 28.3% mentioned that they understood the effect of climate change to water resources. The implication of this finding is that in the event of climate-related disasters, most of the residents might not relocate to other places because they believed that the impacts will not affect the supply of water resource. The community refused to accept by adapting the situation with their little knowledge and sometimes it became worse. In this regard, the role of local government together with non-government organization plays more important in the promotion of understanding and knowledge to the community about climate change, water resource, and its relationship.

Table 4. Perception on Climate Change and Water Resource

Statement		Frequency	Percentage
Understanding on the issue of climate change	Yes	40	37.7
	No	66	62.3
This area is vulnerable to climate change impacts	Yes	40	37.7
	No	66	62.3
Water resources' quality and quantity can be influenced by climate change	Yes	30	28.3
	No	76	71.7
Willing to move if the environment is better	Yes	68	64.2
	No	38	35.8

Source: Survey analysis result, 2015

Regarding the perception on climate change and water resource, it can be found that almost all respondents were not aware and did not understand the climate change phenomenon and its impacts as well as the relationship between climate change and water resource. It can be an indication that although the water and sanitation are available, but they still don't have a good awareness and understanding. This low understanding on the climate change indicates that they do not have a clear plan on what to prepare and what to do in the future if impacts of climate change are getting worse. On the other hand, they had

willingness to move to better environment (64.2%). Only 35.8% did not have willingness to relocate. Nonetheless, their willingness and intention to move to other places are limited by their financial access considering that over 95% of the respondents are low income people (less than IDR 3.5 million a month). They also are dependent to the work places located near their homes, which would add more transportation cost and times if they move to other places.

Respondents' Response on Climate Change Impacts to Water Infrastructure

In terms of the response of respondents related to the impacts on water sector, most respondents in the study area had adopted several measures to reduce the impacts to water infrastructure, such as by cleaning waterway, improving community awareness, constructing additional sanitation infrastructure, renewing the current sanitation infrastructure, building a simple embankment, and arranging land use.

Table 5. Responses to Reduce the Impacts

Response	Frequency	Percentage
Clearing drainage channels	73	68.4
Improving community awareness	14	12.8
Adding sanitation infrastructure	10	9.0
Renewing sanitation infrastructure	4	3.8
Building simple embankment	2	1.5
Arranging land use	1	0.8

Source: Survey analysis result, 2015

As indicated in Table 5, majority (68.4%) of the respondents involved in clearing drainage channels to reduce the impacts related to water sector. This measure did not necessarily mean that improvement in the drainage channels was expanded. As a result, this measure might not prevent flood waters or mitigate the disaster impacts. While, 12.8% of the respondents realized that improving community awareness is important to reduce the impacts. In addition, the measures of adding and renewing sanitation infrastructure (12.8) were done by the respondents to minimize the impacts. Only 1.5% and 0.8% of the respondents expressed that building simple embankment and identifying land uses, respectively, in their environment are effective measures in reducing coastal flooding and other water-related impacts.

Conclusion and Recommendation

The study findings show that the affected coastal community in the Tanjung Mas of Semarang City is extremely vulnerable because of land use growth and climate-related disasters, such as coastal flooding and extreme weather events. The locations of the residential buildings nearby the coastal area and low-lying area, the land-use pattern, as well as the state of available water infrastructure facility in this community contribute immensely to their vulnerability. It can be found that the precipitation and temperature trends in Semarang City are very fluctuating, which could cause coastal flooding and tidal flooding. The results also show the residents' responses and perceptions that people really understood the importance of water for quality of life, and the drivers of urban development contributing to reduce quality and quantity of water resource, but they had

not completely understood the relationship between climate-related disasters and water resource. The people in the affected coastal community have perceived that there was not significance matter related to water resource, even though they lived in prone area. In addition, they were unaware to climate change and disasters facing their area, such as the increase of flood trends, the change of weather pattern, land-subsidence, and the related potential risks to the supply of water needs and the quality of water.

Community's knowledge and awareness on the impacts of climate change and disasters related to water sector are limited. Thus, the affected communities' responses to the climate change impacts are poor; thereby it makes them to be more vulnerable to disasters. Based on these findings, there are some recommendations as follows: (1) An urgent need for the local government to provide advocacy campaigns and to involve community in disaster management [19]; (2) The local government should enforce building regulation to ensure that people do not build structures on flood plains and prone areas; (3) In terms of water infrastructure, it requires to find alternative water sources, such as rainwater harvesting, water pond, water reuse and recycling, etc. Implementation of green infrastructure is also one of alternatives to achieve environmental or sustainability goals [39]; and (4) Enforcement of the regulation to ensure people do not over-exploit groundwater.

This study provides influential evidences that urban coastal community has the ability to adapt the situation created by climate-related disasters. However, the performance of its current measures is only able to cope with the impacts in the short term period. It recommends that in long term intervention, the need of encouragement for local government to aware for climate-related disaster risk reduction and enhancing the coastal community to be able to manage the related current situation. This is in line with one study [40] that mentioned about the need to assess and understand the performance of adaptation measures based on several criteria, such as economic, environmental, social and institutional aspects, that the practical adaptation measure in one place will be different in another place due to geographical conditions; there is no one size fits all solution to adapt.

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