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Climate Change Impact on the Livelihood of Semarang Coastal Community

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Abstract — The Semarang coastal zone has high levels of vulnerability, danger, and risk caused by climate change impacts such as abrasion, seawater intrusion, and the phenomenon of land subsidence, which worsen the environmental conditions of the coastal areas. This study aims to determine the limitations of the ecological systems, the impact of climate change on society, and to identify the vulnerabilities of these coastal communities. This research was conducted as a qualitative study with a descriptive approach. Methods of data collection include: secondary data collection, observation, interviews and discussions. It is estimated that Semarang's Genuk District has approximately 1894.2 ha or 1.65% of the total area of land inundated by flood, and 1952.1 hectares or 0.56% of the total area in Tugu District. Additionally, the fishponds in the districts are predicted to disappear by 40% when following the increase of the sea level rise calculation of 21 cm. The increasing amount of area inundated by tidal floods has resulted in the loss of land use in the coastal area of Semarang, which impacts the livelihoods of fish farmers and fishermen. The conclusion of this study is that climate change is not only impacting the environment, but also the social and economic conditions of Semarang coastal communities. Fish farmers and fishermen are the most vulnerable communities facing these climate change impacts.

Keywords— climate change impacts, land subsidence, Semarang coastal area, vulnerability

INTRODUCTION

Semarang City, with 13.6 km of coastline and total area of 373.70 km², has great potential for capture and aquaculture fisheries. However, this condition can be turned into a threat to the community if the city is not managed integrally and sustainably. Based on the research results of Friend of The Earth (FoE) – Japan, since 1998 many of the coastal communities in the Tugu District have lost their river embankment due to tidal abrasion and tidal flood, resulting in the loss of roads and road access. In addition to the above conditions, Semarang is burdened with land subsidence, which has worsened the environmental condition of the coastal area of Semarang (Suhelmi, 2013).

Many efforts to improve the coastal environment have been led by the communities in the coastal areas of Semarang. For instance, the people of Mangkang Wetan village planted mangroves and constructed a breakwater (seawall), and the community of Dukuh Tapak in Tugurejo village also reduced the effects of abrasion in their area by installing a breakwater. In these examples, the breakwater was constructed from used tires filled with sediment mud. Since 2006, the efforts performed by Dukuh Tapak have been quite effective. The breakwaters are still in good condition due to routine maintenance achieved by re-filling the construction with mud. The presence of the breakwater has protected the embankment from continued abrasion. These communities also planted mangrove to provide additional protection from waves and strong wind, and to restore the ecological condition of their coastal areas.

Climate is defined as the average weather condition that is a complex interaction between physical, chemical, and biological processes which reflect the interaction between geosphere and biosphere occurring in the earth's atmosphere. Thus, the climate of an area or region is the statistical description of the atmospheric condition in the long term so that it represents the average weather variable (Murdiyarto, 1999). Based on the report of the Intergovernmental Panel on Climate Change (IPCC, 2001), Earth's climate system is complex and involves the interaction of various climate system components, including the atmosphere, hydrosphere, land surface, and biosphere. Climate change occurs as the result of two things, internal and external variations (either natural or anthropogenic). The impact of external factors on the climate can be compared by using the radiative forcing concept. The radiative forcing concept is defined as the measurement and influence of a factor in changing the energy balance, both inflow and outflow, in the earth's atmosphere system, as well as an index which shows the importance of that factor in the climate change mechanism. The positive radiative forcing factor tends to raise the earth's temperature; on the other hand the negative radiative forcing tends to lower the earth's temperature. The natural factors, such as the change in the solar output or volcano eruption activity, may also cause radiative forcing.

It is evidenced by the rise in sea levels. The IPCC projected that from 1990 to 2100 the increase of the global sea level would reach 18-59 cm, while the world's temperature would rise from 0.6°C to 4°C within that time frame. Resulting effects from the sea level rise are erosion, inundation of coastal areas, and the loss of wetlands rich in biodiversity (de Lourdes and Olivio, 1997). Based on Susandi *et al.* (2008), the impacts of climate change are:

1. The increasing frequency of natural disaster/extreme weather (landslides, flood, drought, tropical storm);
2. Threat to the clean water supply;
3. Shifting of weather and rain patterns;
4. Lowering farming productivity;
5. Temperature increase which causes forest fire;
6. Threat to biodiversity;
7. Sea level rise, which causes permanent flooding and damage of the infrastructure in the coastal area;

and the spread of diseases (typhoid, malaria, fever, etc.).

Furthermore, in addition to the physical impacts on the coastal areas, climate change has social, economic, cultural, and public health impacts that must be considered. Those impacts may cause government and community investments in the respective area become of no use. Merco 3 Corps (2009) identified the vulnerable areas and the impacts of climate change. The vulnerable areas are classified as follows:

1. The lowland coastal area, which is exposed to flood and sea level rise. Residential zones located in the coastal area are threatened by inundation due to sea level rise. Additionally, the embankment area is also threatened by inundation. This results in the decrease of production in the fishery sector and subsequently affects those reliant on fish farming livelihoods.
2. Areas which are exposed to flood. The areas exposed to flood will be frequently inundated due to effects of climate change such as unpredictable rainfall.
3. The hillside that is exposed to strong wind due to extreme weather. The strong winds often threaten the hillside communities.
4. Area which is exposed to subsidence and landslides. Due to climate change, the rainfall is more intensive in the wet season thus increasing the likelihood and severity of subsidence and landslides on hilly areas. Additionally, wave circulation triggers coastal abrasion.
5. Suburban settlements which are far from the water source. These remote communities are threatened by drought in the dry season.

, and vulnerabilities due to those impacts, on the coastal communities of Semarang. The primary focus of this study is to discuss the impact of climate change on the livelihoods of the coastal communities in Semarang.

RESEARCH METHODOLOGY

This study was conducted from June-December 2013 in the coastal area of Semarang, which was divided into two districts: Genuk District, which consists of Kelurahan Trimulyo; and Tugu District, which consists of Kelurahan Karanganyar, Kelurahan Mangunharjo, Kelurahan Randugarut, Kelurahan Mangkang Wetan, Kelurahan Mangkang Kulon, and Kelurahan Tugurejo.

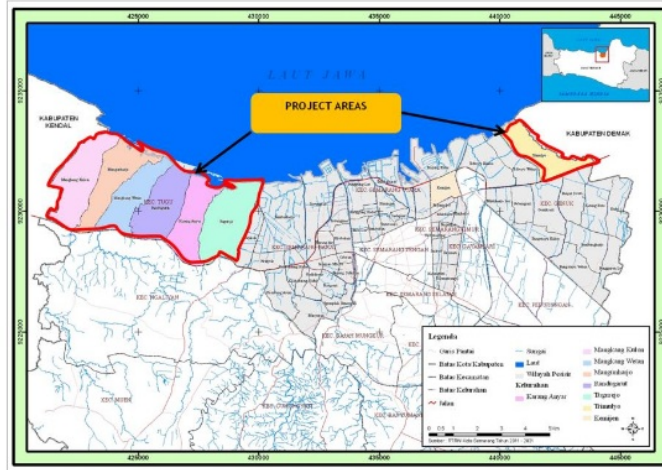


FIGURE 1. MAP OF THE RESEARCH LOCATION

The qualitative study uses a descriptive approach to provide an overview of the data collected regarding the ways the coastal communities in Semarang encounter climate change impacts. The data collected in this study include secondary data and primary data collected through observation, interviews, and focus group discussions (FGD).

DISCUSSION

Effects of Climate Change

Changes experienced throughout the world are caused by the global warming of the earth. As some parts of the world become drier, other parts experience increased rainfall; the effects of climate change are not the same for every region, and not all coastal populations have increased flood risk. The disturbed climate patterns have a direct effect on human health. This is evident in the rise of disease and deaths correlated with extreme temperatures and air pollution caused by spores and fungus. Indirectly, the change in weather patterns can have an effect on public health through water or food-borne diseases, vector and rodent transmitted diseases, or diseases caused by lack of food and/or water. Climate change also endangers the ecosystem's stability and biodiversity.

The climate disturbance has become a serious problem in Semarang, especially the coastal region, which is affected by sea level rise (SLR). According to Asian City Climate Change Resilience Network (ACCCRN) 2010, the resilience strategy of Semarang estimated that the Tugu and Genuk Districts were threatened to be inundated due to SLR. Tugu District has an estimated area of 1,952.1 ha of land, or 0.56% of the total area, already inundated. Genuk District has 1,894.2 ha of land, or 1.65% of the total area, inundated as a result SLR, and about 40% of the total embankment area was estimated to be lost. Following a SLR calculation of a 21 cm increase, 7.2 billion IDR is estimated to be lost each year. If we add it with the other climate challenges, such as wind, extreme temperatures, and increased rainfall, those conditions result in reduced production for fishermen and fish farmers.

From the study of Miladan (2009), Tugu District is presently under greatest threat from sea level rise, with an inundated area of 1,689.133 ha. Tugu has high vulnerability caused by land use in the northern region as embankment area. The topographical condition (the slope) of Tugu District is less steep than the other district at coastal area of Semarang with land gradient of less than 25%.

In addition to Tugu, Genuk District also has quite high vulnerability. This is caused by a concentration of human activity, such as residential areas and industry. The increase of the inundated area due to SLR is

predicted to reduce land use in the coastal area of Semarang.

The extreme climate change. The effects of climate change not only cause the increase of tidal flooding in Semarang, but also cause the increase of wave height in the Java Sea. The rising tides in the Java Sea present safety risks, and fishermen are often reluctant to go fishing. This has led to a reduction in fishing productivity and has forced some fishermen to change their profession to factory labor or construction workers.

Social and Economic Effects

Semarang City has a coastal area 13.6 km long. As in other coastal cities in Indonesia, climate change occurring in the last decades has resulted in ecological problems, namely abrasion and tidal flood caused by SLR and extreme wind patterns. Irresponsible management and land use change aggravates the condition.

The effects of climate change do not only affect the environment, but also the social and economic health of the communities along Semarang's coastline, especially at Tugu and Genuk districts of Semarang. The effects of climate change on the social life and economy of the community is evidenced by a vulnerability analysis, which identifies the socio-economic conditions that affect the vulnerability of the community when climate change impacts occur, specifically sea level rise. Vulnerability is easily affected by danger or potency to change or transform a system when facing disturbance (Gallop, 2006). Meanwhile, Miladan (2009) explains that the socio-economic vulnerability of a community to climate change could be analyzed through the level of poverty and land ownership status.

Poverty level is an indicator of climate change effect on the socio-economic condition of a community. A population's poverty level will affect the community's perspective on addressing climate change. An assessment of the poverty level vulnerability in Semarang is shown in the following table.

TABLE 1 ASSESSMENT OF THE POVERTY-LEVEL VULNERABILITY IN VULNERABLE INUNDATED AREA DUE TO SEA LEVEL INCREASE IN 2009*)

Kelurahan	Poor RT in inundated area (%)	Weight	Score	Vulnerability	Value
Mangkang Kulon	41,64	3	2	Intermediate	6
Mangunharjo	35,39	3	2	Intermediate	6
Mangkang Wetan	50,66	3	2	Intermediate	6
Randu Garut	33,75	3	2	Intermediate	6
Karang Anyar	29,01	3	1	Low	3
Tugu Rejo	41,52	3	2	Intermediate	6
Trimulyo	25,87	3	1	Low	3

*Miladan (2009)

According to As seen in Table 1, the vulnerability levels of the population in the coastal areas of Semarang, especially in Tugu and Genuk districts, are between low and intermediate. Kelurahan Mangkang Kulon, Mangunharjo, Mangkang Wetan, Randu Garut and Tugu Rejo have intermediate vulnerability, while Kelurahan Karang Anyar and Trimulyo have low vulnerability to climate change impacts according to the poverty level in those regions. The intermediate and low vulnerability levels are based on the percentage of poor in the population in the area vulnerable to sea level rise; vulnerability is not high compared to the total population. Furthermore, Suhelmi (2013) categorized Tugu District as a region that will not see vulnerability increase by 2030 because it is located in an area with little land subsidence.

Effects of climate change on the social economics of the community can also be observed through the analysis of land ownership status, be it community, private, or government owned land. Land ownership vulnerability is used as an indicator because land ownership highly affects the community-owned assets which threaten to be lost as a result of climate change impacts.

Based on analysis and evaluations that have been performed, it is known that on average land ownership in the coastal region of Semarang has high vulnerability. This is because much of the land owned by the community is located in the inundated areas. The high vulnerability level in the seven kelurahan at Tugu and Genuk districts shows that climate change leads to loss of community assets ownership, which negatively affects the socio-economic condition of the community. This is also supported by findings following field observations of the socio-economic problems of the seven kelurahans at Tugu and Genuk districts.

The productivity of embankment livelihoods on Semarang's coastline is also negatively impacted by climate change and has been in decline year after year. In 1989 – 1990 the 3 – 5 Ha embankment had a production rate of 1–2 ton/ Ha; in 2000 the productivity started to decline with only 0.5 – 2 ton/Ha; now the average fish farmer can only catch 0.3 – 1 ton/Ha.

As the effects of climate change occur more frequently, fish farmers are encouraged to employ adaptation efforts, such as increasing the height of the embankment dam. In the 1980s, the community focused on embankment maintenance to, but now activities are aimed to maintain and protect the embankment from tidal flood. The frequency of dam enhancement has also increased. Previously, maintenance only occurred once a year, but since 1990 dam enhancement is conducted twice a year and considers the condition of the embankment and surrounding environment. In general, the communities in the coastal area of Semarang already have good adaptive capacity. They improve their conditions according to the

environment, and they have the ability to minimizing the potential of danger. Adaptive capacity is the ability to adapt to all possibilities that may occur in the environment (Smit and Wandel, 2006). According to IPCC (2001), adaptive capacity is defined as natural or system management used to respond to and estimation climate stimulation and its effects, and use or exploit to their advantage.

Aside from dam enhancement, fish farmers also used perimeter nets to prevent loss of milk fish and shrimp due to tidal flood and abrasion. Thus, as a consequence, the investment became expensive and as a result some of fish farmers changed their professions or engaged in additional work on the side, or alternative livelihoods. Alternative livelihoods have been utilized by the fishing community for quite a long time. It is noted that in the 1980s, fish farmers were also farming rice. However, as the ecology of the area has changed, so has the paradigm of the fish farmers. Beginning in the 1990s, fish farmers engaged in construction and trade, and as mangrove cultivation increases, fish farmers have grouped together to make mangrove cultivation a livelihood.

The climate change in Semarang negatively affects the fishermen in seven kelurahans in this study. In general, the categories of fishermen in the seven kelurahans are estuary fishermen who use boats without an engine and those who use boats with a small, single engine. Hence, the yield of the fishermen is generally not very large. The types of fish caught include mullet, shrimp, kodo fish, milk fish, and crab. The number of fish caught from year to year is declining. During 1980 – 1990s fishermen could catch an average of 4 – 10 kg/ day, but from 2000 onward fishermen can only catch 3 – 5 kg/ day. The reduction of catch is a result of the increase of sea wind intensity and sea tides caused by climate change and fishing location change. The catch timing remains the same, which is in the river area in between 17.00 – 03.00 (West Indonesia Time) or in between 06.00 – 16.00 (West Indonesia Time). The reduction of the number of catch is also caused by practice of some fishermen in using toxins to catch fish or shrimp. The use of toxins hampers the reproductive process of fish. Just like the fish farmers, fishermen in the seven kelurahans also rely on alternative livelihoods to support their economy. These livelihoods include fish farming, rice farming, or labor.

SUMMARY

Climate change that occurs today does not only affect the environment, it also affects social life and the economy of the communities along Semarang's coast. Fish farmers and fishermen are the most vulnerable community groups in facing climate change.

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