LIVELIHOOD CHANGES OF FISHERMAN COMMUNITY DRIVEN BY CLIMATE CHANGE: A CASE STUDY IN SEMARANG COASTAL REGION, CENTRAL JAVA, INDONESIA

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Abstract
Purpose of Study: Climate change has triggered sea level rise so as to increase the height of tidal inundation (rob)in coastal areas. Fishermen face the highest risk since their livelihoods and settlement are directly adjacent to the sea in compared with other communities. This paper describes how fishermen living in the flood-prone areas can survive from the flood triggered by climate change. The house renovation certainly requires a lot of funds thus encouraging the fishermen to seek alternative sources to obtain higher income. Most of the fishermen in coastal Semarang change their livelihood from fishing to cultivating green mussels. They utilize the coastal areas inundated by the tidal flood to cultivate green mussels.

Methodology: The approach used in this study was qualitative with the case study method. Sample cases were selected using snowball sampling. Data were collected through in-depth interviews with informants.

Results: The results showed that fishermen living on the coast of Semarang have to face tidal floods with an increasingly high inundation by an average of 1 m/10 years. The increasing height of tidal flood from year to year has forced the fishermen to renovate their houses raising the building approximately every 10 years. The renovation certainly requires a lot of funds thus encouraging the fishermen to seek alternative sources to obtain higher income. Most of the fishermen in coastal Semarang change their livelihood from fishing to cultivating green mussel. They utilize the coastal areas inundated by the tidal flood to cultivate green mussels.

Implications/Applications: However, green mussel cultivation successfully gains higher income as well as more sustainable than fishing. Statistically, it is evidenced by the capability of the fishermen in renovating their houses from preventing them inundated by the tidal flood.

Keywords: livelihood, climate change, fisherman, tidal inundation, Semarang, Indonesia.

INTRODUCTION

Climate change has become one of the greatest challenges in this century to be resolved immediately. The magnitude of disaster derived from climate changes can lead to complex problems, both at the global and regional scale. One of the consequences brought by climate change is the sea level rise, which potentially leads to serious damage particularly in the coastal areas.

It is expected that the global sea levels will rise between 22 cm to 34 cm in the period of 1990—2080. This is primarily caused by the expansion of ocean temperatures and melting of glaciers (Nicholls et al., 1999). In addition, the acceleration of sea level rise will worsen coastal conditions, cause flooding in coastal lowlands, sandy beach erosion, and damage to houses and buildings in coastal areas (Snoussi et al., 2008). The impact of flooding by sea level rise has been experienced by most coastal areas. Meanwhile, the growth and development of urban areas in the area increase the risk of flooding (McGranahan et al., 2007). Decreased soil due to groundwater retrieval and decreased sediment deposition rates also increase the risk of flooding. High urbanization and rapid development in coastal area are as are among the factors driving the occurrence of land subsidence. Basically, the combination of land subsidence and sea level rise will ultimately increase the risk of flooding.

The most vulnerable areas affected by sea level rise are coastal areas and urban areas adjacent to the coast. A study performed by the US National Science Foundation found that about 600 million people (approximately 10% of the world population) currently live in areas within 100 km of the coast and at an altitude of fewer than 100 m above sea level. Of
these, 360 million people live in urban areas. When the sea level rises above the land, seawater will inundate the entire land. This condition will adversely affect the environmental quality and life of the surrounding community.

Indonesia as an archipelagic country is one of the countries vulnerable to flood hazards due to sea level rise. One of the most dangerous flood hazards is those occurring in coastal areas. Most of the coastal cities in Indonesia are vulnerable to flooding. Semarang city, one of the big cities in Indonesia has endured the impacts for years. Coastal floods along with high waves due to tidal movements and accelerated by sea level rise due to climate change caused tidal flooding (Marfai and King, 2008). The tidal floods in Semarang are also exacerbated by land subsidence resulted from excessive groundwater exploitation and rapid urban developments in the coastal areas of Semarang. The combination of sea level rise and land subsidence increases the risk of tidal flooding in coastal areas of Semarang (Marfai et al., 2008).

Tidal inundation, flood, and land subsidence are among the problems faced by Semarang city related to climate change (Suhelmi, 2013). Tidal floods (in the Javanese language called "rob") are floods that occur due to high tides that inundate areas with a lower altitude than sea level. The duration of inundation ranges from days to year depending on the degree of saturation of the soil. On saturated soils, flooding may occur throughout the year. Nevertheless, Tidal flood can occur either directly or indirectly. Tidal flood directly occurs in the coastal areas where the highest tides enter the coastal plains and are retained by land or buildings. While indirect tidal flood frequently occurs in areas far from the sea with poor drainage channels. At the highest tide, the seawater enters the drainage channel, then through the untreated embankment breaks into the land and inundates the area (Kurniawan, 2003).

Climate change has changed the environment gradually rather than suddenly. Similarly, inundations of periodic tidal floods in coastal areas slowly cause environmental degradation and eventually damage facilities and infrastructure. Consequently, these slow changes provide an opportunity for residents to take action in order to survive in the area (Nurlambang, 2011). Therefore it is not surprising residents with positive place valuation and good disaster adaptation tend to stay although threatening by disaster (Amin et al., 2019).

Fishermen face the highest risk since their livelihood and settlement are directly linked to the sea. However, they make various efforts to survive in facing climate-triggered disasters. This study aimed to describe how the fishermen of Kampung Tambak Lorok who live in the coastal area of Semarang can survive in facing the disasters triggered by climate change.

**METHOD**

The approach used in this study was a qualitative approach. The qualitative approach examines the perspectives of participants/informants with strategies that are interactive and flexible. In this research, it was intended to understand the survival efforts conducted by fishermen in Kampung Tambak Lorok against tidal flood disasters triggered by climate change.

In addition, a case study was employed as a method in this study. It was intended to intensively investigate the background of the current state and position as well as the interaction of a given social environment. A case study is an in-depth study of a particular social unit which results provide a broad and deep overview of a particular social unit. The subjects studied by using this method are relatively limited, although the variables and focus of study have a very wide dimension.

**DataCollection**

The data in this research was obtained through an in-depth interview. This technique was used in relation to qualitative data collection methods in this research, namely the case study method. In the case study, the information should be detail, in-depth, and explorative where the development of relevant information is possible. Furthermore, in-depth interviews were ended when there was no new information that could clarify and deepen the phenomena being studied, was found out.

In-depth interviews included questions about how the environmental conditions affected the circumstance and the efforts undertaken to deal with the environmental conditions affected by the tidal flood. The results of in-depth interviews and observations were presented in diary form.

In-depth interviews were conducted on case units. The selection of case units was performed using snowball sampling technique, i.e. by using a reference from the previous case unit. This technique was considered very precise in terms of effectiveness in obtaining unit cases in accordance with the expected criteria. In snowball sampling, researchers can make initial contact with small groups of people who are relevant to the research topic and then use it to establish contacts with other cases, therefore, a sample frame is no longer required in this method (Bryman, 2012).
Data Processing

Data processing was done by making memos, coding, categorization and analytic files. The memo was significantly important for this researcher to record field notes or interview results. Consistent coding for the same phenomenon is also required during the analysis of the interview transcripts or field notes. Meanwhile, the analytical archive refers to the process of analytical data archiving in the process of of data collection. To make the analysis easier, the researchers classified each archive, for example by sorting the generic archives such as question interview archives, respondent archives, and archives of sites or locations, from the beginning of the stage.

Data analysis

Data analysis was commenced at the beginning of data collection, data reduction, data presentation, until the formulation of conclusions. The analysis of qualitative data in this research involves two important processes, namely: (1) recognition and separation between the researchers’ opinion and the informants’ opinion; and (2) data re-arrangement in accordance with the increasingly sophisticated interpretation of data (Alwasilah, 2012).

Therefore, this research used the contextualization analysis strategy so that data could be organized systemically and analytically. Instead of seeking common ground to be included in a context-free category, context analysis strategies was used to determine relationships that relate questions to events in the climate change context.

RESULTS AND DISCUSSION

The location of the study

Semarang City is the fifth largest city in Indonesia. It has a total area of 373.67 km² with a population of about 1.5 million. Since the 1990s, Rapid increase of population and urbanization has been a part of this city, particularly in the northern coast and some lowland areas.

There are 4 sub-districts in Semarang City directly in adjacent to the northern sea of Java Island, namely Tugu sub-district, West Semarang sub-district, North Semarang sub-district, and Genuk sub-district. In line with the development of urban activities, the coastal areas have developed into a residential area, warehousing area, and public services, such as trade facilities, offices, health centers, and so forth. North Semarang sub-district, for instance, is also transformed into a transportation hub of 3 (three) main modes, namely Tanjung Mas Seaport, Ahmad Yani Airport, as well as Tawang and Poncol Railway Stations.

With the main functions as mentioned above, Semarang coastal area becomes an area that has a high intensity of public activities in terms of strategic land value, due to its association with the central business district (CBD). This condition is supported by the availability of flat and sloping land, which support the efficient utilization of space. However, as mentioned earlier, some obstacles remain to be a major consideration, given that the area is vulnerable to threats of inundation, sea level rise, and land subsidence.

Kampung Tambak Mulyo (formerly called Tambak Lorok), which is administratively included in Kelurahan Tanjungmas, North Semarang Sub-district, is known as the fishing village in Semarang City. With a population of approximately 13,500 people divided into 5 citizen’s association (RW) and 34 neighborhood association (RT), the majority of the population in this village fishermen and employees related to marine fisheries.

Before the increase of population rate, Tambak Lorok area was a meadow, weeds, and fish ponds. There was no village road built in the area. At the beginning of the 1950s, several welir houses (house made of coconut leaves) were initially built. The number of such houses was less than 10 houses and inhabited by some fishermen who became the earliest residents of this village.

Most of the residents of Tambak Lorok are immigrants who came from Demak and Jepara. This village began to have a population in 1975 in which the majority of the population were fishermen. The population increased after the Central Java Provincial Government established Tambak Lorok as a residential area in 2000 and granted land ownership rights to residents.

Currently, Tambak Lorok is the largest fishing village in Semarang City. The activities of the fishermen in this village are not much different from those in other fishing villages. However, there is a serious peril in relation with sea level rise as an impact of climate change that is exacerbated by land subsidence.
Tidal flood inundation in Tambak Lorok

Tidal flood in Semarang is caused mainly by sea level rise and land subsidence. Examined from its nature, sea level rise is both the global and the local impact. Local sea level changes occur as an effect of land subsidence that only covers a narrow area, while global sea level change is caused by the increase in seawater volume as the result of melting ice at the poles due to the effect of global warming. Both of these causes an increase of inundation height of the tidal flood in the coastal areas of Semarang (Marfai et al., 2008).

The increase in of tidal flood height in Tambak Lorok is considered to be quite fast. An informant informed that when he was in the 4th grade of elementary school, around 1992/1993, the area was higher than the sea. Approximately 1 (one) km from the resident’s house to the north (toward the sea) was formerly a coastal area. The area used to have open fields, even many soccer fields. Subsequently, the area development turned the open field and playground into fish ponds and diminish them. However, after the tidal flood water was getting higher from day to day, the number of fish ponds declined. In 2016, there was no single fish pond could be found because the entire area was inundated by sea water.

Currently, the beach that once existed has been inundated by sea water. The beach does not exist anymore and the village is directly adjacent to the sea. The settlement is only about 5 meters from the sea, even some houses are directly in contact with sea water. As a consequence, the walls and roofs of those houses are susceptible to big waves that may cause major damage.

The average increase in the height of tidal floods about one meter per 10 years. The increase is caused mainly by land subsidence and sea level rise. Land subsidence is related to groundwater extraction generally in the form of uncontrolled drilling of artesian wells. On average, each RT has one artesian well where the water is sold to supply the needs of the surrounding community.

The height of the tidal flood continually rises and the houses adjacent to the coastal area start to drown. Consequently, the residents have to raise the height of the buildings and to spend the fund to rebuild their houses.

An informant informed that in 1994, the foundation of his house was 2 meters above the ground and it was a two-story house. Twenty years ago, his house was the highest building in the village. Recently, the 1st floor of his house has been stockpiled into the floor of the current house. Two years ago, the road in front of the house was elevated and now, it becomes just like a small river because it is inundated by sea water if a tidal flood occurs. The settlement is the most important area in the activity of disaster mitigation. The biggest detriment caused by the disaster is generally situated at the settlement or residential area (Marwasta and Priyono, 2007).

Another informant also mentioned that currently, the tidal flood has not reached his house yet. The inundation of tidal flood just reached the street in front of his house. However, he predicted that in less than two years, the tidal flood will surely enter his house. Therefore, it can be estimated, if the residents elevate their houses one meter from the ground, the houses will be inundated in the next 10 years.

In the dry season, the tidal flood comes quickly and disappears quickly as well. But in the rainy season, tidal flood usually pools longer. In the rainy season, the dense buildings hinder the flow of rainwater, thus even in the absence of tidal flood, the settlement is still inundated. Therefore, when the tidal flood comes, the inundation is worse.

However, the flash floods occurred in January 2014, the houses in Tambak Lorok were also inundated. It was heavy rain
along with the arrival of the tide, coupled with the Southwest monsoon winds which made the tidal waves rose high and the area was flooded with water as high as the chest of an adult. It was midnight, the sea water rise increased driven by strong winds from the sea combined with heavy rain that caused the flood. At that time, some of the residents whose houses are at the seaside were evacuated.

Fisherman livelihood changes

Fishermen of Tambak Lorok face a threat of tidal flooding which the inundation level increases by an average of one meter per 10 years (1 cm per year). The increase in the inundation level of tidal flood forces fishermen living in Tambak Lorok to renovate their houses every 10 years. Renovation is in stockpiling the old house and elevating the house. The height of the house is enhanced so as not to be inundated by the tidal flood. It surely requires special funds, therefore, they need a steady income and higher than common income to afford the house renovation.

In fact, most of the fishermen has unstable income depending on the season. An informant stated that in the dry season, the fishermen in his village gain lower income than in the wet season. It is because the gain of fishing is also lower. Generally, they leave to sea from 05:00 AM to 02:00 PM and only get a few pounds of fish.

On the one hand, the yield is declining, while on the other hand, the price of fuel for ship engines is increasingly high. Thus, the income of fishermen decreases from year to year while they face increasingly serious threat from tidal flood.

Furthermore, the lack of fish catching triggers some fishermen to change their livelihood from fishing to cultivating green mussels. It has been done by fishermen for the last two years, approximately since 2014. It is made in relation with the insistence of the need to afford house renovation and the unstable income from fishing.

The presence of abundant green mussels begun since the inactive operation of Tambak Lorok Steam Power Plant in 2012. The power plant was operated by using fuel oil, hence it could not survive when the price of fuel oil enhanced sharply. The number of green mussels in adjacent to the former power plant is indeed more and more easily obtained. It is because when the power plant was operated, the chemical liquid was used to clean up the green mussels attached to the steam power plant in the sea from preventing the chimney was clogged. As a result, the green mussels in the ocean around the power plant were also affected. The number of green mussels population was limited. But since the power plant is inactive, the green mussels are widespread easily. Even with only the use of bamboo stuck in the seabed, many green mussels will attach to the bamboo.

Figure 2: Bamboo as a medium of green mussels cultivation.

Currently, many fishermen turn their livelihood from fishing to green mussels cultivation. Approximately hundreds of green mussels cultivation media have been established by fishermen on the coast of Semarang City.

This change is due to the cultivation of green mussels provide a more stable and higher income. Furthermore, the income gained by the community from green mussels cultivation does not depend on the season. The green crop is high, both in the dry and the rainy seasons, while the income from fishing highly depends on the season.

Currently, the fisherman can harvest 100 kg of green mussels a day on average. The yields sold at local fish auction Tambak Lorok. The price of green mussels is IDR 3,000/kg, in average the income is 100 kg x IDR 3,000= IDR300,000/day. The primary expenditure is to buy gasoline for boat engines, which amounts to IDR50,000/day. Therefore, the net income of fishermen is IDR300,000 to IDR50,000 = IDR250,000 in a day. The monthly income is IDR250,000 x 26 working days = IDR6,500,000. Meanwhile, the regional minimum wage of Semarang City (UMR=Upah Minimum Regional) in 2016 was IDR210,000. Thus, the total income of fishermen who cultivate green mussels is much higher than the UMR. It is
approximately three times higher than the UMR of Semarang City.

Moreover, by cultivating green mussels, the working load is also lighter. They will be in the sea for only about 3-4 hours/day, started in the morning at around 7:00 AM and finished at 1:00 PM. To harvest green mussels, fishermen must dive under the sea about 2-3 meters. There are fishermen who dive without any tools of diving, but the crop is usually less because they cannot live longer without any diving tool. Fishermen who harvest green mussels without any tools will get tired easily and usually gain a maximum of 100 kg of green mussels per day. While fishermen who use air compressors by using Décor can dive longer hence they will be able to harvest more green mussels up to 200 kg of green mussels per day.

However, fishermen should be equipped to cultivate green mussels. The main requirement is the cost to make the bamboo *rump on* for green mussels cultivation, which is quite expensive. Bamboo *rumponis* a place where green mussels will stick and flourish. Fishermen need as many as one trucks of bamboo that costs approximately 5-6 million rupiahs. In addition, bamboo for green mussels cultivation must be replaced every year. Thus, the fisherman must spend about 5-6 million rupiahs to build bamboo *rumpon*. To replace bamboo on a regular basis, an informant informed that he used to save money every day at a bank near to the local fish auction. If he earns a net income of IDR 200,000, he will save INR 50,000 in the bank and give IDR 150,000 to his wife for daily expenditure. By saving some of his earning, he will have no difficulty in buying the new bamboo to replace the bamboo *rumpon*.

The bamboo *rumson* will be harvested about 5-6 months after being plugged in on the seabed. Usually, each fisherman not only have one bamboo *rumpon*, but some bamboo *rumpon* that are planted in different periods in order to get harvest green mussels continuously.

Fishermen in Tambak Lorok utilize coastal areas that are now inundated by seawater due to the increase of sea level rise to cultivate green mussels. Thus, there is a livelihood change from fishing to cultivating green mussels.

The cultivation of the green mussels requires the patience of the fishermen because the harvest is done every four months. However, the profit earned from the harvest can cover the losses during the cultivation period. Income from green mussels cultivation is not fluctuating and the fishermen can gain higher income than the income obtained from fishing in the sea. The income is more than enough to afford their daily needs. And more importantly, the income from green mussels cultivation makes fishermen have the financial ability to renovate the height of their house that drowned by tidal inundation.

**CONCLUSION**

Climate change has changed the environment gradually rather than suddenly. The periodic tidal flood in Kampung Tambak Lorok gradually leads to environmental degradation. The height of tidal flood increases by one meter per ten years causing the houses drowned slowly. This slow change, however, provides an opportunity for fishermen to make efforts in order to survive in the area. Fishermen in Tambak Lorok survive in flood-prone areas of the tidal flood by utilizing coastal areas that are now inundated due to the increase of sea water rise to cultivate the green mussels. It leads to a livelihood transformation from fishing in the sea to cultivating green mussels. The income gained from green mussels cultivation is high and steady,
therefore, the fishermen have the ability to afford the house renovation from preventing them inundated by tidal flood.

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