

ANALYSIS OF FISHERMEN'S RESPONSES AS AN EFFORT TO MITIGATE AND ADAPT TO CLIMATE CHANGE IN TAMBAK LOROK

ANALISIS RESPON NELAYAN SEBAGAI UPAYA MITIGASI DAN ADAPTASI PERUBAHAN IKLIM DI TAMBAK LOROK

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ABSTRACT

Climate change is a natural phenomenon resulting from global warming on earth which occurs continuously and increases every year. The main factor causing global warming is greenhouse gases produced from human and industrial activities. Coastal areas are zones that play a large role in the world carbon cycle which influences global warming. The low response of coastal communities to climate change can have an impact on the emergence of social and ecological problems, namely tidal floods. The purpose of this research is to analyze the fishermen's response to climate change as a mitigation and adaptation effort in Tambak Lorok, Semarang City. This research uses a quantitative descriptive approach, with research subjects of 30 respondents. The research results show that as many as 67.72% of the fisherman's already respond to the climate change phenomenon in Tambak Lorok, Semarang City. The climate change mitigation efforts carried out are mangrove restoration and conservation by cultivating mangroves and collaborating with Corporate Social Responsibility to carry out environmental programs based on mangrove conservation such as the planting program of 1,000 mangroves in the coastal area of Tambak Lorok. It is hoped that this program can be a commitment of the community and industry that synergize to mitigate climate change in Tambak Lorok.

Keywords: global climate changes, mitigation effort, tidal floods.

ABSTRAK

Perubahan iklim adalah fenomena alam yang diakibatkan dari pemanasan global di bumi yang terjadi secara terus menerus dan meningkat setiap tahunnya. Faktor utama yang menjadi penyebab pemanasan global adalah Gas Rumah Kaca yang dihasilkan dari aktivitas manusia dan industri. Wilayah pesisir merupakan zona yang memegang peranan cukup besar dalam siklus karbon dunia yang mempengaruhi terjadinya pemanasan global. Rendahnya respon masyarakat pesisir terhadap perubahan iklim dapat berdampak pada timbulnya permasalahan sosial dan ekologi yaitu banjir rob. Tujuan dari penelitian ini adalah untuk menganalisis respon nelayan terhadap perubahan iklim sebagai upaya mitigasi dan adaptasi di Tambak Lorok Kota Semarang. Penelitian ini menggunakan pendekatan deskriptif kuantitatif, dengan subjek penelitian 30 responden. Hasil penelitian menunjukkan bahwa sebanyak 67,72% nelayan sudah merespon terjadinya fenomena perubahan iklim di Tambak Lorok Kota Semarang. Upaya mitigasi perubahan iklim yang dilakukan adalah restorasi dan konservasi mangrove dengan melakukan budidaya mangrove. Selain itu berkolaborasi bersama *Corporate Social Responsibility* untuk melakukan program lingkungan berbasis konservasi mangrove yaitu program penanaman 1.000 mangrove di wilayah pesisir Tambak Lorok. Harapannya program ini dapat menjadi komitmen masyarakat bersama industri yang bersinergi untuk mitigasi perubahan iklim di Tambak Lorok.

Kata kunci : perubahan iklim global, upaya mitigasi, banjir rob.

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INTRODUCTION

An increase in greenhouse gases in the atmosphere, oceans and land on earth if it occurs continuously and over a long period of time can cause global warming. Based on research by IPCC R.K. Pachauri (2014), the increase in greenhouse gas concentrations in the atmosphere is caused by increased human activities such as the use of fossil fuels for industrial and transportation purposes, air conditioning, freon, forest fires and so on resulting in an increase in global average surface temperature observed from 1951 to 2010. According to Afdal (2016), an increase in CO₂ in the atmosphere results in an increase in sea surface temperature and causes sea level rise.

Social and ecological problems in coastal areas are important problems that are interconnected with each other. One of them is the relationship between environmental management factors. According to Hafsaridewi et al., (2018) ecological systems in coastal areas are closely interconnected and influenced by one or more social systems. Where in this social ecological system is an integration between understanding ecology and socio-economic values in coastal management which aims to maintain and maintain the sustainability of the ecosystem so that it is able to guarantee the continuity of resource supply for the social and economic interests of the community.

Environmental conditions are decreasing due to climate change, such as water pollution and reduced fisheries productivity. Coastal communities, fishermen and cultivators in Tambak Lorok have experienced the impact of climate change, namely tidal floods, due to damage to the mangrove ecosystem and an increase in sea surface temperature or sea level rise, as a result, if the sea waves are high, the fishermen in Tambak Lorok village cannot go to sea. According to Bunga et al., (2013) the low level of human resources in coastal areas and the threat of climate change are direct causes of the decline in fisheries production. This will cause a further decline in the level of welfare of the fishing community. Therefore, appropriate concepts are needed to overcome the problems that exist in coastal areas (Andersson et al., 2013).

Sustainable Livelihood emerged as an effort to balance the relationship between human activities and nature, which does not reduce the opportunity for future generations to enjoy quality life. According to Lathifah & Khoirudin (2021) that sustainable livelihood is an integration between capability, equity and sustainability. Therefore, the use of this concept is able to realize development evenly and fairly according to the capabilities/potential possessed in a region. This sustainable livelihood approach was chosen because the degree to which social and ecological needs are met is carried out in a fair and balanced manner by combining activities and the use of existing capital in the living system. It is hoped that this approach concept will help coastal communities become more independent and empowered in efforts to mitigate and adapt to climate change (Alifian et al., 2022).

Tambak Lorok is one of the fishing villages located on the coastline of the Java Sea. According to Geospatial Information Law no. 4 Year 11 article 13 which explains that the coastline is the line where land meets the sea which is influenced by tides. According to Natalia et al. (2014), coasts are areas that are vulnerable to sea level rise, one of which is the coast in the North Coast region of Java. Tambak Lorok is a coastal settlement in the city of Semarang which currently has a very

worrying condition and is prone to disasters. Its location on the edge of the sea makes Tambak Lorok prone to disasters such as floods, land subsidence and tidal waves. Tidal floods that hit this settlement usually reach a height of 60 cm. Tambak Lorok's location close to the sea has resulted in this area developing into a fishing village. The fishermen who live in Tambak Lorok are mostly traditional fishermen who still use simple tools for their work and are very dependent on the weather. Therefore, Tambak Lorok is suitable as a place for research and it is important to carry out mitigation efforts on climate change at this location to find out how fishermen respond to the climate change phenomenon that is occurring.

RESEARCH METHODS

This research was conducted on January 24 2023 in Tambak Lorok, Semarang City, Central Java. The subjects of this research were fishing communities with a sample size of 35 people from a total population of 138 people. This research uses a mixed method, namely a qualitative and quantitative approach.



Figure 1. Map of Research Location

Data analysis in this research uses descriptive analysis and linear regression to measure how big the influence is between the fisherman response variable and the education level variable. The main variables used in this research include (Table 1).

Tabel 1. Main Research Variables

No	Research Variable	Research Indicator	Category
1	Social capital	Institutional conditions	Good enough
2	Natural capital/environment	Ecological conditions and fisheries production	Not Enough
3	Physical capital	Type of equipment, accessibility, sanitary conditions and drainage conditions	Good enough
4	Human capital	Level of education, skills and response of fishermen	Good enough
5	Financial capital	Average monthly income of fishermen	Good enough

RESULT AND DISCUSSION

A growing global issue, namely climate change, can cause disasters in coastal cities. Based on previous research conducted by Alifian et al., (2022), currently 71% of the earth's surface is covered by sea so it cannot be denied that the ocean greatly influences the movement and circulation of the atmosphere and the weather in any area on earth. Changes in SST (Sea Surface Temperature) such as high CO₂ gas in the atmosphere and in the sea occur due to the melting of glaciers and icebergs in the polar regions. According to Afdal (2007), sea level rise over a long period of time will result in an increase in the volume of sea water so that it can increase the intensity and frequency of floods and inundation of land areas can occur. According to Setianingsih (2018), the rise in sea level causes a reduction in land area such as changes in coastlines.

According to Afdal (2016), increasing sea surface temperatures cause sea water to expand so that the volume of sea water increases. It is known that this increase in sea water temperature is accompanied by high values of water pCO₂ and ΔpCO₂ which causes the function of waters to become a source or releaser of CO₂. This means that when water conditions function as a source of CO₂, there is the potential for sea level rise. Rising sea levels cause land area to decrease and coastlines to decline. This also causes when high tide occurs, sea water enters settlements and other land uses, thereby disrupting residents' activities. According to Wacano et al., (2013) tidal floods are flooding events caused by the entry of sea water onto land as a result of high sea tides.

The Result of data Analysis from BMKG (Meteorology Climatology and Geophysics Council)

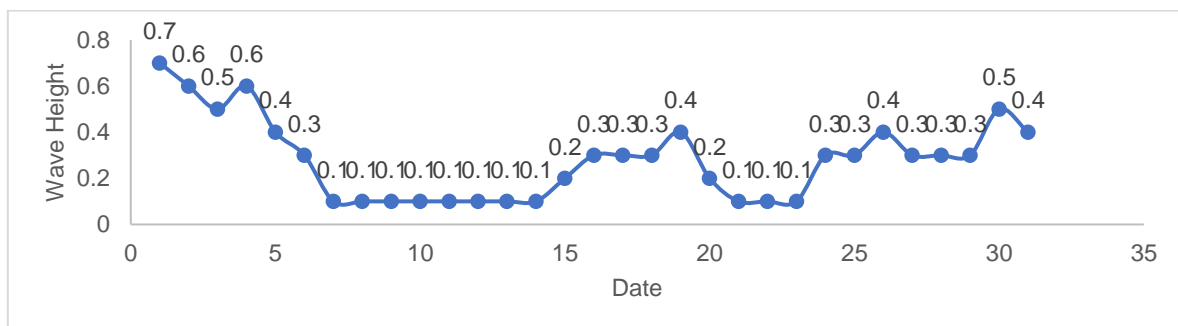


Figure 2. Wave Height Graph

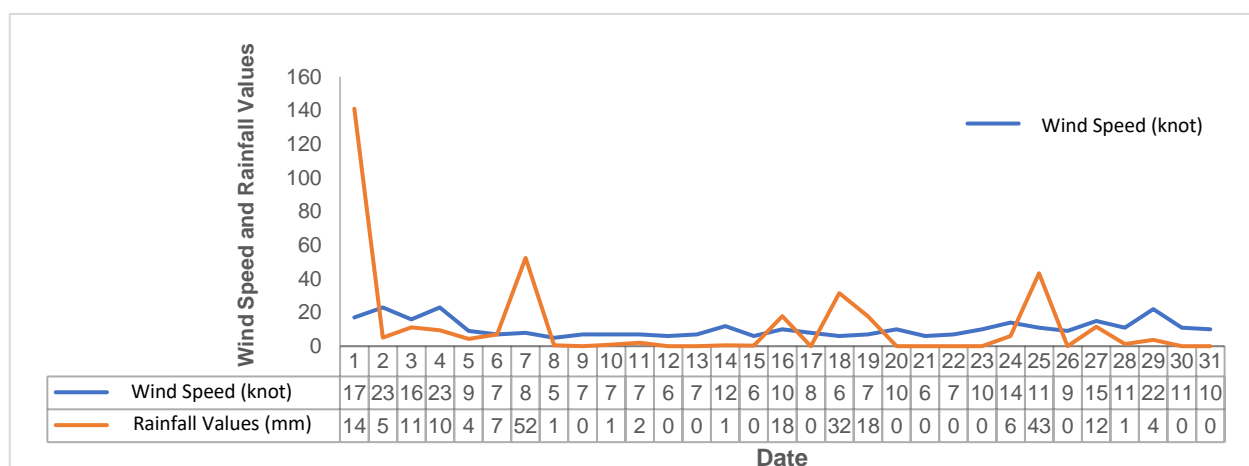


Figure 3. Graph of Wind Speed and Rainfall

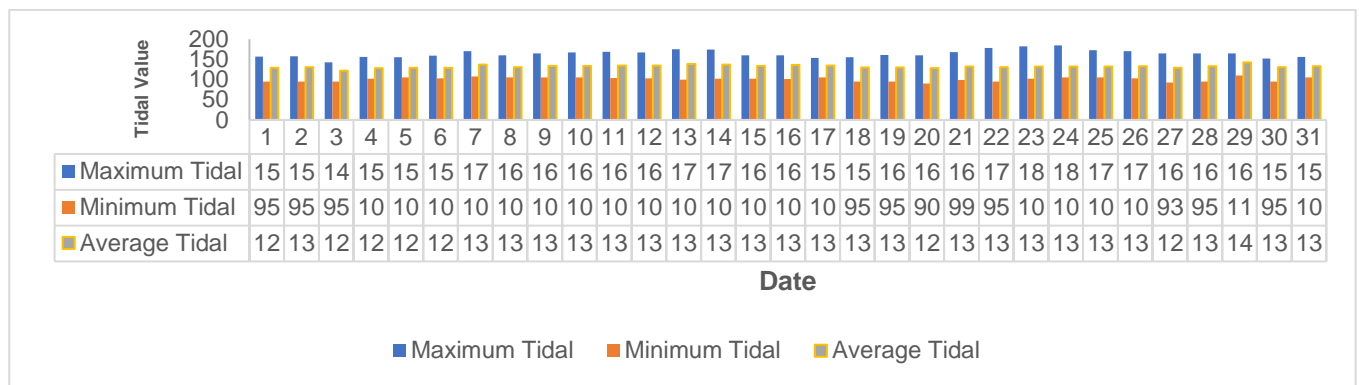


Figure 4. Tidal Graph

Based on secondary data from BMKG in January 2023, it can be seen that the daily average wave height is 0.30 m and the wind speed is 10.54 knots. The average daily rainfall value obtained was 11.86 mm. Meanwhile, the daily average tidal value obtained is 132 cm with the highest tidal value being 164 cm and the lowest 100 cm. The height and low of these waves is influenced by the duration of the wind, the longer the duration, the bigger the waves produced.

The significant effects of rising sea levels will be felt by residents living in coastal areas. In November and December 2009 the intensity of rainfall was quite high. In that month, several parts of Semarang City were inundated with flood waters reaching 15-20 cm. Tambak Lorok is a coastal settlement in the city of Semarang which currently has a very worrying condition and is prone to disasters. Its location on the edge of the sea makes Tambak Lorok prone to disasters such as floods, land subsidence and tidal waves. Tidal floods that hit this settlement usually reach a height of 60 cm. Apart from that, the quality of the residential environment in Tambak Lorok is increasingly decreasing. According to Natalia et al. (2014), coasts are areas that are vulnerable to sea level rise, one of which is the coast in the North Coast region of Java.

The duration of wind blowing is related to the existence of a temperature gradient between two places, the greater the gradient, the longer the duration of the blowing. According to Habibie & Fitria, (2019), sea wave conditions are quite high, namely between (2–4 m) with wind speeds in the categories of strong (31–64 knots), medium (11–30 knots), (1–10 knots), then as a preventative effort to obtain appropriate mitigation of the potential impacts of sea level rise is sustainable management of mangrove ecosystems. The function of mangroves is as a natural defense against potential damage that may occur in coastal areas such as coastal erosion and tidal waves (Illona et al., 2018)

Based on the issues that have occurred, currently the condition of the mangrove ecosystem in Tambak Lorok, Semarang City is experiencing a lot of damage. Damage to the mangrove ecosystem in Tambak Lorok is caused by extreme weather due to climate change phenomena. Based on research by Patriana (2013), there are two types of impacts caused by climate change. These two impacts are ecological and socio-economic impacts. Where ecological impacts such as damage to the mangrove ecosystem can be exacerbated by unwise human behavior in carrying out activities in

the coastal environment such as excessive fishing using fishing gear that is not environmentally friendly. As a result of this incident, organisms around the mangrove, seagrass and coral reef ecosystems will also be damaged and can affect the availability of resources for coastal communities. One of the causes of this unwise behavior in society is a lack of awareness of climate change in coastal areas. In fact, the community is the group that will feel directly the impacts of disasters due to climate change such as tidal floods and coastal erosion. According to Natalia et al. (2014), low community education and skills make climate change adaptation efforts still difficult to carry out.

Fishermen's Response and the Role of Regional Government in the Climate Change Phenomenon

Based on the results of interviews with fishermen (Figure 5) with the aim of finding out how coastal communities respond to climate change in the Tambak Lorok area of Semarang City so that appropriate mitigation and adaptation efforts can be formulated, where the focus of this interview is on fishermen who often go to sea. Many fishermen claim to understand what climate change is because they have received counseling from the Village Government. As many as 67.72% of respondents said they already knew and responded to the phenomenon of climate change, but 32.28% said they had never heard of the term climate change. This shows that more than half of the total sample of coastal fishing communities already know what climate change is. Apart from that, most people also know the impacts of climate change, where respondent data shows that 75.86% of people already know the impacts of climate change, while 24.14% do not know the impacts of climate change. In handling climate change, the community also knows about actions to deal with climate change, almost 70.65% of respondents stated that they already understand how to handle climate change appropriately. The community is the group that will feel directly the impacts of disasters due to climate change such as tidal floods and coastal erosion. Therefore, it is important to have a response from society to disasters due to climate change.

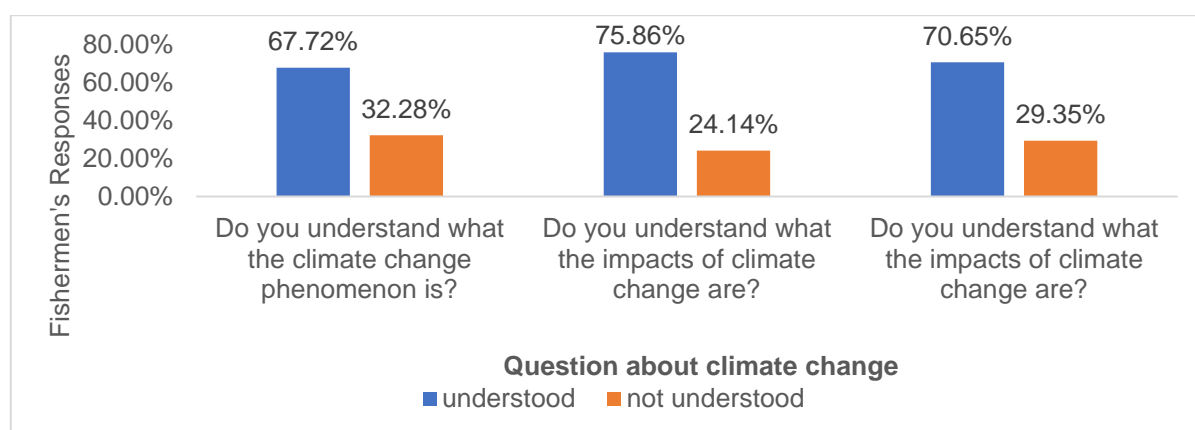


Figure 5. Fisherman Response to Climate Change

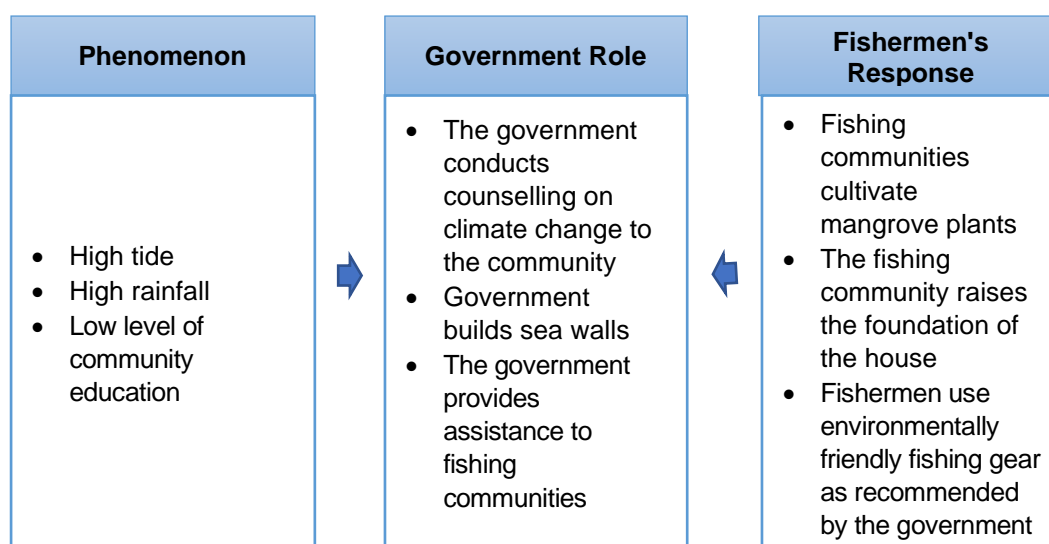


Figure 6. The Role of Government and Fishermen's Response to the Climate Change Phenomenon

Model Summary ^b										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.999 ^a	.998	.993	1.59394	.998	221.244	2	1	.047	2.809
a. Predictors: (Constant), Kursus, PendidikanFormal										
b. Dependent Variable: Respon										

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1124.209	2	562.105	221.244	.047 ^b
	Residual	2.541	1	2.541		
	Total	1126.750	3			

a. Dependent Variable: Respon

b. Predictors: (Constant), Kursus, PendidikanFormal

Figure 7. Results of Linear Regression Analysis

Results of Analysis of Fishermen's Formal and Non-Formal Education Levels on Climate Change Responses

Based on the results of the liner regression analysis (Figure 7), it can be seen that the R square value is 0.998 and the significance value is 0.047, which means that the formal education and course variables have a strong correlation with the fisherman response variable. According to Rahmawati et al., (2021), the results of this analysis show that the independent variable, namely the level of formal and non-formal education (courses), influences the dependent variable, namely the response of fishermen to the climate change phenomenon in Tambak Lorok, Semarang City. This course was obtained by fishermen from training and counseling from the local government to increase awareness of coastal communities regarding the dangers or impacts of global climate change in Tambak Lorok, Semarang City. Based on research from Wacano et al., (2013) in Aldrian et al., (2011), the forms of response that society can make to disasters due to climate change can be divided into two, namely: adaptation and mitigation. What is meant by adaptation action is the

community's efforts to get used to or adapt to the disaster they are facing, while mitigation is an effort to reduce the impact.

Climate Change Mitigation Efforts

As an effort to mitigate climate change, based on the results of field observations that have been carried out, it can be seen that mangrove restoration and conservation efforts are currently needed. Apart from that, empowering coastal communities as an effort to adapt to climate change is also important. Steps that can be taken in terms of mitigating climate change are cultivating mangrove plants, where this activity can be added value to increase fishermen's income during the lean season because currently many industries need the harvest from this mangrove cultivation activity. This can also be pioneered in synergy with industry through the "Mangrove Conservation Based Environmental CSR Program". According to Suffa Azzahra et al., (2020) it can be seen that mangroves have ecosystem services as protection against coastal hazards, such as high waves, sea level rise, storm winds and erosion. Currently, at Tambak Lorok Beach, Semarang City, a sea embankment has also been built on the east side of the beach and the embankment construction process will continue on the west side of the beach. This is one of the Semarang City government's efforts to overcome tidal flooding in Tambak Lorok due to rising sea levels. According to Sekatia (2015), this sea wall includes protection in the concept of climate change adaptation strategies.

Climate Change Adaptation Efforts

As an effort to adapt to climate change, an approach is needed to live a sustainable life (sustainable livelihood) with the aim of fulfilling social and ecological needs in a fair and balanced manner through combining activities and utilizing available capital in the living system. The hope is that with this approach, coastal communities will be able to increase their independence and competitiveness in facing climate change (Lathifah & Khoirudin, 2021).

The characteristics of sustainable livelihoods are seen through the aspects of human capital, social capital, natural capital, financial capital and physical capital. An assessment was carried out on the condition, availability and ability of coastal communities to access capital in accordance with a sustainable livelihood approach. This approach is an activity that is needed by individuals or communities to live their lives by utilizing the abilities and resources they have in order to achieve the desired level of life. This approach can be applied using a group method. More than that, the community sees this livelihood approach as a coaching effort, where they are encouraged to explore their own potential, the potential of their region, understand the various problems they face, as well as face challenges and achieve their vision of the future (Gai, 2020).

Livelihood outcomes describe the hopes that people have to achieve what they consider to be a prosperous family and community life. According to Kusuma et al., (2018), each result or achievement can have significant value in one particular context, but may be less relevant in a different situation. Therefore, efforts to understand accurate achievements can only be done through a participatory approach, as also suggested by (Lathifah & Khoirudin, 2021). The characteristics of sustainable livelihoods in Tambak Lorok, Semarang City, can be observed through the aspects of

human capital, social capital, natural capital, financial capital and physical capital. Assessments are carried out on the condition, existence and ability of coastal communities to utilize resources in accordance with a sustainable livelihood approach (Gai, 2020).

a) Social capital

The existing institutions in the Tambak Lorok coastal area of Semarang City are functioning well. Community social awareness is quite good in efforts to mitigate and adapt to climate change.

b) Natural Capital

The potential of the mangrove ecosystem in Tambak Lorok, Semarang City is quite high, but the community's exploration capacity is still low. Environmental health in residential communities is quite bad. Environmental health is influenced by how dirty the area is and public awareness of environmental cleanliness is still minimal. Apart from that, the condition of clean water in coastal fishing areas is also poor.

c) Physical Capital

Accessibility for fishermen to and from the city center has been fulfilled. Environmental sanitation and drainage conditions have generally been improved, but they still depend on the awareness of coastal communities to maintain them.

d) Human Capital

On average, coastal fishing communities in Semarang City have been able to optimize the potential of mangroves as a natural defense against potential disasters due to climate change such as tidal floods. According to Wacano et al., (2013) People tend to focus on self-defense efforts in utilizing marine products to meet their daily needs. The level of education in the coastal area of Semarang City is \pm 55% of elementary school graduates, of which 47% have taken courses and 50% have also responded, 20% of junior high school graduates, of which 17% have taken courses and 18% have responded, 15% have graduated from high school, of which 13 % have taken the course and 15% have responded and 10% are college graduates, all of whom have taken the course and responded to the climate change phenomenon in Tambak Lorok. This course or training is held by the Semarang City regional government. This has an impact on the response of fishing communities in efforts to adapt to climate change. In Figure 8, it can be seen that the R² value in the linear regression analysis has an average value of 0.76, where this figure shows that there is a fairly strong correlation between the level of formal and non-formal education and fishermen's responses to climate change in Tambak Lorok, Fisherman's City.

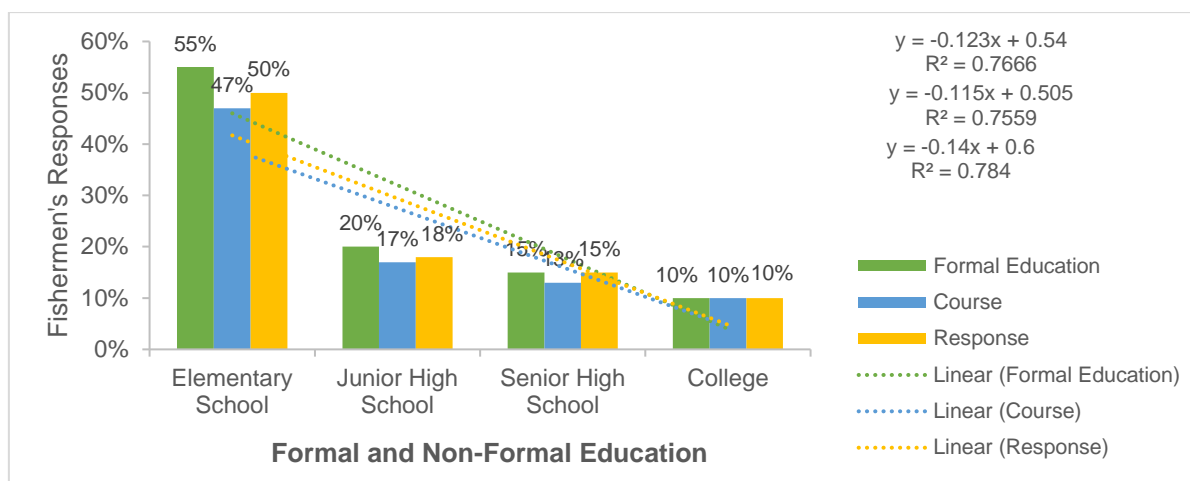


Figure 8. Response Graph Based on Formal and Non-Formal Education Level

e) Financial Capital

The average income of the Tambak Lorok coastal community, Semarang City, is IDR 1,500,000 with 3-5 dependents. The majority of coastal communities work as fishermen and depend on marine products to meet their daily needs. Apart from selling their catch directly, coastal communities also carry out small-scale fish processing such as salting, smoking fish, making crackers or making shrimp paste. Fishermen in Tambak Lorok, Semarang City are traditional fishermen who are very dependent on weather conditions when carrying out fishing activities, so that if extreme weather conditions or a tidal disaster occurs, they lose their source of income.

Based on Figure 9, it is known that the high average income of the fishing community is accompanied by a high level of education. The figure shows that the highest average income of fishermen of IDR 3,500,000.00 was obtained by respondents of productive age, namely 32 years with a high school education level. This is supported by the greater number of fishermen's skills and knowledge obtained from formal and non-formal education.

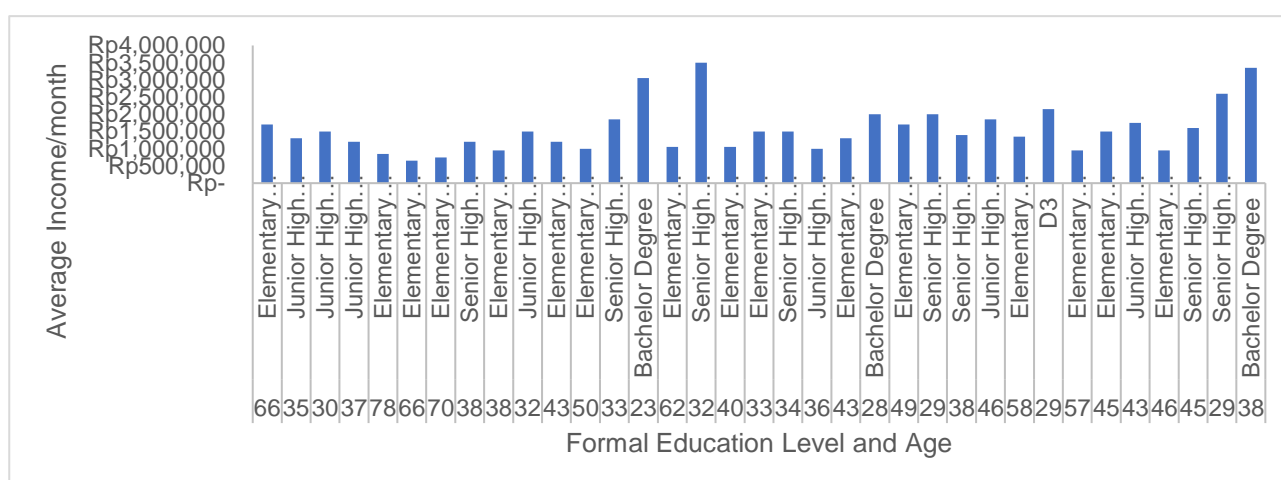


Figure 9. Graph of Average Income/month

Community Empowerment Steps Based on Sustainable Livelihood

Steps to empower coastal fishermen through sustainable livelihoods are based on analysis and characteristics of the community in the Tambak Lorok coastal area, Semarang City, namely:

Social Capital:

The concepts applied in social capital for coastal fishermen include:

1. Provide convenience for members of fishing organizations or communities. This institution or organization aims to:
 - a) Increased solidarity
 - b) Media networking
 - c) Community resource mobility
 - d) Improve fishermen's soft skills and hard skills
2. Opens opportunities to expand marketing Some steps that can be taken according to the existing concept are:
 - a) Training from academics and practitioners regarding branding strategies for processed seafood products at regular forums held, for example study groups, fishing communities, PKK or RT/RW meetings.
 - b) Identification and optimization of the capacity and capabilities of fishing groups that have the potential to be developed.
 - c) Formation of a community using the form of Learning Organization (OP).

Natural Capital:

The concepts applied in natural capital for coastal fishermen include:

1. Provide education to fishing communities regarding changes in weather conditions that must be taken into account, including forms of climate change that occur in coastal areas.
2. Increased knowledge about fishing tips and tricks or the latest technology in catching fish that is adapted to current natural conditions.

Some steps that can be taken according to the existing concept are:

- a) Utilize forums for routine fishing community activities to expand information regarding ecosystem sustainability, environmental health and water quality.
- b) Utilizing fishing communities or OPs to increase knowledge about the latest fishing patterns in accordance with current climate change.
- c) Mastery of environmentally friendly fishing gear and more effective fishing methods.
- d) Mastery of technology and methods in processing marine products and other marine crafts.
- e) Expansion of the types of livelihoods carried out, as an alternative income during the lean season.

Physical capital:

The concepts applied in physical capital for coastal fishermen include:

1. Making a master plan to provide facilities for selling marine products and handicrafts from the Tambak Lorok community to increase the use of local material resources to optimize the types of sales at community stalls.
2. Carry out regular maintenance on infrastructure and facilities that have been built.
3. Improve facilities and infrastructure in coastal fishing settlement areas that are inadequate or do not meet ideal standards.

Some steps that can be taken according to the existing concept are:

- a) Repairing infrastructure that has experienced damage or decreased quality.
- b) Construction of a trading area intended for buying and selling fishermen's seafood and processed products.
- c) Collaboration between fishing communities and local governments, so that appropriate policies can be formulated.

Human capital:

The concepts applied in human capital for coastal fishermen include:

1. Provide appreciation in the form of appropriate incentives or give a way for people who participate in routine community/organization programs or activities in the context of climate change mitigation and adaptation.
2. Collaborate with government organizations, industry or Non-Governmental Organizations (NGOs) to improve the soft skills and hard skills of the community in managing marine products.
3. Provide training according to the characteristics of each region.
4. Collaborating with internal and external parties to improve the quality of human resources with financial assistance for educational development, both formal and informal.
5. Empowering the younger generation and fishermen's wives to cultivate crafts or develop marketing of marine products.

Some steps that can be taken according to the existing concept are:

- a) Providing educational scholarships or professional training certification to the Tambak Lorok community.
- b) Transfer of knowledge and technology regarding the importance of education to help improve the standard of living of fishing communities.

Financial Capital

The concepts applied in financial capital for coastal fishermen include:

1. Establish cooperation from various parties related to the fisheries sector to develop fishing settlements in the form of capital investment, promotion and technology.
2. Technology transfer related to marketing strategies and calculating the feasibility of processing seafood and handicraft businesses.

Some steps that can be taken according to the existing concept are:

- a) Expanding marketing relationships and adding investors to increase capital.
- b) Training on optimizing social media and digital platforms (market places) as media for selling processed seafood along with marketing development procedures.

CONCLUSION AND SUGGESTION

Conclusion

The fishing community already knows and responds to the climate change phenomenon in Tambak Lorok, Semarang City with a percentage of 67.72%. The climate change mitigation efforts carried out are mangrove restoration and conservation by cultivating mangroves. Apart from that, collaborating with Corporate Social Responsibility to carry out an environmental program based on mangrove conservation, namely a program to plant 1000 mangroves in the coastal area of Tambak Lorok, Semarang City. Meanwhile, the adaptation efforts carried out are by empowering fishing communities through social capital, natural/environmental capital, physical capital, human capital and financial capital.

Suggestion

Stakeholders and local governments can synergize with industry through environmental CSR programs to improve community skills and abilities in managing coastal ecosystems so that there is an improvement in the standard of living of coastal communities in Tambak Lorok, Semarang City. Apart from that, it is also important to establish political access between the fishing community and the local government so that more appropriate policies can be formulated regarding climate change mitigation and adaptation in Tambak Lorok, Semarang City.

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