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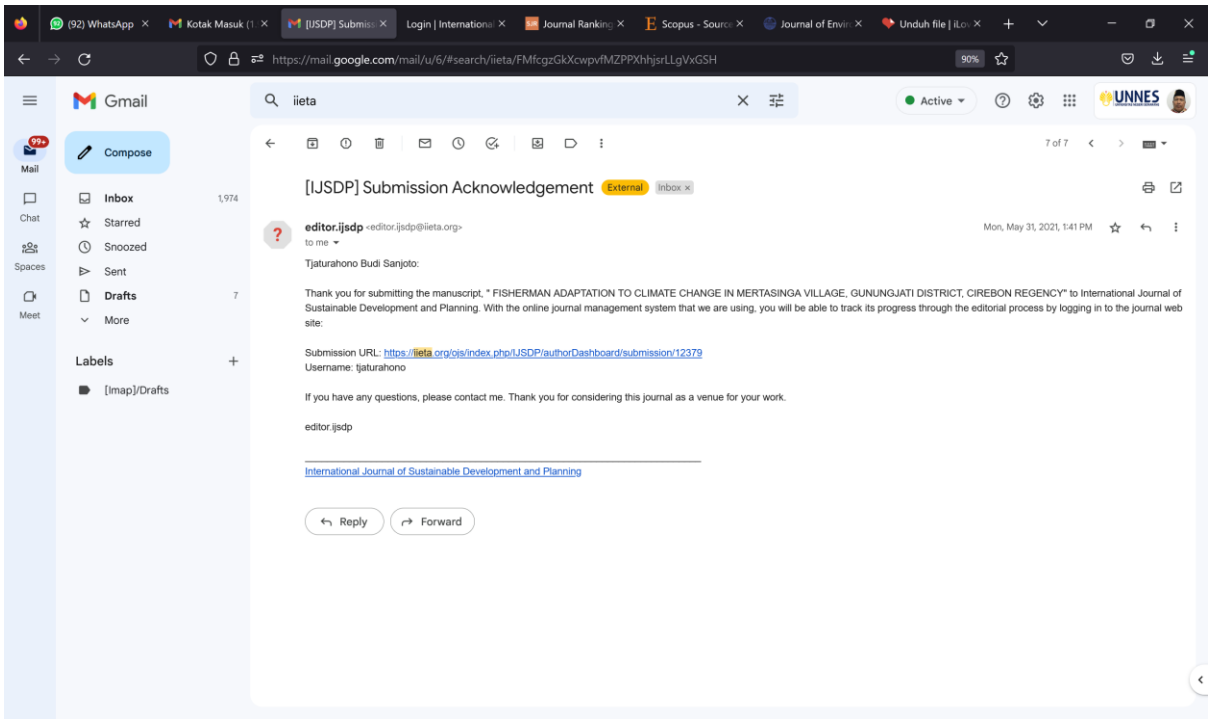
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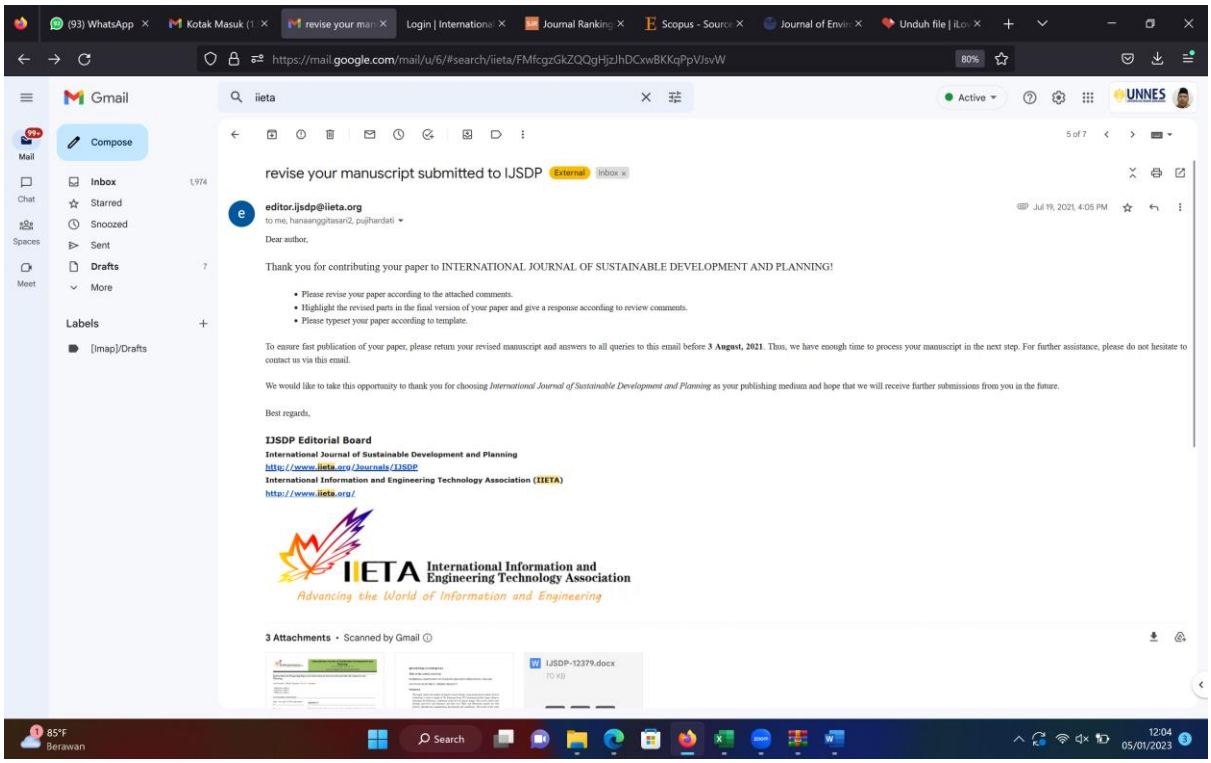
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REVIEWER'S COMMENTS

Title of the article reviewed:

FISHERMAN ADAPTATION TO CLIMATE CHANGE IN MERTASINGA VILLAGE,

GUNUNGJATI DISTRICT, CIREBON REGENCY

Summary

This paper adopts the method of mixed research design, using proportional random abstract technology to select a sample of 102 fishermen from 2025 fishermen in Mota Singa village to determine the fishermen's adaptation in the face of climate change. This article collects data through interviews and literature, and then uses Miles and Huberman models for data analysis, through data simplification, presentation and conclusions. The results of the study show that the adaptation of fishermen is mainly achieved through the use of GPS and cold storage technology. Climate change has an impact on fishery activities, and the fishermen in Mertasinga village have adapted to climate change. There are some structural problems in this article, and there are some detailed problems in this article.

Major Issues

- Whether Mertasinga Village is representative is debatable. This article does not give the reasons for studying Mertasinga Village.
- The collected information has not been screened and verified, and the reliability and objectivity of the information has not been confirmed.
- The results and discussion of the article are more like research empirical research and do not meet the requirements of the paper.
- Although the hybrid research design seems feasible, whether there is a better method remains to be explored.

Minor Issues

Abstract:

- The overall logic of the abstract part is too confusing, and the introduction of research methods is not clear enough, such as data analysis methods: Miles and Huberman, data collection methods: interviews and literature materials, etc. The introduction should be clearer. It is recommended to sort out the overall logic.
- The introduction to the research background in the abstract part is too simple and the abstract is overall lengthy. It is recommended that this part be supplemented and deleted.

- The narrative level of the conclusion of the article is not clear enough, and it is recommended to reorganize and modify it.

Introduction:

- The relevance between the process of global warming and the research in this article is not particularly strong, and there is no need to elaborate on the process of global warming.
- This article does not have any data to support the fact that the current weather conditions are unpredictable. If so, please briefly introduce the reasons for the unpredictability.
- There are problems when citing the article, such as 25. It is recommended to modify this section.

Methodology:

- What is the difference between owner fishermen, small fishermen, and labor fishermen? This article does not give an introduction. It is recommended to supplement this part.

RESULT AND DISCUSSION

- The format of "Adaptation of Fishermen in Mertasinga Village in Facing Climate Change" is in question.
- Table 2 shows the strategy of three people, so it is doubtful that it is representative of the whole.
- There is no objectivity in summarizing the research results based on the comments of several interviewees.

CONCLUSION：

- It is better to write conclusions and recommendations separately.
- Social and economic adaptation are not reflected in the foregoing.

Others:

The following minor issues should be looked into by the author:

- There is a spelling error in the title in 2. METOD.
- Part of the language of this article can be optimized to make the language more academic. Some meaningless words should be deleted.
- Some non-English passages in the article make it difficult to read.

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FISHERMAN ADAPTATION TO CLIMATE CHANGE IN MERTASINGA VILLAGE, GUNUNGJATI DISTRICT, CIREBON REGENCY

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ABSTRACT

Climate change affects to fishing activities. Fishermen in Mertasinga Village feel that the current weather conditions are difficult to predict. The impact of climate change requires fishermen to adapt. Adaptations that are carried out must be appropriate in order to minimize impacts. Studies about climate change adaptation in Cirebon Regency are still minimal, it is necessary to conduct studies because many fishermen depend on the sea and climate for their livelihoods. The purpose of this study was to determine the adaptations made by fishermen in the face of climate change. This study used a mixed research design. With an explanatory secunial approach. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using proportional random sampling technique. Data were collected using interviews and documentation. Data were analyzed using the analysis model of Miles and Huberman by reducing data, presenting data, and drawing conclusions. The results showed that the adaptation made by fishermen is by adapting technology in the form of the use of GPS and cold storage. In social adaptation, fishermen take advantage of the social relationships between fishermen and between fishermen and middlemen. Economic adaptation is in the form of a double income pattern and out of fishing activities From the results of the analysis, it can be concluded that climate change has an impact on fishing activities which require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of the technology used by fishermen is still minimal, fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and fishermen have not used fish tracking devices.

1. INTRODUCTION

Global Warming is a fact that is happening. Global warming is a topic of conversation in almost all levels of society in the world. What is very real about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1] and human activities [1-3] thus changing composition of the global atmosphere and natural climate variability over time [3,4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89ºC. In Southeast Asia, the temperature increase reaches 0.4-1ºC. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5 - 2ºC [4] . Indonesia is one of the countries most vulnerable to the threats and impacts of climate change[3,5,6]. The results of observations of data for 39 years from 1981-2020, the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95ºC [7] and data for 30 years (1980-2010) indicated that there was a change in rainfall. normal annual rainfall [7] and shift in peak rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role for people's lives [11] however, coastal ecosystems are ecosystems that are vulnerable to the impacts of climate change [12-13]. Climate change is increasing the vulnerability of coastal areas which were already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15] Coasts are vulnerable to sea level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities[18] and on the welfare of fishermen resulting in increased uncertainty regarding aspects fishermen's livelihoods[19]. The phenomenon of climate change causes capture fisheries to decrease and increase in certain areas, this is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall and wind seasons also affect capture fisheries. Increasing the frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13,20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands[19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, less effective fishing gear they use, and difficulty determining fishing areas[12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall, changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati District, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Deputy head of the Meteorology, Climatology and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from tribunnews.com (05/18) states that a number of fishermen in Cirebon cannot go to sea due to bad weather, can only work odd jobs and some fishermen even sell their belongings to meet their daily needs. climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current climate, climate fluctuations and the trend will continue[21]. Fishermen are faced with the threat of climate change [22] and must adapt to these conditions for their livelihoods. The uncertain climate has an impact on the economic conditions of fishermen [23]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geoinformation and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [24]. The fishing profession is the profession most vulnerable to the impacts of climate change [13] the impact of climate change causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall, so that it has an impact on fishermen's activities and fishermen's life.

Education plays a role in shaping good attitudes, behavior and thoughts in the perpetrators regarding the environment [25] Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change, so that these impacts can be minimized. It is expected that fishermen are conscious and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

Studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati District, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. Most of the fishermen in Mertasinga Village have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires fishermen in Mertasinga Village to adapt. This study aims to determine the adaptation

carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in the face of climate change, can be used as a reference for similar research, and can help the government to create programs that are suitable for fishermen.

2. METOD

This study uses a mixed research design or better known as mixed methods research. The mixed methods design in this study used a sequential explanatory type approach. The population in this study were fishermen who live in Mertasinga Village, Gunungjati District, Cirebon Regency, who feel the impact of climate change, namely 2,025 fishermen. Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Sampling in this study using a proportional random sampling technique. The proportional random sampling technique was chosen to take the sample in this study because at the research location there were three groups of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group of fishermen. Sampling using the formula Isaac and Michael. In order to obtain a sample of 102 samples. The sample proportion can be seen in table 1.

Table 1. Research Samples of Fishermen in Mertasinga Village by Class of Fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Nelayan Pemilik	623	$\frac{623}{2025}\ x\ 102$	31
2	Nelayan Kecil	1.300	$\frac{1300}{2025}\ x\ 102$	66
3	Nelayan Buruh	102	$\frac{102}{2025}\ x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Collecting data using interview and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in the face of climate change. The qualitative analysis in this study used the Miles and Huberman model analysis. Where the steps taken to analyze qualitative data begin with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns and removing unnecessary. After reducing the data, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. Through the presentation of the data it will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that had never existed before. Findings can be in the form of descriptions or descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the

fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, Cirebon Regency is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. The people in Mertasinga Village work as PNS, TNI, POLRI, Entrepreneurs, Employees, Laborers, Farmers, Traders and Fishermen. As many as 32% or 2,025 people in Mertasinga Village are fishermen. Fishermen in Mertasinga Village are divided into three groups, namely; small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

In this study, the adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change, so that fishermen take steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Adapt technology to ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes the form of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Economic adaptation in the form of a double income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time, the uncertainty of fishing seasons and reduced catches make fishermen try to develop technology and adapt to changing conditions. the use of the development of ship technology and fish storage is carried out to adapt to the impacts of climate change by fishermen. The use of technology is very useful to prevent or reduce the impact and / or risk that may occur, so that it will reduce the costs required compared to not carrying out adaptation activities. In accordance with the results of interviews conducted by researchers to one of the fishermen named Pak Seta :

> "In Mertasinga, most of the fishermen, so if the boat is damaged, just fix it, the engine is damaged, the business is repaired first, if it can't work at all, then replace it"

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple because the majority of fishermen in Mertasinga Village are small fishermen using outboard motor boats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS, as explained by Mr. Juned below:

"My ship is 10 GT using GPS, the big ships use GPS for going to sea"

In addition to ship technology in the form of GPS, fishermen in Mertasinga Village also use technology to adapt in the form of cold storage or refrigerators at Bondet Fishing Port to extend the life of

the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

Table 2. Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

Class	Adaptation		
	Technology	**Social**	**Economy**
Pemilik	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Join a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish / shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Kecil	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses / middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers / breeders 2. Switching professions to become farm laborers / ponds 3. Switching professions to become construction workers / porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop / service
Buruh	Helping the maintenance of the ship	1. Join a fishing group 2. Utilizing social networks with bosses / middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers / ponds 2. Switching professions to become construction workers / porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship is if there is between skipper and fisherman, the skipper provides capital to go to sea and horizontal social relations in the form of mutual cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. Small fishermen when it is difficult to find fish they seek capital by utilizing their social network to the skipper. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high seasonThe influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is evidenced by an interview with Pak Didi that:

> "...saat paceklik nelayan pemilik saling tukar relasi secara online, menjual ikan dalam keadaan beku, biasanya diambil dari surabaya, banten"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village during the dry season or when the fish are difficult to find, the owner fishermen communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish with the fish frozen. The fishermen relations of Mertasinga Village have reached other regions, such as from East Java, Central Java, and the coastal part of Banten. Fishermen with a high number of family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual nadran ceremony. This local wisdom is a hereditary legacy which is held annually. Nadran takes place at the end of the western season in April. Nadran is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. Like the interview with Pak Saduri as follows:

> "When it's hard season I usually work as a coolie at the Celangcang market, sometimes I become a coolie. When someone builds a house, sometimes I rent my boat. Yes, workers added, yes farm workers. Just do everything "

The majority of fishermen in Mertasinga Village, when it was difficult to get fish, worked odd jobs as coolies or casual laborers. The following is an interview with Mr Sarkad who owns land for farming:

> "Apart from fishing, my side job is planting bananas on my land. So if it's hard season, I can sell the fish or eat the bananas right away"

Fishermen have also adapted to raising chickens and goats, which can be used for their own consumption or for sale in markets and the people of Mertasinga Village. Fishermen who own land for farming or livestock benefit, because farming and raising livestock can increase their income and have unlimited time, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to trading in their yard. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children and basic necessities such as soap, detergent, rice, sugar, and other basic necessities. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasinga Village, Gunungjati District, Cirebon Regency, it can be concluded that fishermen have felt

climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include the following: technology adaptation in the form of utilizing GPS technology and refrigerators. Social adaptation is carried out by communication between fishermen and fishermen and middlemen. Economic adaptation is carried out by fishermen, namely with a double income pattern and leaving fishing activities.

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal, such as fish processing technology by drying the fish directly under the sun. It can be said that this method is still traditional because it depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes of fishermen. Apart from the local government, fishermen must also be willing to work together to make socialization programs a success by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

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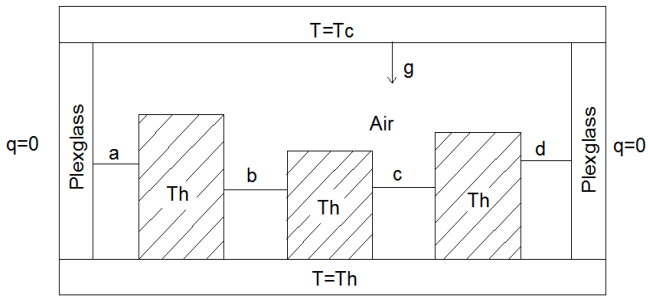

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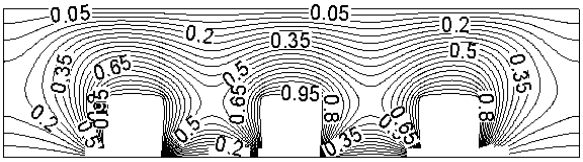

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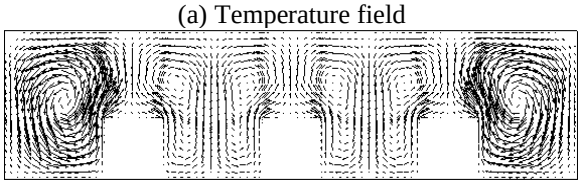

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Figure 2. Three heat sources

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NOMENCLATURE

B	dimensionless heat source length
CP	specific heat, J. kg^{-1}. K^{-1}
g	gravitational acceleration, $m.s^{-2}$
k	thermal conductivity, $W.m^{-1}$. K^{-1}
Nu	local Nusselt number along the heat source

Greek symbols

α	thermal diffusivity, m^2. s-^{1}
β	thermal expansion coefficient, K^{-1}
ϕ	solid volume fraction
Θ	dimensionless temperature
μ	dynamic viscosity, kg. $m^{-1}.s^{-1}$

Subscripts

p	nanoparticle
f	fluid (pure water)
nf	nanofluid

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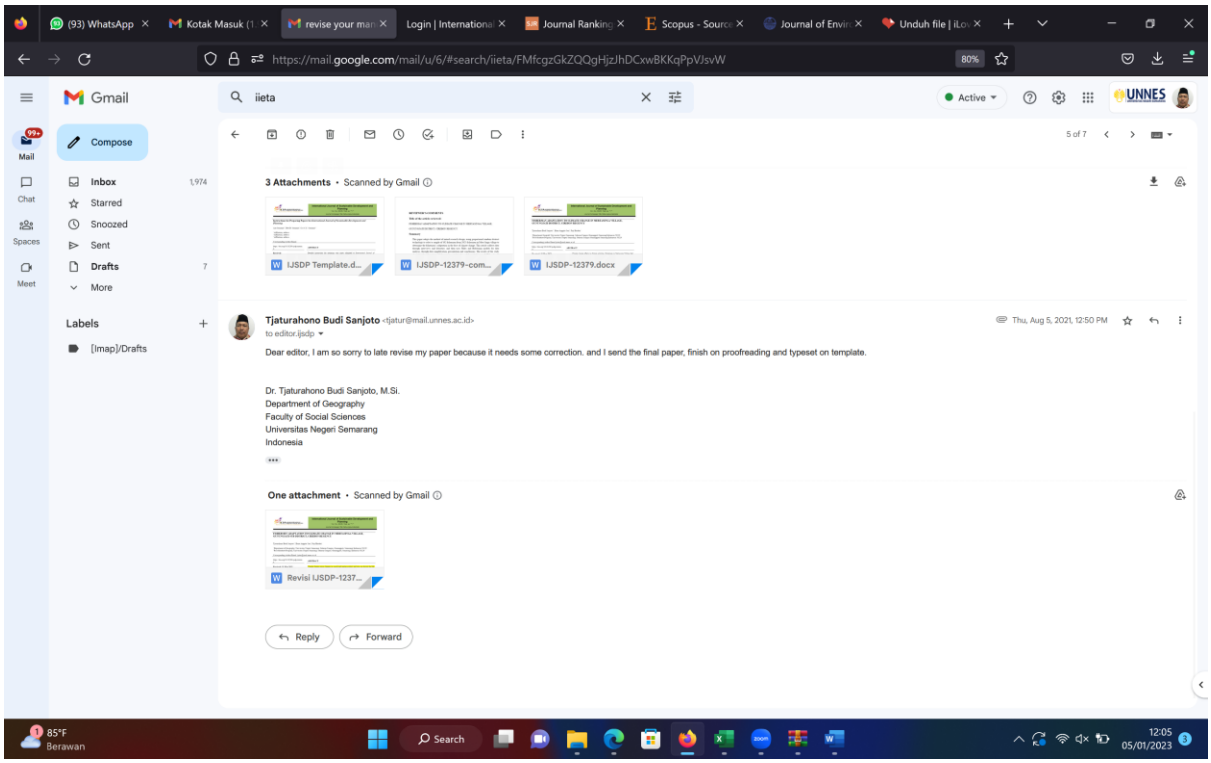
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FISHERMEN ADAPTATION TO CLIMATE CHANGE IN MERTASINGA VILLAGE, GUNUNGJATI SUB-DISTRICT, CIREBON REGENCY

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ABSTRACT

Climate change causes changes in coastal and marine ecology and also can disrupt the fish catch of fishermen. It impacts the livelihood systems of coastal communities and the welfare of fishermen. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province. There, Mertasinga Village exists as a fishing village established since the Dutch colonialist era. It has the largest fishery products that are even exported abroad. Hence, there is nothing studies on fishermen, especially the adaptation of fishermen to climate change in Mertasinga Village. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman by collecting data, reducing data, presenting data, and drawing conclusions. The results show that the adaptation made by fishermen is utilizing technology in the form of the use of GPS and cold storage. In social adaptation, fishermen take advantage of the social relationships between fishermen, as well as between fishermen and middlemen. Economic adaptation is in the form of a double income pattern and out of fishing activities. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of the technology used there is still minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3,4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89ºC. In Southeast Asia, the temperature increase reaches 0.4-1ºC. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5 - 2ºC [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3,5,6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95ºC [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12-13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities[18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13,20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall,

changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati Sub-district, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now, fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from {21} and {22} also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing {23}. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes

knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33] [34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research Samples of Fishermen in Mertasinga Village by Class of Fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025} x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025} x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025} x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun

to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of fishing seasons and reduced catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

> "In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

> "My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

Table 2. Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with	1. Switching professions to become farmers/breeders

		bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

> "...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

> "When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

> "Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have felt climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

5. RECOMMENDATION

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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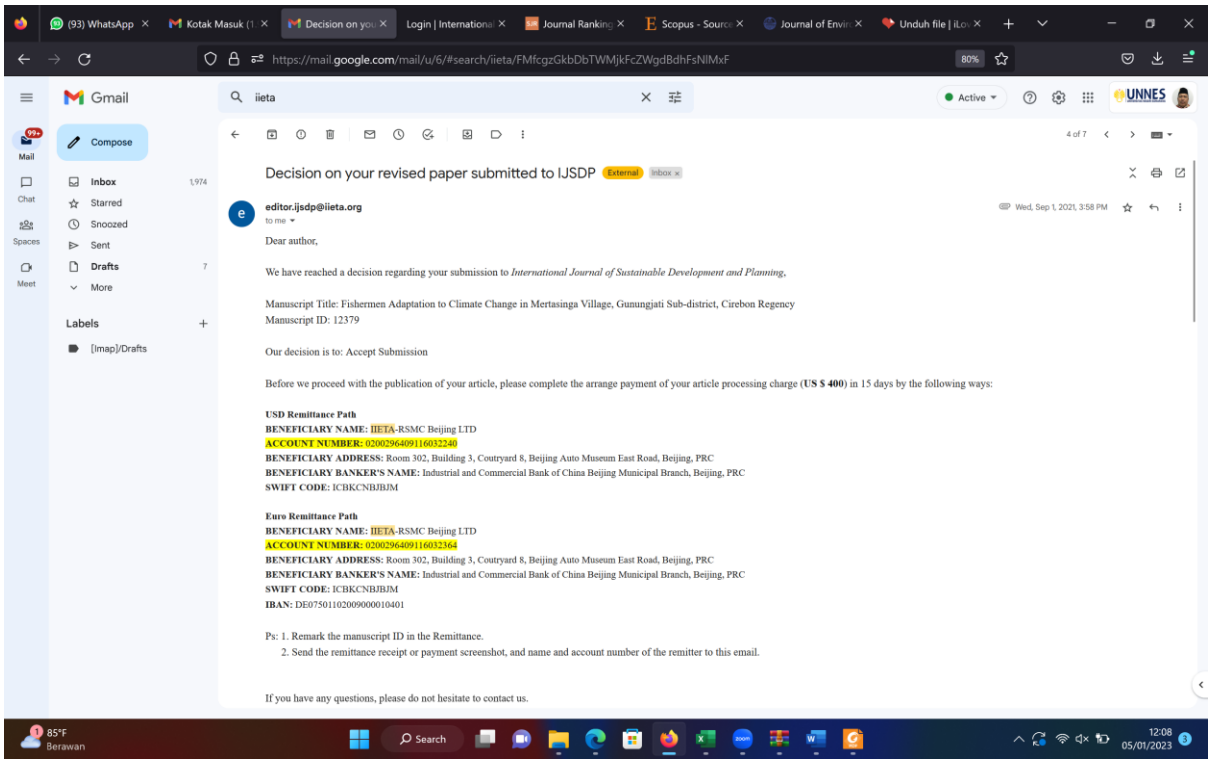

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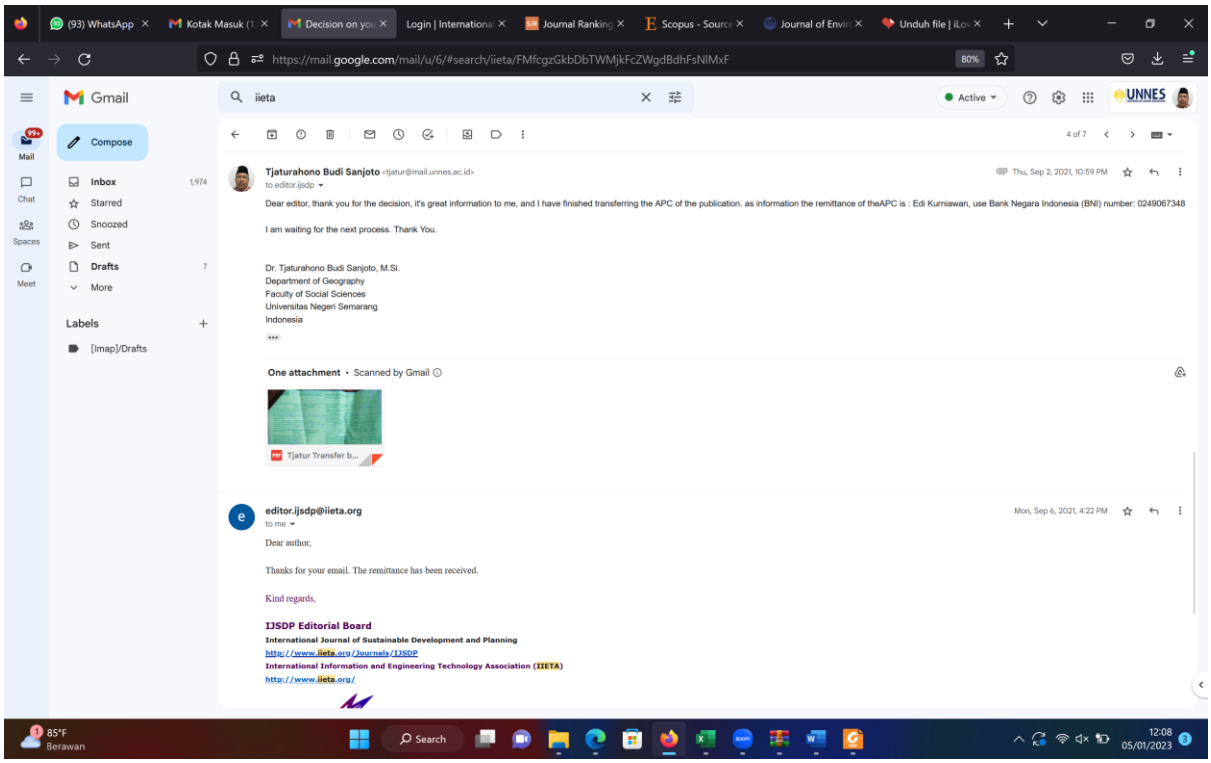
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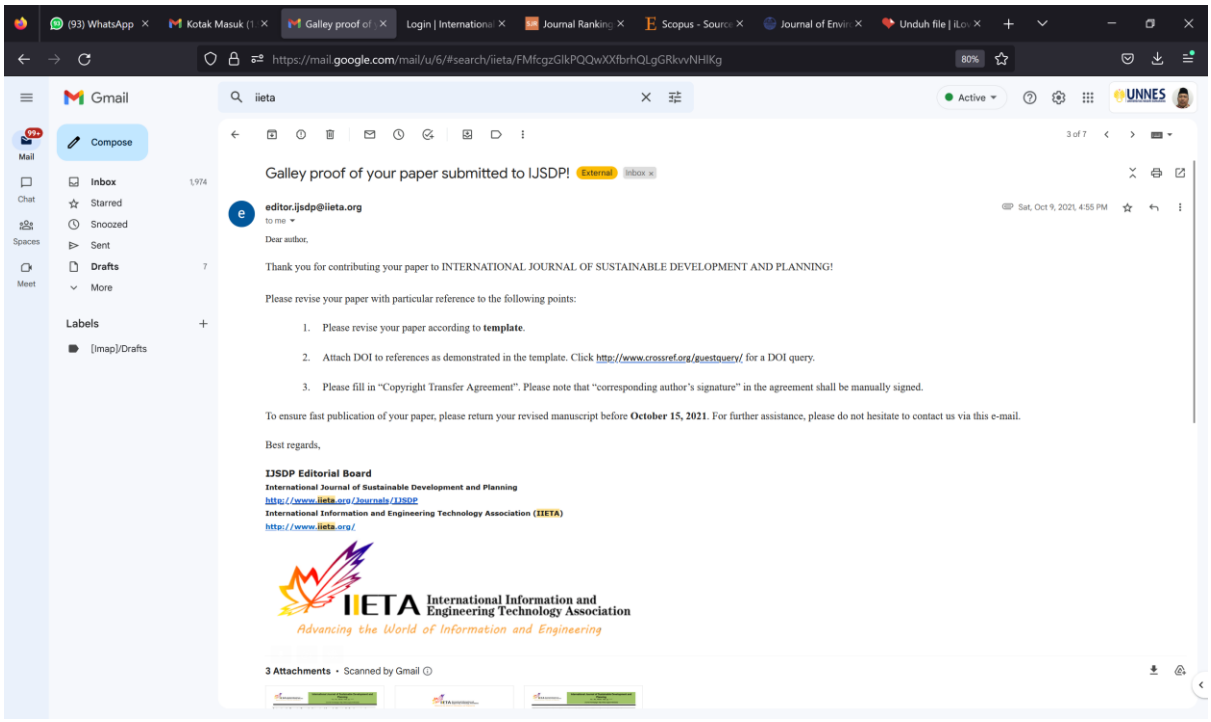

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Fishermen Adaptation to Climate Change in Mertasinga Village, Gunungjati Sub-District, Cirebon Regency

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ABSTRACT

Climate change causes changes in coastal and marine ecology and also can disrupt the fish catch of fishermen. It impacts the livelihood systems of coastal communities and the welfare of fishermen. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province. There, Mertasinga Village exists as a fishing village established since the Dutch colonialist era. It has the largest fishery products that are even exported abroad. Hence, there is nothing studies on fishermen, especially the adaptation of fishermen to climate change in Mertasinga Village. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman by collecting data, reducing data, presenting data, and drawing conclusions. The results show that the adaptation made by fishermen is utilizing technology in the form of the use of GPS and cold storage. In social adaptation, fishermen take advantage of the social relationships between fishermen, as well as between fishermen and middlemen. Economic adaptation is in the form of a double income pattern and out of fishing activities. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of the technology used there is still minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3, 4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89°C. In Southeast Asia, the temperature increase reaches 0.4-1°C. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5 - 2°C [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3, 5, 6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95°C [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12, 13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities [18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen

availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13, 20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall, changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati Sub-district, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now, fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from [21] and [22] also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing [23]. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33, 34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and

experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research samples of fishermen in Mertasinga village by class of fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025}\ x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025}\ x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025}\ x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Table 2. Adaptation of fishermen in mertasinga village in facing climate change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers/breeders 2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change. In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in Table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of fishing seasons and reduced catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

"In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

"My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

"...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

"When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

"Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have felt climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

RECOMMENDATION

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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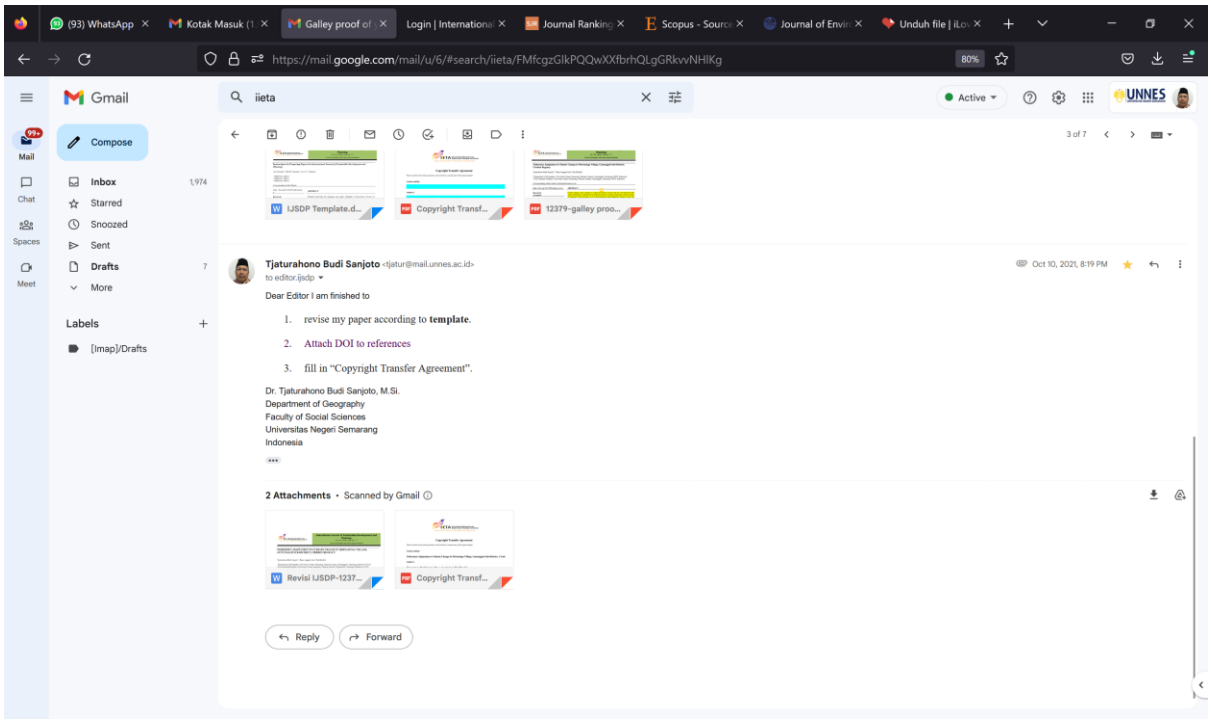
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FISHERMEN ADAPTATION TO CLIMATE CHANGE IN MERTASINGA VILLAGE, GUNUNGJATI SUB-DISTRICT, CIREBON REGENCY

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ABSTRACT

This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of the technology used there is still minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3,4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89ºC. In Southeast Asia, the temperature increase reaches 0.4-1ºC. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5 - 2ºC [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3,5,6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95ºC [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12-13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased

carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities[18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13,20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall, changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati Sub-district, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now, fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from {21} and {22} also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing {23}. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes

in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33] [34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research Samples of Fishermen in Mertasinga Village by Class of Fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025}\ x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025}\ x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025}\ x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of fishing seasons and reduced

catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

> "In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

> "My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

Table 2. Adaptation of Fishermen in Mertasinga Village in Facing Climate Change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers/breeders 2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

> "...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

> "When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

> "Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have felt climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

5. RECOMMENDATION

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT

boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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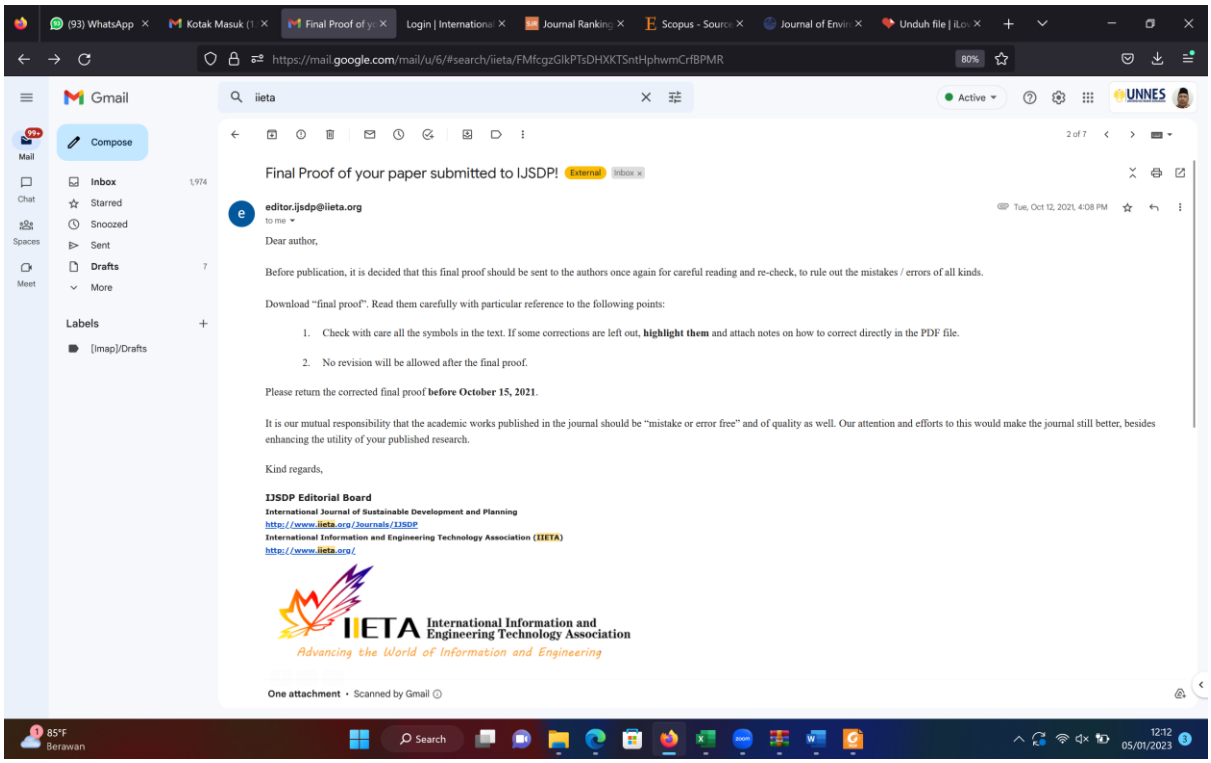

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Fishermen Adaptation to Climate Change in Mertasinga Village, Gunungjati Sub-District, Cirebon Regency

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ABSTRACT

This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of the technology used there is still minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3, 4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89°C. In Southeast Asia, the temperature increase reaches 0.4-1°C. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5-2°C [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3, 5, 6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95°C [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12, 13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities [18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13, 20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall,

changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati Sub-district, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now, fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from ref. [21] and ref. [22] also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing [23]. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33, 34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the

formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research samples of fishermen in Mertasinga village by class of fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025}\ x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025}\ x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025}\ x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Table 2. Adaptation of fishermen in mertasinga village in facing climate change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers/breeders 2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change. In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in Table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of

fishing seasons and reduced catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

"In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

"My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

"...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

"When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

"Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have felt climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

RECOMMENDATION

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it

depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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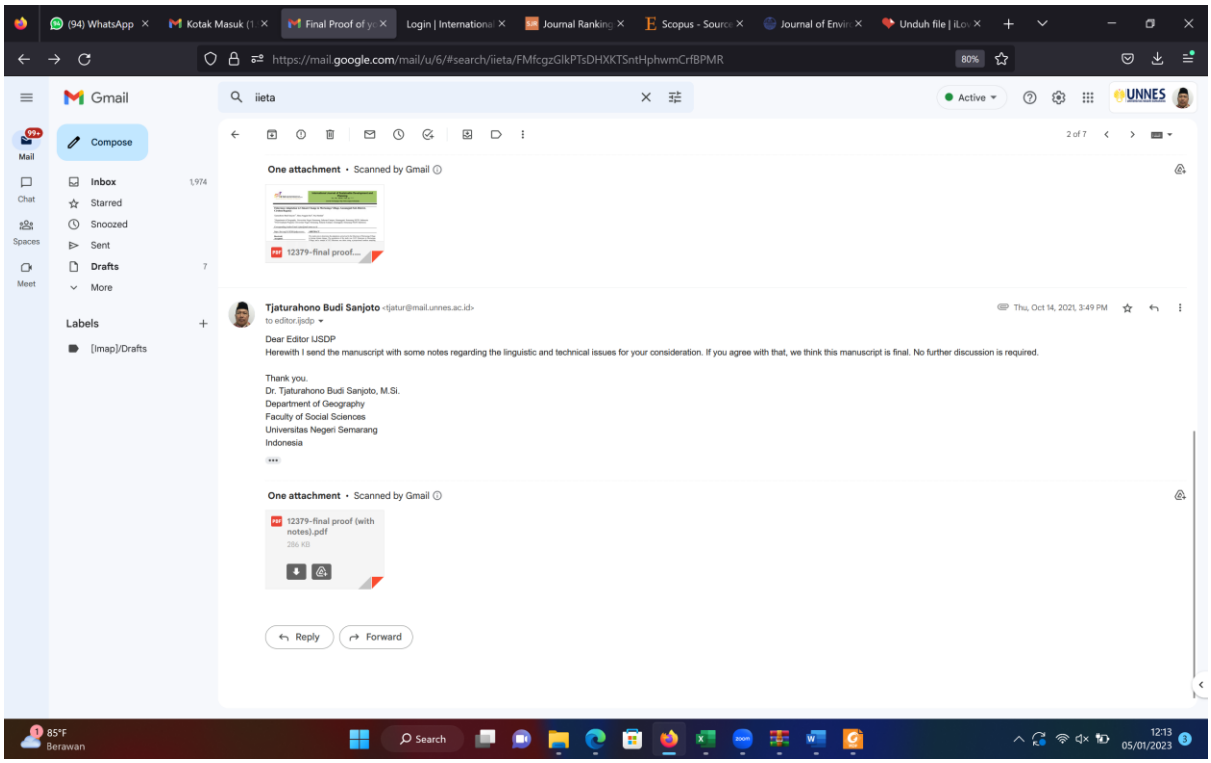
Tanggapan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Fishermen Adaptation to Climate Change in Mertasinga Village, Gunungjati Sub-District, Cirebon Regency

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ABSTRACT

This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. Fishermen in Mertasinga Village have adapted to climate change. However, the adaptation of technology used there is still minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3, 4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89°C. In Southeast Asia, the temperature increase reaches 0.4-1°C. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5-2°C [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3, 5, 6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95°C [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9], this causes Indonesia to have a large coastal area as well [ ]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12, 13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities [18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13, 20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall,

changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

The results of interviews with fishermen in Gunungjati Sub-dis the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish, but for now, fishermen find it difficult to read natural forecasts. has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from ref. [21] and ref. [22] also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing [23]. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33, 34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the

formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research samples of fishermen in Mertasinga village by class of fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025} x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025} x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025} x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how to adapt the fishermen in Mertasinga Village in facing climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

Table 2. Adaptation of fishermen in mertasinga village in facing climate change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers/breeders 2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

Adaptation of Fishermen in Mertasinga Village in Facing Climate Change. In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in Table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of

fishing seasons and reduced catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

"In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

"My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

"...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

"When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

"Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the Adaptation of Fishermen to Climate Change in Mertasi Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have felt climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

RECOMMENDATION

The technology for adapting that is used by fishermen in Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it

depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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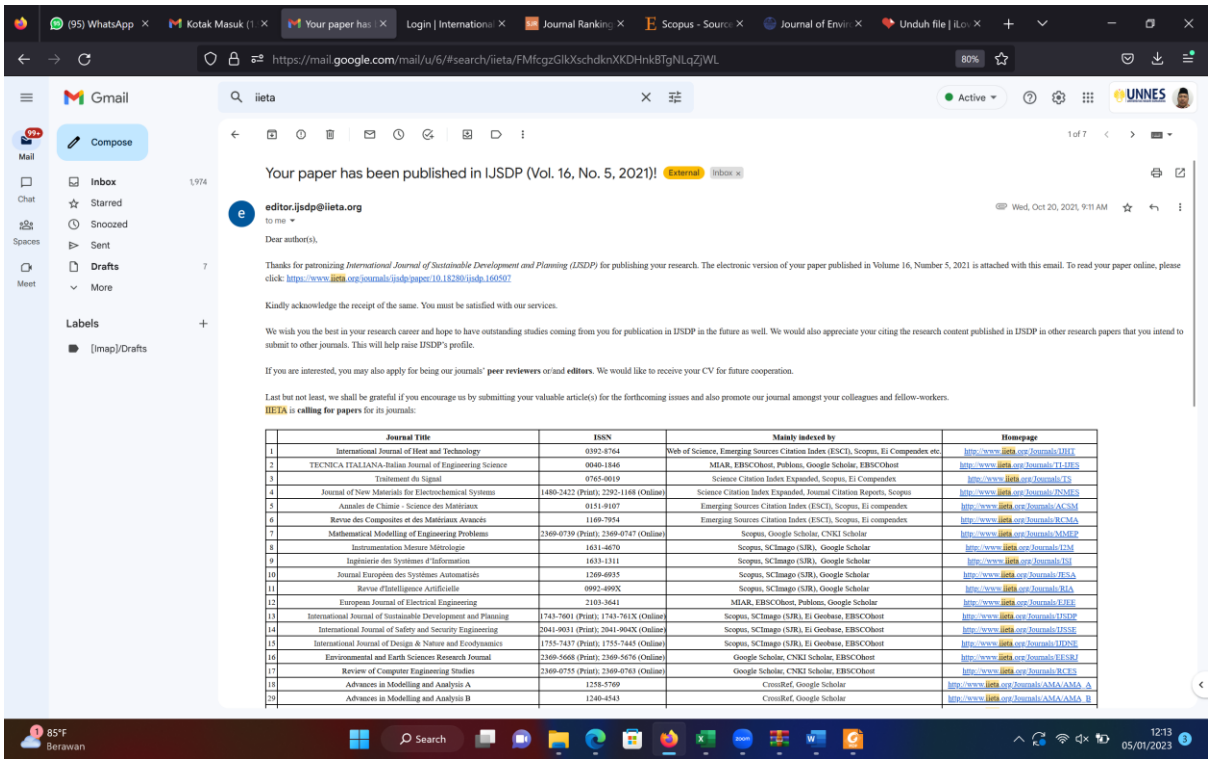

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Fishermen Adaptation to Climate Change in Mertasinga Village, Gunungjati Sub-District, Cirebon Regency

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ABSTRACT

This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The population of the study was 2,025 fishermen in Mertasinga Village, and a sample of 102 fishermen was taken using a proportional random sampling technique. Data were collected using observation, interviews, and documentation. Data were analyzed using the interactive analysis model from Miles and Huberman. Based on the results of the analysis, it can be concluded that climate change has an impact on fishing activities that require fishermen to adapt. In fact, they have adapted to climate change even though the used technology is still quite minimal; fishermen have not developed a ship, have not used weather information and maps of fish catchment areas from the BMKG, and have not used fish tracking devices. Carrying out continuous socialization, strengthening social capital and organizational capacity, and holding various trainings concerning on alternative livelihood are greatly essential to do.

1. INTRODUCTION

Global warming is a fact that is happening for years or even decades. It is a sensational topic at almost all levels of society in the world. The real thing about global warming is climate change. Climate changes continuously due to interactions between its components with external factors such as eruptions, sunlight variations [1], and human activities [1-3]. They thus change the composition of the global atmosphere and natural climate variability over time [3, 4].

Climate change is characterized by a tendency to increase in temperature over time, change in rainfall patterns, and increase in sea level [2]. The increase in global temperature since 1901 reached 0.89°C. In Southeast Asia, the temperature increase reaches 0.4-1°C. The temperature increase in Southeast Asia in the medium term (2045-2065) is estimated to reach 1.5-2°C [4]. Indonesia is one of the most vulnerable countries to the threats and impacts of climate change [3, 5, 6]. The results of data observations for 39 years from 1981-2020 is that the air temperature anomaly in Indonesia in January experienced an increase in the average air temperature of 0.95°C [7]. Then, data for 30 years (1980-2010) indicates that there was a change in rainfall, normal annual rainfall [7], and a shift in the peak of rainfall [8].

Indonesia is an archipelago whose ¾ territory is sea [9]. This causes Indonesia to have a large coastal area as well [10]. Coasts have a very important role in people's lives [11]. However, coastal ecosystems are vulnerable to the impacts of climate change [12, 13]. Climate change is increasing the vulnerability of coastal areas which are already vulnerable to erosion, destruction of mangrove forests, and exacerbated by human activities such as the construction of docks and sea dikes [14]. Climate change causes changes in coastal and marine ecology [15]. Coasts are vulnerable to sea-level rise, changes in the frequency and intensity of wind speeds, increased wave height, increased ocean temperatures, and increased carbon dioxide concentrations that cause acidification in the oceans [16].

Climate change can disrupt the fish catch of fishermen [17] so that it has an impact on the livelihood systems of coastal communities [18] and the welfare of fishermen resulting in increased uncertainty regarding aspects of fishermen's livelihoods [19]. It also results in the increase and decrease of fisheries in certain areas. This is due to temperature, oxygen availability, and availability of fish food in these waters [13]. If the controlling factor is not suitable in certain waters for fish life, the fish will certainly migrate to waters that have the availability of these controlling factors. Apart from the erratic distribution of fish, rainfall, and wind seasons, climate change also affects capture fisheries. The increasing frequency of big waves is also a challenge for fishermen to reach the fishing ground. Unfavorable water and weather conditions cause fishermen to often delay fishing operational time and affect income from their catch, thus making fishermen and fishermen's families adapt to cope with climate change [13, 20]. Climate change has an influence on changes in the fishing season calendar, the loss of several animals that are markers of changing seasons, and an increase in the intensity of storms in the sea that suddenly come to fishermen in Natuna Regency, Riau Islands [19].

Bajau fishermen, Konawe Regency also feel climate change. Fishermen feel the increased risk of going to sea, reduced fish production, increased costs of fishing, the less effective fishing gear they use, and difficulty determining fishing areas [12]. The impact of climate change felt by fishermen in Indramayu Regency is in the form of high tidal waves, changes in rainfall,

changes in wind patterns, difficulty reading the weather, and fishing ground that moves further to the high seas [17].

Based on the results of interviews with fishermen in Gunungjati Sub-district, the current weather conditions are difficult to predict, unlike in the past certain months can predict the number of fish. For now, fishermen find it difficult to read natural forecasts. This has an impact on the decreasing fish catch of fishermen, they only look for fish around the coast of Cirebon, for fear of being suddenly hit by high waves.

Data from ref. [21] and ref. [22] also propose that extreme and erratic weather results in much-reduced fish catch, namely from 1 ton per day to 1 quintal per day. If the extreme and erratic weather comes about, then many Merstasinga fishermen do not go sailing [23]. In addition, the production of salted fish is also constrained by the erratic weather [24]. This uncertainty could be influenced by climate change which resulted in disruption of the environmental balance [25]. What is more: climate change causes cycles of climate anomalies such as La Nina and El Nino to become increasingly erratic [26].

Deputy Head of the Meteorology, Climatology, and Geophysics Agency (BMKG) Mulyono R Prabowo explained that one of the causes of waning natural navigation systems cannot be separated from environmental changes, one of which is that global warming is considered to have an effect. News from *Tribunnews.com* (05/18) states that many fishermen in Cirebon could not go to sea due to bad weather, could only work odd jobs, and some fishermen even sold their belongings to meet their daily needs. Climate variability that occurs in one village in Cirebon Regency has a detrimental impact on fishermen's households. The losses that are felt are decreased fishing yields, decreased production of salted fish, and failure to go to sea [18].

The future climate can be very different from the current. Climate fluctuations potentially will continue [27]. Fishermen are faced with the threat of climate change [28] and must adapt to these conditions for their livelihoods as the uncertain climate has an impact on their economic conditions [29]. Natuna Regency fishermen are pursuing a strategy of diversifying their economic activities, diversifying their fishing gear, changing fishing ground areas, utilizing social networks, and globalizing family members for adaptation to climate change [19]. The use of the development of ship technology, fishing gear, and geo-information and communication technology is carried out to adapt to the impacts of climate change by fishermen in Indramayu Regency [17]. The adaptation strategy taken by Bajau fishermen to deal with climate change is to verify livelihoods, diversify fishing gear, and change the fishing ground area [12].

The richness of the Indonesian sea that is used by fishermen has not provided welfare to fishermen Development needs to be done for the welfare of humans [30]. The fishing profession is greatly vulnerable to the impacts of climate change [13] as it causes sea level rise, changes in sea temperature and acidity, increases in frequency and intensity of extreme weather, and changes in rainfall. Indirectly, climate change influences fishermen's activities and life.

Reflecting on those issues, education still becomes a notable element in finding an exact solution—especially for fishermen. A study [31] mentions that education plays a great role in shaping good attitudes, behavior, and thoughts in the perpetrators regarding the environment. Fishermen play a role in determining the right adaptation strategy to deal with the impacts of climate change. It takes knowledge, attitudes, and appropriate skills to deal with the impacts of climate change so that these impacts can be minimized. It is expected that fishermen are aware and active in determining the right adaptation strategy to minimize the impact of climate change and participate in environmental conservation.

One of the areas possessing greatly potential fishery is Cirebon Regency, West Java Province [32]. There, fishery is one of the various important economic bases for local income [33, 34]. Gunungjati Sub-district is named as a sub-district with the largest fish productivity in Cirebon. Then, of the 15 villages there, Mertasinga Village has the largest fishery products which are even exported abroad [35]. Mertasinga is a fishing village that has existed since the Dutch colonialist still put hands in Indonesia. As a fishing village, it has a very strong fishing culture, adequate fishery infrastructure, and a large fish market and holds fish bazaars regularly [36].

Hence, studies on fishermen, especially the adaptation of fishermen to climate change in Cirebon Regency, are still very minimal. It is necessary to do an in-depth study related to the adaptation of fishermen to climate change in Gunungjati Sub-district, especially in Mertasinga Village, because most of the people of Mertasinga Village are fishermen who depend on the sea for their livelihoods. The majority of them have already felt the impacts of climate change, such as difficulty reading the seasons, unpredictable weather, high risk of going to sea, and decreasing fish catches. The impact of climate change requires them to adapt. This study aims to determine the adaptation carried out by the fishermen of Mertasinga Village in facing climate change. The results of this study are expected to provide benefits regarding the adaptation of fishermen in facing climate change. They can also be used as a reference for similar research and help the government to create programs that are suitable for fishermen.

2. METHODOLOGY

This study applied a mixed research design or better known as mixed methods research. The mixed-methods design in this study used a sequential explanatory type approach. The population in this study was fishermen who live in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency and experience the impact of climate change, namely 2,025 fishermen.

Fishermen in Mertasinga Village are divided into three groups, namely; owner fishermen, small fishermen, and labor fishermen. Owner fishermen are described as fishermen who have their own means or equipment of production such as boats, nets, and others. They are usually upper-class fishermen or skippers who have many production tools. Meanwhile, small fishermen are those with their own production tools but with low quantity and sophistication as they only have little capital. Then, labor fishermen are those who do not have their own means of production. They can only contribute their labor services in fishing activities and earn lower wages than fishermen who own production equipment.

Sampling in this study applied a proportional random sampling technique. The proportional random sampling technique was chosen because at the research location, there were three groups or classes of fishermen, namely owner fishermen, small fishermen, and labor fishermen. Each group of fishermen has a different number, so it is necessary to take a proportional sample with the aim that the sample can be taken evenly from each group. The sampling utilized the

formula from Isaac and Michael to obtain 102 samples. The sample proportion can be seen in Table 1.

Table 1. Research samples of fishermen in Mertasinga village by class of fisherman 2020

No	Class	Total Population	Calculation	Total Sample
1	Owner Fisherman	623	$\frac{623}{2025} x\ 102$	31
2	Small Fisherman	1.300	$\frac{1300}{2025} x\ 102$	66
3	Labor Fisherman	102	$\frac{102}{2025} x\ 102$	5
Total		**2.025**		**102**

Source: Primary Research Data, 2020

Data collection applied observation, interview, and documentation techniques. In this study, interviews were conducted with research subjects to obtain data about the adaptation of fishermen in facing climate change. The data validity test in this study used triangulation, namely comparing various information obtained from observation, interview, and documentation methods.

The qualitative analysis in this study used the Miles and Huberman model analysis. Steps taken to analyze qualitative data began with reducing the data. Reducing data means summarizing, choosing the main things, focusing on the important things, looking for themes and patterns, and removing unnecessary things. After reduced, the data is presented. In qualitative research, the data presented can be in the form of brief descriptions, tables, graphs, pies, and the like. The presentation makes the data will be easy to understand. Conclusions are drawn after reducing and presenting the data. The conclusion in qualitative research that is expected is a new finding that has never existed before. Findings can be in the form of descriptions of an object. Drawing conclusions in this study is also expected to be able to answer research questions. The research question is how fishermen in Mertasinga Village adapt to and face the climate change.

3. RESULT AND DISCUSSION

Cirebon Regency is located in West Java Province. Based on its astronomical location, it is in the position of 6º30'-7º00'S and 108º40'-108º48'E. Mertasinga Village is a village located on the coast of Cirebon Regency and is traversed by the Bondet River which empties into Mertasinga Village. The total population of Mertasinga Village is 6,422 people. 3,262 residents are male and 3,160 are female. They work as PNS, TNI, POLRI, entrepreneurs, employees, laborers, farmers, traders or sellers, and fishermen. 32% or 2,025 people in Mertasinga Village are fishermen. They are divided into three groups, namely small fishermen, owner fishermen, and labor fishermen. The majority of fishermen in Mertasinga Village are small fishermen and labor fishermen.

This is not supposed to be a part of the paragraph. It is a sub-point of "Results and Discussion" and therefore must be separated and written in bold. You might revise or just simply remove this sentence. In this study, adaptation is a modification process caused by a stimulus. The presence of a stimulus is in the form of an environment that has begun to change due to the impact of climate change. Therefore, fishermen took steps to adjust their livelihoods to this stimulus. The adaptation strategy carried out by fishermen in Mertasinga Village can be seen in Table 2.

The adaptations made by fishermen in Mertasinga Village in facing the impacts of climate change are technological adaptation, social adaptation, and economic adaptation. Technology adaptation is in the forms of ship maintenance, use of GPS, and use of refrigerators. Social adaptation takes forms of joining as a member of a fishing group, following socialization, utilizing social networks, and trading or working family members. Then, economic adaptation is in the form of a double-income pattern and changing professions.

Table 2. Adaptation of fishermen in mertasinga village in facing climate change

Class	Adaptation		
	Technology	**Social**	**Economy**
Owner Fisherman	1. Ship Maintenance 2. Using GPS 3. Using Cold Storage	1. Joining a fishing group 2. Buying and selling online with fishermen outside Cirebon 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Cultivation of green fish/shellfish 2. Opening a side business in the form of a shop 3. Opening a side business in the form of services
Small Fisherman	1. Ship Maintenance 2. Using Cold Storage	1. Join a fishing group 2. Utilizing social networks with bosses/middlemen 3. Following the socialization from related agencies 4. Family members work and help with seafood processing	1. Switching professions to become farmers/breeders 2. Switching professions to become farm laborers/ponds 3. Switching professions to become construction workers/porters 4. Cultivating green mussels in groups with other fishermen 5. Opening a side business in the form of a shop/service
Labor Fisherman	Helping the maintenance of the ship	1. Joining a fishing group 2. Utilizing social networks with bosses/middlemen 3. Family members work and help with seafood processing	1. Switching professions to become farm laborers/ponds 2. Switching professions to become construction workers/porters 3. Opening a side business in the form of a shop

Source: Primary Research Data, 2020

The knowledge of fishermen about weather and climate and their implications for the management strategy of marine and fisheries resources has changed over time. The uncertainty of fishing seasons and reduced catches make them try to develop technology and adapt to changing conditions. The use of ship technology and fish storage is executed to adapt to the impacts of climate change by fishermen. The use of technology is very beneficial to prevent or reduce the impact and/or risk that may occur so that it will reduce the costs required. This is under the results of interviews conducted by researchers to one of the fishermen named Seta:

"In Mertasinga, most people are fishermen. If the boat is damaged, just fix it. If the engine is damaged, the business repairs it first. If it can't work at all, then replace it."

From the results of interviews with fishermen in Mertasinga Village, the technology used in fishing boats is in the form of 15-40 PK outboard motors and if the boat's body is damaged, the fishermen repair the boat themselves. The technology used by fishermen is still simple as the majority of fishermen in Mertasinga Village are small fishermen using outboard motorboats. Small fishermen have not used GPS for determining the catchment area, but fishermen who own boats of 5-10 GT have already used GPS—as explained by Mr. Juned below:

"My ship is 10 GT using GPS. The big ships use GPS for sailing."

In addition to the use of GPS, fishermen in Mertasinga also utilized cold storage or refrigerators at Bondet Fishing Port to extend the life of the fish. Another adaptation is in the form of fish preservation for the manufacture of salted fish by traditional drying in the sun. The process of making salted fish is usually done by fishermen's wives and children when fishermen go out to sea.

The use of social networks is an adaptation carried out by fishermen in Mertasinga Village by optimizing family members. Social networks consist of two relationships, namely vertical social relationships and horizontal social relationships. Vertical social relationship talks about the relationship between skippers (owners) and fishermen; the skippers provide capital to go to sea. Meanwhile, horizontal social relationship is in the form of cooperation between fishermen and fishermen and fishermen with coastal communities who have livelihoods on land. When small fishermen face difficulties to find fish, they seek capital by utilizing their social network to the skippers. Fishermen are looking for capital to go to sea or are forced to go into debt to meet their daily needs and will pay them during the high season. The influence of climate change on social conditions in Mertasinga Village also adds to the social network among fishermen outside the region. This is proved by an interview with Mr. Didi:

"...when famine comes, the owner fishermen exchange any relationships online, sell frozen fish—usually taken from Surabaya and Banten…"

From the results of interviews conducted by researchers, it is known that the fishermen of Mertasinga Village face difficulties to find fish in the dry season. The owner fishermen then communicate online with other fishermen who are outside the Cirebon area. If the fish stocks in Cirebon Regency run out because the fishermen do not get fish, the owner fishermen take the fish stocks from other areas. Fishermen buy and sell fish in frozen form. The fishermen relations of Mertasinga Village have reached other regions such as East Java, Central Java, and the coastal parts of Banten. Fishermen with many family members tend to have extensive social networks or relationships. Another social adaptation is in the form of an annual *nadran* ceremony. This local wisdom is a hereditary legacy that is held annually. *Nadran* takes place at the end of the western season in April. It is a symbol of gratitude for the abundant marine products and the hope for abundant seafood in the following year.

The economic adaptation carried out by fishermen to deal with climate change is by means of a double income pattern or changing professions temporarily and leaving fishing activities or changing professions. The double income pattern of fishermen is in the form of changing professions temporarily when it is difficult to fish, usually during the beetle season and the western season. When it is difficult to get fish, fishermen turn to porters, construction workers, farming, raising livestock, opening shops in the surrounding area, opening side service businesses, working as farm laborers, and working as fishpond laborers. This is in line with the interview with Mr. Saduri as follows:

"When it's the hard season, I usually work as a coolie or laborer at the Celangcang market or when someone builds a house. Sometimes I rent my boat, and being a farmer is also just fine. Just do everything."

The majority of fishermen in Mertasinga Village do odd jobs as coolies or casual laborers when they are difficult to get fish. The following is an interview with Mr Sarkad who owns lands for farming:

"Apart from fishing, my side job is planting bananas on my land. So if hard season comes, I can sell the fish or eat the bananas right away."

Fishermen have also adapted to raising chickens and goats that can be used for their own consumption or for sale in markets. Fishermen who own lands for farming or livestock also do these jobs as both can increase their income and have unlimited time. Simply, they can do it all year round. Apart from farming and raising livestock, fishermen also adapt to selling or trading in their yards. The shop is managed by the fishermen's wife, selling various shellfish and fresh fish, snacks for children, and basic necessities such as soap, detergent, rice, sugar, and others. Another fishermen's economic adaptation is changing professions and leaving fishing activities at sea. This change of profession is like raising green clams and working as a farm laborer.

4. CONCLUSION

Based on the results of research on the adaptation of fishermen to climate change in Mertasinga Village, Gunungjati Sub-district, Cirebon Regency, it can be concluded that fishermen have experienced climate change that has an impact on their lives so that fishermen have to adapt to the situation. The adaptations carried out by fishermen in Mertasinga Village include 1) technology adaptation, namely in the form of utilizing GPS technology and refrigerators; 2) social adaptation, carried out by communication between fishermen and fishermen and middlemen; 3) economic adaptation, carried out by fishermen, namely with a double income pattern and leaving fishing activities.

RECOMMENDATION

The technology for adapting that is used by fishermen in

Mertasinga Village is still very minimal such as fish processing technology by drying the fish directly in the sun. It can be said that this method is still traditional because it depends on the weather. The local government should be able to provide drying tools for drying fish that can be used by fishermen and can optimize fishermen's work. Fishermen in Mertasinga Village are still minimally used, such as GPS, technology. Only owner fishermen owning the new 5-10 GT boat use GPS. Fishermen also do not know the fish catch area distribution map that has been provided by the relevant agencies. The local government should work even harder by holding outreach for fishermen in Mertasinga Village, especially regarding the use of GPS, the use of maps of fish catchment areas, and the use of fish detection tools. The fishermen who are given the socialization must also be from all classes. Various socializations have to be held regularly and continuously—not only incidentally—so that fishermen can obtain adequate information and skills to deal with important matters in terms of fishery dynamics. Apart from the local government, fishermen must also be willing to work together to succeed in socialization programs by regularly attending socialization activities and having the intention of adding knowledge which will certainly be beneficial for life.

Moreover, escalating social capital between fishermen and the government is very notable for cooperation in dealing with climate change. Strengthening solidarity and the capacity of fishermen's organizations is greatly prominent so that fishermen can exist continuously even in the midst of a fluctuating climate. The government must provide alternative livelihood training for the community and empower women so that fishermen do not only rely on their income from the fisheries sector. Soft skills such as entrepreneurship and other creative industries are extremely recommended.

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