Volume 3, No. 11 November 2024 - (2529-2547)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Economy, Development, and Fishermen's Income in Atauro Island Affected by Natural Disaster Impacts

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ABSTRACT
Fishermen's income is greatly affected by various factors, including frequent natural disasters, such as strong winds, high waves, and heavy rains. This phenomenon is of particular concern to fishermen on Atauro Island, as it can have a significant impact on their livelihoods. This research aims to analyze the impact of natural disasters on fishermen's income in Atauro Island and measure the total effect of natural disasters on economic growth in their livelihood. This research used quantitative methods with data collection through questionnaires, interviews, and documentation. Data analysis was conducted using simple linear regression, hypothesis testing, and coefficient of determination analysis. The results show that 17.6% of fishermen's income is influenced by natural disasters, such as strong winds, high waves, and heavy rain, with a double R value of 0.176. In contrast, 82.4% of fishermen's income is influenced by other factors outside natural disasters. This finding strengthens the research hypothesis that natural disasters have a significant influence on fishermen's income on Atauro Island, so the null hypothesis (Ho) is rejected. This research implies that mitigation measures and adaptation strategies are needed for fishermen in Atauro Island to reduce the negative impact of natural disasters on their income. Government policy interventions and community support are essential to improve fishermen's economic resilience.

Keywords: Impact of Natural Disasters, Development, Fishermen's Lives.

INTRODUCTION

Climate change and the impacts of natural disasters are becoming an increasing global challenge. Phenomena such as floods, heat waves, prolonged droughts, and earthquakes are becoming pressing issues for many countries, especially developing countries (Middleton & Sternberg, 2013). Climatologists predict that the Southeast Asian region, including Timor Leste, will face increasingly hot and dry climatic conditions, accompanied by irregular rainfall that can trigger flooding in certain areas (Gusty et al., 2024). These changes affect not only environmental sustainability but also the economic well-being of communities that depend on natural resources.

Timor Leste, as a relatively newly independent country in the 21st century, faces severe challenges in establishing economic and social stability (Lundahl et al., 2019). The vulnerability of its lowland regions to climate change exacerbates the risk of natural disasters such as floods,

which have significant impacts on the agriculture and fisheries sectors. Floods can damage infrastructure, reduce agricultural productivity and cause people to lose their homes and livelihoods (da Fonseca, 2015). On the other hand, the lack of community awareness and knowledge on climate change adaptation and disaster preparedness exacerbates the impact of such disasters. Under such conditions, the sustainability of key economic sectors such as agriculture and fisheries becomes increasingly important to ensure economic stability and community welfare.

Globally, climate change has led to an increase in the intensity and frequency of natural disasters, which has a significant impact on economies and people's well-being. The report (Timotiwu et al., 2021) shows that changing weather patterns due to climate change have increased the risk of disasters in various countries, including Timor Leste. The country, despite its abundant natural resource potential, faces serious challenges in managing disaster risk and its impact on key sectors of the economy, including agriculture and fisheries.

Fisheries, as one of the key sectors in Timor Leste, plays an important role in supporting food security, increasing community income, and providing employment (Lestari, 2014). However, the sector is highly vulnerable to the impacts of climate change, such as sea level rise, changes in ocean temperature, and other natural disasters that damage marine ecosystems. On Atauro Island, known for its beautiful marine biodiversity, fisheries are one of the mainstays of the local economy (Robie, 2015). However, the impacts of natural disasters such as high waves and floods often disrupt fisheries activities and impact the income of fishers.

In addition, agriculture is also an important sector for Timor Leste's economy. Data from the Ministry of Agriculture and Fisheries (Williams et al., 2018) shows that around 80% of the country's population relies on the agricultural sector as their main livelihood. However, climate change that affects rainfall patterns and soil fertility poses a major challenge to the sustainability of this sector. As a new developing country, Timor Leste requires transformation and modernization in these sectors to support sustainable development (Joseph & Hamaguchi, 2014).

Several previous studies have explored the impacts of climate change on key economic sectors in Timor Leste. (Lopes, 2021) highlighted the importance of the agricultural sector in supporting food security and creating jobs in the country. The research suggests that the sector's vulnerability to climate change requires better mitigation and adaptation strategies. Other research by (da Costa, 2024) discusses the impact of flooding on infrastructure and livelihoods in vulnerable regions, including Timor Leste. This research emphasizes the importance of community-based approaches in dealing with disaster risks. However, specific studies on the impact of natural disasters on fishers' income, particularly in Atauro Island, are limited.

The urgency of this research is high because the impact of natural disasters on the fisheries sector is not fully understood, especially in the context of Atauro Island. As a small island with a high dependency on fisheries, Atauro faces an intensified risk of income loss due to natural disasters. Furthermore, there is an urgent need to identify effective mitigation strategies to support the economic resilience of fishers in the region. By understanding the impact of natural

disasters on fishers' income, this research can make an important contribution to policy planning focused on the sustainability of the fisheries sector in Timor Leste.

This research has novelty value by exploring the relationship between the impact of natural disasters and fishermen's income in Atauro Island specifically. Previous studies have mostly focused on the impact of climate change on agriculture or fisheries in general. This research fills this gap by providing a more in-depth analysis of how natural disasters affect the lives of fishers on a small island, which has unique social and economic characteristics.

Based on the above background, this research aims to identify the impact of natural disasters on fishers' income in Atauro Island, explore the factors that influence fishers' vulnerability to natural disasters, such as infrastructure limitations, access to information, and local community adaptation patterns, and develop strategic recommendations that can be used by the government and other stakeholders to improve fishers' economic resilience in the face of natural disasters. This research is expected to provide a scientific basis for designing evidence-based disaster mitigation and adaptation policies, assist the Timor Leste government and related agencies in developing intervention programs to support the economic sustainability of fishers, and provide guidance for local communities on effective adaptation measures to reduce economic losses due to natural disasters.

RESEARCH METHOD

The research was conducted in the Beloi area, which leads to the sea with a place that is a tourist attraction near the beach. Tourist attractions include white sand including various ruins, to attract tourists to the place of Ataúro Municipality, Ataúro-Vila Administrative Post, Suco Beloi, thus becoming a tourist attraction for the community. The livelihood of the community is mostly fishing. In this area the community gets a good income because every day people go to buy fish in this place, especially tourists who travel in the area.

This place also has calm sea water and help from other places is provided through information to expand the lives of people in this place. Important advantages for their livelihoods are raising sea urchins, boek and catching fish in the sea. The important thing is that it can provide a large income but if it is not utilized according to needs or good management, it can also have an adverse impact on life. According to the research it can be seen as follows on the real coordinate line which is as follows; the longitude is 125.60995 and the latitude is -8.22149.

The boundaries of the research site in Beloi are as follows:

East : Border with Biqueli
South : Border with Alor Island
North : Border with Dili
West : Border with Jaco

Figure 1. Research Map

Source: Google Maps

Materials and Equipment

The materials and equipment to be used in this research are as follows:

Table 1. Materials and Equipment

No.	Material	Function
1	Telefone	Questionnaire sheet using Google Form
		https://forms.gle/YcYPYiVyDzXaVYwj8
Equipment		
1	Camera	To collect documents at the research location

Variable Identification

Research variables are attributes or characteristics or values of people, objects or activities that have certain variations that are fixed for researchers to research and draw conclusions, (Hidayat, 2019). The variables that need to be considered in this research are as follows:

1. The independent variable in this research is the impact of natural disasters (X).
2. The dependent variable in this research is the income of fishermen in Atauro City (Y).

Research Data Collection Methods

The data collection techniques in this research are as follows:

Interview

Interview is a method used to communicate directly with the fishing community to obtain clear information based on its relationship with the research topic.
https://forms.gle/YcYPYiVyDzXaVYwj8.Indriantoro.

Observation

Observation is a method used to go directly to the field to observe activities carried out.

Documentation

Documentation is a way of collecting data through direct observation and using documentation such as reports, questionnaires, and asking questions to respondents in the field (Fadilla & Wulandari, 2023).

Questionnaire Technique

Questionnaire Technique The researcher made a questionnaire and finally before interviewing respondents in the field. (Data, 2015) emphasizes that the technique is an instrument for collecting data, namely respondents filling out questionnaires or questions given by researchers.

Population and Sample

Population

According to (Sugiyono, 2013), says that population is the general whole determined by the researcher to research in order to draw conclusions. Therefore, the place or object of research is the population in Atauro Municipality. General Population The subjects to be conducted in this research are communities that have their own initiative to form fish farming groups. The total community to be interviewed in this research is 211 people.

Sample

According to the scholar (Sugiyono, 2013), giving his definition that the sample is the entire representative who represents the entire population in the area. Thus the researcher himself has completed the sample in this research with a population of 211 people whom the researcher took to be the sample of this research.

Research Methods

The method used in this research is quantitative method. Descriptive method is a method that has the status of a group of people or objects with an idea, a set of conditions or classes within a certain period of time. The purpose of using this quantitative method is to create adequate imagination or facts about the facts of the relationship between the phenomena under research (Sugiyono, 2013). Quantitative research involves collecting data to find events and then organizing, tabulating, describing, and explaining data collection (Waruwu, 2023).

Service Procedure

The type of research procedure used to collect data is by asking questions to researchers and answering questions from the community.

Data Analysis Method

According to (Sugiyono, 2013) said that the data analysis method used in this research is simple regression analysis to determine the relationship of influence between the independent variable (Y) and the dependent variable (X). Simple regression analysis in this research is an analysis that aims to determine and identify the independent variable, namely natural disasters (X) and income as the dependent variable (Y), the dependent variable is an important factor for the development of fishermen and community life. Atauro Island. According to the scholar (Drajat, 2018), said that the simple linear regression formula in this research is as follows:

Formula: Y = a + b*x

Observation

Y : The dependent variable

a : Intercept value (Constant)

b : Regression coefficient

X : Independent Variable

Research Design

This research design has an explanation related to the theory of variable X and variable Y which are closely related. Based on the theory that has been written, this research design is to look at natural disasters (X) and the income of fishermen (X) who cultivate fish, which are strong variables that affect community livelihoods. With the development of fisheries.

Based on research on the impact of natural disasters on increasing fishermen's income on Atauro Island, the research design is as follows:

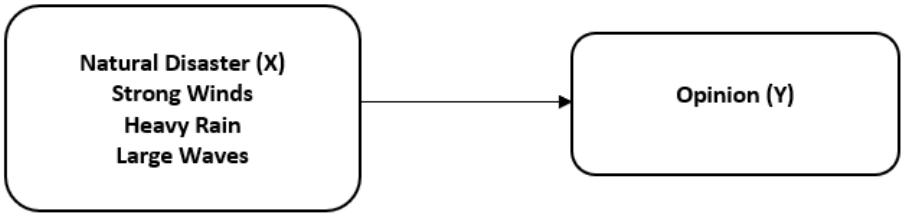

Figure 2. Research design

RESULT AND DISCUSSION

Based on research conducted for one and a half months, there were 211 fishermen respondents, 100% of whom worked as full-time fishermen, with no other jobs, Figure 3 below explains the employment status of respondents.

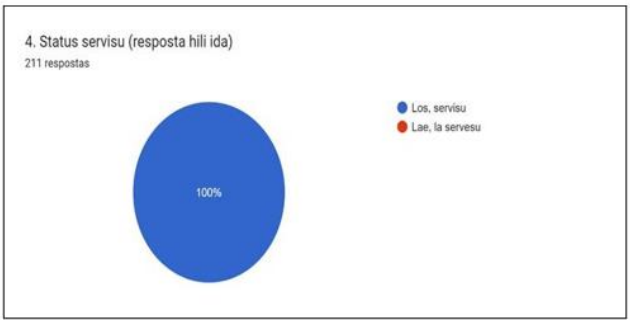

Figure 3. Percentage of respondents' employment status

Based on figure 3. Eight percent of respondents 100% are all employed so in figure 4 it can be seen that 100% of respondents work as fishermen.

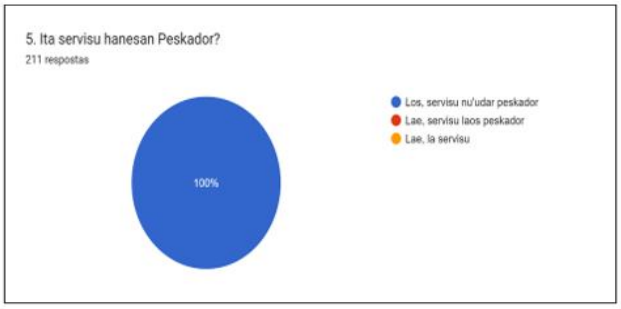

Figure 4. Service status as a fisherman

Based on the survey results from 211 households, 35.5% had 6 household members, 32.2% had 5 household members, 15.6% had 4 household members, and 10.9% had 7 household members. Household members aged thirteen years and above were given the date.

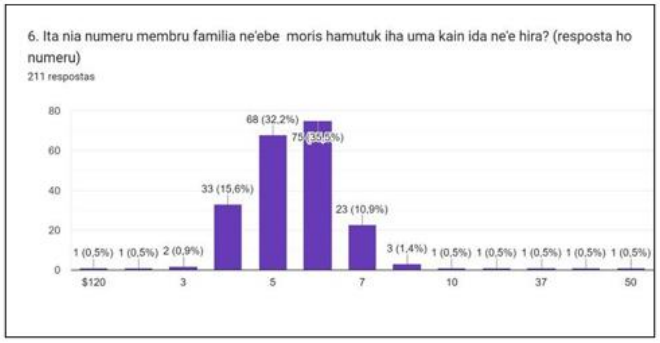

Figure 5. The following is a description of household members.

This research also shows results on the budget spent on food while at sea. Figure 5 below explains that: 96.7% of fishers spend less than $1 to buy food to take to sea, 2% responded that fishers spend between $1 - 5 to buy food to take to sea.

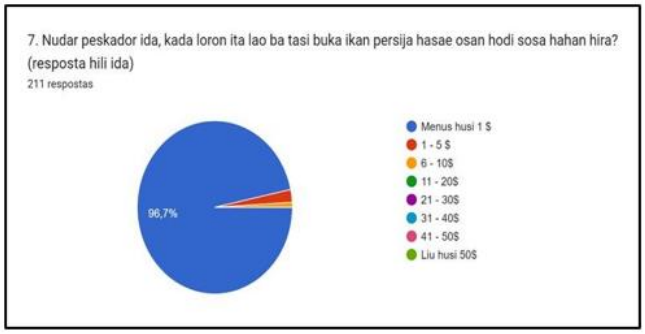

Figure 6. The cost of purchasing food when fishing at sea.

Result of Data Tabulation of Income Questionnaire Y

Based on the research results, 211 people became respondents tabulating data on income variables (Y) a total of three (3) income questions with components:

1. The fishermen's total income will be used for operational costs plus monthly income.

2. The income received and immediately become operational costs during fishing include (1) fishermen, every day fishing using boats and engines using gasoline / diesel, (2) fishermen, every day fishing to collect money to buy gasoline / diesel, (3) fishermen become owners of boats and engines, (4) how many people work together in fishing boats (assistants),
3. Fishing revenue during December 2022 ($), (2) Fishing revenue during January 2023 ($), (3) Fishing revenue during February 2023 ($)

The results showed that (1) fishermen, their facilities go to sea every day looking for fish using boats and engines that use gasoline / solar power.

Figure 7 below describes the fishing facilities using boats and the type of engine used, 99.1% of motorized boat facilities use gasoline energy, and less than 1% of fishers will use boats with solar energy and no engine.

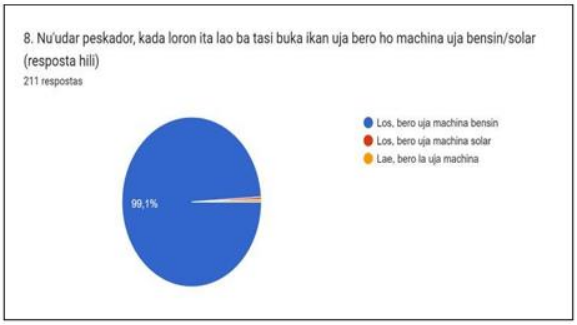

Figure 7. Ship facilities and engine types

As a result of having two (2) peskadors, there is no need to pay for gasoline/diesel ($). Figura 4.6 shows that the facilities of the fishermen are not limited to the type of machine they use, 57.3% of the fishermen use gasoline between 11 and 20$, 42.2% of the fishermen use gasoline between 10$ and 42.2% of the fishermen use gasoline.

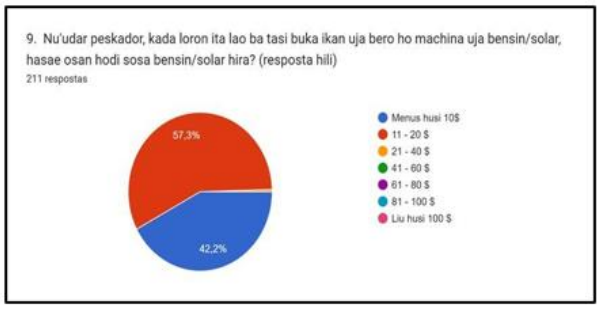

Figure 8. Comparison of osan hodi sosa gasoline ba machina bero nian.

The results show that (3) fishermen become boat and engine owners, the income of which reflects the fishermen's facilities to catch fish such as boats and engines. If a fisherman owns a boat and its engine, then he will earn more income compared to a fisherman who does not have facilities to catch fish (e.g. renting or leasing a boat and engine).

Figure 9 below explains the facilities of fishermen who own boats and engines, 58.3% of fishermen own their own boats and engines, 41.7% of fishermen fish with the facilities of boat and engine owners from the group.

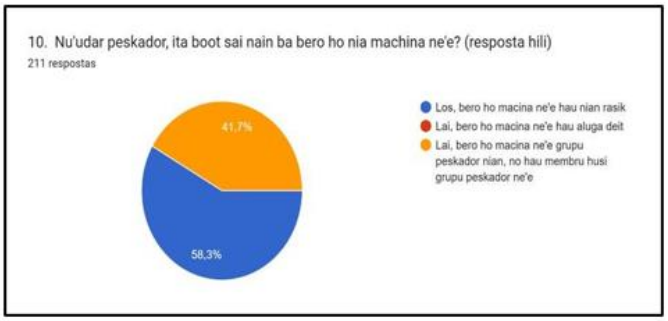

Figure 9. Fishermen and owners of boats and their engines

The results show that income can be measured by (4) how many people work together in the fishing boat (helper), with the thought that the more people who help, the more expenses are considered. Figure 4.8 below describes the fisherman and his assistants who work with him, 100% not more than 5 people. With a capacity of no more than 5 people.

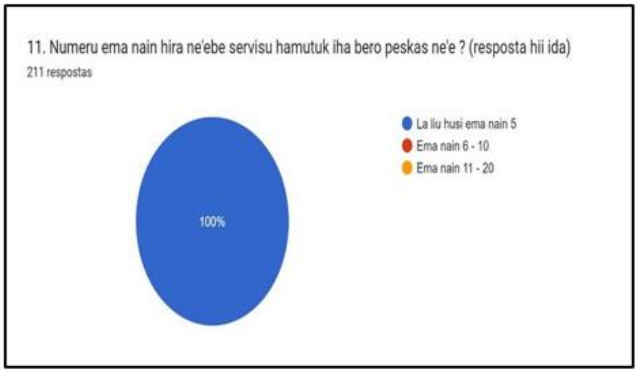

Figure 10. The fisherman and his assistant who works with him.

Every day fishermen fishing at sea need ice (ice stone) to preserve fresh fish. The results showed that fishermen spend money to buy ice 52.6% of the money $1-$5, and 46.9% is a withdrawal of less than $1.

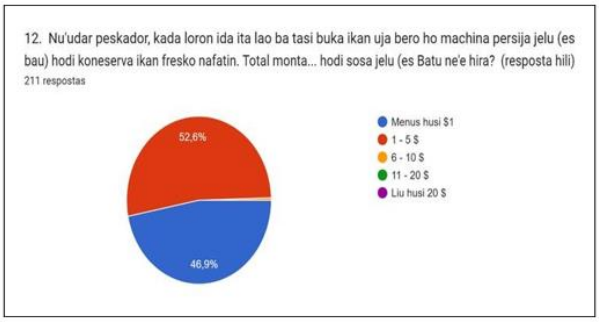

Figure 11. Fishermen buy ice to preserve the fish they catch.

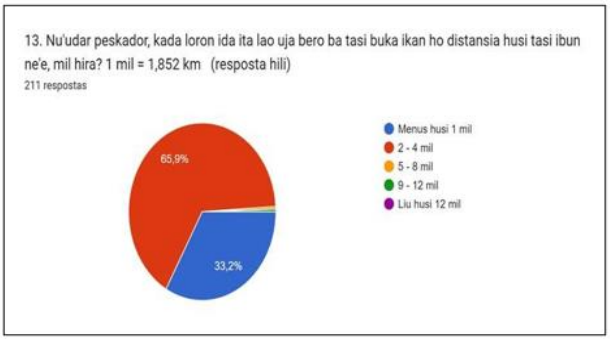

Figure 12. Distance of boats used by fishermen to catch or capture fish.

Figure 12. lists the distance to sea to search for fish to catch Based on the results, 65.9% use boats and machines to search for fish with a distance of 2-4 mill, 33.2% of the distance to sea that use boats and machines to search for fish with a distance of less than 1 mill.

In a questionnaire sent to the Atauro community, during the month of December 2022, respondents were asked to respond to the questionnaire with 100% of the total number of fish in the community.

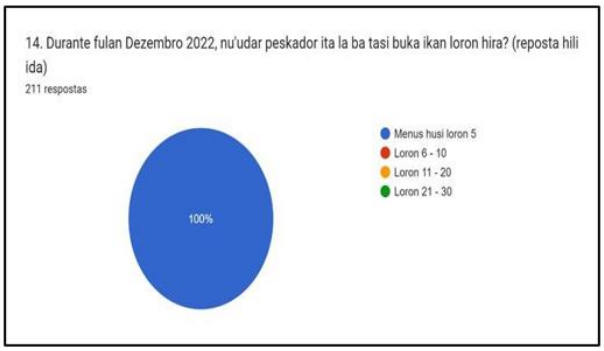

Figure 13. Durasaun tempo ne'ebe peskador buka kaer ikan.

The income received by fishermen during natural disasters in December is the result of research based on respondents' answers showing that most of them received income results 55% received was $50-$265, and 43% of the income they received was $266-$480. and the income they could not get was $481-$700 only 2%.

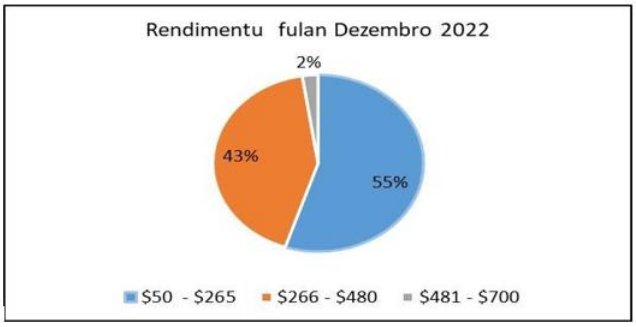

Figure 14. Fishermen's income during December 2022 from fishing.

In Figure 14 regarding fishermen's income in January 2023 in this table respondents stated that in January the highest percentage they received was 49% with a budget of $80-$253, and the lowest percentage was 33% with a budget of $254-4. Six respondents also said that the budget was large but with a small percentage of 18% with a budget of $427-$600.

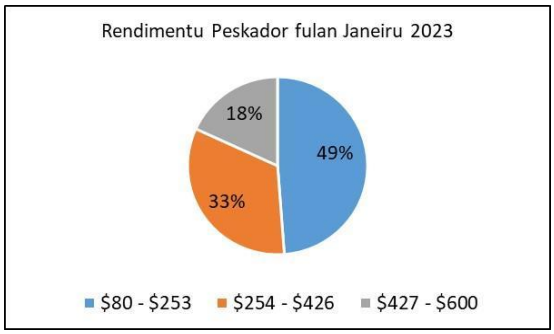

Figure 15. Fishermen's income during January 2023 from fish catches

Based on the survey respondents said that during February 2023, 43% of them had a budget of $99-%$299, 37% had a budget of $300-$499, and the income of $500-$700 was high but the lowest percentage was 20%.

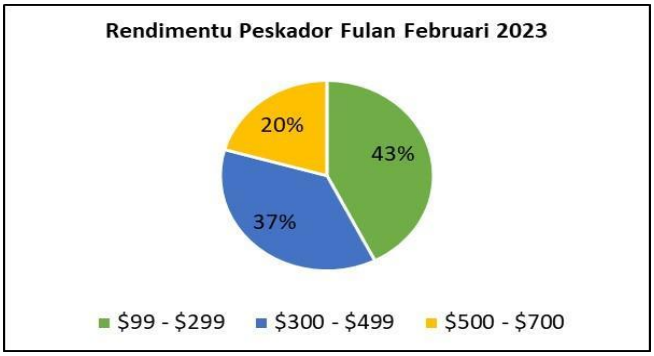

Figure 16. Fishermen's income during February 2023 from fishing.

The researchers prepared to ask the fishermen and the variable amount of income (Y).

Results of Tabulation of Natural Disaster Questionnaire Data (X)

Based on the results of the research, respondents on the variable natural disaster data table (X) totaled 211 people, a total of twelve (12) questions about natural disasters that researchers have prepared to ask fishermen. The total number of natural disaster variables (X) can be seen in the following table:

Based on the questionnaire data of natural disasters that occurred in December 2022, respondents stated that they stopped fishing activities 99.5% of the time for less than five days due to the large waves impacted by natural disasters, and the small capacity of the boats, unable to withstand the large waves.

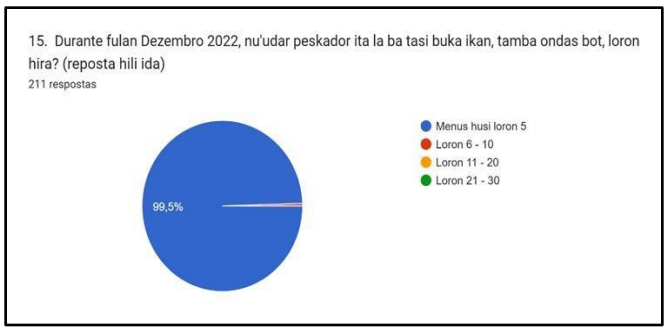

Figure 17. Large wave natural disaster in December 2022

Bazeia ba dadus husi konaba dezastre naturais nebe akontense iha fulan dezembru 2022 respondents sira hatete sira paradu sira nia atividade pescas tuir figura 4.15 In 99.5% of the menus in the fifth month of the year, the profitability of the impact on the anin boot was higher than that of the other two months of the year.

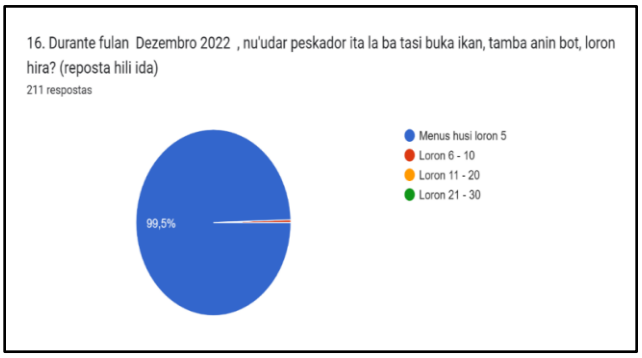

Figure 18. Desastre naturais anin bot fulan Desembro 2022

Natural disasters that occur on Atauro Island such as heavy rains have an impact on fishermen and other activities cannot run. according to figure 4.16, 99.5% percentage of the sea is less than five days. Especially in the field of fisheries, this has a big impact on fishermen who cannot go to sea at sea.

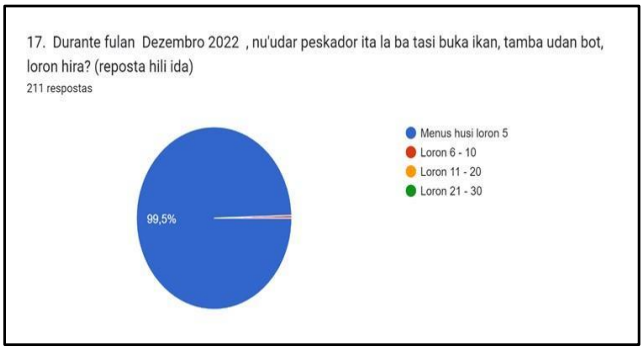

Figure 19. Heavy rainfall natural disaster in December 2022

As well as the explanation in Figure 19, respondents answered with an explanation that almost simultaneously with natural disasters large waves stopped their fishing activities for five days under the figure 99.1% will go to sea based on respondent data in the figure.

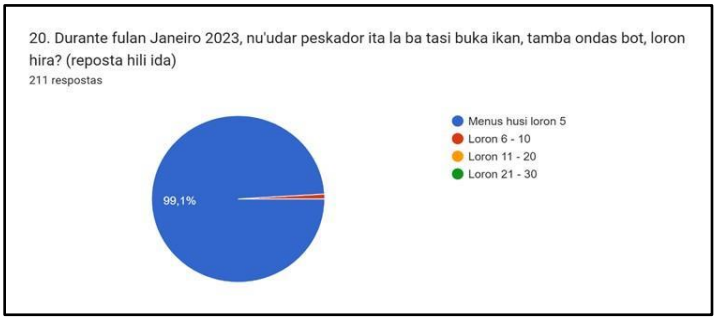

Figure 20. Large wave natural disaster in January 2023

Based on questionnaire data on natural disasters that occurred in January 2023, respondents stated that they stopped fishing activities according to Figure 4.18 in 99.1% of the sea area for less than five days, the impact of strong winds damaged their belongings, some fishing boats and small capacity boats could not be used at sea during strong winds.

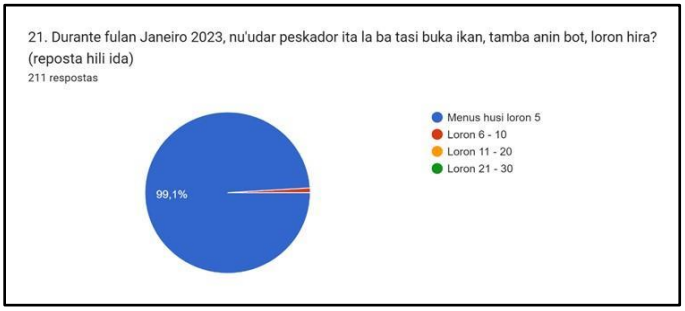

Figure 21. January 2023 hurricane natural disaster

Based on questionnaire data on natural disasters that occurred in January 2023, respondents stated that they stopped fishing activities, 99.1% had less than five days at sea, the impact of strong winds damaged some of their fishing gear and small capacity boats could not be used at sea during strong winds.

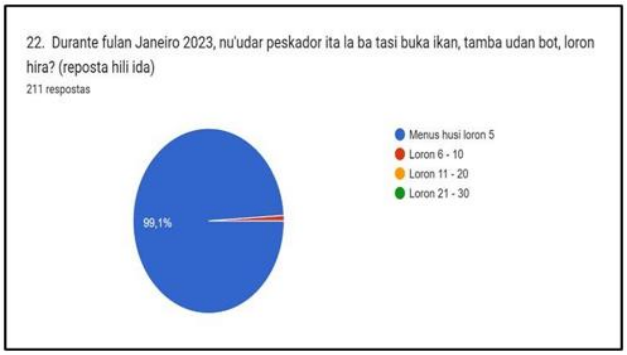

Figure 22. Heavy rainfall natural disaster in January 2023

Based on the questionnaire data of natural disasters that occurred in February 2023, respondents stated that they stopped fishing activities 99.5% of the time for less than five days due to large waves caused by natural disasters, and the small capacity of the boats, unable to withstand large waves.

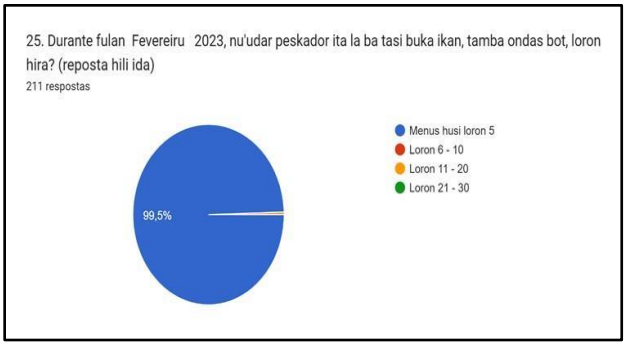

Figure 23. Large wave natural disaster in February 2023

Based on questionnaire data on natural disasters that occurred in February 2023, respondents stated that they stopped fishing activities according to Figure 4.21 in 100% less than five days at sea due to the impact of strong winds damaging some fishing gear and small capacity vessels that cannot be used at sea during strong winds.

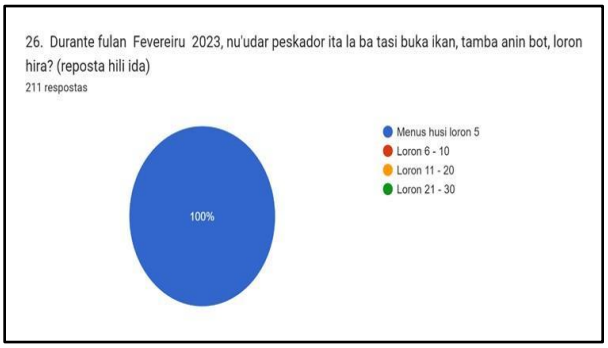

Figure 24. Catastrophic storms in February 2023

Based on the questionnaire used to interview fishermen in Atauro Municipality, 100% of fishermen go to sea when it rains heavily for less than five days. NB: Most of the residents of Atauro Municipality are fishermen by profession, when a natural disaster occurs it affects their lives because they cannot go to sea in the tai.

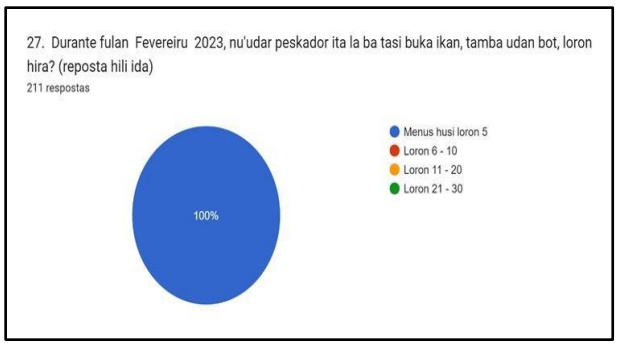

Figure 25. Heavy rainfall natural disaster in February 2023

Statistical Regression Results

Statistical regression results are statistical methods used to define or analyze the character of the relationship between dependent and independent variables (Qudratullah, 2013). can be seen in the following table:

Table 2. Regression Results

Regression Statistics	
Multiple R	0.176
R Square	0.031
Adjust R Square	0.026
Standard Error	357.102
Observations	211

Based on the results of regression statistics Multiple R value to measure the relationship between the dependent variable and the independent variable (Bhirawa, 2020), it is said that 17.6% of fishermen's income is influenced by natural disasters they encounter during fishing, including natural disasters: strong winds, high waves, and heavy rain. This research produces a multiple R value of 0.176 (Susanto, 2005) which can answer that we accept the hypothesis we have prepared, that 17.6% of fishermen's income on Atauro Island is influenced by natural disasters, strong winds, strong waves, and heavy rain, and 82.4% is influenced by other factors (not natural disasters) that are not measured in this survey.

This research produced an R Square value of 0.031 (Susanto, 2005) which means the square of the Multiple R value which means that the income of fishermen on Atauro Island during December 2022 to February 2023 is 'e 3.11 explained by natural disasters, in other words 96.88% is explained by other factors.

This research produced a standard error of 357.102 with a standard deviation of 361.055 (Susanto, 2005). The result of the standard error value of 357.102 is lower than the standard deviation value of 361.055, meaning that the results of this regression model are feasible to use as a model to estimate the income of fishermen on Atauro Island with the estimated natural income. disaster.

Explanation of analysis

Linear regression analysis of variance is a statistical analysis that tests for differences between means and groups. Anova was invented by a statistician named Ronald Fisher (Fisher & McDonald, 2014). The meaning of Anova Analysis of Variance, as a statistical test procedure, but the difference of Anova is that it can test the difference between two groups.

Anova is used as an analytical tool to test the researcher's hypothesis, the final result of anova is to see, and compare the results of the Fsura and Ftabel values, using the fundamental basis for making a decision to accept or reject the null hypothesis (Ho).

The basis for accepting or rejecting the F test is as follows:

a. If the F statistical value is smaller than the F table value at the 5% error level, then Ho is accepted.
b. If the F statistical value is greater than the F table value at the 5% error level, it is rejected.

Based on the research results in Table 2, the following comparison of the F statistical value (6.65) is greater than the F Significance value (0.01) which indicates that this research rejects Ho (or accepts H1) with the intention that the income of fishermen on Atauro Island may be influenced by natural skills.

This research provides the results of the t test, whose function is to see or evaluate the effect of the independent variable (natural disasters) on the dependent variable (fishermen's income). The value of t statistic in this research (-1.65) (see Table 4.2) is compared with the value of t table at 211 respondents with 5% error rate (1.652). This result indicates that the linear regression model obtained is feasible to predict fishermen's income in Atauro Island using the natural disaster factor.

Table 2 of the results also shows the P value to evaluate the significance of the statistical model formed by the regression. The terms of using the P value for model evaluation are based on the following notice:

a. If the P value is less than 0.05, the model is significant and we can reject Ho (or accept H1).
b. If the P value is greater than 0.05, the model is not significant and we can accept Ho (or reject H1).

The research results in Table 2 show that the P value of the natural disaster variable (0.01) is lower than the value of 0.05. so it can provide evidence that the regression model of this research is appropriate for estimating fishermen's income based on natural disasters.

Table 2. Results of Analysis of Variance

Anova				
df	**SS**	**MS**	**F**	**Significance F**
Regression	848403.29	848403.29	6.65	0.01
Residuals	207	26397015.98	127521.82	
Total	208	27245419.27		
Coefficients Table				

Anova				
df	**SS**	**MS**	**F**	**Significance F**
Intercept	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
Intercept	-1590.10	964.98	-1.65	0.10
Desaster Naturais	206.85	80.20	2.58	0.01

The ANOVA results of this research can form a simple linear regression equation as follows:

Y = a + b1*X1

Fishermen's Income = -1,590.10 + 206.85*Natural Disaster1

The equation explains that if the value of natural disasters = zero (no natural disasters), then the income of fishermen on Atauro Island is constant with a value of -892.15$. However, if there are 12 points of natural disasters (strong winds, heavy rain, big waves, dutante three months in a row) the income of fishermen on Atauro Island affected is less than 1,590.10$. This equation starts in quadrant 4 with a significant minus value (-1,590.10). Table 4.3 and Figure 4.22 below can further explain the relationship of fishermen's income in Atauro Island with its natural disaster variables as factors affecting the income. Fishermen's income on Atauro Island can start to be positive if the natural disasters they face are only 4 points with a value of $64.74.

Table 3. Table listing performance (y). Natural Disaster (X)

Rendimento (Y)	Desastre Naturais (X)
-1590.10	12
-1383.24	11
-1176.39	10
-969.54	9
-762.68	8
-555.83	7
-348.97	6
-142.12	5
64.74	4
271.59	3
478.44	2
685.30	1
892.15	0

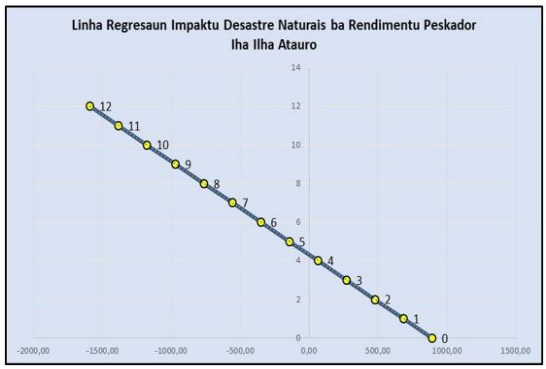

Figure 26. Regression Line of the Impact of Natural Disasters on Fishermen's Income on Atauro Island

CONCLUSION

The conclusion of this research is that natural disasters occurring in the Atauro Island region significantly affect fishermen's income. The results of simple linear regression analysis showed that fishermen's income decreased by -1590.10 (negative) on average when natural disasters occurred intensively (12 consecutive points). In contrast, in situations where natural disasters occur in low intensity (4 points), there is an increase in income of +64.74 (positive). The data from the questionnaire confirmed that disasters with an intensity of no more than five points allowed fishermen's income to remain in normal condition. Thus, this research proved that the intensity and frequency of natural disasters are factors that directly affect the economic stability of coastal communities in Atauro Island.

This research makes an important contribution to the development of disaster mitigation and adaptation policies, particularly in coastal areas dependent on the fisheries sector. The findings underscore the need for the Timor Leste government to develop a more integrated disaster risk management strategy, including strengthening fisheries infrastructure, providing income insurance for fishermen, and training programs to improve the adaptive capacity of local communities. In addition, this research opens up opportunities for further studies, such as analyzing the long-term socio-economic impacts of disasters on the fisheries sector or developing technology-based disaster risk prediction models to improve community preparedness.

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