



ORIGINAL RESEARCH

A STUDY ON COMMUNITY ECONOMIC RESILIENCE IN RESPONSE TO EARTHQUAKES IN JAILOLO SUB-DISTRICT, NORTH MALUKU

Resiliensi Ekonomi Masyarakat Terhadap Gempa Bumi di Kecamatan Jailolo, Provinsi Maluku Utara

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ABSTRACT

Background: The earthquake that hit the Jailolo sub-district in 2015 caused massive damage and loss. This catastrophic event affected not only impacted the local government's economy but also affected many communities, households and individuals living in these communities.

Purpose: Aim of this study is to assess the economic resilience of communities in the Jailolo sub-district in response to earthquakes.

Methods: This research was based on a descriptive observational study and employed a survey method to assess the economic resilience of communities in the Jailolo sub-district. The study was conducted in five villages, namely Tedeng, Payo, Saria, Matui, and Buku Maadu. The cut-off point for each indicator was classified as very high criteria (>1.05), high (0.95–1.05), moderate (0.85–0.94), low (0.74–0.84), and very low (≤ 0.73). **Results:** The proportion of community home ownership was found to be 100% (Resilience Factor Index (RFI)=1.67). The proportion of community work was 33.75% (RFI=0.68). The proportion of dual-income sources of communities in the Jailolo sub-district was 50.89% (RFI=1.02). The proportion of community income that exceeded the provincial minimum wage (PMW) was 8.71% (RFI=0.10). Based on the results of these indicators, the economic resilience of people in the Jailolo sub-district, which was obtained by considering the average RFI of each indicator, was 0.86. **Conclusion:** Community economic resilience in the Jailolo sub-district was found to be in the medium category. The highest and lowest resilience factors resulted from home ownership and income, respectively.

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ABSTRAK

Latar Belakang: Gempa bumi yang melanda Kecamatan Jailolo pada tahun 2015 menyebabkan kerusakan dan kerugian yang sangat besar. Peristiwa bencana ini berdampak tidak hanya pada ekonomi pemerintah daerah, tetapi juga mempengaruhi banyak komunitas, rumah tangga dan individu yang tinggal di komunitas tersebut. **Tujuan:** Penelitian ini bertujuan untuk menilai resiliensi ekonomi masyarakat terhadap gempa bumi di Kecamatan Jailolo. **Metode:** Penelitian ini merupakan observasional deskriptif dengan menggunakan metode survei dalam menilai resiliensi ekonomi masyarakat di Kecamatan Jailolo yang dilakukan di lima desa yaitu Tedeng, Payo, Saria, Matui dan Buku Maadu. Cut of point masing-masing indikator dibagi menjadi kriteria sangat tinggi ($>1,05$), tinggi ($0,95-1,05$), sedang ($0,85-0,94$), rendah ($0,74-0,84$) dan sangat rendah ($\leq 0,73$). **Hasil:** Proporsi kepemilikan rumah masyarakat yaitu 100% dengan Resilience Factor Index (RFI) 1,67. Proporsi pekerjaan masyarakat adalah 33,75% dengan RFI 0,68. Proporsi sumber pendapatan ganda pada masyarakat Kecamatan Jailolo 50,89% dengan RFI 1,02. Proporsi pendapatan masyarakat yang lebih dari Upah Minimum Provinsi adalah 8,71% dengan RFI 0,10. Berdasarkan hasil indikator tersebut, resiliensi ekonomi masyarakat Kecamatan Jailolo yang diperoleh dari rata-rata RFI setiap indikator adalah 0,86. **Kesimpulan:** Resiliensi ekonomi masyarakat di Kecamatan Jailolo berada pada kategori sedang dengan RFI tertinggi adalah kepemilikan rumah dan RFI terendah adalah pendapatan.

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INTRODUCTION

Indonesia is located at the boundary zone of four major plates: the Eurasian Plate, the Indo-Australian Plate, the Philippine Sea Plate, and the Pacific Plate. As a result, earthquakes are one of the inherent natural threats for Indonesia. Tectonic processes or earthquake events often occur in most parts of Indonesia, which have been well identified as active subduction zones in the western and eastern parts of Indonesia (Indonesian Center for Earthquake Studies, 2018).

The North Maluku province is among the regions in Indonesia that has a fairly high level of vulnerability to earthquakes. This province, located in the eastern part of Indonesia, is situated at the junction of three major plates that run across the Indonesian territory. Earthquakes have been one of the most frightening natural occurrences in this region because of the substantial loss it has caused by impacting people's livelihood as well as by causing fatalities (Aldo & Pratama, 2019).

According to previous research studies, one of the main causes for massive casualties during a disaster is the lack of community preparedness in facing disasters (Satria & Sari, 2017). If disaster risk mitigation efforts are adhered to, people will notice improvements in their risk preparedness. In this regard, many previous studies have argued that disaster risk mitigation should focus on building societal resilience. In the context of disasters, resilience can be defined as the ability of a system or a society affected by a disaster to recover quickly and efficiently. Resilience assessment of a disaster area is of vital importance to gain an idea of the resilience condition and to provide the foundation for formulating directions for adapting resilience improvement measures (Ciptaningrum & Pamungkas, 2017). Earthquakes inflict a more devastating impact on the local economic development and welfare in poor and developing countries than in wealthy and developed countries. Economic resilience refers to actions taken after rather than before a disaster since it focuses on mitigating disruptions in the

process of distributing goods and services as well as property damage to areas affected by an earthquake (Xie et al., 2018).

Areas affected by a large-scale earthquake are at risk of economic disruption at the governmental, individual, and household levels. Therefore, it can be said that economic aspects play a vital role in the capacity of communities and individuals to reduce the impact of disasters. The ability of a society or a system to recover after undergoing disruptions is called resilience (Oliva & Lazeretti, 2017).

The term economic resilience is used to define the ability of a city or a regional economic system to adapt to environmental changes. In 2005, Adger suggested that resilience means recovering to a pre-disruption state, but also increasing future responses through learning in the current situation (Liu, Chen, Zhou, Tang, & Li, 2020). Economic resilience, in an area where a disaster and a catastrophic disruption has occurred, is used to describe the stability of an urban economic system as the main driving force for recovery and development (Zhou, Chen, & Wang, 2019).

This research was conducted in the Jailolo sub-district of the West Halmahera District (in the North Maluku province), which is prone to earthquakes. The people of the Jailolo sub-district were thus expected to possess a strong capacity for resilience. This study contributed to the efforts made in improving the resilience of the people in the Jailolo sub-district, especially from an economic standpoint: to assess the economic resilience of these communities. It aimed to evaluate the economic resilience of the people of this sub-district.

METHODS

This study was based on an observational descriptive approach. It employed a survey method to assess the community economic resilience index of the people of the Jailolo sub-district in the West Halmahera District using secondary data in the form of Village Medium Term Development Plan or Rencana Pembangunan Jangka Menengah Desa (RPJMDesa) in 2017 and 2018. The population of the study group included all villages in the Jailolo sub-district, which initially totaled 34 villages and was then narrowed down to five villages that were selected as random samples. These villages are Tedeng, Payo, Saria, Matui, and Buku Maadu. The variables that were assessed in economic resilience

were the current state of the communities to withstand a disaster condition (based on home ownership), employment, sources of income, and the amount of income. The cut-off points for each indicator were obtained by referring to the study by Ainuddin & Routray (2012), which was based on the results from surveys conducted in several Asian countries. Home ownership was considered good when it was higher than the cut-off point of 60%; employment was considered good when it was higher than the cut-off point of 50%; dual sources of income was considered good when it was higher than the cut-off point of 50%; and income was considered good when it was higher than the cut-off point of 50%.

The analysis was carried out by calculating the proportion of each indicator. Subsequently, the Resilience Factor Index (RFI) was calculated by using the following formula:

$$RFI = \frac{\text{Proportion value of each indicator}}{\text{Cut-off points of each indicator}}$$

The formula used to calculate the average value of index factor resilience or Community Resilience Index (CRI) as follows:

$$CRI = \sum_{i=1}^n \frac{RFI}{n}$$

The resilience category employed was calculated using the formula indicated in Table 1. If the RFI was ≤ 0.73 , the economic resilience category obtained was very low. Similarly, the economic resilience category was low, moderate, high, and very high when the RFI range was 0.74–0.84, 0.85–0.94, 0.95–1.05, and > 1.05 , respectively. This study has been declared as ethically valid by the Faculty of Dental Medicine at the Universitas Airlangga with the certificate number 540/HRECC.FODM/VIII/2019.

Table 1
Category Calculation Formulas

Category	Formula
Very Low	$x \leq \bar{x} - 1 \frac{1}{2} SD$
Low	$\bar{x} - 1 \frac{1}{2} SD \leq x < \bar{x} - \frac{1}{2} SD$
Moderate	$\bar{x} - \frac{1}{2} SD \leq x < \bar{x} + \frac{1}{2} SD$
High	$\bar{x} + \frac{1}{2} SD \leq x < \bar{x} + 1 \frac{1}{2} SD$
Very High	$x > \bar{x} + 1 \frac{1}{2} SD$

RESULTS

Home Ownership

The proportion of people with their own dwelling in the Jailolo sub-district was 100%, amounting to 802 houses, which meant that all people in the five villages had their own houses. The results in Table 1 indicate that the proportion of home ownership is well above the established cut-off point of 60% and lies in the high category. The results of home ownership can be seen in Table 2.

The RFI for home ownership in the five villages had an identical RFI value of 1.67. The RFI for home ownership for the five villages can be seen in Figure 1.

Employment

The proportion of people working in the Jailolo sub-district was 33.75%, equaling 1,744 people, and the proportion of people not working was 66.25%, totaling 3,423 people. This meant that the percentage of employment in the South Jailolo sub-district was in the poor category since it was below the established cut-off point of 50% (Table 4).

The most prevalent profession in the Jailolo sub-district was farming, with a total of 55.56% (969 farmers), and the least prevalent one was fishing, with a total of 2.47% (43 fishermen) (Table 3). Among the five villages, the highest RFI value noticed was 1.52 in the Buku Maadu village, and the lowest was 0.08 in the Saria village. The RFI for employment in the five villages can be seen in Figure 1.

Dual Sources of Income

Many people in the Jailolo sub-district had more than a single source of income. A proportion of 50.89% and 49.10% of people only had a single source of income. Therefore, sources of income of the people in the Jailolo sub-district were in the good category since it was above the cut-off point of 50% (Table 4).

Among the five villages, the highest RFI value for dual sources of income was 1.23 in the Tedeng village, and the lowest was 0.08 in the Saria village. The RFI for sources of income in the five villages can be seen in Figure 1.

Income

A majority of the population in the Jailolo sub-district had an income of less than Rp1,000,000.00. The proportion of people who had an income higher than the Provincial Minimum

Wage (PMW) of Rp2,147,022.00 was 8.71%, and the proportion of people who had an income below the PMW was 91.29%. This meant that the income of the population was in the poor category, with the income proportion below the established cut-off point of 90%. The proportions of employment, sources of income, and the amount of income can be seen in Table 3.

The RFI for the highest income among the five sample villages was 0.02 in the Buku Maadu village. The lowest was 0.02 in the Saria village. The RFI for income in the five villages can be seen in Figure 1.

Economic Resilience Index of the Jailolo Population Based on Indicators

The RFI of the Jailolo population was in the high category. The indicator with the highest proportion of economic resilience was home ownership, with a proportion value of 100%, and the lowest was income with a proportion of 8.71% (Table 5).

The highest economic resilience index value in the Jailolo sub-district was home ownership, with an RFI value of 1.67. The lowest was income with an RFI value of 0.10. Based on the index calculation carried out on each indicator, the average economic resilience was 0.86, which meant that the economic resilience of the population in the Jailolo sub-district was in the medium category (0.85–0.94). The economic results of index resilience can be seen in Figure 1.

DISCUSSION

Seismicity in Jailolo Sub-district

The North Maluku province is an archipelago. One of the island groups is the Halmahera Islands. Based on the physiographic and geological aspects, the Halmahera Islands can be divided into two parts: the western and eastern parts. The western part of the Halmahera Islands is a volcanic arc that extends northwards and southwards from Morotai, the western Halmahera Island, the Tidore Island, the Ternate Island, and the Bacan Island. The eastern part of the Halmahera Islands consists of the northeastern part of the Halmahera Islands, which is located to the southeast of the Halmahera Islands and extends continuously towards the Gag and Gebe Islands in the southeast of the Halmahera Islands (Indonesian Center for Earthquake Studies, 2018).

Jailolo is a sub-district located in the West Halmahera District of the North Maluku Province. Minor earthquakes occur frequently in this sub-

district. The number of small-magnitude earthquakes in the Jailolo area has increased since 2015. The earthquakes that were felt had characteristics similar to an earthquake swarm, which is defined as an increase in the number of earthquakes in a certain time span without any major shocks. An earthquake swarm generally occurs in volcanic areas, fault areas, or areas of stress concentration. Until December 2015, the Central Badan Meteorologi Klimatologi dan Geofisika (BMKG) earthquake analysis system in Jakarta had recorded 96 earthquakes with the highest magnitude of 4.8 on the Modified Mercalli

Intensity (MMI) scale. The number of earthquakes that were felt were 33 (Y. T. Putri et al., 2016).

The data obtained from the International Seismological Centre-Global Instrumental Earthquake Catalogue (ISC-GEM) revealed that seven earthquakes with a magnitude of above six had occurred from 1963 to 2007 in the Jailolo sub-district. As a result of its geographical location, situated on plate collision paths, Jailolo is decorated with a chain of volcanoes stretching from the north to the south (Y. T. Putri et al., 2016).

Table 2

The Proportion of Homeowners Among the People Living in the Jailolo Sub-District

Home Ownership	Number	Proportion	Category
Owned	802	100.00	High
Rent	0	0.00	(>60%)
Total	802	100.00	

Table 3

The Proportion of the Type of Profession in the Jailolo Sub-District

Type of Profession	Number	Proportion
Civil Servants	78	4.47
Entrepreneur	372	21.33
Fishermen	43	2.47
Farmers	969	55.56
Labor	282	16.17
Total	1,744	100.00

Table 4

The Proportion of the Working Population, the Sources of Income, and the Income of the Population in the Jailolo Sub-District

Indicator	Number	Proportion	Category
Employment Status			
Employed	1,744	33.75	Less
Unemployed	3,423	66.25	(<50%)
Sources of Income			
More than one source of income	654	50.89	Good
Single source of income	631	49.10	(≥50%)
Population Income			
≥2,147,022	450	8.71	Good
<2,147,022	4,717	91.29	(≥90%)
Total	5,167	100.00	

Table 5

The Results of Economic Resilience Index of the Jailolo Sub-District Population, West Halmahera District

Variable	Proportion	Cut-off Point (%)	Resilience Factor Index
Home Ownership	100.00	60	1.67
Employment	33.75	50	0.68
Dual Sources of Income	50.89	50	1.02
Income	8.71	90	0.10
Average Resilience Factor Index			0.86

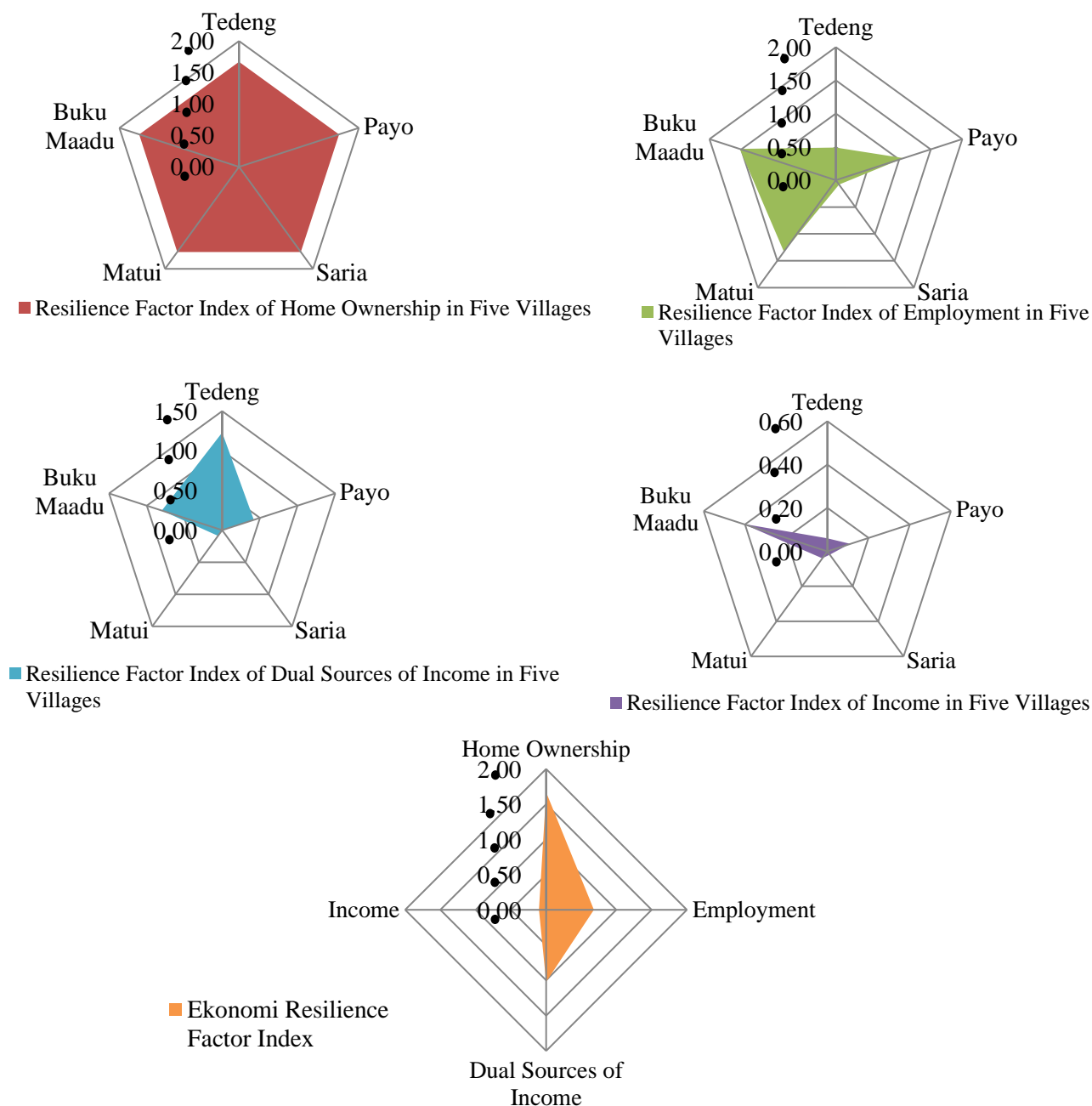


Figure 1. Resilience Factor Index of the Five Villages in Jailolo Sub-district

The high number of volcanoes affects the geological condition, which mostly comprises alluvium deposits, quaternary sediment deposits, and quaternary volcanic deposits. The rocks partly consist of lava. Some rocks have been weathered while some are loose, unconsolidated, and bear the character of amplifying the effects of quakes. All of these conditions make this region susceptible to earthquakes (Y. T. Putri et al., 2016).

Economic Resilience

Economic resilience is defined as the process through which a community develops and implements its capacity efficiently to absorb the

onset of a disaster by mitigating, responding, and adapting following a disaster as well as maintaining and accelerating recovery in order to be in a better position to reduce losses arising out of future disasters. Factors that minimize economic impact (including other types of impact) mostly pertain to provision of adequate access to funds, assistance to help accelerate economic reconstruction, rehabilitation, and recovery. In general, a stable and growing economy boosts resilience, while a frail or declining economy indicates increased vulnerability (Noy & Yonson, 2018).

A study conducted by Muttalib & Mashur, (2019) in the North Lombok District indicated that

the direct impacts of earthquake disasters are especially devastating for an economy. Economic losses that are directly observed are damages and destruction caused to housing and business sectors, which not only lead to output disruption but also lead to poverty because of adjustments made to change the structural conditions of a community.

The economic conditions of a population undergo a drastic change before and after a disaster, even to the point of total dysfunction, because all economic activities effectively cease to run. There was a time before earthquakes occurring when a community had the time to carry out economic activities, both in terms of production and consumption and by performing activities to find other economically viable sources (Muttalib & Mashur, 2019).

Another direct impact of a disaster is the financial loss incurred from damages to economic assets, such as damages to buildings, residences, business premises, and infrastructure. Indirect impacts include the cessation of production processes, loss of revenue, and impact to sources of reception or income. This leads to subsequent impact in the form of stunted economic growth, disruption of development plans that have already been prepared and so on (Muttalib & Mashur, 2019). Another indirect impact can also occur in the form of psychological trauma caused to an individual after a disaster, which can make things worse (Sherchan et al., 2017).

The index derived from the assessment of economic resilience in this study indicated that the economic resilience of the population in the Jailolo sub-district lies in the moderate category with an RFI value of 0.86. Home ownership had a high RFI value of 1.67, which meant that almost all people in Jailolo had their own houses, and no one paid rents. The lowest indicator was income with an RFI value of 0.10, indicating that the population of Jailolo had a low income (i.e., below the PMW of 2,147,022 in the North Maluku province (Table 4 and Figure 1).

Home Ownership

At the household level, following a disaster, housing restoration is vital. Without housing, the ability of households to carry on performing normal activities and rebuilding routines will be limited and hampered. In the event of an earthquake, casualties are most likely to be the ones residing in residential buildings, office buildings, places of worship, school buildings, or buildings that witness plenty of crowds, such as hotels and shopping centers (Munandar, 2018).

A study conducted by Maryam, Sukandar, Guhardja, Asngari, & Sunarti (2008) regarding post-earthquake and tsunami functioning in Nanggroe Aceh Darussalam, suggested that housing problems were felt by the families of tsunami victims because of the discomfort faced in having to deal with very inadequate facilities. The results of the categorization of housing problems faced by families indicated that as many as 25.40% of the families experienced housing problems in the high category. The highest score for housing problems was experienced by intact families (29.11%) and the lowest was felt by widows (6.70%). This occurred due to the availability of small and limited spaces, so all activities in a room were carried out without a dividing wall.

Home ownership of the population in the Jailolo sub-district was in the high category (Table 1 and Figure 1). The higher the home ownership, the better was the quality and maintenance of the house. High involvement of regional heads, appointment of appropriate leaders and agencies, and adequate budget allocations can optimize existing mechanisms and encourage regional apparatus organizations to carry out their duties more effectively (Aldo & Pratama, 2019).

Employment

The proportion of the population who had a job was 33.75% with an RFI of 0.68, which meant these people were in the poor category. The most prevalent type of profession of the population in the Jailolo sub-district was coconut farmers (copra) with a total of 969 people (55.56%), and the lowest was fishermen with a total of 43 people (2.47%) (Table 2). The highest RFI value was noticed in people working in the Buku Maadu village with an RFI of 1.52, and the lowest value was observed in the Saria village with an RFI value of 0.08 (Figure 1). Considering that most of the population were farmers, an earthquake situation could disrupt the community's economy, such as cessation of agricultural processes for a while, thereby stopping the sale and purchase of community agricultural products. Similarly, people working in sectors other than agriculture were also affected. Livelihood changes were carried out as a form of adaptation to sustain life (Umaroh & Ritohardoyo, 2016).

Research conducted by Yoon, Kang, & Brody (2016) on the topic "A Measurement of Community Disaster Resilience in Korea" in 229 cities in Korea. The results revealed a high resilience in the Seoul metropolitan area because most areas in Seoul had a small percentage of people living below the poverty line, and a high percentage of per

capita income was allocated for the safety budget and disaster relief funds of the local community.

Natural disasters may cause losses and impact people's livelihood. During a crisis period, a community becomes dependent on aid, which cannot last long, especially if the assistance cannot fulfill all needs and make the community return to normal life. Therefore, community efforts should be carried out to restore livelihood (Yuliasari & Kiswari, 2018).

Dual Sources of Income

In this study, dual sources of incomes refer to a situation in which the members in a family have more than a single source of income. For this indicator, the Jailolo population was in the good category. The proportion of dual sources of income was 50.89%, which meant that it was above the established cut-off point of 50% (Table 4). Many family heads worked as farmers, and family members (e.g., wives and children) helped others in the family perform work. The community with the most multiple sources of incomes, were the inhabitants of Tedeng village with an RFI of 1.23. The lowest was Saria village where none of its inhabitants had multiple sources of income (Figure 1).

A study by Ainuddin & Routray (2012) revealed that the percentage of multiple sources of income in zone A was 16% and 34% in zone B, indicating that both zones were in the low category since they were below 50%. In terms of economic resilience, zone B had a higher resilience (0.96) than zone A (0.52). This meant that the high proportion of multiple sources of income would greatly assist community resilience to restore a community's economy in the event of a disaster.

Income

Each family had their own needs that could be met by resorting to the family income fund. Income is the amount of earnings a person receives in the form of money or goods in exchange for their work or labor (L. T. Putri, 2016). The proportion of income of the population in the Jailolo sub-district was in the low category (8.71%). The most common profession was farming (18.80%) (Table 3). The farmers referred to here were coconut (copra) farmers who harvested once every three months and earned \leq Rp1,000,000.00. People who had incomes above the PWM were those who worked as civil servants and village officials. The highest income among villages in the Jailolo sub-district was observed in Buku Maadu with an RFI

of 0.41, and the lowest was Saria village with an RFI value of 0.02 (Figure 1).

A study by Sosmiarti, Khaliq, & Uspri (2017) revealed that, in terms of income before the disaster, 50% of the respondents were in the low category; 42% were in the middle category; and 7% were in the high category. This meant that before the disaster, most of the respondents were poor. These poor households were the most vulnerable compared to other categories. Even the smallest disruption to their livelihood could disrupt sustainability. After the disaster, drastic changes occurred, especially in the emergency response phase. In this phase, the number of respondents in the low-income group increased to 77%, while the respondents in the middle and high groups decreased to 17% and 6%, respectively. This indicated that disasters exacerbated the percentage of poor populations. It is likely that other affected regions experience similar conditions. Thus, it is necessary to prepare a community 'community financially (e.g., have them focus on the importance of savings) to cope with the impact. The low level of income of the people in the Jailolo sub-district can lead to poverty, which could disrupt the stability of the community's economy in the event of an earthquake.

Research Limitations

Continued observations were not carried out to determine the home ownership variable, so it is not known whether the houses owned by the communities were earthquake-resistant buildings or not.

CONCLUSION

The economic resilience of the population in the Jailolo sub-district lies in the moderate category. The highest RFI value was observed in home ownership, and the lowest RFI value was observed in income. This is because the majority of the population's income was below the PMW of Rp2,147,022.00. Thus, it is important to focus on economic improvement, especially in the low-category areas. The high level of home ownership must also be accompanied by good-quality housing, specifically buildings that are earthquake-resistant. This element, however, was not explored further in this study; therefore, the authors of this study suggest that future research should include the building quality aspect to examine the resilience of the Jailolo community to earthquakes.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

F performed the data analysis, drafted the article, and approved the publication. FD supported with data interpretation, revised important content, and approved the publication. SM took the lead with the data collection process, aided with data interpretation, and approved the publication. ACH designed the study, took the lead with data interpretation, was the corresponding author, led with the revision, and approved the publication.

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