

## Impact of Natural Disaster on Local Society Income in Maninjau Resort, Agam Regency, Indonesia

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**Abstract**— Persistent natural disasters in Maninjau, mainly landslide, and fish death, have affected the local society income in the tourism destination of Maninjau, Agam Regency West Sumatra, Indonesia. This research aims to identify the effect of natural disasters on local society's income. The research was conducted using the survey method. Samples were collected (300 respondents) from 3 Nagari in Maninjau Resort, especially Nagari Sungai Batang (location of the Buya Hamka Museum), Maninjau, dan Bayua. The parameters identified were the income of local society and the type of economic activity they want to develop. The collected data was classified into categories, then the percentage was calculated, and finally presented in a pie chart. Based on data, it was found that natural disasters, especially landslides and fish deaths in the lake, significantly decreased the local society income. Most (81.7%) of society decreased their income by 40%. The income reduction was not only due to the property loss but also associated with the decrease in tourist visits. To recover the economic growth in Maninjau, most of the community (87.7%) wanted tourist visits increased. Then, they also wanted to develop culinary business (41.5%), agroforestry (29.9%), and religious tourism (26%), especially Hamka Tourism in Sungai Batang. An alternative way to recover quickly and to increase local society's income can be done through online promotion. Website development of each industry in Maninjau is really suggested.

**Keywords**—Local society income; Maninjau lake; natural disaster.

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### I. INTRODUCTION

Maninjau known around the world is due to its distinctive lake. The performance causes the uniqueness of Maninjau Lake. It looks like a cauldron because a high cliff surrounds the lake. This lake was developed from the eruption of Mount Tinjau; therefore, it is considered a volcanic lake. The crater of Mount Tinjau, which erupted around 52 thousand years ago [1], is filled with water to become a lake. This lake is also known as a dam because water gets stuck in the crater after a volcanic eruption (see Fig 1).

Geographically, lake Maninjau is between 100° 08 '53.84' - 100° 14 '02.39' E and 0°14 '52.50' - 0° 24' 12.17 "S. It has a cool climate, having a mean annual temperature between 20-28°C [2]. It is located ± 459 m above sea level with a length is approximately 16 km, the widest part is 4 km, the maximum water depth is 168 m, and the minimum water volume is 9.79 km<sup>3</sup> [3].

The water of Maninjau Lake is utilized not only for domestic people's needs but also to turn a hydroelectrical

power turbine, which produces 68,000 KW [2]. Furthermore, the lake water is also used for irrigation in the regions passed by the outflow river (Batang Antokan River), especially Lubuk Basung and Tanjung Mutiara Districts.

The local people of Maninjau mostly work as farmers and fishermen, as civil servants, traders, and others. As farmers, people work in the fields, especially rice fields and dry land farming such as corn, peanut, and onion, for seasonal crops, as well as cinnamon, nutmeg, clove, avocado, durian, etc., for perennial crops. Rice, as a staple food for Indonesian people, production from Maninjau has prime quality. Some surrounding regions, such as Lubuk Basung, buy rice from Maninjau.

As the fishermen, they not only collect the natural resources of the lake, such as *pensi* and *langkitang* (protein sources other than fish), *rinuak*, *bada*, and some other fish directly from the lake, but they also cultivate fish in the lake using a floating cage. Since the last two decades, people in Maninjau have made much money from the lake, especially

from the fish cultivated in floating cages. The number of floating net cages increased by the year.



Fig. 1 Maninjau caldera

Both women and men could work as farmers, fishermen, traders, or others, but most women just stayed at home as a household. Women working as fishermen are used to collecting *pensi*, *langkitang*, and catching *rinuak* near the lake's edge or < 50 m from the edge (Fig 2.). Due to the scenic view and the culture of the indigenous people, farming and catching things from the lake have caused many international tourists to visit the Maninjau area. In addition to the natural condition, Maninjau is also visited because it has a very famous cultural tourism center, especially the birthplace of Prof. Dr. Buya Hamka, the great "Ulama" of Indonesia, and even in the world. The village of his birth is located on the outskirts of Lake Maninjau; to be precise, it is in the Nagari of Sungai Batang. The visit of tourists improved the income of the local society.

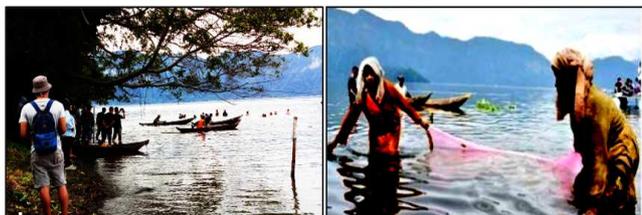


Fig. 2 Local society activities in the Maninjau lake

As stated by the West Sumatra Government, Maninjau is one of the top priorities for developing tourist destinations or DPP I (Tourism Destination Development I) within the 2010-2030 Agam Regency Spatial Plan [4]. Therefore, many infrastructures, such as hotels, homestays, and cafes, were developed. This had increased the income of the people.

However, during the last ten years, the local society income declined. This decrease aligns with successive natural disasters, such as landslides in Maninjau, especially after the devastating mega earthquake (SR 6.7) that shook West Sumatra on September 30, 2009. Many areas of the cliffs surrounding the lake have experienced landslides (Fig. 3), such as Nagari Batu Naggai (2009), Galampung (2009 and 2019), Sungai Batang (2013), Kelok 3 Jorong Laksa (2018), Nagari Koto Malintang (2018, 2020) dan Tanjung Sani (2020, 2021, 2022), Nagari Lubuak Sao (2021), Kelok 9 (2021).



Fig. 3 Landslide happening around Maninjau Lake

It is not only in Maninjau; tourist destinations in Indonesia are mostly susceptible to natural disasters [5]. Some natural disasters in tourist destinations during the last decade (2011-2020) have impacted the tourist industry. Subsequently, a disaster caused a decline in regional development, even if it could stop people's economic activity, especially the impacted persons [6]. Besides reclaiming areas post natural disasters, the climate of improving tourist visits must be created to bring the society income back to the golden era between 1970 and 1990 [7].

Natural disasters also affect the growth of the economy and reduction in the number of tourist visits in some countries in the world [8] even though they never go to zero. Natural disasters directly affect the environment, economy, and loss of properties of individuals either in developed or developing countries. However, the direct impact of natural disasters is worse in developing than in developed countries [9]. The short-term impact of disasters could be the same severe both in developing and developed countries, but since developed countries are wealthy, they could be easily and quickly recovered [10]. Natural disasters include volcano eruptions [11], tsunamis [12], infectious diseases, etc.

The area's vulnerability around Lake Maninjau is triggered mainly by the soil material that is still relatively young that makes up the hills around the lake. The soil material was dominated by sand [13]–[15], which is easily separated from one another, because soil aggregates were not yet stable. This is partly because the main soil material near Lake Maninjau is derived from very light tuff pumice. Soil formed with tuff pumice material is prone to shifting and landslides if a shock occurs, such as an earthquake [13]. In addition, landslides are also triggered by community activities in managing land that did not follow the conservation rules.

Besides landslides, disasters in Maninjau also occurred due to lake water contamination. The water quality of Maninjau Lake has been affected by floating net cages (KJA) used for fish cultivation, which was over the lake's capacity. In the last two decades, the lake water began to be polluted due to the excessive intake of fish feed, subsequently causing the death of thousands of tons of cage fish in Lake Maninjau [7]. The oxygen dissolved in the lake water decreased from 40 m (in 2006) to only 12 m (in 2018) depth from the lake surface [16].

The death of fish in Maninjau Lake (Fig. 4) has become a big problem for the environment, the individual capitals, and consequently, the region's economic growth. By fish death, the owners would lose billions of rupiahs they had invested to that type of business. This kind of disaster also causes environmental pollution, both water and air pollution. Bad smell due to dead fish causes people to avoid visiting the area. Since the area is a tourist destination, fewer visitors caused a decrease in the local society's income.



Fig. 4 The death of cage fish in Maninjau Lake

Based on the local government, the development of Lake Maninjau must be carried out based on three pillars of balance: economic, social, and environmental. Lake Maninjau and its water catchment areas were designated as 1) catchment areas for the Antokan watershed and its surroundings, 2) natural and artificial tourism objects, 3) renewable energy sources for West Sumatra and Riau Provinces, 4) water sources for local residents and communities downstream and 5) aquaculture or freshwater capture fisheries [17]. Therefore, Lake Maninjau has a strategic role in the power development process.

However, until now, the development of the Lake Maninjau area is still not significant. Based on statistical data, there was only 1 (one) fishery extension person, 1 (one) forestry person, 9 (nine) agriculture sector officers, and there are no tourism guides listed in the sub-district for the three Nagari [2]. Even though tourist destinations are susceptible to disasters, tourism is believed to become the world's largest industry by the next century [18]. Therefore, it is very important to manage the tourism industry intensively. Initially, basic data on the problem must be provided and analyzed before the decision is made to recover the problem. One could be done by collecting data concerning how large the impact of natural disasters is directly and indirectly through tourist visits on the local community's income. Based on the description above, this study aimed to determine the impact of natural disasters on the local people's income in Maninjau as a tourist destination in West Sumatra, especially in Nagari Bayua, Maninjau, and Sungai Batang.

## II. MATERIALS AND METHOD

This research was conducted in the tourist area of Lake Maninjau in Tanjung Raya District, Agam Regency, West Sumatra Province. This study used a survey method. Samples were taken at three main points of Maninjau tourist destinations, especially Nagari Bayua, Nagari Maninjau, and Nagari Sungai Batang (Fig. 5). Three hundred questioners were distributed to the people in the destined areas. The people being interviewed were the local community, especially those with potency in the Nagari, NGOs, entrepreneurs, the young generation, community leaders, and local governments. There were five main stages in this research:

1) *Stage 1*: The preparation stages. In this stage, secondary data were collected, especially climate data and topographic maps, land use, and disaster-prone maps.

2) *Stage 2*: The stage of determining variables and making a questionnaire. The secondary data obtained were analyzed to determine the variables and questionnaires.

3) *Stage 3*: Field survey stage. The survey was conducted in three Nagari - Bayur, Maninjau, and Sungai Batang - (Fig. 2). The data were obtained through direct interviews, filling out questionnaires, and focus group discussions with the community and local government.

4) *Stage 4*: The data analysis stage. The percentage of the questionnaire results was calculated and then displayed in the form of a pie chart.

5) *Stage 5*: The stage of making the final report and writing the article. This stage was conducted after analyzing the data.



Fig. 5 Research area (●) in Maninjau tourist destination

## III. RESULTS AND DISCUSSION

### A. The Occupation of Local Community in Maninjau Resort

Fig 6 shows that most of the people in Maninjau had professions as farmers (41.9%), then as private sectors, and traders. The rest (27.5%) work as service, convection, labor, fishermen, etc. Men and women were included in all jobs as farmers or as traders, fishermen, and others. In the private sector, people mostly worked in hotels or homestays as employees, employers, or owners.

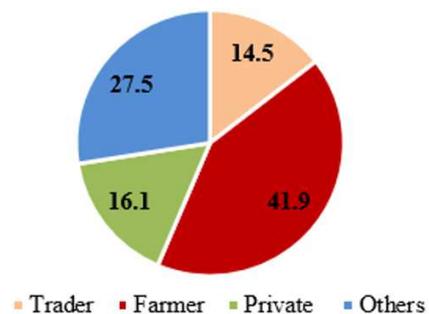


Fig. 6 Types of local community livelihood in Maninjau Resort.

Besides farming, the local society in Maninjau also worked as fishermen (catching fish) in the lake. They catch fish, *pensi*, *langkitang* naturally in the lake and then immediately sell their fish in the markets within the region and also to the surrounding such as Lubuk Basung (The Capital of Agam Regency), Matur, and Bukittinggi (another tourist destination in Agam Regency). The famous endemic fish of Lake Maninjau, namely the Rinuak fish, are small fish without bones. It could be considered the smallest fish in the world. This fish is very popular among the locals, especially the people of Maninjau and Lubuk Basung, who have consumed the fish for decades. Therefore, besides fishermen, the people also some as traders.

From different livelihoods in Maninjau, the income of people was also varied (Fig. 7). Most people (87.7%) had the lowest income ( $\leq 1.5$  million rupiahs). It was only 1.4% of people had income  $> 4.5$  million rupiahs). It means that Maninjau was considered a less developed region. Disasters in the small and isolated region were more impacted and less supported by the government [19].

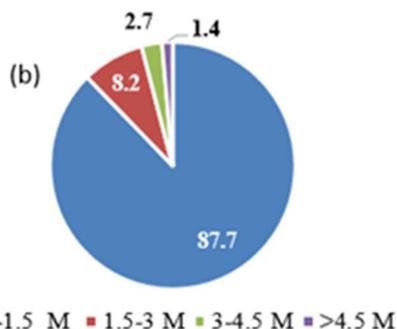


Fig. 7 Level of society income in Maninjau Resort.

### B. Natural Disasters

Based on the data obtained, two main types of natural disasters threaten Maninjau tourism: landslides and the death of cultivated fish in the lake. These two natural disasters directly and indirectly affect economic growth in Maninjau. The direct effect of disaster was due to the loss of individual properties, the decline in economic activities, and fewer investors to capitalize on some business in the region. Indirectly, natural disasters, as happened in Maninjau, reduced the number of tourist visits.

The impact of natural disasters on economic growth in Maninjau was initially triggered by the 2009 West Sumatra earthquake, which shook the hills around Lake Maninjau. The hills around the lake are the crater wall of Mount Tinjau, which is relatively new erupted [1], so the soil is not yet stable. This was indicated by the soil texture, which is considered coarse or dominated by sand particles [14], [15]. From 2009 to 2022, landslides occurred in several Nagaris in Tanjung Raya District. Therefore, it frightened tourists to visit, especially overseas tourists. Tourists like to visit tourist destinations with at least the same security level as their country [20].

The second natural disaster that really disturbed the local society's income and the effect on visitors was the death of thousands of tons of floating net cage fish cultivated by local people in the lake. The presence of floating net cages in Maninjau Lake has spoiled the sights of tourists and has also reduced the lake water quality due to the fish food being left over. Moreover, the smell of the fish death had polluted the lake water and the surrounding area's air. Fish death is used to occur if the weather is windy and less sun radiation.

Among the two main types of disasters in Maninjau, a tourist destination area, landslides are more natural. However, it could still be anticipated by educating local society in managing and cultivating the land based on the conservation rule. While the other disaster, fish death in the lake was more human-induced.

The problem of fish death is very intricate since the main source of the local society's income is the cultivated fish. The local government had a dilemma to solve the problem

between protecting people's income and improving the tourist destination quality. Therefore, to reduce disaster risk, it is suggested to combine "top-down" and "bottom-up" approach as well as to strengthen the institutions [21].

### C. Effect of Disasters on Local community Income

Disasters affect economic growth in any place in the world. However, the level will differ, and the recovery time will not be the same. Based on the data collected (Fig. 8), it was found that more than 80% of people reduced their income by 40%, and only 4.2% of people's income was not affected. The highest reduction in people's income reached 60%, but it was only 7.1%.

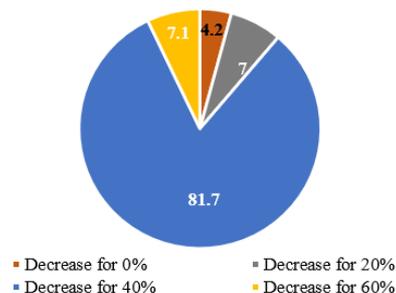


Fig. 8 Decrease in people's income after natural disasters

People with an income decline of up to 60% were generally businessmen in the hotel industry. This high reduction was associated with the tourist visit, especially overseas tourists from Europe. They used to stay for months in hotels. Since natural disasters persistently happened in Maninjau since 2009, tourist visits dropped significantly. Therefore, people having high capital will experience a high-income reduction in natural disasters.

### D. Income Recovery

For income recovery post natural disasters in Maninjau, the community chose two things: increasing tourist visits and developing some types of business. Almost 90% of the people wanted the tourists to be back two decades ago (Fig. 9). By tourist visits, they could increase their income through accommodation, especially hotels and homestays, and business for people having big capital. For common people, they can open cafes and souvenirs and become guides for tourists.

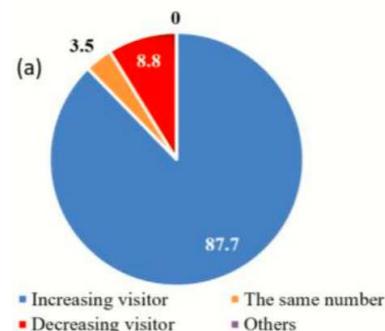


Fig. 9 People desire a tourist visit.

However, less than 10% of people wanted to reduce tourist visits. This could probably be associated with environmental degradation. Some visitors did not care about the

environment. Therefore, to anticipate it, some rules must be created and socialized to the tourists as well as to local community. The local government must be consistent in law enforcement. So far, there were no clear rules for both the local community and visitors.

Another alternative that people chose to recover their income was through business development (Fig.10). The three main businesses that liked to be developed were business in culinary (41.5%), then followed by natural business (29.9%), and business in religious tourism (26%), especially Buya Hamka tourism.

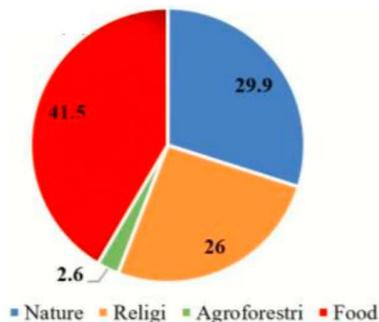


Fig. 10 Some businesses wanted to develop.

The culinary business in Maninjau seems to be a very promising business. Rich natural resources from the lake support it. From *rinuak*, the smallest fish in the word, *bada*, *pensi*, etc can create many kinds of food. Small or home business has been started by individuals living around the Maninjau lake. However, it still needs companionship and capital to develop and improve its business.

Natural business means the desire of the people to sell their overwhelming view and landscape, or it is grouped with tourism development. This is also highly possible since the area has a lake, cliff, farming land, etc. Another business that is also to improve is religious tourism, especially Buya Hamka tourism in Sungai Batang. Sungai Batang is the birthplace of Buya Hamka, a great Muslim scholar in Indonesia and worldwide.

Based on data obtained from the local community through FGDs and questionnaires, it was found that the major natural disasters in Maninjau (landslides and fish deaths) have reduced the number of tourist visits to Maninjau. The questionnaire data found that 77.6% of the community stated that the decrease in tourist visits was due to the death of the Floating Net Cage (KJA) fish in Lake Maninjau. Landslides were also the cause of the decline in tourist visits, 76.9% of respondents said.

Based on secondary data from the Agam District Tourism Office (Fig. 5), it was found that the decline in tourist visits was mainly for tourists from foreign countries. However, the number of local tourists tended to increase. The eruption of Mount Merapi in Yogyakarta in 2010 decreased the number of tourists by almost 50%, and Mount Agung in Bali in 2017 canceled about 1 million tourists visiting Bali [5]. However, national tourists tended to increase every year until 2019. Total tourist visits continued to increase because the number of tourists decreased was only foreign tourists. The number of foreign tourists was only small (1.6-7.0%) compared to local tourists visiting Agam Regency.

For domestic visitors, landslides and the death of many fish were also objects for them to see, so their numbers always increased even during disaster conditions. Some researchers also reported the same tendency that disasters could increase the number of tourists visiting the site [8; 22]. Furthermore, it is reported that the objective of the tourists visiting the destination after the disaster was divided into three parts: visitors being interested in the disasters (1), the landscape deformation (2), or the changes in historical sites (3) [22]. However, the number of visitors was much lower than that during normal conditions.

The decline in the number of foreign tourists visiting Maninjau has caused a decrease in tourists visiting Agam Regency. Compared to landslides, pollution of lake water and fish death in Maninjau Lake consecutively from 2014, 2015, and 2016 more affected visitors. The overseas tourists enjoyed the beautiful scenery, the clean and cool lake water, and the beautiful environment of Maninjau a few decades ago. As stated by Bintang, a hotel owner in Maninjau, approximately 1,500 overseas tourists stayed in his hotel each month for almost 20 years (1970s-1990s) [23].

However, since the lake water was polluted, overseas tourists were no longer interested in visiting the lake. They, mainly from Europe and Japan, generally wanted to enjoy the lake, especially bathing and swimming in the lake. With this water pollution, they had eliminated their interest to visit Maninjau. As reported in [20], tourists who travel to tourist areas have the same security and safety level as their countries. It was also found that choosing a tourist destination is not only the object to see but also the supporting condition, such as the safety and security level of the place [24].

According to LIPI [23], the income got from tourists, based on people staying in hotels, after the disaster was approximately one-third (IDR. 7.68 billion) of that (IDR. 22.65 billion) before the disaster. This was mainly due to the absence of overseas visitors.

It was reported that disaster failure impacted the income inequality factors [25], the middle-income people were mainly affected by instant natural hazards [26]. Separation of income varied among critical facilities; regions with lower facilities showed higher level of segregation, and there was a difference in admission to critical services between low- and high-income regions [27].

Some strategies that could be suggested for natural disaster recovery are (a) to invest in infrastructure part to support the economy, (b) to raise funds for producing export commodities, (c) to improve human capital through maintaining health, education, labor, and vocational skills, (d) to develop renewable energy to solve the energy crisis, and (e) to increase FDI (Foreign direct investment) inflow [28]. Working together among communities could anticipate bad impacts happening on the post-disaster [29].

Based on the focus group discussion, it was implied that there were two main obstacles to economic growth in Maninjau. The first problem is the low understanding and participation of local communities in maintaining the sustainability of the lake. The second problem is the lack of government attention, especially from the central government, in developing the Maninjau area, such as a lack of counseling to the community and low enforcement of regulations.

For tourist visit recovery, some strategies could be conducted after the disaster: (1) announce the clear location a week after decontamination, (2) apply a new policy for visitors 24 to 36 weeks after a disaster, (3) inform the visitor within 37-52 weeks after the step 2, (4) give discount price up to 52 weeks after the step 3 [30]. It is also suggested to recover the tourism condition through the emotional solidarity of the tourists [31]. Some activities, such as informal education, gave tourists awareness, tools, knowledge, and motivation to get a sustainable environment [32]

For the local society and the tourists, some suggested guidelines could be done through education, training, and cultural understanding [33]. Knowledge of management and quick responses among the agencies is needed directly after a disaster for midterm and long-term recovery of the tourist destination. Local government action and preparedness are very important in controlling natural risks.

Improving the tourism industry in Maninjau Resort is possible. The existing natural potency and community skills support this. Nature tourism can be more developed due to lakes, waterfalls, and steep cliffs around the lake. It can also improve, especially Buya HAMKA museum, then culinary tourism which is based on unique products. Maninjau lake has rich of natural protein source, especially *rinuak*, *pensi*, *langkitang* and *bada*. It was inferred that improvement of policies in socio-economic seems to be effective in reducing economic losses, mainly in indigent locations such as in developing countries [34]

#### IV. CONCLUSION

It could be concluded that natural disasters, either due to landslides or fish death, decreased the local society income in the tourism destination Maninjau by up to 60% for 7.1% of people. Most people (81.7%) decreased their income by 40%, and there were only 4.2% of people who were not affected their income by natural disasters. The income reduction in the research area was not only due to the property loss but also the lack of tourist visits. To recover the economic growth in Maninjau, most of the community (87.7%) wanted tourist visit to increase. Then, they also wanted to develop culinary business (41.5%), agroforestry (29.9%), and religious tourism (26%), especially Hamka Tourism in Sungai Batang. An alternative way to fast recovery and to increase local society's income can be done through online promotion. Website development of each industry in Maninjau is really suggested.

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