

# The climate change resilience of Lemon Island Community, West Papua - Indonesia

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## ABSTRACT

Lemon Island is located in Manokwari, West Papua, that borders directly with the Pacific Ocean. This island is vulnerable to various threats. The purpose of this research was to determine the vulnerability and adaptation of the island's community to climate change. This was achieved through survey and interview techniques and observations to ascertain the level of exposure, sensitivity and adaptive capacity. The results of this study indicated that tsunamis posed the biggest threat to Lemon Island people, infrastructure, and environment. The adaptive capacity of the island as a whole included that of individuals, communities, and institutions. The calculation of the resilience aspect showed that the value of the human aspect was the highest value while the value of business aspect was the lowest value of the aspect of resilience.

*Key words: Vulnerability, Sensitivity, Adaptation, Climate change, Lemon Island.*

## Introduction

A small Island is defined as one with an area of less than or equal to 2,000 km<sup>2</sup>. The limited size and isolation of islands cause the level of threat from climate change to be very high (Van Beukering *et al.*, 2007). Climate change is influencing all aspects of life and the environment through rising air and sea temperatures, changes in ocean oxygen levels, acidity, salinity, turbidity, and the flow of deep and surface ocean currents, and the development of water borne diseases, parasites, and the abundance of toxic algae (FAO, 2015). The IPCC (2014) states that there are two factors that greatly affect the vulnerability of coastal areas, namely (1) global warming that has an impact on the frequency of storms in coastal areas, and (2) factors that increase sea water temperatures between 1-3°C which result in in-

creased potential for coral bleaching and mortality in tropical seas, and which impacts the lives of dependent coastal communities. In addition, sea level rise causes submergence of small islands, increased flooding, coastal erosion, sea water intrusion, and changes in ecological processes in coastal areas. These changes will indirectly affect the socio-economics in coastal areas through the loss of infrastructure, the decline in ecological values, and the economic value of coastal resources (Romadhon, 2014). In addition, the development of residential areas and rapid population growth in coastal areas will also be fundamentally affected by climate change (Wardhani and Farid, 2017).

Lemon Island is one of the small islands in Manokwari Regency, West Papua and borders the Pacific Ocean. The land area of the island is approximately 16.3 hectares with a coastline of about

1693.39 m. Geographically, this island has endogenous vulnerabilities. The people who live on the island cause it to be exposed to various exogenous pressures related to the ecological and social economic functions of the community. On the other hand, the people who inhabit Lemon Island permanently make it interesting to study, especially in terms of the resilience of the community to climate change and how they are adapting.

## Materials and Methods

### Description of the study sites

This study was conducted at Lemon Island (Fig. 1) Indonesia, about 4,97 nautical miles from the mainland. Access to the island is by small boat from mainland for 15 minutes.

This research was conducted by survey and interview techniques and observations. The aspects observed included:

1. Human aspects consisting of age composition; education level: knowledge, readiness and ability to face a crisis; population density; and counseling.
2. Business aspects included: employment status of residents; village business management; economic facilities; and entrepreneurship.
3. Resource aspects included: coastal ecosystem

condition; resource maintenance; coastal resource management group; provision of coastal resource information facilities.

4. Environmental and infrastructure aspects included: the availability of facilities; condition of buildings and settlements; clean water sources; pollution; and health services.
5. Disaster preparedness aspects and climate change adaptation included; early warning system; physical building; availability of facilities; regulations related to disaster alert.

Data collected were analyzed to determine the level of resilience of Lemon Island to climate change. The level of resilience was assessed and scored on a scale of 1 to 5.

## Results and Discussion

Climate change has a huge impact on people's life patterns, especially on small islands. Exposure, sensitivity, and adaptability are three important components that need to be understood in assessing community resilience to climate change. A community's adaptation and mitigation capacity in dealing with the impacts of climate change is the measure of its resilience in addressing these. Based on the results of research conducted on the Lemon island of Manokwari, West Papua, the resilience

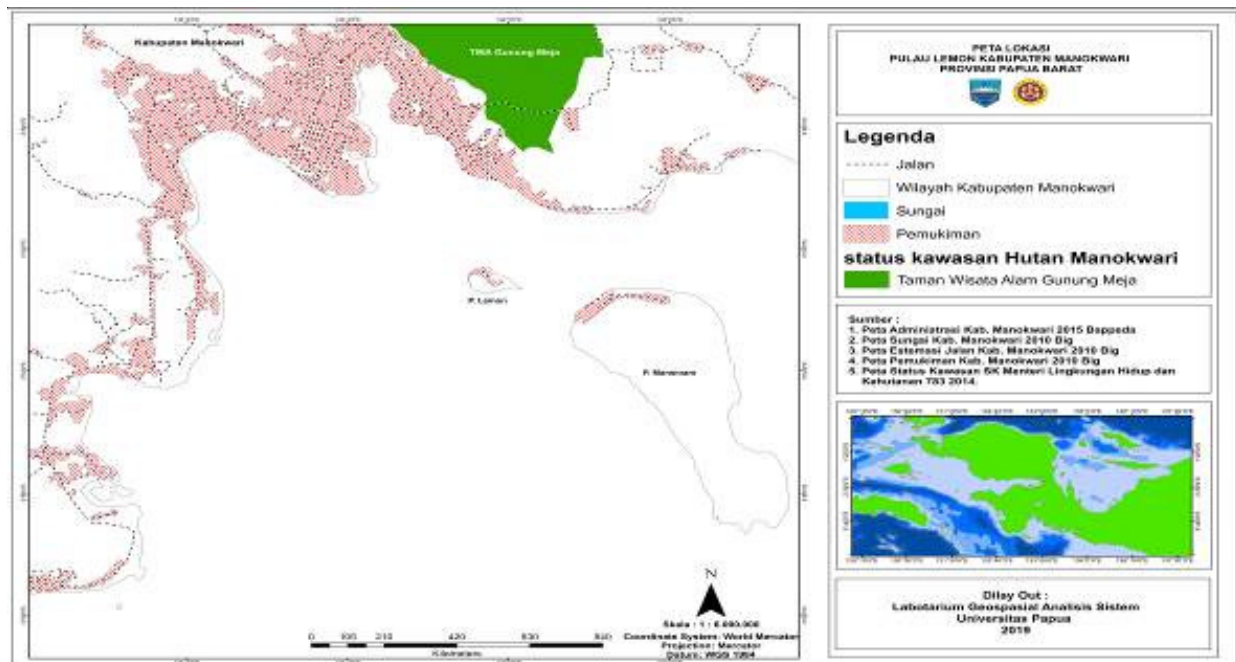


Fig. 1. Map of the lemon island, between the main island and the island of Mansinam

level of the island was in the medium category, based on the five studied aspects below.

### Human aspect

Of the Lemon Island permanent residents, children and elderly people (< xx or > xx years old) were considered to be most vulnerable to extreme climate change events and natural disasters. A high value of these age groups in a population would greatly impact the disaster evacuation process. The reproductive age group (67%) comprising people between xx and xx years old was dominant on Lemon Island (Figure 2).

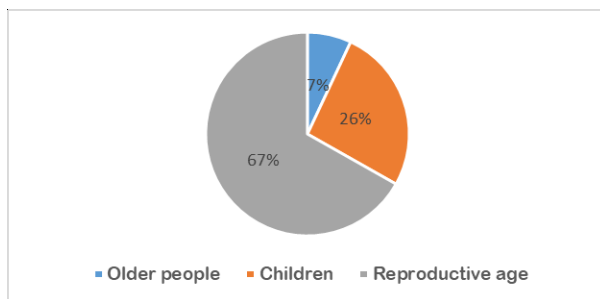


Fig. 2. The proportion of different age groups on Lemon Island

These data indicate that the community's ability to recognize, respond to, and recover from a disaster would be strong because 67% of the people are in the reproductive (fittest) age group. In addition, knowledge of climate change events would be more easily understood by some community groups depending on their level of education. Eighty two percent of Lemon Island people have completed their Middle School education. Children of this age are expected to understand, recognize, and respond to the natural signs of disaster that they have learned from teachers, parents, as well as the private sector and government officials who care about community life on small islands.

### Business Aspect

Values obtained from the results of this analysis were slightly different from those of the human aspect. Analysis of businesses engaged in by the people of Lemon Island showed the low economic diversity of the community (45%). This indicates that more residents of island are farmers or fishers. People whose main source of livelihood is agriculture or fishing tended to be more vulnerable to natural disasters. If a catastrophic event occurs, such

livelihoods will tend to be paralyzed. Besides that, the frequency of assistance and training activities to the island residents by outside parties is also low. As a result, the modification of the business carried out is very limited as can be seen in Fig. 3. An assessment of business contribution to the resilience of the Lemon Island community shows that the proportion of the population working in the agriculture and fisheries sector is very high. In some cases, if this livelihood is not modified with supplemental business activities, it will contribute to weakening the community's economy (Romadhon, 2014).

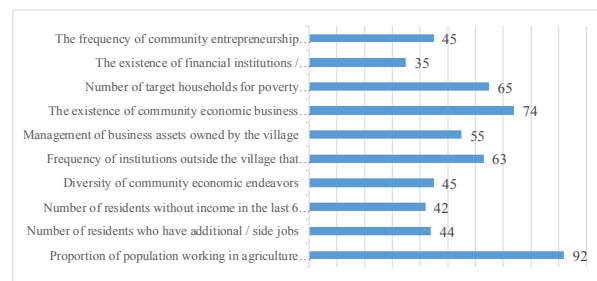


Fig. 3. Assessment of business aspects of Lemon Island Resilience

The financial capacity of the government and individuals would represent the resilience of the community in absorbing losses as well as the acceleration of the post-disaster recovery period (Putirulan *et al.*, 2019). When viewed from this criterion, the resilience of Lemon Island is moderate because of the 74% existence of community economic business groups. Although development of community economic development groups has begun, it is slow, but still operates to help the community's economic growth.

### Resource aspect

Ecosystem services on and around the island are resource aspects that need to be considered in assessing the resilience level of Lemon Island. If the condition of resources, such as forest vegetation, mangroves, coral reefs, seagrass, and fisheries potential around the island is good, then the resilience value of the island is very good. Calculation of the resource values of Lemon Island indicates the resilience contribution of this aspect is strong. The data for the calculation of resource aspects is shown in Fig. 4.

When related to business aspects, the community's dependence on the existence of natu-

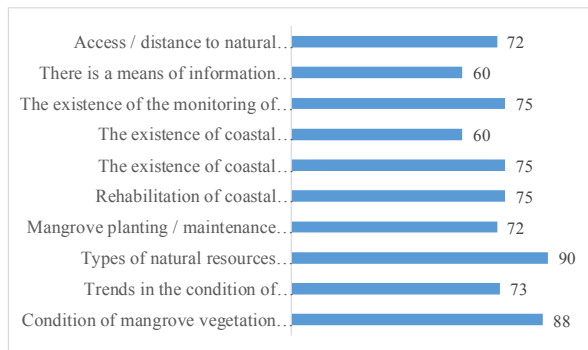


Fig. 4. Resource aspects of Lemon Island

ral resources is very high, because almost 90% of the people live from harvesting these around the island. Therefore, if there are changes such as mangrove deforestation along with such associated impacts as increased coastal erosion, reduced retention of sediments, and loss of habitats of mangrove dependent organisms, it will disrupt the stability and sustainability of related economic activities. Diversity value of ecosystem would increase the capability of ecosystem to adapt with environment, according to the literature (Siburian *et al.*, 2013; Siburian *et al.*, 2017; Wabia and Siburian, 2019). Community awareness of resource management is the key to sustainability and increasing the resilience value of an area. This awareness is built on local knowledge that makes people wiser in adapting to changes caused by climate change.

#### Environmental/infrastructure aspect

Various preparations were made by the Lemon Island community to minimize the impact caused by disasters especially those that may occur due to sea level rise or other natural events arising from climate change. These include temporary shelters in the event of a tsunami and warning bells that will be sounded during a disaster. These are intended to support pre-disaster preparation, evacuation processes, and post-disaster recovery. Besides these, the availability of clean water is also an important measure of the Lemon Island community's disaster preparedness. This includes the quality and quantity of clean water sources required by the community in their daily lives. Lemon Island has a very good spring and the quality of clean water is very good (Fig. 5).

Residential buildings on Lemon Island generally are semi-permanent structures with foundations

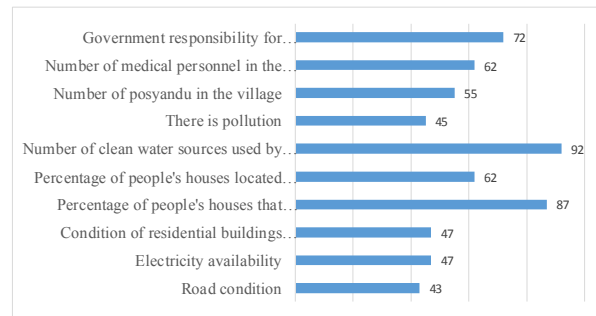


Fig. 5. Environmental/infrastructure Aspect in Lemon Island

that have been raised about one to one and a half meters to avoid flooding. Sea level rise is the main cause of such flooding. In addition, buildings have been relocated to higher ground where they are safer from rising sea levels, and perpendicular to the coastline. Lemon Island is also not classified as a densely populated area, so that handling climate and post-disaster preparedness is relatively easier.

#### Disaster and climate change aspects

The Lemon Island community has studied and developed methods to reduce climate change and disaster risks. This legacy of knowledge is passed on by parents to their children. Disaster preparedness includes evacuation routes and the presence of disaster response groups that are ready to assist and direct the community to specified shelters. Early warning instruments are usually taught by parents to their children in every family activity. This evident is from the data (Fig. 6). However, the existence of an early warning system on the island is very limited.

Some of the facilities built by the government include coastal protection structures, such as dykes,

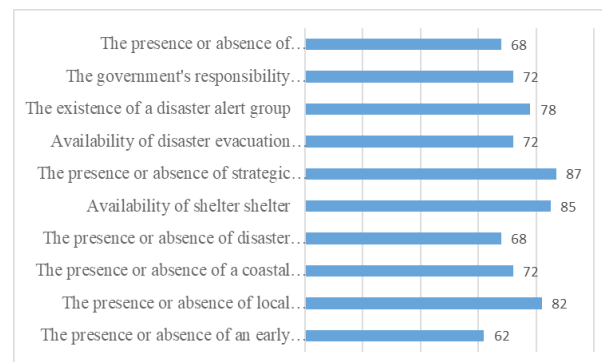


Fig. 6. Aspects of Disaster and climate change of Lemon Island

that protect the land from inundation and erosion caused by storm waves and sea level rise. In addition, socialization plays an important role in disaster preparedness by reducing public panic and helping to prevent associated casualties. The socialization helps the community to deal with crises and builds on its knowledge, readiness and capability in preventing the adverse effects of disasters. Forms of socialization provided included evacuation planning and implementation, recovery and rehabilitation.

## Conclusion

Although protected to some extent by its position between the mainland and a second island, Lemon Island remains vulnerable to a number of impacts. These include those resulting from tsunamis, sea level rise, especially at extreme spring tides, erosion of the coast due to currents and waves, extreme weather (storms and wind), and even rubbish transported by wind and currents from the mainland. The results of the calculation of all these factors are outlined in the net diagram (Fig. 7).

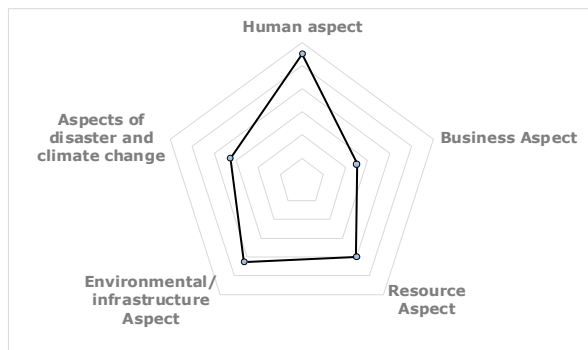


Fig. 7. Resiliency of Lemon Island

The adaptation activities that have been implemented by the government and the Lemon Island community included: (a) building dykes aimed at protecting settlements and land from waves, rising sea levels and the danger of erosion; (b) raising the foundation of the houses from one meter to one and a half meters and strengthening the structure of buildings with concrete (Fig. 8), (c) building clean water facilities in anticipation of shortages in the dry season. The results of this study indicated that structural activities placed greater emphasis on group businesses, with assistance and advisory from government and non-government organizations.



Fig. 8. Adaptation model in Lemon Island

The cultural strategy adopted by the Lemon Island community in dealing with climate change is carried out by establishing a protection area for the preservation of coral reef ecosystems (Dasmasele *et al.*, 2019; Iriansyah *et al.*, 2021). In addition, there is also an unwritten citizen agreement regarding land ownership on this island which is a private property inherited from their ancestors from generation to generation.

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