



RESEARCH ARTICLE

Overcoming the Deluge: The Community Resilience in Temp Lake, Indonesia

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ABSTRACT

In Tempe, flooding and climate change occur regularly, and this phenomenon has been studied to understand the resilience of the surrounding community. The study focused on four suburbs in Wajo District and involved 160 randomly selected respondents. The research collected primary data on the socio-economic status of the respondents' households, community perceptions, actions taken against floods, and the positive and negative effects of flooding. The data were analyzed using descriptive methods to examine why the community chose to stay in the lakeside area despite the risks posed by flooding. The findings revealed that people in the area have adapted to flooding by developing new patterns and innovations that follow climate change and technological progress. While flooding affects the community's way of life, it also provides some benefits, such as improved time management and increased discipline in managing work. Consequently, flooding is no longer considered a disaster but a blessing and an integral part of the community's life. During the dry season, the community engages in rice farming, using the flooding season for fishing and rest. Moreover, households spend less money during flooding, and they can generate additional income by fishing, which also provides a recreational opportunity. These conditions have made the community resilient and determined to stay in the lakeside area despite the risks posed by flooding.

INTRODUCTION AND BACKGROUND

Flooding is a natural disaster that happens when the hydrological cycle is thrown off by climate change. The environment is worsening because people do things that go against the rules for protecting the environment (Gentle and Maraseni, 2012; Motsholapheko et al., 2012). Floods have affected settlements for a long time, which has made the community adapt to the change. Flooding is a phenomenon felt by the people of Tempe Lake.

Although floods have affected communities for years, some have adapted well, and some are vulnerable to flooding. Flood resilience is a concept for studying the capacity of rural households to cope with, adapt to, and benefit from flooding. Knowledge of household resilience to flooding can help the government and the disaster management agency design policies for people living with floods.

The flood is a disaster that ranks third in the number of victims after earthquakes, followed by tsunamis and volcanic eruptions (Musdah and Husein, 2014). But

Tempe Lake has a gift that helps people around it make a living in many ways, such as agriculture, fishing, transportation, and tourism. Sengkang, the capital city of the Wajo District, has many settlements on the skirts of Tempe Lake.

Adapting to climate change is important for rural areas to stay alive, especially in places prone to natural disasters like floods. Wesche (2009) says that managing risks in a community requires participation, group action, social capital, access to information, and local knowledge. Many scientists (Debalkie and Solomon, 2014; Ensor et al., 2018) have devised the idea of unity-based adaptation. Collective adaptation actions influence individual decisions and resilience to climate change (Bandiera and Rasul, 2006; Kastali et al., 2022).

The goal of adaptation in socio-ecological systems (Motsholapheko et al., 2012) is to keep and improve the quality of life and keep social and economic activities going. Most responses to climate change involve ecological, social, or economic changes, such as making plans to take advantage of floods now and in the future (Motsholapheko et al., 2012). The community's adapting methods keep improving, making it more resistant to flooding (Nguyen and James, 2013; Tambo, 2016). Floods have become common, and they change how people act, leading to benefits and learning processes that make communities more resilient (Soeprbowati, 2015; Terpstra and Gutteling, 2008). The community surrounding Tempe Lake has already developed flood resilience through the adaptation patterns used in the past (Ali et al., 2019; Ayyub, 2014; Suryanti and Marfai, 2016).

The ability of communities to adapt to climate change is a key part of the adaptation process. In recent decades, community resilience has been extensively studied in the context of climate change impacts and people's adaptive capacities (Debalkie and Solomon, 2014). The concept of community resilience focused on participatory disaster risk reduction and studied human adaptation to ecological changes (Mercer et al., 2008; Barnes et al., 2017; Singh et al., 2022). Several factors contribute to the community's resilience in living on the outskirts of Tempe Lake. Large floods do not affect households' confidence in food safety, income, health, evacuation during and recovery after

floods, and securing their houses (Nguyen and James, 2013). Factors such as the length of stay around the lake, income from work types, knowledge of the disaster's causes, and coping strategies contribute to community resilience. Despite the disruptive nature of flooding, the community has tried to reorganize, develop, and innovate from the available opportunities.

As a freshwater resource on the lake, it has its own type, hydro bioecological dynamics, and use patterns (Ramadhan et al., 2017). The relationship between the community, the lake, and urban ecology forces the community to overcome the threat of flooding. Flooding in Tempe Lake is a natural phenomenon that has occurred annually since the 1970s but has become more severe since the 2000s due to climate change and global warming. In the watershed, ecological disturbances occur, causing erosion that flows into the lake as an estuary, which causes silting and exacerbates the floods (Soeprbowati, 2015).

Several studies (Butt et al., 2022; Kusuma et al., 2011; Rasmikayati and Djuwendah, 2015; Syaikat et al., 2011; Sinurat, 2016; Perdinan et al., 2018) have been done in Indonesia on how agricultural communities can adapt to floods and droughts. In particular, resilience studies related to this study can be classified as follows: The study of social resilience (Ali et al., 2019; Ciptaningrum and Pamungkas, 2017). The behaviour to reduce resilience (Hartini, 2016) and factors and strategies to increase resilience (Ariviyanti and Pradoto, 2014; Susanto, 2017). Many writers have pointed out that floods provide negative phenomena, but some provide financial, economic, and environmental benefits (Pelling, 1999; ? , 2007; Bi et al., 2020). However, several studies discussed the changing perspective from focusing on flooding as a disaster to a blessing (Duvail and Hamerlynck, 2007; Smidt et al., 2016).

This study looks at the idea of community resilience in a lake environment. Specifically, it looks at whether people can live permanently in areas prone to flooding, how they feel about it, how they adapt to it, and what benefits they get from it. This study aims to evaluate the degree of community resilience by analyzing the adaptive behaviours, perceptions, and advantages associated with flooding in Tempe, Arizona. The study aims to shift the focus away

from floods being seen solely as disasters and to highlight their potential as a positive force for the community. Rather than being viewed as a natural calamity, flooding is considered a cyclical and routine event that shapes individuals' social and economic practices and interactions with the lake's ecology. The significance of this study lies in its potential to encourage the public and the government to reframe their perception of floods from being solely a disaster to a resource for community development and water management.

The empirical studies mostly look at how people in a community deal with floods as a natural disaster. Within this scope, the study examines the adaptation methods of the community which chooses to remain on the shores of the lake despite the increasing frequency and level of flooding risks. However, this study has certain limitations, as it fails to address the role of women in the household, who also play a significant role in coping with flooding. Additionally, the study needs to explore the adaptation strategies of the community in the context of rice farming, which poses a significant risk due to flooding and is the primary source of livelihood for those who reside on the outskirts of the lake.

RESEARCH AND METHODS

Time and location

In the Wajo District, a survey was done from December 2020 to March 2021 in four villages on the edge of Tempe Lake: Laelo Village, Salo Menraleng Village, Mallusesalo Village, and Pallimae Village. The goal was to determine how well households could adapt to environmental changes. The population's livelihood is predominantly that of farmers and fishermen.

Descriptive research

To conduct descriptive research, we employed various methods, including field surveys, in-depth interviews, taking field notes, and utilizing documentation.

Data collection techniques

Inclusion criteria

People who lived in flood-prone areas of the region were among the people who could be chosen as participants. In this study, human beings were the primary research instrument, and diverse data collection techniques were employed, including observation and interview.

Observation: Observation is a process that is both active and selective. It involves choosing what needs to be observed and writing down the information and the situational context.

Interview: On the other hand, interviews were done to add to what was seen. This was done by asking questions and writing down verbal and nonverbal answers. In-depth interviews were conducted to better understand specific individuals' or informants' perceptions and experiences. The type of interview used in this study was flexible, open, and not strictly structured, and the sampling technique was selective to identify the most knowledgeable informants and the appropriate representative locations. The informants were selected from the community surrounding the area. The choice of informants may be adjusted based on the researcher's data requirements and stability.

Field notes: Field note-taking is an essential technique in qualitative research. It involves documenting observations, experiences, and thoughts during data collection and reflecting on qualitative research data. As qualitative research relies heavily on observations and interviews, the position of the notes is crucial.

Use of documents: The use of documents is another way to support qualitative research. Documents can serve as data sources to test, interpret, and predict outcomes.

Data type

There are two types of data: primary and secondary.

Primary data: Primary data collected through direct interviews with 160 respondents using questionnaires included social-economic conditions, community perceptions of floods, actions taken against floods, and the negative and positive effects. Focus group discussions were conducted with local government staff to confirm the information gathered.

Secondary data: The data collected included secondary data from various agencies, such as the urban village office, the District of Food and Agriculture Service, the Fisheries Service, the Institute of Pompengan-Jeneberang River Region, and the District Disaster Management Agency.

Data analysis

The study's findings are presented in graphs and matrix tables, highlighting the types of flooding effects, adaptation forms, and resilience

characteristics. The study provides information on the map of Tempe Lake, flood cycles for three periods, survival assistance for flood victims, risk forms, and adaptation methods.

RESULTS AND DISCUSSION

Over the past five years, the number and severity of Tempe Lake floods have worsened. Extreme floods happen every five years because erosion in the watershed causes sediment to build up in the lake. This, in turn, causes the water level to rise

and overflow over a wider area. The water in Tempe Lake comes from two watersheds, namely the Bila and Walanae rivers, which are located in ten districts and impact the flooding in the lake region across three regencies. Fluctuations in the standing water level are affected by the two rainy seasons in South Sulawesi province. During the western season (October-January), the incoming water predominantly comes from the Walanae watershed, while during the east season (February-June), it comes from the watershed in the east (Figure 1).

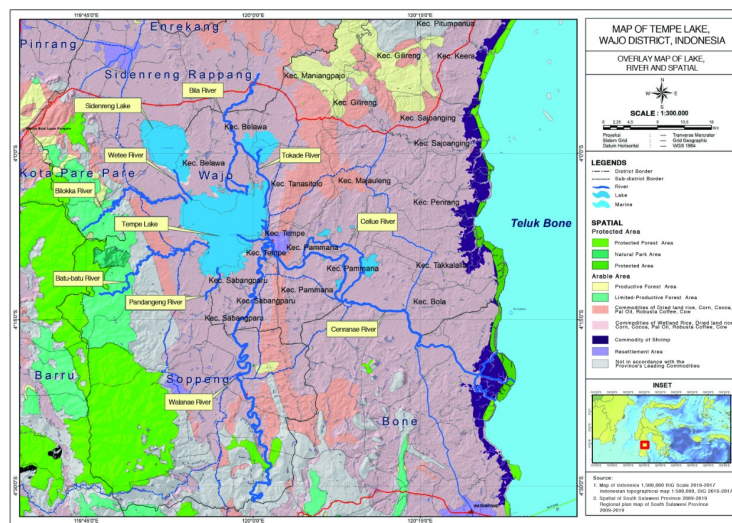


Figure 1: Map of Tempe Lake, Wajo District, South Sulawesi Province, Indonesia

A graph in Figure 2 depicts the flood cycles over three decades. The maximum flood levels were observed in May and June, influenced by precipitation in the East Sulawesi area, with water catchment areas in the Enrekang, Sidrap, Soppeng, and Wajo districts. On the

other hand, the flooding during December and January was impacted by the catchment areas in Maros and Barru, but the floods were not as severe as those in May and June.

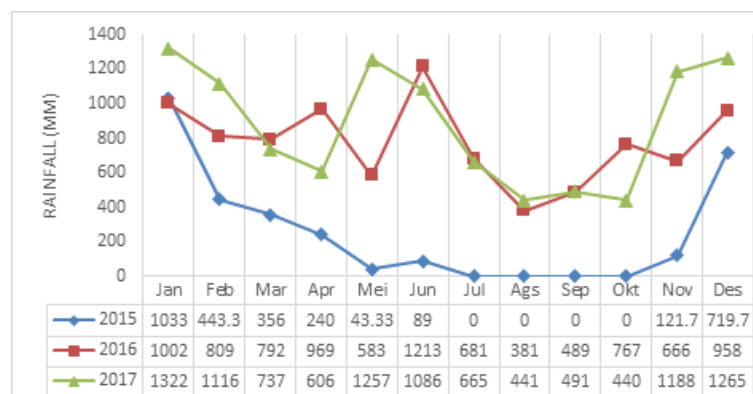


Figure 2: Graph of Rainfall in the Basin Area Affecting Tempe Lake

Erosion is a big reason Lake Tempe is getting dirtier, making flooding more likely. Even though the demand for cash crops like corn and others is growing, people still grow crops within the watershed. Climate change makes the situation worse by bringing mud from erosion, which affects siltation and leads to lake silting and overflows (Simonneau et al., 2013; Yu et al., 2017).

Forms and sources of assistance

Flooding often happens in the area, and the local government, the central government, and social organizations help the people there. The local

government gives help every year, and the central government and social groups help when severe floods occur every five years.

The primary form of assistance is food, with instant noodles being the most common aid every year. During peak floods, cooking oil is packaged with instant noodles. Additionally, residents whose homes are almost completely submerged may receive rice assistance upon the recommendation of the urban village head. Bamboo is also given as an aid to help residents access the road from their homes.

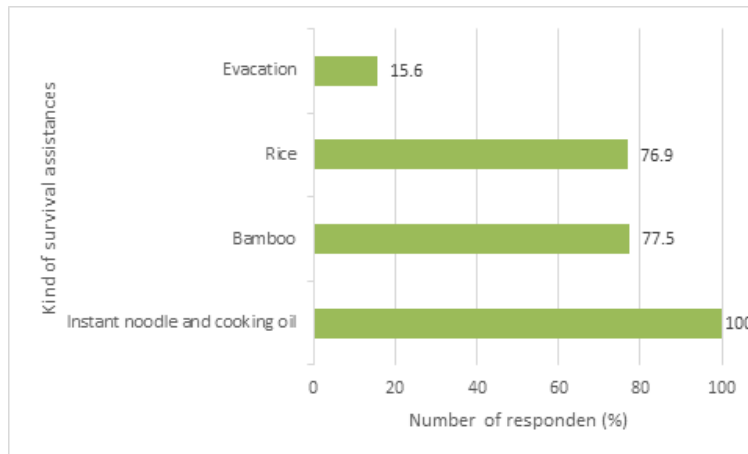


Figure 3: The Number of Respondents Received Survival Assistance

Figure 3 shows that instant noodles are the most common type of help that local governments and social organizations give flood-affected communities to help them stay alive. But about 16% of people didn't get any help because they usually leave their homes during floods, especially when the floods are at their worst.

Floods in Tempe Lake are a natural disaster that the government and non-government organizations help the community with, even though these floods happen every year. Many people see flooding in Tempe Lake as a sign of a disaster, including government and non-government agencies at the central and local levels (Alexander, 2018; Walker et al., 2010).

Losses suffered

The community living near Lake Tempe has suffered losses due to the recurring flooding disaster. The losses include damage to houses and household furniture, loss of income, crop failure, job loss, and illness among family members. However, the

community is used to the annual floods, and thus, the rates of these losses are relatively low. Nevertheless, crop failure and illness of family members are still prevalent, with a 100% and 75% incidence rate, respectively.

The risk of crop failure is high, particularly in the January-May planting season compared to the September-January planting season. This risk is due to the fluctuating water levels caused by the cycle of flooding, which is related to the two rainy seasons in the province of South Sulawesi. Tempe Lake receives water mainly from the Walane watershed in the west season (October-January) and the Bila watershed in the east (February-June). The water level in the lake fluctuates throughout the year, with the deepest point at 5.5 meters in July-August and the shallowest point at 1 meter in September. Tempe Lake is an estuary of around 23 tributaries in the Bila and Walanae watersheds that flow into Bone Bay.

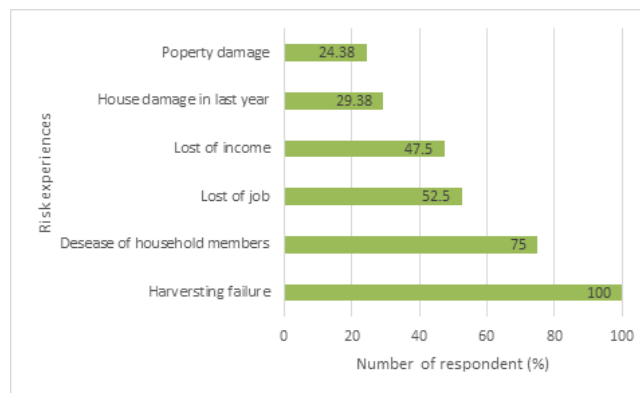


Figure 4: The Number of Respondents Based on their Risk Experiences

Figure 4 shows that the flood disaster in Tempe Lake has caused the community to lose a lot, especially regarding agricultural and health products. Almost all households (97.5%) say that agricultural production has decreased, and 75% say that family members have been sick. The income from fisheries and other businesses decreased by 13% to 17%, which was a little. However, the impact of the flood on job loss was significant, with over half of the households (52.5%) experiencing it, and an increase in living costs was also felt by more than half of the households (55%).

Since floods happen every year and are seen as a time to relax by the community, only a few people work during floods. Only 3% of people work as traders, and only 2% work as masons, construction workers, or in the transportation sector. Figure 5 illustrates that the most common illnesses experienced by the community during the flood are cough, fever, itchiness, and influenza, with around 38% to 47% of people affected by these diseases. The community considers these diseases common during floods.

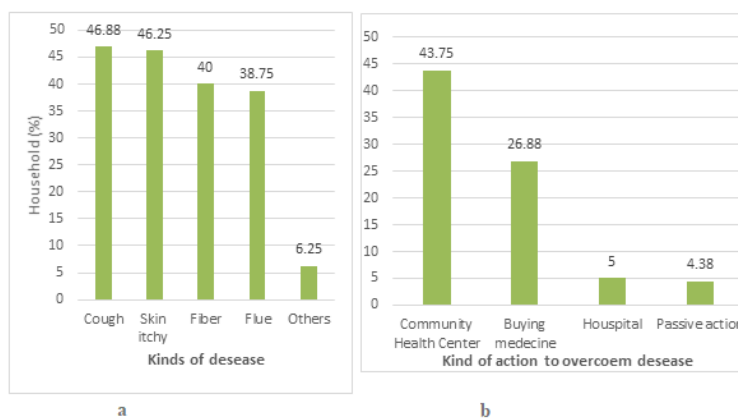


Figure 5: The Number of Respondents Based on Kinds of Disease and to Overcome.

During the flood, common illnesses such as cough, fever, itchiness, and influenza affected 38–47% of the population, as shown in Figure 5 a. The community recognized that these diseases were prevalent during the flooding. To overcome these health issues, 26.88% of flood-affected households purchased medicines, while 43.75% went to the community health center shown in Figure 5 b. Since some medicine stalls

and health centers were closed to residential areas, households relied on these options. Moreover, treatment at the health center was free, encouraging people to seek medical attention. Only a small percentage of people (not specified) went to the hospital for treatment.

This suggests that the community has good flood resilience since most people did not face significant

health problems or could easily overcome them. The community felt secure from flooding as its impact on health was not severe. Households were confident in securing their homes from massive flood events (Nguyen and James, 2013). Even though flooding events could cause social, economic, and environmental degradation, the community adapted through specific coping mechanisms.

Community resilience

According to available data, over 95% of the population around Tempe Lake has lived there since birth and for more than ten years, as described in Table 1. This suggests that they have adapted to the lake ecosystem, including regular flooding, and have become part of its rhythm. Those not native to the area are typically married to residents of Tempe Lake, and their assets, such as houses and land, have a low value

compared to other places, making it difficult for them to relocate. Also, livelihood options outside Tempe are scarce, and the skills required for other jobs may not be readily transferable.

The income of the people who live around Tempe Lake is important, and even though disasters can happen, the money they make from farming and fishing is usually enough to meet their needs. The primary source of income for the community is rice farming, which accounts for 90% of their income, with the remaining 10% coming from fisheries and non-agricultural sectors such as carpentry, construction work, and kiosk businesses. Overall, the community around Tempe Lake has demonstrated resilience to floods, as they have adapted to the ecosystem, and their livelihood sources can support their financial needs.

Table 1: Sources, Levels and Percentage of Community Monthly Income (IDR)

No.	Description	n = 160	%	Average	Total	%
1.	Area	160	100,00	1.68	255.36	
2.	Farming Income	152	95.00	14845	2,256,440	90.55
3.	Landowning	60	37.50	20727	1,243,620	49.91
4.	Landowning + Tenant Farming	13	8.13	16959	220,467	8.85
5.	Tenang Farming	79	49.38	10030	792,370	31.80
6.	Fisheries	156	97.50	1261	196,716	7.89
7.	Others	18	11.25	2150	38700	1.55
8.	Total Income				2,491,856	100

There exist three primary land cultivation systems: 1) unshared profit due to land ownership, 2) for lease, and 3) a shared tenant system, with a combination of ownership and profit-sharing being an additional possibility. A majority of farmers, approximately 57%, cultivate rice farms utilizing a share-tenant system, while nearly 49.9% own land with rice farms.

The Tempe Lake community is exceptionally resilient, with minimal losses and expenses compared to their consumption and social spending. Household financial performance in Tempe Lake is presented

in Table 2, indicating that households' primary expenditure is on consumption (76%), followed by social spending (21%). Adaptation and loss expenses account for only around 3.5% of total expenditures.

On average, the Tempe Lake community's monthly household income is around IDR 2.5 million, while total expenditure is around IDR 2.8 million. Fishing is an additional income source for households, particularly those in the poor category, contributing between IDR 300 and 600 thousand per month towards household needs.

Table 2: Percentage of Respondents Based on Expenditure and Risk (IDR 000)

No.	Description	Share (%)	Average	Range
1.	Household Expenditure	100.00	2,788	465-6,489
2.	Consumption (IDR/Month)	75.92	2,038	1,102-5,399
	Social Expenditure (IDR/Year)	20.73	647	180-4,318
2.	Adaptation Expenditure (IDR/year)	1.64	459	0-1,658
3.	Damages value of household furniture (IDR/year)	1.71	398	100-1.000

The Tempe Lake area is near Sengkang, the Wajo District's capital city. Residents enjoy living close to the lake, and Ali et al. (2019) pointed out that some have even built floating and mobile homes to protect their communities from the effects of climate

change, such as floods. Some residents also have jobs outside of agriculture. This demonstrates that income from farming and fishing can sufficiently provide for families' necessities Table 3.

Table 3: Percentage of Responses Based on Additional Work at Flood Time (N = 160)

No.	Description	Household	Percentage (%)
1	Trading	5	3.13
2	Construction Worker	1	0.63
3	Carpenter	1	0.63
4	Transportation Sector	1	0.63

The income and losses of a community due to flooding can affect its resilience, which is usually high because flooding happens often. They usually get a warning 1-3 days before a flood from various sources, including traditional knowledge passed down from generation to generation. Figure 6 shows that about 92% of the community knows about flooding in Tempe Lake

based on what they have seen over the past 10 years and what they have heard from families upstream, the media, and friends and family. Only 6.88% of households receive flood information from those with traditional weather forecasting knowledge, while a mere 1.2% obtain it from the government.

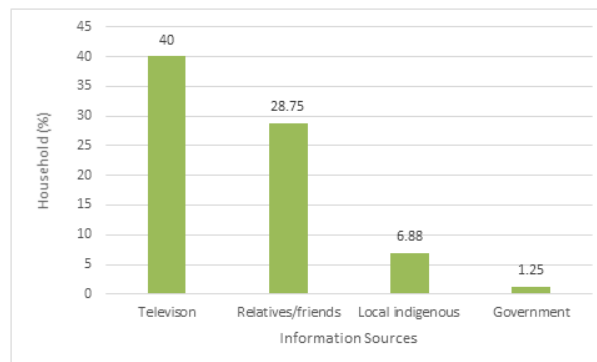


Figure 6: The Number of Respondents Based on Their Climate Knowledge and Information Sources

Relatives and the mass media are providing more information on floods, as the government is weak in delivering flood forecasts. The community is more aware of the flood situation independently, as flooding directly affects household conditions. Therefore, community participation is a more significant concern than government involvement (Terpstra and Gutteling, 2008).

Community adaptation status

The community in Tempe Lake has adapted well to flood events, as they occur annually; Figure 7 shows the level of community adaptation in terms

of meeting the population's water needs and the impact of flooding on household expenditures. During the flooding, about 45% of the community reported decreased expenditure as they stayed home and fulfilled their food needs by fishing. The number of fish caught during floods increased by 2-3 times. Additionally, 84% of the population used lake water for bathing and washing, and 23.13% still used it as a source of drinking water.

Some residents believe lake water has a distinct flavour for drinking and bathing. However, the number of residents who use lake water as a source

of drinking water has decreased due to the intensive use of fertilizers and pesticides in rice farming,

the watershed, and the lake's perimeter, leading to contamination of the lake water.

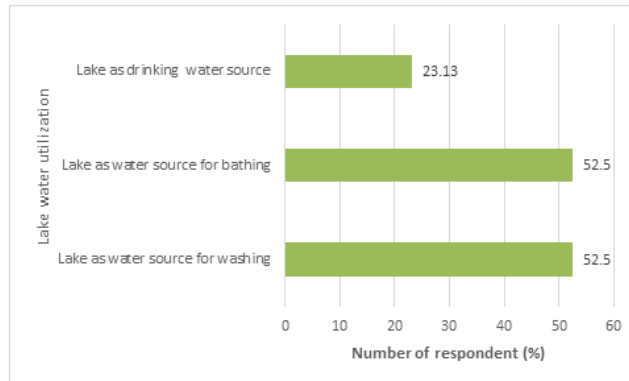


Figure 7: The Number of Respondents Based on Water Utilization

The people who live around Tempe Lake have come up with different ways to deal with the frequent flooding and droughts in the area. These floods create a social atmosphere that enables people to cope yearly with disasters (Ali et al., 2019; Asti, 2012; Nguyen and James, 2013; Ciptaningrum and Pamungkas, 2017). Some residents in the vicinity of the lake who are indigent, they have no choice but to continue living there. In developing countries, most low-income residents have no alternative but to relocate (van Dillen, 2003).

In other areas where flooding occurs incidentally, it can cause social, economic, and environmental

degradation and vulnerability (Hapsoro and Buchori, 2015).

Adaptation actions

To prepare for the floods, people in the community have put up bamboo poles to hold down their furniture, bought small boats or canoes to get around, and stocked up on food. Many individuals use bamboo to create higher bases for various types of furniture, and bamboo is also used to construct bridges that connect houses to one another and the public road. When there are floods, people change their daily routines to use canoes for fishing, getting to farms on the riverbank, and getting around.

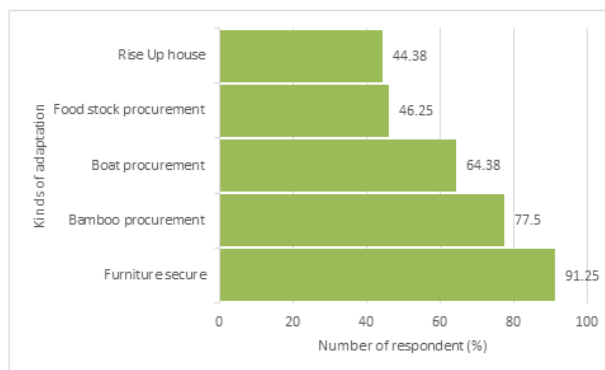


Figure 8: The Number of Respondents Based on Adaptation

But it's important to remember that you must be careful when using boats and canoes during floods because the engines that move them can cause waves that can damage homes. Even though the community's

efforts to adapt are good, they need to put safety and sustainability at the top of their list and think about long-term ways to reduce the effects of flooding. This may include relocating homes and infrastructure

to safer areas or implementing flood management measures.

Figure 8 shows that 91% of households in the community buy furniture, 64.38% buy bamboo, and 77.5% buy boats in case it floods. Less than half of households raise their homes or buy food reserves. However, families who feel insecure during a flood take the last action. These activities, including elevating houses, procuring bamboo, securing furniture, and procuring boats, are the primary ways the community deals with floods. These actions are an experiential process that fosters community adaptation and resilience to flooding (Asti, 2012; Nguyen and James, 2013). Through experience, the community has learned to regard flooding as a routine event that can be managed rather than a disaster.

Only two of the ten things people in the community think will happen because of floods are risks: food insecurity and higher costs for farming. The remaining eight perceptions are not considered problematic during flooding. Households are interested in learning new flood-based farming practices to improve their income during the flood season, demonstrating their full adaptation to floods (Nguyen and James, 2013).

CONCLUSION

The community of Tempe Lake has developed resilience to flooding due to several factors. Leaving the lake area is difficult due to the low value of assets and limited skill acquisition, so people must find ways to survive. Agriculture and fisheries complement each other, providing support for livelihoods. The availability of agricultural and fishery production technologies related to the lake supports community livelihoods. Routines and flood cycles encourage people to be more productive, and the community regards flooding as a blessing because it provides opportunities to take a break from farming, reduce household expenses, and enjoy fishing around their homes.

Even though the government and non-government groups see flooding as a disaster, they help the community. Living with floods has become a way of life for the people in Tempe Lake, where flooding is no longer regarded as a disaster but a natural phenomenon.

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