SETTLEMENT ADAPTATION MODEL FOR FLOOD DISASTER MITIGATION IN SALOMENRALENG VILLAGE WAJO REGENCY

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ABSTRACT

The background of this research is that a flood disaster hits residential areas in Salomenraleng Village every year with flood inundation for months. This can lead to a decline in the quality of life, housing and public facilities because they cannot function properly and threaten the community's safety. However, decades of experience dealing with floods have created a formidable adaptation process for this community. This study aimed to find an adaptation model for living that can mitigate flood disasters in the village of Salomenraleng to improve the safety and security of living. The method used in this research is descriptive-spatial, using morphological, behavioural and architectural approaches. The results of this study are to find architectural adaptations by creating space in the space in the form of a ladder; morphological Adaptation is to change the height of the house/other facilities and create Alleteng two (floating street) in the face of flood disasters. Novelty This research is the discovery of architectural engineering models in flood disaster mitigation.

Keywords: *house adaptation model, infrastructure adaptation, behaviour adaptation*

INTRODUCTION

Floods that cause inundation for days or months will cause social, economic and security problems (Santri, dkk., 2020). The leading cause of flooding is the change and escalation of human behaviour in changing environmental functions (Khasan M., dkk., 2011). In the cultivation area, there has been a massive spatial change, so the environment's carrying capacity has decreased drastically; it is also due to high rainfall. This condition is exacerbated by the inadequate settlement drainage system so that at sure rains, it causes puddles of water everywhere (Ekawaty, R., dkk., 2018). The potential for flood disasters in Indonesia is huge when viewed from the topography of the lowlands, basins, and most of the area is the ocean. Rainfall in the upstream area can cause flooding in the downstream region, especially when the

ground level is lower or only a few meters above sea level (Rosyadie., A., 2013; Suprapto, 2011). Floods can damage agricultural land, destroy bridges and houses, and often cause fatalities (Sahara F., dkk., 2013). Another impact in the form of secondary disasters that can occur after flash floods are the number of unemployed due to loss of livelihoods and disease attacks due to lack of sanitation and availability of clean water (Suliono, 2018).

Wajo Regency is a Regency that is hit by floods almost every year. One of the villages with the most severe flooding is Salomenraleng Village. Salomenraleng Village has a lowland morphology. This causes this village to have the potential to be flooded. The WalanaE river also crosses this village and is directly connected to Lake Tempe so that when it rains heavily, the river and lake water will overflow and cause flooding (Beddu S., dkk., 2017). The impact of flooding in Salomenraleng Village is the inundation of settlements and agricultural land. This condition severely damaged some residential facilities and infrastructure, such as houses, educational facilities, worship, embankments and environmental roads. This causes the quality of the residential environment to decline (Naing, N., dkk., 2022).

Floods that hit the Salomenraleng area usually occur once or twice a year depending on climatic conditions and the duration of inundation which usually reaches 2-3 months per flood. When there is a flood, the water level is between 2 and 2.5 meters. This will undoubtedly affect the living system of the people who are on the coast of the WalanaE River and Lake Tempe. According to the study results, the number of houses and other facilities affected by the flood in Salomenraleng Village in 2021 was 450 units, which 558 families and 2,037 people inhabited. In addition, several residential facilities and facilities that were affected were educational facilities (2 units), health and security posts (5 units), and sports facilities, as well as rice fields and community gardens (185 ha) (Naing, N., dkk., 2022).

Flood conditions in settlements that inundate existing facilities and infrastructure in the Salomenraleng sub-district will result in economic, social and security conditions for living. The level of the community's economy will decrease drastically due to the overflow of water in the river that inundates rice fields and plantations which are the main livelihoods of the community apart from being fishermen (Beddu S., dkk., 2017). Accessibility to education, health and economic facilities is limited due to waterlogging; some even cannot function if the puddle of water reaches the roof. The land transportation system between settlements using two wheels and three wheels or on foot will turn into a water transportation system using boats. This will undoubtedly hamper the community's social, economic and cultural activities and threaten the security system of living on the water (Mushar, P., dkk., 2021). The condition of settlements when there is a flood can be seen in Figure 1 below.

However, according to the community in Salomenraleng Village, flooding that inundated settlements for months is not a problem because the local community already has an adaptation system to live during floods based on the local wisdom of the local community. The adaptation system is carried out by making engineering on still houses because the community understands the principles of building safety in this flood-prone area, thus making people survive and remain comfortable doing daily household activities. The community persists and does not move from their homes.

(Thobiyah, R., N., dkk., 2020).

Figure 1. Residential Conditions When Floods Occur
Source: Naing, 2022

Disaster mitigation in Law No. 24 of 2007 concerning Disaster Management is defined as "A series of efforts to reduce disaster risk, both through physical development as well as awareness and capacity building in dealing with disaster threats". In mitigating disasters (Rahardjanto K., 2018), Disaster geography emphasizes spatial, regional, and ecological concepts more. To cope with the flood disaster that occurred, it is necessary to have a better adaptation system for flood disaster mitigation carried out by the affected community, as well as by the government so that negative impacts in the form of losses can be reduced (Yuniartanti, R., K., 2018).

Based on the above background, the problem of this research is that the flood disaster for months has caused a decline in the quality of life, housing and other public facilities that can threaten the community's safety. However, decades of experience dealing with floods have created a formidable adaptation process for this community.

This study aimed to find an adaptation model for living in the Salomenraleng Village that can mitigate flood disasters to improve the safety and security of living. This study will find an engineering model for Adaptation to living during a flood with a disaster mitigation system. The discovery of this settlement adaptation model will overcome settlement problems, especially environmental facilities and infrastructure.

THEORY / RESEARCH METHODS

The method used in this research is descriptive-spatial, using three approaches: the Approach Morphological, Behaviour Approach and Architectural Approach Approach (Tallo, A., J., dkk, 2014; Syafi'I, 2020; Delvis, 2021). A morphological Approach is an approach taken to find out the history of changes in form, from public facilities and infrastructure to the settlements of Salomenraleng Village in adapting during the flood disaster. A behaviour approach is a form of Approach used to determine community behaviour in adapting to facilities and infrastructure for flood disaster management. At the same time, the Architectural Approach is a form of research approach used to identify and assess the Adaptation of the physical culture of the Bugis community in building facilities and infrastructure in anticipating flood disasters.

The location of this research is in a flood-prone settlement of Salomenraleng Village, Tempe District, Wajo Regency, with the form of a house on stilts. The population and samples used are residents affected by flooding in Salomenraleng Village. The sampling technique used is random sampling because the population of houses and facilities in the research location are flooded, and the economic condition of people has the same tendency (livelihood as fishermen and farmers)—data collection techniques in the form of interviews, observations, and documentation. Data analysis in this study was carried out using spatial analysis techniques and qualitative descriptive analysis. In this study, the unit of analysis of traditional settlements that are prone to flooding is used. The objects studied are architectural adaptation systems, morphological adaptations and behavioural adaptations during and after flooding.

RESULT AND DISCUSSIONS

Salomenraleng Village, located on the banks of the WalanaE River and Lake Tempe, has become a regular flood every year. This condition has occurred for decades since Lake Tempe experienced silting, which serves as an estuary for gathering water flowing from various tributaries in Wajo Regency. Floods will hit this area during the rainy season, which causes the water of Lake Tempe to overflow into residential areas, including Salomenraleng Village. Frequent flooding causes inundation in this village for months, causing the community to have created an adaptation model for dealing with this annual flood.

This study found various forms of community adaptation during floods in Salomenraleng Village, Wajo Regency. However, the Adaptation carried out by the farming and fishing communities in the Salomenraleng village is based on natural signs that have been understood and become local knowledge of the local community, which is obtained based on experience and knowledge from generation to generation.

Natural Signs

Changes in global weather cause constellations, natural signs that are commonly used, sometimes appear, sometimes not. According to the knowledge of the local community, before the arrival of floods in this area and its surroundings, people will find and see natural signs such as astrology or constellations (*pananrang*), wind direction/season and moon. For *pananrang*, people use it less now since the global weather changes, which causes an uncertain climate. Especially in the last three years, the marking of this constellation cannot be a reference for the arrival of a flood.

Therefore, people use natural markings with the wind and moon seasons. Based on these natural markings, the people of Salomenraleng Village know the terms *Wettu Timo'* (East Wind Season) and *Wettu Bare'* (West Wind Season). During the East wind season and there is a flood, it is called *WaE Timo'* (water that rises/floods during the East wind season), and during the West wind season and there is a flood, it is called *WaE Bare'* (Water that rises/floods during the West season).

Wettu Timo' is the monsoon season from the East that brings strong winds accompanied by continuous heavy rains throughout the day for several months. This condition causes the water of rivers and lakes to overflow onto the mainland to settlements, including Salomenraleng Village. While *Wettu Bare* 'occurs when the wind direction reverses from the West. *Wettu Bare'* sometimes brings rain and strong winds, and sometimes it only brings wind but not rain. When *Wettu Bare'* is accompanied by rain, flooding will occur again in this settlement. According to the results of an interview using Bugis with the resource person Mr Abdul Muin, one of the older community leaders in this village, said:

> "*wettu Timo' mappammula uleng eppa', pole Alau'I angingnge, engkana bosi matterru-terru de'napaja, turung toni paggalungngE, narekko paggalung Langi'. Uleng lima angkanna uleng Pitu, menre'ni uwwaiE. Narekko nadapini uleng Aruwa iyarega uleng Asera, nonno'ni uwwaiE."*
> Artinya :
> "When the East season begins in the fourth month (April), the wind will blow from the East, and it has started to enter the rainy season continuously throughout the day without stopping. At times like this, the 'sky farmers' (farmers who grow rice expecting rain from the sky) start planting rice in the fields. From the fifth month (May) to the seventh month (July), the water in the rivers and lakes started to rise and inundate this settlement. In August or September, the water has started to recede."

The condition of the water level every month in the western season can be seen in Figure 2 below.

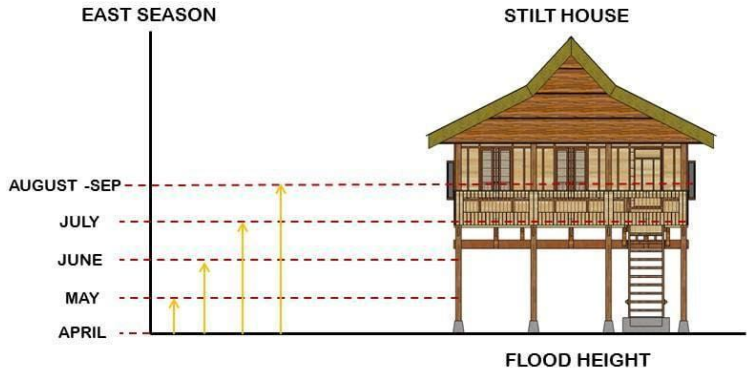


Figure 2. Flood Conditions Against Houses During the East Season
Source: Naing, 2022

For the local community, the East wind season (*Timo'*) is the first stage of the flood season, which causes inundation, where inundation in these settlements reaches a height of up to 2.5 meters each season, and water inundates the settlements for one to two months. In a year, if the climate is very extreme, sometimes flooding (inundation) occurs during the west wind season (*Bare'*). This is what is known by the local community as *WaE Bare'* (West flood). According to an interview in Bugis with Mr Abdul Muin :

> "*WaE Bare' pole, ko pole Orai'I angingngE. Wettunna mappammula uleng seppulo seddi. Iyana iyasengngi uwwaE Bare' tellu nasaba' tellungngessoi bosiE de'na paja. Wettunasi menre uwwaiyye. Narekko tamani uleng seppulo dua, polesi Bare' pituE nasaba' pitungessoi bosie de'napaja. Pede' mattambai menre'na uwwaiye. Narekko tamani uleng seddi (mallimbang taunni), poleni uwwae bare' asera, nasaba' asera essona de'na paja bosiE. Narekko tamani uleng dua, mallawangenni bosiE, gangkanna uleng tellu, pajani BosiE. Nonno' toni uwwaiE. Uleng eppa' tabblessi angingge, Timo'si. Wae timo'ttu asenna. Maderri'to tikka'I de'gaga uwwaina. Pura to seddi wettu asera uleng Tikka', degage bosi"*
>
> It means :
>
> "West monsoon floods occur when the wind blows from the West in the eleventh month (November). This is a sign that the water will rise because of the three days of continuous rain called *Bare' Tellu* (West Three). When entering the twelfth month (December), *Bare 'pitu* (West Seven) rains continuously for seven days. Then the puddle gets higher. If it has entered the first month (January) then the time will come when it rains continuously for nine days, it is called *Bare 'Asera* (West Nine). Stagnant water is getting higher in settlements. If it has entered the second month (February) to the third month (March), it rarely begins to rain until the rain stops. The water also began to recede until the ground dried up. In the fourth month (April), the wind will reverse toward the

East. There was the season of the East. However, sometimes, there was a dry season (*tikka')* for nine months. It never rains."

The interviews with community leaders show that the natural signs understood by the community are based on the wind season (East and West) and the rainy season. East monsoon floods are characterized by winds blowing from East to West and accompanied by continuous rain without stopping. This flood has the longest inundation, one to 3 months, compared to floods in the West Season (*Bare'*). In the western season, natural signs of flooding occur *Bare' tellu* (3 days of rain in December), *Bare' pitu* (7 days of rain in January) and *Bare Asera* (9 days of rain in February). If the natural signs of *Bare' tellu*, *Bare' pitu* and *bare' asera* do not appear, then it is a sign that there will be no flooding this season. It can be concluded that the natural signs of flooding in the East Season are fixed while in the West Season are not. The condition of the water level every month in the western season can be seen in Figure 3 below.

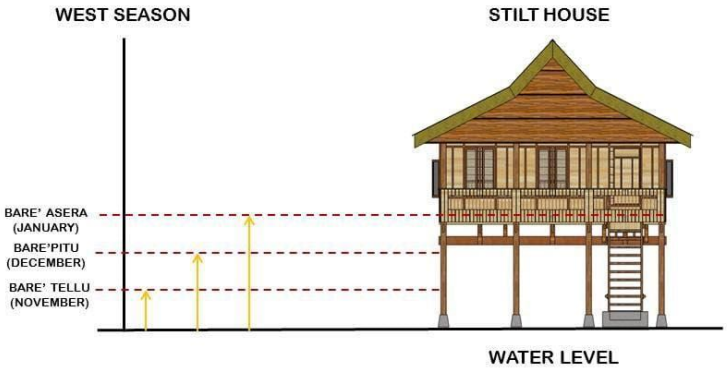


Figure 3. Condition of Flood Height Every Month In West Season
Source: Naing, 2022

Residential Adaptation Model for Flood Disaster Mitigation

The existence of natural signs that are used as guidelines for the community in recognizing the impending flood, the people in this area have prepared themselves in the face of rising water as in previous years. For people in this and other affected villages, flooding with inundation for months is no longer a disaster. However, they consider it an abundance of grace from Allah SWT because the overflow of water that inundated the village means that the fish will also approach the community, which is scattered under the house. Communities will be closer and easier to catch fish around their homes, and they will not need to take a boat to the river or lake to catch fish.

Following the local knowledge of the people in Salomenraleng Village and the experience of dealing with changes in the physical and non-physical environment from nature, after the natural signs of impending flooding have appeared, the

community has begun to prepare themselves, their homes and their environment in the face of the coming of a flood.

1. Architectural Adaptation

   Architectural Adaptation is the adjustment of the physical culture of the community in building facilities to anticipate flood disasters (Artiningrum, P., dkk., 2017; Batubara, 2014). Physical cultures include houses/occupations and other environmental facilities such as schools, offices and places of worship/mosques. According to interviewees, several decades ago, when the water conditions of Tempe's rivers and lakes around this settlement were still intense. If the flood season arrives, the water overflows to the highest settlement 1 meter above ground level. At that time, the height of the house on stilts was still the same as the average for other stilt houses in different areas, which was between 2 and 2.20 meters. However, since the last 40 years, when the upstream area has begun to be bare, and the river water carries the mud that flows into Lake Tempe, causing the silting of Lake Tempe as much as 1 cm/year, so Lake Tempe is getting shallower (Naing, 2021). This causes water to inundate settlements an average of 2.5 to 3 meters from the ground during the flood season. As a result, the height of the house on stilts also changes. The community began to adjust the condition of their houses to natural or environmental conditions to anticipate annual floods. This change in the height of the house on stilts is a form of Adaptation to residential facilities. This is like the Adaptation made to the physical building of residential houses in flood-prone settlements in Semarang, namely by piling up/raising the floor of the house every time it is renovated between 50-100 cm because it is a permanent house (Ariandini, D., W., 2016; Putra, A., D., 2013).

   If the conditions are extreme and it rains continuously, and the water rises above the house floor on stilts, the community has prepared some bamboo to make *Ladda'*. *Ladda'* is a bale-bale with bamboo poles/frames with a plank floor. According to the results of an interview with Ningsih, one of the informants in this village, the structure and function of ladda' are:

   > "*narekko menreni uwaiye ko yase'na pepengnge, mappammulani tawwe malladda". Seddi ladda mappake seppulo Lorong awo' ipake pattumpa'. Yase'na itutuki pepeng. Mula menre'na uwwaiye laddaE tanrena seddimi metere'.Narekko pede' menresi uwaiyye, itambaisi tanrena pattumpu'na gangka bakki tellu. Pattutu'na itaroi pepeng. laddaE ipakei matinro, manre, cemme, sau-sau dodong*."
   >
   > It means :
   >
   > "If the water has started to rise to the floor of the house on stilts, the community has prepared bale-bale from bamboo poles as a support, with boards as the top cover as the floor. As the water rises, the Ladda's level also increases, usually up to three times, until the water completely recedes. Initially, Ladda's height was only 1 meter. Ladda' is used as a place to sleep, a place to eat, a place to bathe and rest."

   The location of *Ladda'* in the house is in the first plot near the main door (*Lontang rivalling*), like in picture 5 below. The *Ladda* area is as wide as the room in *Lontang Risaliweng*. This is intended to make it easier for homeowners to access

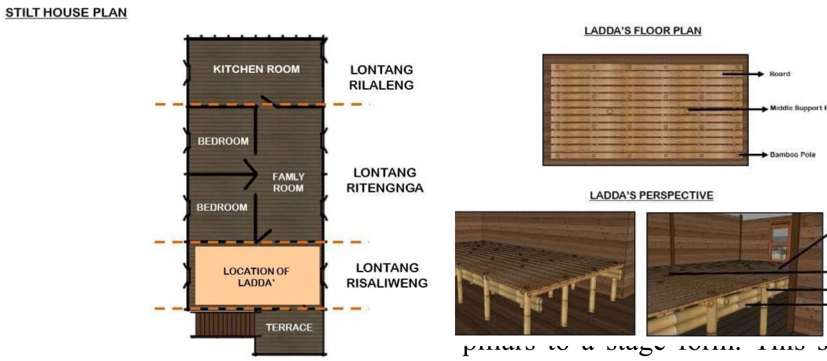
the boat at the main door, thus facilitating circulation in and out of the boat to *Ladda'*. This *Ladda'* is in the form of a bench/bale without a wall/backrest. Because of its location along the first-floor plan, the wall of the house serves as a support for *Ladda'*. If the water rises above the floor, all the houses in it have *Ladda'*. The problem is that all activities in *Ladda'* are done sitting or squatting because the low ceiling height causes people to be unable to stand on the *Ladda'*. This condition can be seen in Figure 4 below.

Figure 4. Conditions for Activities Above Ladda' on the Stage House
Source: Naing, 2022

As a temporary residence, *Ladda*' is also usually built and placed on the house's front porch. The function of the ladda' on the terrace differs from that found in the house, which is only a place to put furniture and oversized items that cannot be placed on the inside of the *Ladda'*, such as chairs, tables and refrigerators and other equipment. This is to make transporting these items to the boat easier if the water is getting higher. People who already have *Ladda*' the previous year and can still use it because it is not yet obsolete usually store this bamboo material on the *rakkeang* or under the house. *Ladda '*can be disassembled and reassembled, making it easier to store after the flood recedes or is no longer used. *Ladda*', created by the people of Salomenraleng village, is different from *Antru ampik-ampik*, which is used to mitigate flood disasters in Centini-Lamongan Village, which uses roof truss space to store goods during floods (Thoyibah, R., N., dkk.,2020).

Apart from houses, other facilities such as schools, mosques and offices have also undergone adjustments. If on other lands, the form of houses and other public facilities is not in the form of a stage, then in this flood-prone area, the form of houses and other facilities is in the form of a stage with stairs at the front as access from the main door. However, if the water rises above the floor in this public facility, all activities, such as school, office and worship, are usually temporarily suspended. All these activities are carried out from home/*ladda*". The stage for all facilities in this area is for flood disaster mitigation every year. This is like the results of the interview stated by the resource person Ningsih :

“*narekko menreni uwaiye gangka pepeng, de’na nassikola anak-anakE. De’tona na jokka tawwe massumpajang ko masigiE. De’tona na enre makkantoro tawwe ko kantoro’ DesaE. Narekko melo’ki mangurusu’, jokkaki ko bolana pak Desa*”
It means :
"If water starts to rise above the floor of public facilities such as schools, then schools will be closed, people cannot worship in mosques, and offices will be closed. The service will be moved to the villager's house/ village head."



ion mo ... use pol ... tes spa ... vas an ... ns. Me ... ues and ... pillars to a stage form. This shows that community adaptation to flood conditions is to adjust behaviour to environmental conditions that will occur. This Adaptation is cultural and physiological (Bitta, 2015).

2. Environmental and Behavioral Morphological Adaptation Model

Morphological Adaptation determines changes in the shape of the environment and residential infrastructure of Salomenraleng Village in adapting during the flood disaster. At the same time, behavioural Adaptation is a change in behaviour that occurs in the community due to changes in the shape of the environment during floods.

The form of the environment that occurs during the flood changes due to the presence of puddles. Before the flood, some environmental facilities and infrastructure could function properly, such as sports fields, gardens and roads. However, when a flood occurs, environmental facilities and road and drainage infrastructure cannot be used anymore because they are submerged in water. This change in the form and function of environmental infrastructure has changed the behaviour and habits of the community. Previously, sports activities were carried out in the environmental field, changing people's behaviour by exercising at home with limited movement. Meanwhile, making a living by gardening, which can be done during the dry season, has turned into making a living by catching fish because the garden is submerged in water. The flood conditions have changed the shape of the environment, which causes changes in people's behaviour that adapts to the shape of the environment during a flood/inundation.

Road infrastructure in this area is generally in the form of concrete roads that have been elevated. Several decades ago, this concrete road was still an unpaved dirt road, so after months of flooding, this dirt road would be muddy and

could only be used as an access road once the road was dry. However, this dirt road has been replaced with a concrete road with a level elevation of 1 meter. This is so that this road can still be accessed when the water level has not reached the road and is safe to use at low tide. To anticipate flood disasters with water levels that exceed the height limit of concrete roads and muddy and wet roads when the water recedes, the community makes a floating street or people in this area call it *Alleteng*.

When the flood waters slowly rose, *Alleteng* or floating street was built and placed next to a concrete road connecting small alleys and one house to another. This is following the results of an interview with one of the informants, who is also a housewife, Mrs Senna, who said:

> " *alletengge ipake narekko meloki mallimbang ko bolana silessurengnge iyarega sampung loloE. Nasaba' macawe'mi pole BolaE. Narekko meloki jokka mabela, yanaritu meloki jokka mangantara anak sikola, yarega melo jokka mappasa, mallopi mi tawwe."*
>
> It means:
>
> "*Alleteng* is used when crossing to a relative's or other family's house because it is close to the house. If you are going far away, such as taking your children to school or the market, use a boat."

Several years ago, before people could have a boat in each house, this *Alleteng* became the only infrastructure to connect one alley or house to another. However, the people in this village's economic condition is improving, causing the community to have a boat in every house. Hence, boats are another alternative used as a means of transportation during floods. The community uses the boat to take their children to school, the market, or other environmental facilities. Meanwhile, *Alleteng* or floating street is used only for access between family homes and closest neighbours.

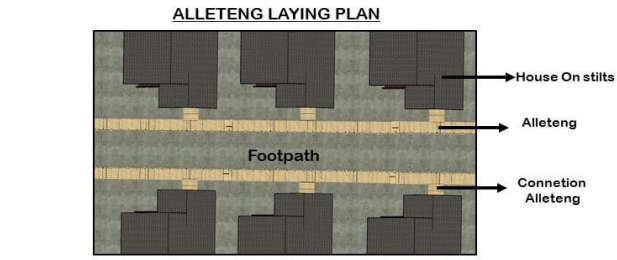


Figure 6. Boats and *Alleteng* as Transportation Means During Floods During Floods
Source: Naing, 2022

From the above conditions, it can be concluded that the Adaptation of environmental morphology occurs in changing the shape of the garden/rice field into a stretch of water which changes the behaviour of the community from being active as farmers to being active as fishermen. In addition, infrastructure adaptation is carried out by building an *Alleteng* during the flood season until the water recedes as a floating street, which changes people's behaviour from walking or using vehicles on concrete roads to using a boat or walking on an *Alleteng*. The use of *Alleteng* and Boats as a means of transportation during floods can be seen in Figure 6 below.

ACKNOWLEDGMENT

Thank you to the people of Salomenraleng Village, especially the resource persons who have provided information through in-depth interviews during the research process. Thanks also to the Wajo Regency government, in this case, the Salomenraleng Village Head, Wajo Bappeda and the Wajo Regency Disaster Management Office for their support.

CONCLUSION

When there was a flood in Salomenraleng Village, the community had adapted for decades. This experience has created an adaptation model for mitigating flood disasters by changing environmental architecture and settlement facilities. So the critical finding in this research is the creation of architectural, morphological and behavioural adaptation models. Architecturally, the Adaptation that occurs is to create space within the space, *using Ladda'* in the house and on the terrace. At the same time, Morphological Adaptation is a change in the shape of the house from standard pillars to high pillars. In addition, there has also been a change in road infrastructure from a concrete road to a floating street made of bamboo or *Alleteng two*. This physical Adaptation has changed people's behaviour towards houses and settlement facilities,

where people adjust their behaviour to changes in physical facilities (houses and public facilities) and environmental road infrastructure.

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