FLOOD ADAPTIVE SETTLEMENTS TOWARDS URBAN DEVELOPMENT IN THE RIPARIAN OF MEUREUDU RIVER, ACEH PROVINCE, INDONESIA

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ABSTRACT

Meureudu Riparian in the past was a place of a collective settlements;it was then developed to become a Meureudu City in Aceh Province, Indonesia. Initially, it was formed as traditional fishermen settlements but now has shifted into semi-modern settlements. However, the settlements developed sporadically to form an unplanned pattern of settlements. This condition resulted in low maintaining river and non-adaptive existence of the dwellings with the environment. Floods occur repeatedly in the river that affected great lost to the community. This study aimed to propose residential pattern design and adaptive settlements with Meureudu River riparian. Easy access roads to markets will facilitate economy growth to the people.This will also cause large numbers of unbridled migrants to enter and build settlements. In this study the a combination of quantitative methods based on interview data and questionnaires and qualitative exploratory methods based on field observation were used. The data were collected through observation, field measurement and secondary data sources. The results show that the condition of settlements along the river basin do not reflect the culture of the river. In order not to further aggravate the condition of the settlement and its impact on the occupants, we recommended two types of houses, namely in the form of stage and non-stage. The stage houses are located on the riverfront with an orientation overlooking the river. Additionally, undersea area can be used as security from the puddle of river water runoff during

the flood and as a garden area and public while dry, while at a distance of 100 meters from the river non-stage houses form would be built because the runoff of flood water no longer affects the occupancy.

Keywords: *Adaptive settlements, Riparian, Floods, Meureudu River, Indonesia*

INTRODUCTION

In many cities of developing countries, especially in Indonesia, rapid urbanization has created unplanned settlements along the riverbanks of rivers. As an archipelagic country, many Indonesia cities have grown on the water's edge, either on coastal or by riverbanks (Fitri et al., 2017). As the largest archipelago on earth, Indonesia is both blessed with abundant natural resources and afflicted by natural disasters. Meureudu is one of the cities that evolved on the riparian riverbanks of Meureudu river, Aceh, Indonesia. Most growing cities in Indonesia, some which are located at the urban areas, decline into slum areas, especially in riverbanks. Majority of settlements have grown in areas around the water, including rivers, lakes, as well as seas (Mahatmanto, 2008). This may be due to cultural ecosystem services that are not easily integrated into planning decisions when rehabilitating the urban rivers (Vollmer et al., 2015). In the beginning Meureudu River was collective settlements. It was eventually developed into Meureudu City. Thus, it can be observed that living culture on the riverbanks has become part of the history of this city (Fitri et al., 2017). Currently, Meureudu City acts as the capital of Pidie Jaya Regency in Aceh Province, Indonesia, as a center of district government, tourism activities, trade and service center and city of transit. However, due to the settlements growing sporadically along the Meureudu River basin, it has formed an unplanned pattern of settlements. The currently rapid population overcrowds the settlements in the riverbanks. Such conditions resulted in not ideally circulating environments of settlements and resulted in poorly maintained river, bad infrastructure in the neighborhoods (swales) for drainage flow, unavailability of adequate green open spaces along the riparian, and non-adaptive existence of the dwelling (both construction, distance) as a form of flood mitigation (Irwansyah et al., 2015). Meureudu riverbanks are low in topography which may resulted flood when the river overflow. This condition caused Meureudu City to experience repeated floods that may harm the community.

Flood hit areas along the riparian river banks, lowlands, downstream areas, and others that have bad drainage system and unstable soil structures. The flood may be caused by extreme natural disasters and human activities. Along with the rapid growth of population as well as unplanned urban development, geographic and demographic location, the threat and flood risk

have increased. The impact of unplanned urbanization has also contributed to the change of hydrologic characters in the urban areas.

In addition, regional geographic and climate conditions have also caused flooding in Meureudu City. According to Azmeri (2009), Meureudu river is categorized as a river with severe problems and prone to flood hazards. Thus, appropriate physical treatment of floodplain areas, such as repairing of drainage channels, so that floods will be resolved more quickly is vital. Housing and natural disasters have a close relationship in Indonesia, especially for Meureudu City which is prone to floods. Ahmed (2011) stated housing is considered as the most valuable asset for the inhabitants. Meureudu is one of cities in Aceh that faces such environmental degradation problems due to part of upstream land along the flood plains. The cause of such environmental degradation is the decreasing amount of land covering along the riparian river course zone. The increasing environmental degradation is the initial indicator of the environment vulnerability. However, community acceptance is necessary in ensuring the implementation success of sustainable development concept based on an ecological approach. Planning should be responsive to desires of the community and its ecological context (Scott et al., 2013).

Residential and human is an inseparable entity, involving mutually beneficial relationships and is strongly influenced by the quality of the environment and the quality of the individual. Human relationships with the environment that they reside formed by various factors, among others: culture, environmental conditions, influence from outside, and behavior (Hirsan, 2011). Settlement is a collection of dwelling where initially each occupant mutually agreed formally and informally to form a community based on socio-cultural proximity. Besides, socio-cultural relationship and ability of each individual to adapt are greatly influenced by the development of controlled settlements and subsequently, this provides a feeling of security for residents. Many settlements are not developed or developed but they are uncontrolled and have caused inconvenience to their inhabitants. Thus, planning should integrate wetlands as part of the townscape to make a unique environment (Alberti 2010).

In addition, improper design solutions and poorly built homes are one of the root causes of increased disaster risk (Davis, 1978). A review

of housing construction is important to be carried out on settlements in Meureudu River watershed area, which is prone to flooding, to provide adaptive housing with its environmental characteristics. Besides, sustainable housing development is a consequence of achieving long-term results for settlements in the watershed area. Relocating people to other places is not a proper and easy solution because the settlement has been established long time ago. According to Audefroy (2010), improving the quality of construction to be much better will not only guarantee the technical stability of the buildings but also offer many social, economic and environmental benefits for the community in the future. Therefore, housing assistance for local communities like that does not only focus on improving physical housing but also includes increasing public awareness about disaster preparedness and reduction.

Adaptation is a strategy that humans use to respond to environmental and social changes (Allan, in Marfai, 2012). Maryono (2005) explains rain factor is a natural condition that can cause floods depending on the intensity. Flood is a natural phenomenon that is part of the climate cycle. Floods can cause disastrous for humans. Flood is the result of human intervention to nature (Kusumaatmadja, 2004, in Suhandini, 2011). It is an ordinary natural event, then developed into a disaster problem if the water overflows disrupt the life, livelihood, and human safety (Setyowati, 2010). In order for settlements in Meureudu river watershed area to be sustainable, it is necessary to make adjustments to respond to repeated floods in Meureudu City. Marfai (2012), stressed that the adaptation process is very dynamic because the environment and human population are changing constantly. Human adaptation to the environment indicates the interrelation between humans and the environment (Desmawan, 2012). Thus, flood adaptive housing model is one form of mitigation that can be recommended for the development of Meureudu City.

Aceh Middle Term Development Planning Year 2012-2017 (RPJM) mentioned that the quality of the environment and disaster is one of the priorities of development handling the impact of development of regional economy. The reason for the research conducted in the Meureudu riparian is because it is a new district capital. Besides Meureudu is an important development barometer in Aceh, so planning in preparation for anticipated development and inadequate development and minimal disasters is a necessity.

RESEARCH METHODOLOGY

The study is located in Meureudu City, 152 km from Banda Aceh City (Figure 1), the regency covers an area of 1,073.6 square kilometers, precisely in Meureudu river watershed area. This area is used as trading area, fisherman's housing and its facilities with medium density level, and pond land.

Figure 1: Map of Meureudu City

Source: Detailed Spatial Planning (RDTR) Capital of Meureudu Sub-district, Pidie Jaya District

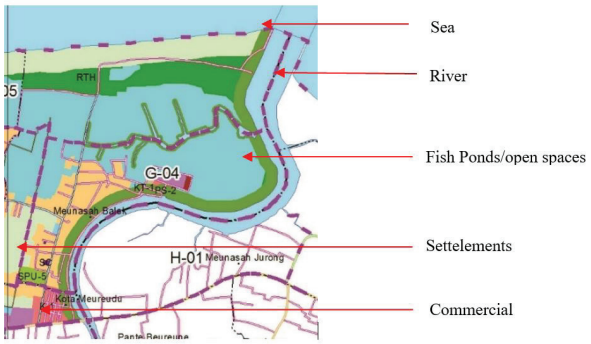

Figure 2: Map of Research Locations

Source: Detailed Spatial Planning (RDTR) Capital of Meureudu Sub-district, Pidie Jaya District

Study Approach

The study used a combination method (mixed method). The researchers used a combination of quantitative method based on interview data and questionnaires and qualitative exploratory method based on field data (field observation) in the exploration of potential settlement Meureudu River. Sources of data in this study include primary data derived from field research (observation, questionnaires, interviews, and documentation) and secondary data derived from literature review and documents from agencies related to this research. Field observation is the most dominant portion in obtaining data and information.

Data analysis involved the analysis of survey results on the pattern of adaptation of the dwelling and the environment. The analysis process aims to understand certain phenomena in order to have a deeper knowledge through space based on the process of formation and expression of spatial. In this case, the symptoms on how the process of flooding formed the expression of society as they adapt when facing the flood were examined so that spatial pattern can be recognized.

RESULTS AND DISCUSSIONS

Description of the Meureudu City

The settlements in Meureudu River riparian are one of the oldest settlements. This settlement has a swampy type of land, with topography in the form of a gentle plain with an altitude between 2-5 m above sea level, having a slope classification of <8%. The measurement from the height of the river i.e. about -0.5-1 meter, means there are some residential locations that are below the level of river water.

This settlement lies in the trading zone, therefore many residents work as merchants and shopkeepers. Other professions are civil servants. There are also people who work as fishermen and fish farming and pond shrimp. In this area there is harbor Fish Landing Place (TPI) so that many residents who work as transporters. Based on the data on the study site, 60% of indigenous population and 40% are migrants. Easy and close access

to markets has also caused a large number of unbridled migrants to enter and reside in the area.

Subsequently, residents get land as a residence derived from inheritance, buy, and rent it. Non-stage house (land) dominates the shape of the house by 70%, followed by the stage-shaped house. The orientation of the building is toward the river, sideways from the river, and back to the river. The orientation is influenced by changes in environmental conditions where there are roads facilities. However, the condition of the settlement paid less attention to the environmental hygiene problem, where the people are still throwing garbage into the river and making the communal toilets on the river.

Transportation routes are dominated by land access. There is an asphalt road that the frontal car can pass from downtown to the beach, while the road environment is made of concrete and land that can only be passed by motorcycle. In addition, through land access there are still people who use river transportation by boat.

Land Use of Meureudu River Watershed and the Problems

The form of the settlement extends along the stream with the development in the border of the river to the mainland. The settlement of Meureudu City originally shaped the structure of a traditional fishing town settlement, characterized by the existence of open spaces and proximity to water access. From the analysis it was found that fisherman settlements in Meureudu City experienced a shift in function from traditional to modern. This condition is caused by the large number of migrant residents who have strong capital, have trade skills, and have good management skills, which can affect indigenous people.

The land use for designation leads to the Meureudu River watershed leading to an optimal land use system that can support all regional functions. Newly grown homes on vacant land in the basin make irregular conditions. The composition of houses is very close together and there are unclear environmental roads. The settlement pattern of Meureudu River watershed area and settlement problems is shown in Figure 3:

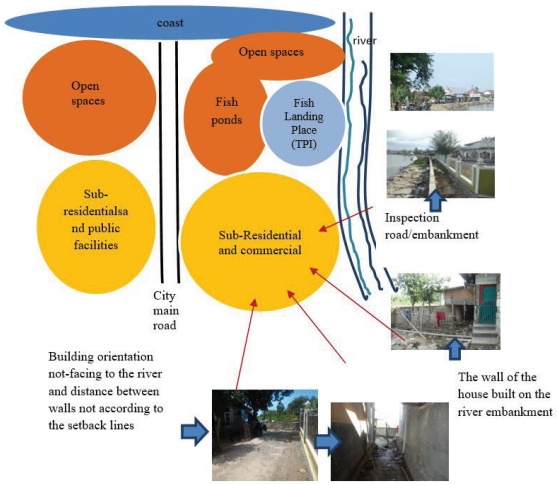

Figure 3: Settlement Pattern of Meureudu City and its Problems
Source: Analysis and Personal Photos

The increase population but the unavailability of residential lands has resulted in the large number of residents build buildings along the riparian corridors. Riparian corridors and water bodies are the determination of a certain distance from the river or water body that allows flooding. The closer the building to the river, the likelihood of a puddle or flood coming from a larger river overflow. Buildings that are located on the banks of the river caused disruption of the flow of rainwater that will flow into the river.

The phenomenon of the width of the river 20-30 meters with a depth of 5-8 meters is given dykes as high as 1 meter from concrete rebates and boulders. Based on the Detailed Spatial Planning (RDTRK) of Meureudu City 2014-2034, Meureudu River must have a minimum border of 5 meters along the outer leg of the embankment but the width of the river border 0-2 meters, almost along the river body is directly adjacent to the wall of the building. In addition, population growth is not followed by the availability of settlement land, resulting in the large number of residents who build buildings on the river border/buffer area. The river buffers and water bodies are the determination of some distance from rivers or bodies of water that allow for flooding.

Thus, this shows the importance of designing adaptive settlement model.

Design of Adaptive Settlement Models

This study resulted in the formulation of an adaptive settlement model with the Meureudu River watershed environment as one of the solutions to tackle floods. It is noteworthy that the most important thing in order to reduce the impact of flooding on housing in the Meureudu River watershed area is to increase the floor height above the estimated flood height (2 meters) and improve the surrounding drainage, including planned two types of houses, namely in the form of stage and non-stage. The stage house is located on the riverfront with an orientation overlooking the river. Undersea area can be used as security from the puddle of river water runoff during the flood and as a garden area and public while dry, while at a distance of 100 meters from the river non-stage house form may be built because the runoff of flood water has no effect anymore.

The house on stilts is located at the edge of the river but there is a space of the embankment with an orientation facing the river. Under-house areas can be used as a safeguard from river water inundation during flooding and as a park and public area when dry. The new construction, namely the use of reinforced concrete replacing the wooden pillars in the traditional house stage method, does not only help secure the building but also prevents material damage by flood water. This has also partly contributed to the reduction of deforestation for the needs of construction materials in the region.

Reuse of traditional house-stage forms will familiarize local residents with their new homes. Replacement of wooden structures with reinforced concrete poles provides a safer home for people in the future. The involvement of local builders in installing reinforced concrete poles for stilt house buildings will help them better understand the importance of applying new construction technology to promote valuable local characteristics in disaster risk reduction. This approach is expected to build perceptions about safe housing construction in the region.

Furthermore, materials such as concrete and bricks are more flood resistant than other building materials because they do not bend, rot or lose structural integrity as a result of flooding (Concrete Center, 2009). Ensuring that every part of the building that are affected by floods are made of concrete is better but not practical. This means that the only sustainable way to reduce the cost of repairs from flood water entering the house is to keep the type of non-stage house away from the danger of flooding. Therefore, non-stage houses are recommended to be located at a distance of 100 meters from the river bank because flood water runoff has no effect.

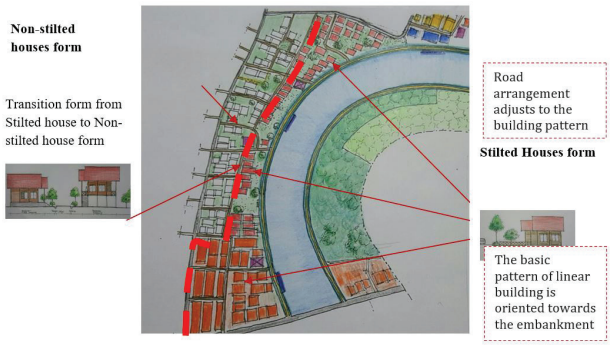

Figure 4: Adaptive Settlement Pattern in Meureudu Watershed
Source: Analysis

Some areas that can be developed are as follows:

1. Reuse of the river border area according to the capital Meureudu City District Spatial Planning (RDTR) by providing inspection roads and green lines along the Meureudu river, for easy maintenance and protection of riparian. Besides, it is also to provide comfort, ease of enjoying the view, and ease of achievement to the settlement area and the beach.

2. Residential environment conditions that tend to be moist and watery, has the potential to be developed as a residential environment with the concept of stage building that utilizes the under-area for security from inundation of river water runoff and infiltration during flooding and as a park and public area when dry.

3. Housing arrangement on the banks of the river by utilizing the river

as a building orientation.

4. Utilization of areas of pond farming as mangrove forests that function ecologically and protect from natural disasters including erosion, tsunamis and pollutants and support coastal development. Besides, it can be developed as a tourist area.

5. Trading zone as a central market that has the potential to become an orientation and land view with market arrangements that are also oriented to the waters.

6. Boat mooring zones, suburbs or river banks which have ease of achievement from the river to the housing zone and Fish Landing Place (TPI).

Based on the settlement model recommended by the Ministry of Housing and Regional Infrastructure, the settlement model for the Meureudu River watershed area is an integrated design model that is planned (by design). The choice of this model considering the people in this region has historically been settled for a long time, so relocation is not an easy problem because people are reluctant to be moved to other places, while the threat of flooding can come at any time. Being friendly with floods is the right solution for the settlements in the Meureudu City.

CONCLUSIONS

In addition to being influenced by topographical factors of sloping areas and river boundaries that do not meet the standards, the floods in Meureudu City are worsened by the conditions of occupancy and infrastructure that do not respond to flooding. Mitigation systems for riparian areas ideally apply types of hard protection and soft protection. The easy and close access road to the market keeps the people's economy moving, but that aspect also causes the large number of unbridled immigrants to enter and residein the Meureudu River watershed. Thus, the concept of handling is proposed based on the study of settlement conditions and adapted to the needs and desires of citizens (interviews). The concept minimizes eviction house residents. It is concluded that settlements along Meureudu River riparian is still vulnerable to flood disasters, which was based from the land allotment

for housing. However, the settlement infrastructure for disaster mitigation is also not optimal. Besides, sporadic urban development without planning undermines the balance of the ecosystem services at the riverbanks. The improvement of river settlements will not only improve the quality of life of the community but will also rehabilitate the ecosystem services, and minimize natural disasters. Urban development should respond to residents' preferences, and also be sensitive to the impact of planning on the local environment, including recognizing underlying cultural values. Natural disasters have a disproportionate impact on the urban poor, who often live in informal settlements at vulnerable parts of the urban centers.

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