ISSN 2541-223X

icsbe 2016
Fourth International Conference on Sustainable Built Environment

STUDY OF DWELLING CONSTRUCTION IN WET LAND AREA OF WEST COAST ACEH IN TERMS OF SUSTAINABLE SETTLEMENT (CASE STUDY: SETTLEMENT OF *KRUENG* TRIPA WATERSHED AREA)

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ABSTRACT

Rural settlement in West coast Aceh has been developed in groups along the coast, river, and main roads. This condition is caused by the cliffs of *Bukit Barisan* Mountain, so not all conducive spots become a place for living. The region of western coastal settlements has numerous large and small rivers, so the settlement is mostly found in the watershed and swampy area. Regarding this, the land is relatively vulnerable to be destroyed by flooding. Since the early history, the local people have constructed their houses on stilt. However, since about thirty years ago, the local people started to build their house on the ground, constructing an underground foundation. The house walls are made of concrete but their houses are damp and some houses stand unstable or pitching. This indicates that houses construction may not be adaptive to the wetlands, so it threatens the continuity of settlement in this region. This study aims to examine the house construction built on wet land and to find out the solution on how to build an ecological dwelling house. The methodology of this study is a descriptive qualitative where the data were collected using a purposive sampling. The data were analyzed based upon the theory of typomorphology, focused on construction and material aspects in relation to a wet land area. Data were derived from sources of documentation, direct observation, in-depth interviews, and architectural drawings. It was found that the construction of houses built on the ground has resulted in the closure of land and reduced water infiltration and the concrete does not meet the construction standards of strength and not waterproof. The building is also not responsive to the local climate. The construction of houses on stilts is the most appropriate solution to adapt to the condition of wetlands in the *Tripa Bawah* area. Local communities can learn to understand the concept of the stilt house as the vernacular architecture in the region. It is indigenous to address local issues.

Keywords: *D*welling construction; Sustainable settlement; Wetland.

1. INTRODUCTION

Region on the west coast of Aceh consists of little lowland and mountain alongside steep cliffs that are part of the west side of the Bukit Barisan mountains (*Dinas Kelautan dan Perikanan Aceh*, 2003). These conditions resulted showed that not all places are conducive to evolve into a living area. Rural settlement on the west coast of Aceh grows in cluster, linear to follow the coastline, rivers and roads. The majority of settlements in the area of tidal or in Watershed (DAS) environments is marshy and prone to flooding (Nursaniah, 2011). As in *Krueng Tripa* area where research was

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conducted, a settlement is along the river and adjacent to the estuary. Therefore, the soil of settlement is in the form of marshland and frequently flooded by the tide and overflowing of rivers. (Timberlake, 1998) stated that wetlands, particularly swamp is an unstable environment. The undermining wetlands on the life support systems have some detrimental effects on residents and the surrounding environment. However, a traditional society here has been adapting since long by building a tilt house construction (called *rumoh santeut*) to adjust to these conditions.

Now the local people do not want to build the stilt houses construction, but prefer to build their houses with the construction on the ground. The problem is that these residential looks moist and some houses begin to tilt position due to the unstable soil conditions. This indicates that home construction is not adaptive to the wetlands, so it threatens the continuity of settlement in this region. (Sithole and Goredema, 2013) stated that the housing construction in wetlands raises many issues and settlements are not sustainable, but it has a rather disturbing implications that undermine the efforts to provide a housing. Such measures reduce the absorption capacity of groundwater and cause the loss of water storage, drainage congestion, logging and loss of vegetation. The results of the data collected shows that residents with houses built on wetlands complain about the dangers they are facing when undertaking the infrastructure development on wetlands, including reducing the life of their home because of large cracks and bending as a result of excessive moisture in the soil wetlands. Inaccessibility to their homes during the rainy season is due to flooding, and vulnerable to waterborne diseases. (Muderere, 2011) also stated a similar opinion that the house built on land in the wetlands is vulnerable to flooding and structural failures, cracks, and bending structure resulting building is not long lasting.

Therefore, a study of adaptation of residential construction on the land to wetlands is necessary to be done to understand the feasibility so that the public has an insight and solution to build a sustainable housing. The uncontrolled development that is not adaptive to the environment could threaten the sustainability of settlement in a long term.

2. METHODOLOGY/ EXPERIMENTAL

The research method was descriptive survey methods (descriptive survey methods) because the data were obtained from the results of direct observation in the field. Data were collected by interview, observation, and literature study. The determination of the samples was done by a purposive sampling method based on the predetermined criteria, namely: the house constructed on the ground and still inhabited. The analysis of data used typomorfologi theory of architecture with an overview on the aspects of construction, materials, and condition of wetlands.

2.1 Typomorphology

Typology is an activity to study the type of architectural objects and categorizes them into a type classification based on the similarity in certain things owned by the architectural object. The similarities can include similarity basic shapes/properties of the base in accordance with the basic shape of the object; the similarity of function of these objects; and the similarity of origin or social background and the development community where the object is located, including style (Mentayani 2010). The morphology of the architecture is the study of the shape and structure of space and the built environment. (Moudon, 1994), stated that the typology is a combined study of typology and morphology, as an approach to reveal the physical and spatial structure.

ISSN 2541-223X

Understanding the construction of homes on the land is intended to ensure the life safety and health of the occupants with the criteria used including: strength of construction, method of how to construct adapted to function for wetlands, and strength of materials (Schneekloth and Ellen, 1989).
On the other hand, adaptation is an ability to adapt. In the book Environment and Culture, Volume 1 (Altman, 1980), the notion of adaptation is the reduction of the mismatch in a system.

2.2 Research sites

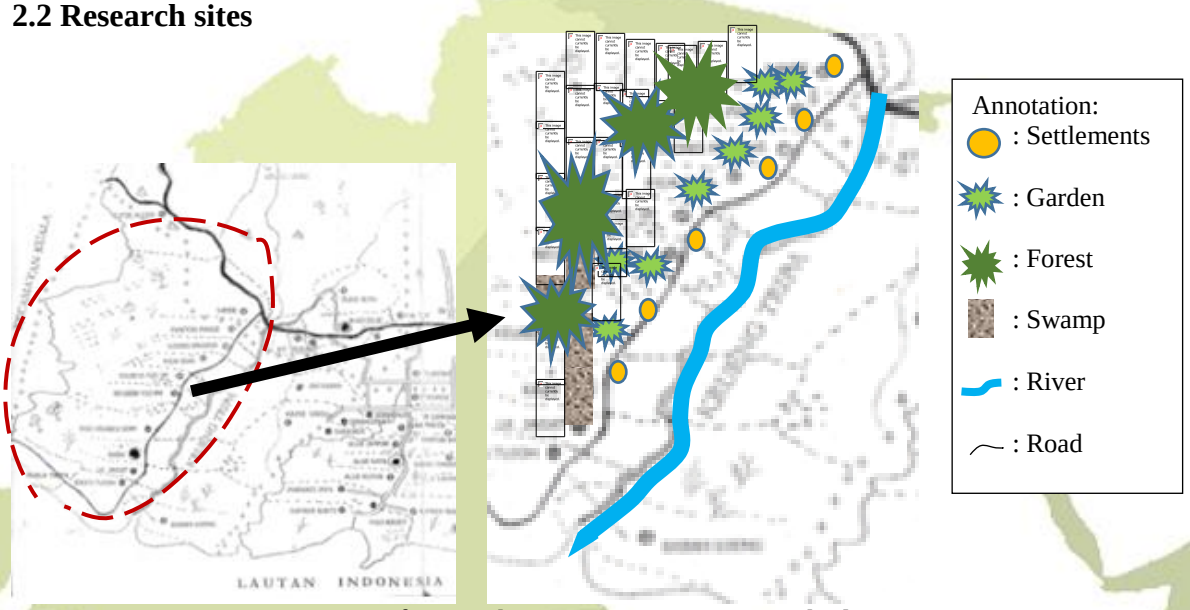

Figure 1 Map of research sites Rawa Tripa Watershed Region

3. RESULTS

3.1 Settlement conditions

Rawa Tripa Watershed area has a habitat and estuarine ecosystems. According to Pickard (1967) the estuary is a semi-enclosed waters largely dominated by the muddy substrate deposition and carried by freshwater and seawater. Historically and morphologically, *Tripa Bawah* region has a character of land that is relatively flat, forming wetlands such as swamps.
The threat of flooding in the *Tripa Bawah* settlement occurs due to the geographical conditions, namely in the low-lying areas and environmental water/swamp. Many rivers and waterways around settlements contributing to the increasing threat of flooding are usually due to the tide. Now the floods are becoming more frequent. One reason is the development by hoards swamp supposed to be a sponge for water infiltration. In today's modern development, building a house with a construction on the ground is a trend. As a result, the swamp that serves as a water catchment area decreases.
Since many years ago local people started to build the houses with the construction on the ground. The construction method was carried out by a local technique, namely for the construction of foundations and walls carried out by means of cast concrete. Cement was purchased on the market, while sand and gravel are the natural resources around *Krueng Tripa* River. The area is a rare clay as the main material for making bricks. Although there are bricks but of poor quality and easily destroyed because of building a house directly on the wet land, the floor, walls, and the damp and unhealthy space inside the house. When the flood comes, the house with the construction of the stage remains

ISSN 2541-223X

dry because the water elevation is under the stage floor of the house. While the house is built directly on the ground experiencing the impact of flooding.

Figure 2 a. On the condition of flooded land, there are two different home constructions, the stilt construction and the construction on the ground; b. Research Area in flood conditions. The flood waters do not reach the floor of a stilt house

4. DISCUSSION

4.1 construction foundation

Typically, the foundation is composed of two parts. The first layer is an 80-cm stone construction partially buried in the ground. This foundation has a thickness of about 15 cm from the bottom to the top, instead the usual shape of a truncated pyramid. Coating on top is sloop cast in concrete as high as 20 cm. Local communities build a house in consideration to the economic level, so the sloop varies, there are added iron reinforcement, reinforcement wire, or without reinforcement.

Sloops are not adaptive to the marshland because the concrete construction is not waterproof. Therefore, the foundations are corrosive and calcified. Wet land is also unstable, resulting in the foundation to be shift and fracture and failed in the structure. The construction form of the third type of foundation is not suitable for the environmental conditions of the swamp and prone to flooding. Floods come repeatedly, causing the houses built on the ground to experience humidity and destroyed because it is not adaptive to the environment.

Type 1

Under the construction of river stone and cast reinforced concrete. The wall construction is also with cast concrete

Type 3

Under construction with cast concrete without reinforcement techniques, while construction of the wall uses the wood

ISSN 2541-223X

Type 2

Under the construction of river stone and reinforced concrete cast technique, while construction of a wall is made of wooden material.

Wetlands caused construction shifted to the bottom of the building broken because the construction does not use reinforcement

The process of construction uses the 80-cm river stone foundation partly above ground level. It is placed upon its cast concrete walls. There is no addition of iron in construction

Figure 3 Condition of the house built on the ground

In the case of wetlands, the most important houses construction is the selection of the type of foundation. Using the footprint and pile foundation construction is a right choice. The foundation should be planted about 100 cm with the improvement of the building footprint, among others with the foundation *cerucuk*. Foundation construction must be of material cast concrete reinforced with iron distribution. The type of housing according to the condition of wetlands is stilts constructed. For pole it can use the concrete or wood material. If using wood, the wood should be in the position above the flood elevation (About a 100 cm). As for the construction material of the flooring may use concrete or wood. Wood materials, namely board actually is more adaptive because it has a grille for the air intake through the under occupancy so that indoor air is not humid.

4.2 Wall construction

The dwelling built on the ground by local communities can be distinguished into two types of wall construction: the walls of cast concrete and wall board. If the housing wall is made of concrete, the practical columns are constructed of concrete or wood material (mostly using the wooden poles). Furthermore, with the aid of two planks as malls, mortar cast concrete is poured gradually. After sufficiently hardened, the next cast layer is poured on top again. And so on to fit the needs of the high walls of the house. But the cast concrete mortar is not like a standard brick mortar 1: 4, but more sand. This design is potential to make the construction very weak and porous.

Figure 4 Walls Construction with Concrete Casting Technique

ISSN 2541-223X

Cast concrete technique is done by the community because of sand and gravel is the building materials that are affordable and easily available. In addition, the soil conditions in the West coast of Aceh were not so good for making bricks. The bricks are not uniform in size, with an average of 5 x 12 cm and 2-3 cm thick. And even then the quality is not good because it is easily broken. This condition makes the local people prefer a house with walls made of cast concrete.

4.3 form the foundation of sustainable construction

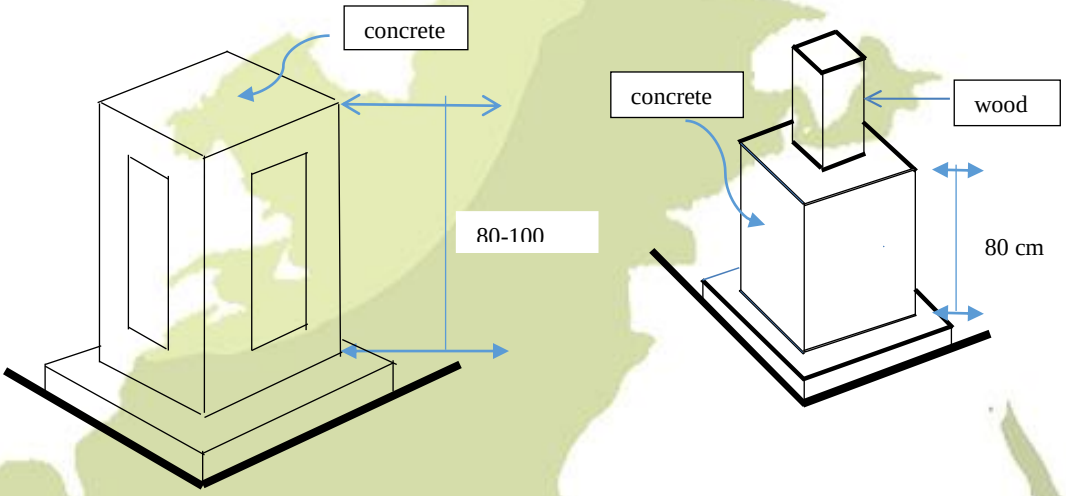

Figure 5 Types of foundation suitable for Houses Construction in *Rawa Tripa*

The construction of the foundation can use concrete to a height above the flood elevation, in the range of 80 cm to 100 cm or 80 cm high concrete use plus a wooden pole at the top.

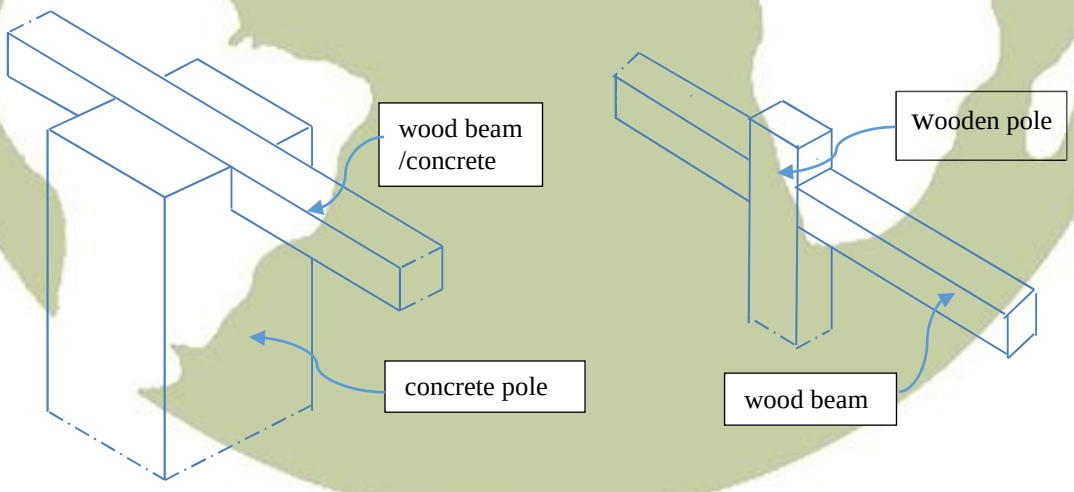

Figure 6 Types of Construction which Adaptive Floor with Wetlands and Local Climate

For a floor construction with concrete foundation it may use concrete or wood material for floor beams, and wooden poles can be used for the wooden beams. As for the flooring material it is recommended to use the board to deliver the air from underneath

into a space in the dwelling through the lattice floorboards. Thus, the space in the dwelling is always on the dry/moist. For wall material, the public can use concrete with cast technique for the floor beams made of concrete. As for the floor beams of wood it should use the board.

Opening in the wall of the house and ventilation will be maximally applied to occupancy if using wall board because the house with cast concrete technique will reduce the strength of the construction if it creates many openings and vents. For the climatic conditions on the hot coastal areas, it should be made many openings in the housing so that the space is comfortable in the afternoon and in evening.

5. CONCLUSION

The construction of houses on the ground is to cover the land and reduce water infiltration and resulting settlements prone to flooding as the hoarding swamp with soil can alter the landscape originally dynamic to be static. All houses constructed on the ground in the *Tripa Bawah* watershed area look damp, unhealthy, and even some foundation and look shifting sloop and broken due to the unstable land and construction of house foundations not adaptive to the land. The concrete did not meet the standards of construction strength and not watertight. This dwelling also does not respond to the coastal climate, i.e. no ventilation in the roof space and on the walls of buildings.

Stilts construction is the most appropriate solution for housing on the condition of wetlands in the *Tripa Bawah* watershed areas. Stilt construction does not hinder the way to build with a local engineering that has been done the local community, but must comply with the standard concrete strength. There is no constraint to apply the technology, the system structure /construction and building materials if people build housing with the construction stage. In addition, it should pay attention to the building wind catchers systems on housing. The public can learn to understand the concept of adaptation *rumoh santeut* construction in the region. It is the local knowledge to solve any local problems. It is important to remember that the house with wood materials remains more adaptive to the condition of wetlands and coastal climate of the residential use of concrete material.

6. ACKNOWLEDGEMENT

Special thanks to DP2M Dikti who has supported this research funds, so this research can be done well. The gratefulness is also dedicated to research institutions of Unsyiah for facilitating and coordinating the study.

7. REFERENCES

Altman, Irwin. 1980. *Culture and Environment*. Monterey. Ca. Brooks/Cole.

Dinas Kelautan dan Perikanan, Pemerintah Provinsi Nanggroe Aceh Darussalam. 2003. *Studi Perencanaan Pengembangan Pembangunan Kawasan Pesisir (Budidaya dan Penangkapan)*, Final Report.

Mentayani, Ira. 2010. *Tipomorfologi Rumah di Atas Air*. National Seminar. Semnas National Seminar on the Research Methodology in Architecture. June 2010. Univ.Udayana. Denpasar-Bali.

Moudon, A. V. Getting to know the Built Landscape: Typomorphology, in Franck, K. and Schneekloth, M. (eds.) "Ordering Space: Types in Architecture and Design" New York. Van Nostrand Reinhold: 289-311 (1994).

Nursaniah. Cut. 2011. Kajian Eko-Arsitektur pada Penghadiran Rumah Rakyat di Desa Pasie Pawang Kawasan DAS Teunom. RaUT Jurnal Arsitektur FT Unsyiah, 2nd Edition, Vol. 1/May-August 2011. ISSN: 2085-0905. pp: 55-61

Pickard, G. L. 1967. Descriptive Physician Oceanography. Second Edition. Massachusetts: Jones and Bartelett Publisher.

Schneekloth, Lynda H. and Ellen Manie Bruce. 1989. Building Typology: An Inquiry. EDRA #20 Proceeding of Annual Conference. Oklahoma City: EDRA, Inc. p 124-131.

Sithole, Angeline and Goredema, Byron. 2013. *Building in Wetlands to Meet the Housing Demand and Urban Growth in Harare*. International Journal of Humanities and Social Science vol. 3 no. 8 (special Issue, April - 2013)