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### PRINCIPLES OF VERNACULAR HOUSE DESIGN FOR THE SUSTAINABILITY OF COASTAL SETTLEMENTS

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#### *Abstract*

The sustainability of a settlement starts from the sustainability of a dwelling. In the era of modern development, the ecological principles contained in vernacular architecture must still be modernly adapted for the sustainability of a dwelling. The vernacular architecture of stilt houses on the west coast of Aceh has proven to be more environmentally responsive and more robust to natural disasters compared to houses built on the ground. With the knowledge of modern technology and materials, several principles of vernacular architecture can be applied to modern construction designs. This paper discusses how the people in Aceh's west coast settlements who live in the peat swamp environment, understand the potential for disasters in the coastal areas through their dwellings. This research was conducted to compare stilt houses and non-stage houses built by the community, by selecting samples based on purposive sampling technique. Data collection is done by literature study, field observations, documentation, interviews, and field notes. Descriptive data analysis techniques by linking the shape and type of development with decent housing needs, especially in terms of resilience in building construction against natural disasters (earthquakes, floods, strong winds, tidal waves) and geographical conditions. Houses in the west coast of Aceh need strong and solid construction and adaptive forms to the environment, coastal climate and potential disasters.

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**Keywords:** Principles of design, stilt house, sustainable, west coast, aceh settlements.



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## 1. Introduction

To adjust to changing needs in each generation or due to natural factors, then gradually the architectural building will experience changes. Space, form and construction as a legacy will change slowly through a habit. Changes that occur are relatively not the same, some are fast and some are slow. The changes that have taken place from the old era to the new era are the effects of economic changes that have finally led to the need for changes in buildings. Oliver (2006) states that vernacular homes are inherited from generation to generation. These houses are not in accordance with the beginning of their history. Houses or dwellings always change from the traditional form to the contemporary according to the activities and values of the occupants (Lawrence, 1987).

Changes that occur due to the spirit of the era also hit the west coast of Aceh in terms of the construction of residential homes. Location factors with the geographical conditions of the coast that should be taken into consideration in building houses tend to be neglected by the local community. Whereas Punpairoj (2013) states, the evolution of vernacular houses throughout history has occurred to respond to factors such as geography, climate, expertise and materials. Harmanescu and Enache (2016) emphasized that vernacular architecture is able to connect different spaces and times and mediate the development of new technological innovations that provide life safety by using local materials, because vernacular knowledge gives birth to architectural characteristics and forms that are contextual with the local climate, local materials and living culture.

The current phenomenon is that people on the West coast of Aceh are more interested in building non-stilt houses compared to stilt houses which are their vernacular houses. Stilt house construction is an ancient construction method that has local wisdom with the environment and society in Aceh's West Coast. Nursaniah, Qadri, and Izziah (2017) studies show that in swamp land settlements in the Aceh West Coast region that is not always submerged in water, it is very appropriate to use concrete pile foundations by considering the quality of concrete to its durability and strength to adapt to the swamp environment, floods and earthquakes. Muchamad, Mentayani, and Aufa (2010) added, buildings in wetlands should be built with a stage construction model using materials that are appropriate to the character and problems of buildings in wet areas, related to strength and water resistance. According to Frick and Hesti (2006), floor construction in humid tropical regions can maintain the coolness of space if the floor does not contain moisture from the ground. They also said, if the swamps that functioned as sponges regulate excess water from land (flood) and from the sea (full moon and tides) were buried for development, flood and rob regulation and the ecosystem would be damaged. Conversely, a house on stilts is more ideal with the environment.

The loss of local wisdom is causing problems for settlements and their communities, including more frequent flooding, humid housing conditions, lack of ventilation, and poor health. As commented by Wallbaum, Ostermeyer, Salzer, and Escamilla, (2012), that vernacular architecture is not sufficiently valued in modern construction, while the natural environment faces serious challenges in terms of environmental impacts and natural resource management. Though knowledge of building traditional culture is a technological principle that is built from time to time through a continuous process. Menurut Khaliesh, Widiastuti, and Budi (2012), ethnic plurality is the cause of the absence of customary rules which generally form the social environment of traditional settlements, and this is what happens in the study location.

This study is very important because the geographical location of the west coast is in the form of swamps and lagoons, which are ideally suitable only for construction on stilts, but are now rife with the construction of houses constructed on the ground. The results of this study are expected to be a reference in planning sustainable housing development for communities in the West Coast region of Aceh, which indeed must have a reference for housing construction and construction for disaster mitigation and management.

## 2. Problem Statement

Along with the development of building materials, the advancement of telecommunications, and ineffective reasons, combined with demanding needs and limited financial capabilities, communities in the West coast built their homes with non-stage construction. Changes in the shape of the building have an impact on the poor quality of buildings, building safety, and security, as shown in Figure 1. However, the stilt house as a vernacular house on the West Coast can reduce the impact of disasters on the safety of the population through the local wisdom of its architecture;

Technology in architecture is always related to materials and construction that focuses on building sites and how to build. Learn and understand how the shape of the stage in the coastal region is born, and whatever in the community that has given birth to it, and in how the power or tradition is realized;



**Figure 01.** Floods eroded settlements and non-stage buildings in Tripa Makmur

Source: Newspaper and survey

Consideration in the current residential development on the coast is a humid tropical coastal climate, coastal geography, and coastal disasters.

## 3. Research Questions

Buildings on stilts as part of a vernacular house on the west coast of Aceh are believed to be very concerned about a sustainable development system and pay attention to social, cultural and environmental aspects. Furthermore, the potential for developing a stage house concept that is in line with current conditions and needs will be able to make the building still have the identity of local architecture. The research questions are:

- What are the useful principles of stilt house architecture on the west coast of Aceh, and can be applied to the construction of current and future housing?
- How can the principles of stage house architecture be implemented in today's housing?

#### **4. Purpose of the Study**

The research objectives are:

- To understand the principles of stage house design on the west coast of Aceh which are related to coastal climate, coastal geography, and coastal disasters;
- To get a way to implement the principles of stilt house design with current conventional development methods.

#### **5. Research Methods**

This research was carried out at the stilt house in the Tripa Makmur settlement area, west coast of Aceh. The sample selection is based on purposive sampling technique, which is by criteria that the house has been inhabited for four generations until now.

This study was conducted to find sustainable principles of stilt house design to ensure the lives, safety and health of residents. Then the analysis is done by typology studies. Moudon (1994) mentions 4 (four) stages that must be passed in the typology analysis, namely: determining the scale, formulating the classification, elaborating the results of identification based on classification to produce concepts, and establishing a dialogue of linkages between types to form types. The variables used are material aspects, construction and the potential for disaster threats (Schneekloth & Ellen, 1989). So for disaster analysis local architectural design criteria are used which explain how the design is in accordance with local conditions, especially the coastal climate, wetlands, disasters (floods and earthquakes) and their handling, in this case the building elements, materials, and joint construction.

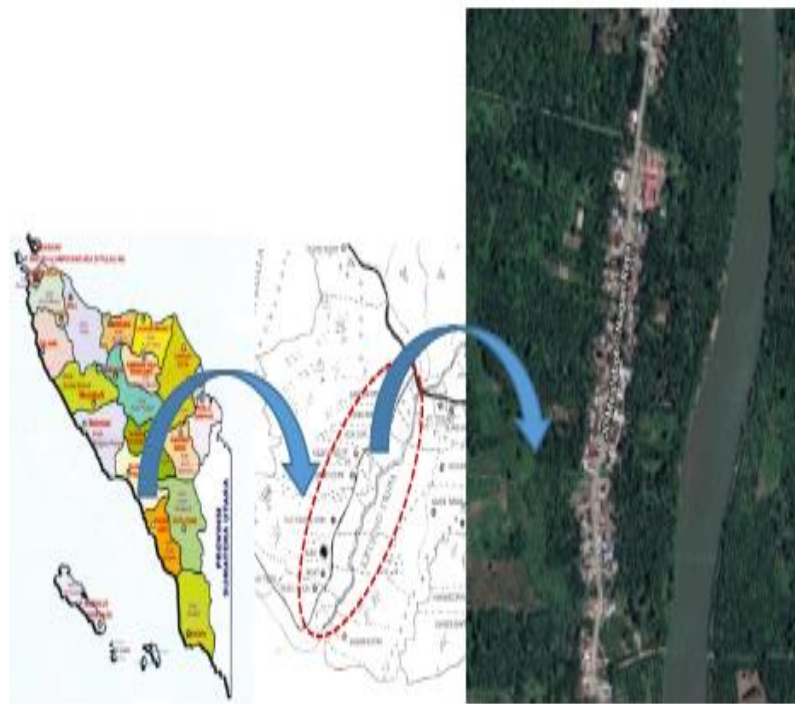
Theoretical analysis of architectural typomorphology is applied to understand the typology of stage house construction designs that produce concepts that are responsive or adaptive to disasters. The study begins with a study of literature, then physical data collection is carried out. Preparation of model data; collected data is edited and processed, then prepared to be compiled into model input data.

Activities carried out include: a). analysis of the characteristics of the typology method to understand its use with problems and research cases; b). Furthermore, the stages of typomorphological analysis are prepared based on empirical data on stilt houses based on the geographical area; c). From the results of the typology analysis, it was concluded that the concepts and models of stage house construction were adaptive to the environment; d). Furthermore, this concept can be developed for contemporary stage house architectural design models (with the application of current technology).

#### **6. Findings**

##### **6.1. Characteristics of Settlement Patterns and Physical Appearance of Stage Houses on the West Coast of Aceh**

In the West Coast region of Aceh, especially in the *Tripa Makmur* settlements shown in figure 2, the forms of community houses are stilt houses and non-stage houses with linear patterns along roads and rivers. This pattern is caused by the presence of water as a vital human need, and the development of houses also tends to build up in empty space or unused space. The orientation of the building towards the road, the building extending from North to South makes the flow of wind and sunlight adaptive to homes living in the humid tropics.



**Figure 02.** Research location in Settlement of *Tripa Makmur*, West coast of Aceh

Source: Processed Maps and google earth

Along this river there are population settlements that are vulnerable to flooding due to the overflowing of the river. *Krueng Tripa* overflows due to river siltation and abrasion. In addition, more land in settlements has been covered by road construction and housing. The contour of the land on the banks of the *Krueng Tripa* river is higher than the land across the road where the majority of the people live, so that the flood water from the river will be flooded in the settlements because it is difficult to return to the river. Whereas more water from the sea also enters the settlements because more canals are made to irrigate oil palm plantations whose area is increasing. The reduction in the area of peat swamp forests has an impact on the decline in environmental quality and the emergence of natural disasters for people living in the area. The conversion of peat swamp forests in the *Krueng Tripa* estuary, Aceh's west coast into oil palm plantations, is indicated to have a negative impact on the region, and encourage natural disasters such as floods, increasingly deep sea water intrusion, and droughts. Flooding is an environmental disaster that routinely afflicts this region, even since the beginning of 2015 has increased from previous years.



**Figure 03.** Two types of house construction, non-stage and stage. Ideally, home land will become an area of water infiltration in this wetland environment

Source: Survey

Along with the development of building materials, the advancement of telecommunications, and ineffective reasons, combined with demanding needs and limited financial capabilities, people in the West coast built their homes with non-stage construction. Figure 03 shows a house on stilts with a pool of water below, a contradiction with the house next to it that was built and constructed on the ground. Changes in the shape of the building have an impact on the poor quality of buildings, building safety, and security. However, the stilt house as a vernacular house on the West Coast can reduce the impact of disasters on the safety of the population through the local wisdom of its architecture. The two types of house construction are shown in figures 4 and 5.



**Figure 04.** Display of stilted house in the West Coast of Aceh Source: survey



**Figure 05.** Display non-stage houses in the West Coast of Aceh Source: survey



## 6.2. Design and Application Principles Elements of Stage Houses related to Earthquakes

Sustainable architecture has a close relationship between architectural buildings and local characteristics and local climate. The geographical condition of the research location is peat soil, which is a soft soil type or low support capacity for buildings / houses and can be said to be the same as land in swamps. Figure 6 shows the height under the houses on stilts is relatively low in Kuala Tripa (50 cm to 80 cm) so that the burden of the building is not too large, because it is on unstable land. The traditional method of laying on a stage house pole is not on hard ground, but on soft ground with swear foundation. With the merging of the construction of the pole above the *umpak*, the shaking of the building will follow Earth's gravity if there is an earthquake vibration so that the construction remains stable. Unlike the rigid concrete foundation and less flexible to vibration. Furthermore, floods in swamp areas can damage wooden poles placed on stone pillars.



**Figure 06.** Traditional structural system on a stilt house on the west coast of Aceh

Source: survey

The concern is strengthening the land or making sub-structure techniques (structures that are under the ground or buildings / houses in this case foundations) that can be stable in peat land so that they can support buildings / houses stably. For the current construction of house poles can be constructed higher using reinforced concrete, because the height of the flood is increasing (see picture 7). Geological expert Abdullah (2019) said that the concept of a stilt house in buildings will help release earthquake energy so that it does not directly hit the floor of the building, while non-stage houses will receive large direct energy from the earthquake making it riskier than a stilt house. However, the building built with the conventional method must really pay attention to the robustness and strength to withstand earthquake shaking so as not to collapse and cause casualties. Houses that have structural robustness will be able to minimize the possibility of accidents caused by the collapse of buildings, so that the connection system must have a good rigid level, so that the building frame system can withstand shocks caused by natural phenomena.



**Figure 07.** Reinforced concrete pillars of the conventional method are appropriately applied to stilt houses on the west coast of Aceh today Source: survey, design recommendations

The coastal area has high rainfall accompanied by strong winds which cause sea level rise. Based on these conditions, the stilt house at the research location already has a slope of the roof that can drain rain water without seeping into the building and can anticipate strong winds that can destroy roofs, walls, and building structures.

Wind characteristics in coastal areas are very specific, namely containing salt and very strong gusts. Coastal wind occurs because of differences in temperature and air pressure between land and sea. Sea breeze blew ashore and land winds blew into the sea. In coastal areas the damage to stilt houses is not only caused by the wind but also by the high content of salt in the air which causes corrosion in metal materials. It is better not to use zinc material as a roof cover, but the material is the most affordable by the community and more durable than thatched roofs.

### **6.3. Principles of Design and Application of Elements of Stage Houses related to Climate**

The engineering design response of stilt houses to be responsive to the coastal tropical climate has been very adequate, including maximum shade with minimum heat capacity through wide eaves, wide openings, minimum use of walls. From the geometry of the shape of the building it is also sufficient for wind and light to pass through the room. Heat storage is not really needed in a small daily temperature range, and heavy construction will inhibit maximum air exchange (an important requirement in reducing body heat).

The form of a house that is classified is not solely to avoid the attack of wild animals, but also as a form of attitude to the conditions of the hot tropical nature. A high pit allows residents to get fresh air. In addition, the construction of a house that extends from north to south will prevent residents from direct sun and wind.

The existence of the veranda shows that there are adjustments to the hot coastal climate and the more open social relations of coastal communities. The design of the existing stilt house has been paying attention to and responding to local climate conditions to be able to create thermal comfort in the inner space,



reflected in buildings that are environmentally friendly and local climate by taking into account the aspects of temperature, air humidity, air movement, rainfall and solar radiation.

## 7. Conclusion

Forms of houses that are classified not solely to avoid attacks by wild animals, but also as a form of attitude to hot tropical conditions. A high pit allows residents to get fresh air. In addition, the construction of a house that extends from north to south will prevent residents from direct sun and wind.

The stage construction is very considerate of the local characteristics of *Tripa* Swamp, such as wetlands, high rainfall, intense solar heat, wind blows, and high humidity. This stage house has a wide eaves roof, a large roof corner, and adequate openings.

The principle of staging house design in *Tripa Makmur* is very adaptable to tropical conditions, where this region is a coastal area, it needs optimal wind flow. With the construction of the stage will maximize the area of infiltration of flood water and the flow of wind under the building will make the housing always dry. The principle of ventilation and lighting in the construction of the vernacular stage houses in *Tripa* Swamp is optimal and can be implemented in the construction of community houses that are currently being built.

The existence of the veranda shows that there are adjustments to the hot coastal climate and the more open social relations of coastal communities.

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