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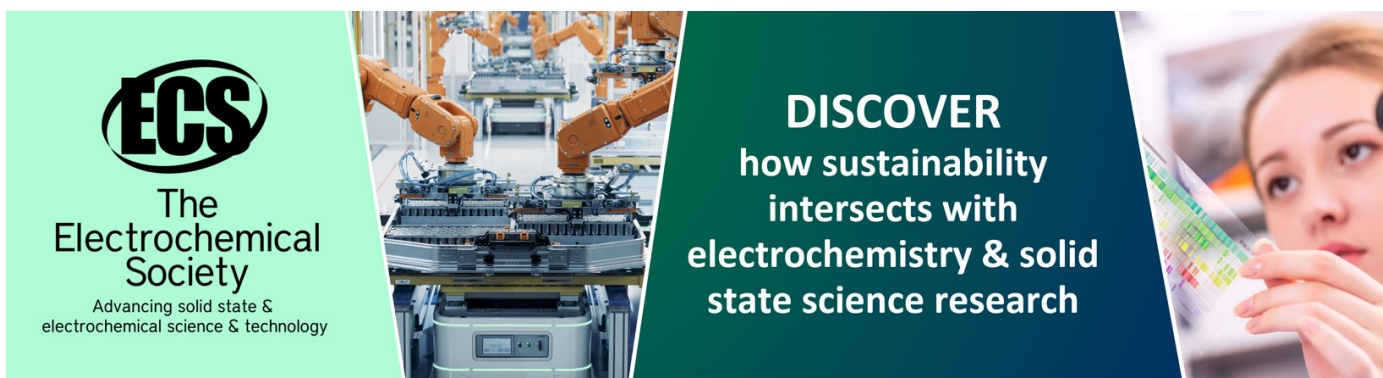
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Transformation of stilt houses: a way to respond to the environment to be sustainable

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Abstract. One type of houses on stilts that are spread on the west coast of the Aceh region is *rumoh santeut* located in the *Teunom* area. This vernacular architecture is a residence that has been tested by climate and natural disasters for hundreds of years, but still stands strong and is still inhabited by the fourth generation today. The *Teunom* settlement environment can represent the characteristics of other settlements on the west coast of Aceh, because it is in the same natural conditions. These settlements often experience flooding due to the overflowing of the *Krueng Teunom* River which is located adjacent to the settlement. This paper discusses the principles and techniques of construction in the construction of houses on stilts, and how the elements of construction respond to environmental problems as sustainable construction through a process of architectural transformation. Data has been analyzed with qualitative descriptive methods to find out the factors that affect transformation, and how transformation occurs. The findings show that the nature and potential of the material affect the structure / construction, building components, and construction methods. The houses on stilts in *Teunom* have been transformed together with changes in the socio-cultural community and changes in the natural environment. The use of cement, brick, and iron has now resulted in changes in the method of construction and appearance of the house. Wooden stilt houses that are transformed can be divided into two types of construction, they are transformed into contemporary houses, and are transformed as new stage houses. How the ancestors took care of their homes, and the fact that these houses still exist, should be an example in modern society.

1. Introduction

Transforming is a method commonly used by vernacular architecture, such as what happened at the stage house in the *Teunom* settlement, the West Coast region of Aceh. Transformation occurs in architectural buildings to adapt to the needs of residents, so that the architecture still exists and is sustainable. Usually buildings are transformed to adjust the shape of construction to the environment in which the architecture is located, or adjust to the social and cultural conditions of the dynamic community. The vernacular homes are inherited from generation to generation, and these houses are no longer the same as the early history of its construction [1]. Houses or dwellings always change from traditional forms to contemporary ones in accordance with the activities and values of residents [2]. If it is unable to adjust to the environment and the needs of its people, then the architecture and



settlements will be destroyed by themselves. The evolution of vernacular homes throughout history has occurred to respond to factors such as geography, climate, expertise and materials [3].

Transformation in architecture is related to the process of changing forms from the initial / basic state to the new state. The process of change can occur on an ongoing basis, both in whole and in part, while not changing the substance or its essence according to the circumstances. This change can also be seen in settlements in the Teunom region, where there are currently several types of stilt houses. The emergence of several types of stilt houses is of course through the transformation process from the basic form of local residential architecture called *rumoh santeut* to adapt to the natural environment and the dynamic needs of the community. *Rumoh santeut* is a type of stilt house in Aceh that has a parallel floor.

The process of transforming the stage house into a contemporary stage house needs to be studied to see whether the development of architecture on the west coast of Aceh is currently still adaptive to its environment, because the area is a settlement adjacent to a large river that often overflows into residential settlements. Even recently more frequent occurrences of flooding have occurred in the region. The west coast of Aceh is a coastal area of peat swamps, so that it has the character as a peat swampland, has a short river flow with heavy currents, there are many estuaries. Natural conditions that tend to runny affect the formation of architecture on the west coast of Aceh [4].

The social and cultural consequences of the dynamic, flood conditions, and reasons for practicality, the *santeut* house in the Teunom region underwent a transformation process so that it tends to be different from the initial construction. The transformation process is a way for the community to maintain the residential architecture so that it can continue to be inhabited to avoid extinction. This architectural transformation study aims to understand how the relationship between house stage and technology is currently interpreted in sustainable development, and finds a direction for transforming the adaptation of the West Coast communities of Aceh in adapting to changes in the living environment and current technology.

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 rise to characteristics and forms of architecture that are contextual to local climate, local material, and living culture [5]. In modern construction vernacular architecture is not sufficiently valued, while the natural environment faces serious challenges in terms of environmental impacts and natural resource management [6]. Though knowledge of building traditional culture is the principles of technology that are built from time to time through an ongoing process.

The transformation of traditional values according to [7] must not reject the latest developments because a meaningful and sustainable traditional values will always live in the present. There are three ways of transformation and their correlation with the stability of meanings: 1) the transformation of traditions and traditional landscapes without changing the code and merely neglecting it with functional adjustments and the context of space and time; 2) transformation that forms a new code through reinterpretation, reinvention or even deconstruction of traditional structures or existing traditional landscapes to produce new meanings of indigenous traditions. The formation of a new code can also be done by attempting to critically dismantle all references from tradition and explore other dimensions of the tradition or layers of other perceptual experiences from traditions that have been neglected; or 3) raise the practice of code which is usually only textual to be militaristic; from representation to experience simulation where. In this context traditional values are not merely read, but are experienced in the present context. In the context of simulation, meaning transformation is an event of reconstitution of traditional values with the aim of creating new traditional habitats in the present that are original and authentic, which still heed traditional values but are free from past logocentrism.

2. Methods

This research uses a descriptive qualitative method to discuss understanding of change that integrates the house on stilts, namely the concept of change with new technological advances and cultural changes. Data collection is done through literature studies, field research with observation, documentation, interviews, and field notes. Field data collected is related to material, type of construction, and construction elements. Data are analyzed and discussed through typological analysis and constant comparative analysis to find out the differences between staged houses in Teunom.

Data analysis techniques are based on the achievement phase of the research objectives, as follows:

1. The understanding of the local community about the potential for disasters in their area is analyzed descriptively through the form of their house;
2. Transformation of stage houses is identified by classifying the forms and types of construction and related to the needs of decent homes from the aspect of safety.

The safety aspect involves the resilience of building construction to the potential for natural disasters that hit the area, such as earthquakes, floods and strong winds. The variables in this study are house shape, floor plans, construction systems, and building materials.

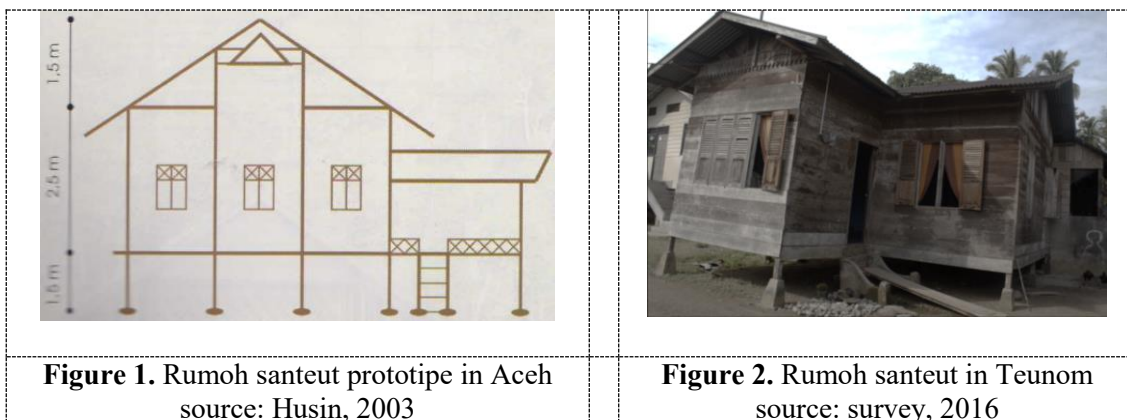
3. Results and Discussion

3.1. Rumoh santeut

The vernacular architecture that developed in the Aceh region was the stilt houses. The type of stilt house known as *rumoh santeut* is a kind of single dwelling house inhabited by a majority of people in Aceh. This stilt house has a parallel stage height. The socio-cultural conditions of the people that differ between the tribes scattered in Aceh, led to the form of a household construction that was somewhat different between the regions.

According to [8] *rumoh santeut* in Aceh has a floor height of about 1.5 meters from the ground with a four-faceted pillar 12x12 cm. The poles are placed on flat stone in the form of a circle as a foundation. Using woven sago palm leaves as a roofing material. Wood and bamboo are the main ingredients of the house, resulting in light construction in this area. The house can be easily dismantled and relocated or reinstalled if necessary, because it uses a traditional connection system for mortise and tenon reinforced by wedges or pegs. It has a front platform that functions as a front porch where guests receive. In the decade of the 1940s and 1950s this house was very favored by young families and oriented to practicality. These types of houses are in Pidie, North Aceh, and the Tamiang area of East Aceh, which is the east coast of Aceh.

While *rumoh santeut* is in the *Teunom* region, West Coast of Aceh, the height of the floor is between 0.5 to 0.8 meters above ground level. However, in terms of form and material there is no significant difference from the house on the east coast of Aceh.



Geographical factors in the form of unstable peat swamps result in the construction of stilt houses with lower floors than stilt houses on the east coast with more stable land geography. The stilt house

on the west coast has a stage height of 0.5 to 0.8 meters above ground level. Soft soil conditions due to part of peat swamps, flooding due to overflow of rivers, and in the dry season the conditions remain wet. Lower stage heights proved to be more able to adapt to the swing of the earthquake that often hit Aceh compared to the higher stage. Lower stage heights produce lighter loads compared to higher poles. Such construction is better able to adapt to the geographic peat swamps with soft and labile soil conditions.

The formation of a stilt house was also influenced by the acculturation of Aceh and Minang cultures, the majority of which lived in West coastal settlements. Immigration from Minang along the West Coast of Sumatra has occurred since the battle of the troops, one of which settled in the Teunom region.

The stilt house known as the *santeut house* has a contextual design principle with its environment, among others, built using local materials and simple construction. The vernacular house proved to be more resistant to natural disasters such as earthquakes, floods, and strong winds, compared to houses built on the ground.

3.2. *Rumoh santeut transformation*

There are two types of stilt house characteristics in the Teunom region, namely: 1) *rumoh santeut* or a flat house with a stage height of about 0.5 meters to 0.8 meters above ground level. This house still uses wood material on the entire body of the building. It is more than 100 years old, but there is some concrete material in the legs replacing wood since 20 years ago. According to the community the water level in the settlements in the event of a flood does not reach the height of the house stage. But lately floods have entered the house. This stage house can be classified into the category of contemporary *rumoh santeut*; 2) Stilt houses which partially use factory materials and some wood materials. Built after the tsunami with a stage height of 1.70 meters above ground level. The toilet is placed on a stage with a conventional piping system to the bottom of the stage where it is placed septic tank and infiltration. Stage height based on current flood conditions. In this utility element planted with flowers or fruits for aesthetics. This stage house is classified into the category of new production houses.

3.2.1. Contemporary *rumoh santeut*. The transformation can be seen on a pole which was previously wood and placed on a flat round stone, now supported by a pedestal foundation. The foundation of *umpak* replaces flat stones after circulating cement material on the market. By using an *umpak* foundation, the position of the wooden pillar can be farther away from the ground. The community's understanding of the use of stone pedestal foundations in earthquake-prone areas is a local wisdom that is still adhered to, namely separating the structure of a house with a foundation. Separation of the structure of a house building with a foundation becomes a very important and fundamental factor so that the vibrations that occur on the ground due to swaying soil only cause effects that are not too large on the structure of the house.

Traditional house plans that tend to be simple and symmetrical or relatively balanced in earthquake-prone areas indicate that they understand if buildings require elasticity or flexibility which can reduce the effects of damage caused by earthquakes. The building is relatively symmetrical and light and with a very adaptive clamping, tapping, tapping and tensile technique in earthquake prone areas. This local wisdom is also still adhered to by local communities.

Another change is that the roof from thatch leaves has been replaced by zinc material, already using nails to strengthen the construction of walls and poles. Cement and brick materials have also been used to build kitchen spaces with non-stage construction. How to construct a combination of traditional and conventional methods.

	
Figure 3. wooden poles have been replaced with a combination of wood and concrete slabs, source: survey, 2016	Figure 4. nails strengthen the connection of poles and beams source: survey, 2016
	
Figure 5. Zinc material replaces thatch leaves for roof coverings source: survey, 2016	Figure 6. Kitchen room with non-stage construction source: survey, 2016

The events of the vernacular house transformation above do not give rise to meaning and without raising a new cultural code. Transformation is basically just a functional-aesthetic modification of design - formal adaptation for certain use purposes. The design process produces representations that are not much different from the original form. The forms that occur are more of a formal-spatial-construction manipulation. The transformation of this form of construction is still adaptable and relevant to its environment.

3.2.2. New production stilt house. This stage house was built after the tsunami from concrete materials for the construction of buildings, bricks and boards for walls, and zinc material for roof construction. Because it uses factory materials, the method of construction is done using conventional methods. The bathroom and toilet are inside the house to make it easier for residents to clean themselves if the settlement is in a flood condition. While septic tank is built higher than the groundwater level to avoid contamination of ground water. Construction of poles with reinforced concrete material with wells or river stones does not affect the height of the stage, because the foundation must be placed on hard ground.

	
Figure 7. New stilt house Souce: survey, 2016	Figure 8. Piping system Source: survey



Figure 9. stilt floor from cement
Souce: survey, 2016



Figure 10. Stilt construction
Source: survey, 2016

Concrete pillars with conventional methods are connected with wooden stairs using bolts and nails.

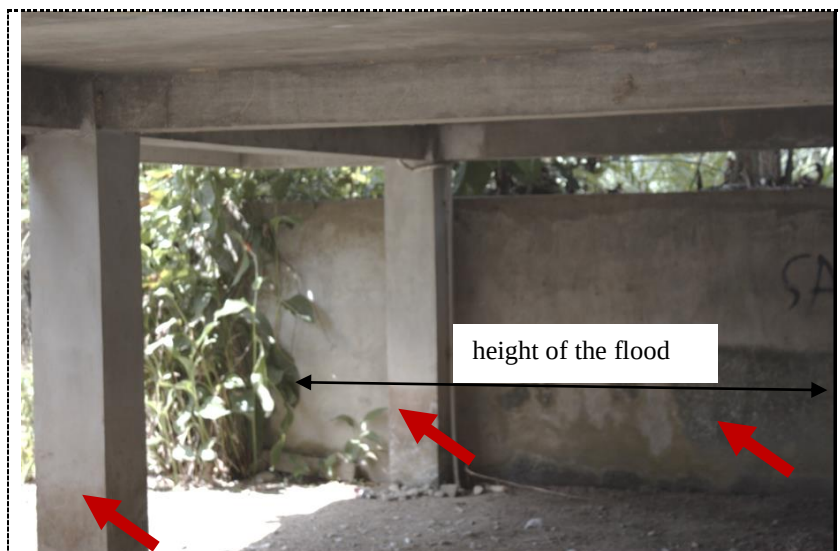


Figure 11. The appearance of flood water on the pole or seepage of ground water
Source: survey and analisis

The design of the new stage house consists of: 1). The lower part is a foundation and pillar / column, so that the lower area can still hold water and pass water; 2). The middle part is the main house which consists of a family / guest room, a bedroom, and a kitchen; and 3). The roof that serves as a protective building from heat and rain. On the stilt house with conventional methods shows the Vernacular tradition has joined the modern tradition to create a new hybrid form.

The construction of a stilt house in *Teunom* is still maintained due to its harmony with the surrounding environment. The stage floor is 0.5 meters from the ground in a contemporary vernacular house. While the distance of the construction of the stage from the ground in a modern house 1.7 meters. This stage height transformation to anticipate water levels in settlements is increasing in the event of a flood, due to the existence of part of the development that depletes the land. The lower part of the stage house can still absorb or pass water, and is in harmony with the hydrological function. This section can also be used to increase air refreshment naturally, because fresh air can move under the floor and reach all spaces. Under this new stilt house can also be used to maintain and cultivate various plants that are beneficial for health or beauty and produce economy and conservation.

4. Conclusion

The stilt house on the west coast of Aceh is still considered to contain local wisdom because of its adaptation to climate conditions and coastal disasters. The form of the stilt house so far still meets the aspects of safety, security, comfort and health. Along with the development of urban areas, demanding needs and limited financial capabilities, homeowners in the west coast of Aceh were able to maintain a form of construction that could reduce the impact of disasters on the safety of residents through their stilt houses.

Geographical and climate constraints are two important considerations in the construction of stilt house construction in the West Coast of Aceh. The stage house is very easy to adapt to climate conditions and coastal disasters.

Water catchment areas are a necessity in flood-affected settlements such as the Teunom region. So the stilt construction building is the local wisdom of the adaptation of the community to the natural environment, so that Teunom settlements remain sustainable.

Presenting a vernacular house does not need to be done by bringing back material objects from the santeut in accordance with the original, but through the process of change by interpreting the space and forms of local architecture that occur today.

5. Acknowledgments

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