

# THE CHARACTERISTICS OF THE SELF-SUPPORT STILT-HOUSES TOWARDS THE DISASTER POTENTIALITY AT THE CAMBAYA COASTAL AREA, MAKASSAR

**Isfa Sastrawati**

Architecture Department, Faculty of Engineering,  
University of Hasanudin, Makassar, INDONESIA  
Email: iysfa@yahoo.com

## ABSTRACT

Self-support stilt-houses at the coastal area have environment characteristics that are different from inland houses, and they have the disaster potentiality such as hurricanes, tidal waves, abrasion, earthquakes, and even tsunami. The stilt houses are very adaptable to climatic conditions and coastal disasters. The shape of the stilt houses at the coastal area must comply with aspects of safety, security, comfort, and health. This paper examines the characteristics of the stilt houses at the coastal area of Cambaya, Makassar, especially in terms of safety and security aspects. The aspects of safety and security include the resistance of the building construction towards disasters. Along with the development of the urban area, the demanding needs and limited financial-abilities, the owners of the houses at the Cambaya coastal area develop their houses by utilizing the empty space at the coastal area and the space under floor of the stilt house. The change of the building shape gives an effect on the poor quality of the building, building safety, and security. However, there are several stilt houses at Cambaya which could reduce the impacts of disasters on the safety of the residents through their local wisdom.

**Keywords:** Stilt houses, coastal area, disasters.

## INTRODUCTION

The urban development causes of land use change at the coastal area which is generally in the urban fringe. It drives the development of the settlement quickly and gives impacts on the disaster threats towards the existing buildings at that area. This study will give descriptions on the characteristics of the stilt houses at Cambaya coastal area in the south of Sulawesi which are built by working together. Generally, the stilt houses are built without fulfilling the criteria of proper houses. Proper houses are the type of houses which have function to fulfill the physical and spiritual needs of the residents, to protect them from the various natural-environment influences which could cause them to feel unhealthy and unsafe due to the natural disasters or the theft and robbery (Frick 2007). The regulation from the Minister of Public Housing No 8 in 2007 on *Pedoman Pembangunan Perumahan Swadaya* (The Guidelines on the Development of the Self-Support Housing) state that proper house are the house buildings which at least fulfill the requirements of the building safety, the sufficiency of the minimum size of the space, and the resident health. The building safety is seen from the strength of the foundations which are able to support the house and shelter the residents from the natural influences. The sufficiency of the minimum size of the space deals with the fulfillment of the

standard of the minimum size of the space for the residents' movement inside the house. The resident health is needed in order that the health of the residents is guaranteed from the natural influences.

That is why; the stilt houses at the coastal area should also consider aspects such as safety, security, health, and comfort. The aspects of safety and security can be seen in the resistance of the building construction toward the natural disasters such as earthquakes, hurricane, tidal waves, abrasion, and tsunami. The aspects of comfort and health are indicated by the air flow, the lighting, and the humidity inside the house. Furthermore, the stilt houses should also give secure feeling from the possibility of crimes and provide easiness for the residents to get the evacuation paths. This study examines the characteristics of the stilt houses at Cambaya coastal area in Makassar, specifically in safety and security aspect.

## STATEMENT OF THE PROBLEM

The stilt houses at the coastal area have various specification because their environment characteristics are different from the inland houses and have the disaster potentiality. The followings are the research problems which are formulated in question sentences:

1. How is the understanding of the society on the disaster potentiality at the coastal area?

2. How are the shapes of the development of the self-support stilt-houses at the coastal area in Cambaya as seen from the disaster potentiality at the coastal area?

**HYPOTHESIS**

Traditional houses which are generally built by the use of local materials and simple constructions are more resistant towards the natural disasters such as earthquakes, hurricane, tidal waves, abrasion, and tsunami. It proves that traditional houses which have been inherited have the characteristics of being adaptable to the natural environment. The previous research on the housing development at the coastal area in South Sulawesi which was done by Wunas (2007) provides the result that the physical characteristics of the houses at the coastal area generally maintains the shape, the structure and construction system, and materials of the traditional houses. In general, the owners of the stilt houses develop their houses by building rooms under floor permanently as the additional room for the household business. The result of this previous research strengthens the hypothesis that by developing and doing changes to the traditional houses such as building rooms in the under floor permanently will cause the houses have disaster risk.

**RESEARCH METHODS**

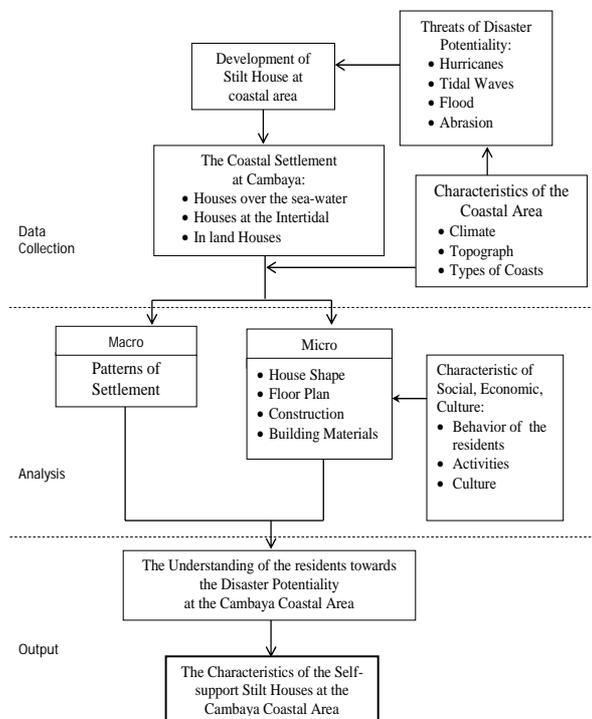
This research aims to identify the society understanding towards the disaster potentiality and the characteristics of the self-support stilt-houses which are related to the disaster potentiality at the coastal area. The research was done to classify and compare the stilt houses at the Cambaya coastal area, Ujung Tanah district, Makassar city. The research was done to the stilt houses at the Cambaya coastal area by choosing the samples based on the purposive sampling technique, that is, by the following criteria:

1. Suitable to the coastal zone, that is, on the space over the water, in the intertidal zone and inland.
2. Suitable to the house development, that is, consist of the stilt houses that are not developed yet and stilt house which have been developed or have additional permanent rooms in under floor.

The data collection was done by library research, field research by observation, documentation, interviews, questionnaire, and field note. The technique of the data analysis is based on the phases of the achievement of the research goals as in the followings:

1. The society understanding towards the disaster potentiality at the coastal area is analyzed descriptively by relating characteristic of socio cultural and economic, with their shape houses.
2. The development shape of the self-support stilt-houses is identified by classify the shapes and types of the development and is related to requirement of proper house especially in safety aspect. The safety aspect involves the resistance of the building construction towards the natural disasters such as earthquakes, hurricane, tidal waves, abrasion, and tsunami.

The variables in this research are settlement patterns, shapes of the houses, floor plan, construction systems, and building materials.



**Figure 1.** The Framework of the Research

**REVIEW OF RELATED LITERATURE: THE INFLUENCE OF THE COAST CLIMATE TOWARDS THE SILT HOUSES AT THE COASTAL AREA**

Geographically, Indonesia is an archipelagic state, a country consisting of many islands. It locates on the junction of four tectonic plates, that is, the plate of Asia continent, the plate of Australia continent, the plate of Indian Ocean, and the plate of Pacific Ocean. In the south and east of Indonesia there is a volcanic belt lengthening from Sumatra-Java-Nusa Tenggara to Sulawesi with 120 active volcanoes which can be

erupted any time. Indonesia also locates in the path of distribution of biodiversity and has various ecosystems such as mountains, forests, grasslands, wetlands, mangroves, coral reefs, deep-sea water, coastal areas (KLH 2007). These make Indonesia as one of the rich countries with its natural resources and biodiversity. However, Indonesia is also proper disaster country. In 2007 many disasters happened to Indonesia such as flood, land slide, hurricane, earthquakes, tidal waves, abrasion, eruption, and tsunami (KLH 2007). These disasters caused great effects on the society, that is, they are displaced and injured, suffered losses of material even death.

Building houses is a cultural phenomenon; so, the shape of the houses and the organization of the building are influenced much by the cultural aspects. The difference of the shape of the house depends on the society responses towards the physical, social, cultural, economic aspects (Rapoport 1969). The characteristics of the coastal area (formed by various factors of natural environment, built environment, and socio-demographic condition) have territorial vulnerability towards disasters and territorial resistance in facing disasters (Papathoma 2003).

The average temperature depends much on the height of the place over the sea level so that the closer to the sea level, the higher the average temperature. The high-heat of the air temperature at noon is caused by the accumulation of the high air-temperature with the sun radiation so that the protection towards the sun heat on the buildings is determined much by the building orientation, the roof shapes, the roof slopes, and the overhangs width. The good air-circulation under floor, the body and the roof of the stilt houses can reduce the heat that occurs in micro-climate.

The coastal area has high rainfall which is accompanied by strong wind which causes sea level rise. Based on that condition, the stilt houses need to have roof slopes which can flow the rain water without permeating into the building and can anticipate the blowing wind which can break the roof, the wall, the building structure. The sea level rise cause flooding in coastal area which can damage the foundation and the body of the house.

The characteristics of the wind at the coastal area are very specific, that is, containing salt and blowing very strong. The coastal wind happens due to the difference of the temperature and the air pressure between the land and the sea. The sea wind blows to the land and the land wind blows to the sea. At the coastal area the damage of the stilt houses is caused not only by the blowing of wind but also by the height of the salt content in the air which causes corrosion in the metal materials.

## ANALYSIS

### The Coastal-Society Understanding towards the Disaster Potentiality

The coastal area in Makassar develops very fast with the high density, including at Cambaya coastal area. The stilt houses at Cambaya are classified based on the place, that is, over the sea-water, at the intertidal zone, and inland. The duration of the society's staying at Cambaya is various: some are less than ten years, some are more than ten years, even there are people staying there over than 20 years. Their reasons to build their stilt houses at the coastal area are also various, among others: being close to the sea so that it is easy for them to do their jobs as fishermen and fish dryers; not having land to stay so that they stay at the coastal area in their stilt houses; having been staying long time so that they stay there because of the inheritance.

The types of jobs of the society at the Cambaya coastal area is heterogeneous, that is, fishermen, workers, *becak* drivers, employees, and civil servants. Instead of these main jobs, they also have side jobs such as selling daily needs and food by opening small stores under floor, and drying fish around their house.

The stilt houses at the intertidal zone and over the sea-water at Cambaya are occupied at average by four to six members of family; while the inland houses are occupied at average by three people. Based on the level of education, the head of the family (the father) and mother have finished their education at the level of the elementary school only; it happens in the entire zone. The income of the head of the family at the Cambaya coastal area is categorized as low income because the majority (76.7%) has income less than one million rupiahs per month. With this very low income, the society at the coastal area, generally, cannot renovate their houses periodically and they just build stilt houses even though they live inland. They develop their houses based on the priority of urgent needs, such as patching the roof or the broken wall due to the strong blowing-wind and tidal waves. The low education level of the society also causes them to renovate their houses without considering the disasters risk. Their basic needs become the stronger reason than the consideration of the disasters risk. It is proved by many people renovating their houses in a way to build a new room under floor, although build it with low quality. This new room is functioned for the household-base businesses, such as a small store, a small place to sell food and drink, a place to keep and dry fish. The room under floor is built permanently without considering disaster risk such as tidal waves, flood, and earthquakes.

## **The Characteristics of Settlement Patterns and the Physical Appearance of the Houses at the Cambaya Coastal Area**

The patterns of the coastal settlement have their own characteristics. It is concordance with the process of the beginning formation of the coastal community, coast line, topography, accessibility, and local culture. Actually, the Cambaya does not have beach because people build their house not only inland, but also over the sea-water. The houses over the sea-water are very vulnerable towards the natural disasters (tidal waves and strong wind or hurricanes). In Cambaya Coastal area, the shape of the houses is stilt houses and the settlement have irregular patterns. The irregularity pattern is caused by the development of the houses which tends to build the empty space or unused space. The orientation and the distance of the buildings are not considered again to build comfortable houses.

There are three types of characteristics of stilt house at Cambaya coastal area, those are: 1) stilt house which hasn't been built its under floor; 2) stilt house which has been partially built its under floor; 3) stilt house which has built permanently all space under floor. The first characteristic type located over the water and at the intertidal zone, the second characteristic type located at the intertidal zone and inland, and the third characteristic type located only inland.

The density of the building is very high. The built space is about 80%. The distance of the empty space among the houses is 0.5-2 meters only; that is why, some roofs are interconnected. The building density, the irregular settlement pattern, and application of low quality of building materials give an impression Cambaya coastal area is looked slums.

The houses over the sea-water have risk of the low resistance of the building materials and the high level of the building damage because of the salty air, the high precipitation, the tidal waves, hurricanes, and so on. However, the existence of the breakwater as a bay for big fishing vessels in the north side makes sea water flows is reduced.

The orientation of the building is influenced by the direction of wind. The houses located in the first line from the sea should lessen the window towards the coming of the strong wind. Vegetation need to reduce the pressure of the wind. The shape of the building influences the strength of the wind pressure. The higher the buildings are, the stronger the wind pressure is. The width side of the buildings should be perpendicular towards the wind direction in order to lessen the most extended area of the buildings; and because of that, it can also lessen the strength of the

wind pressure coming from the sea. At Cambaya the stilt houses over the sea-water have orientation to the sea and to the foot path; while the stilt houses at the intertidal zone and inland have orientation to the foot path in order to assess the pathway. However, there are also houses that have not orientation to the pathway because their priority is just occupying the limited spaces.

## **The Characteristics of the Stilt Houses in Terms of Disaster Potentiality at Cambaya Coastal Area**

### The House Shape

The stilt houses at Cambaya coastal area have gable roof with the 30 degree slope. This condition gives the effect of compression force greater than the lift, so the houses tend to be more resistant to wind flow. The gable roof also makes a good run off and wind flow. However, on the front and back roof that has a vertical field, accept the wind directly. The perpendicular side extends the surface for the wind flow-resistance so that it is vulnerable to damage. Generally, the roof of stilt house at Cambaya have a wide roof-patio with 15 degree slope in front and back roof. That roof is easy blown by the strong wind.

Stilt house with under floor can flow the air and when there are tidal waves, residents do not greater losses. But many people at intertidal zone and inland ads room under floor to meet the needs of household business and needs extra room for family members that are increased. Development stilt house vertically by adding room under floor permanently can bring greater damage if there is high winds, tidal waves and earthquakes. This is because the structure no longer flexible if there are earthquakes, closed-wall under floor closed circulation causing tidal waves and wind currents.

As a whole, the shape of the stilt houses is very adaptive to the coast-climate condition and the disaster that might happen; but demand of but with the demanding needs of residents and the limited ability to develop home, so that homeowners of stilt house tend to build under floor to get the ease of developing their home. Changes in shape and the addition of the room have a bad impact on the security and safety of buildings.

### Floor Plan

The floor plan of stilt house at Cambaya is rectangle, tends symmetrical and compact, has good structural stability, especially toward the earthquake because it resists towards a displacement force.

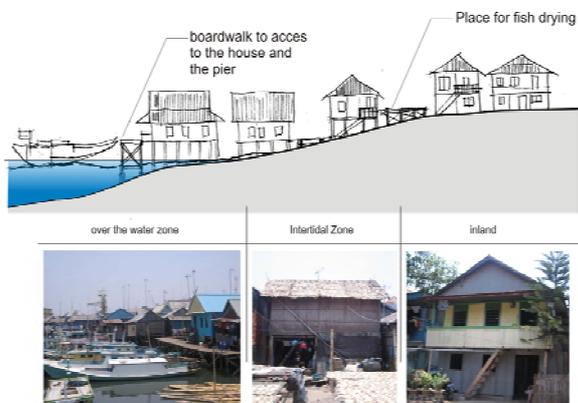
Cambaya coastal stilt houses in compliance with a stable shape, however, the development of the room without partition (over the sea-water) or the the room which have partition but non-continual wall (at the intertidal zone) leads the instability. The building damage easily happens to the weakest wall, for example, the wall between the windows, ventilation, and doors. The wide openness of these can lessen the strength of the wall.

Construction

The type of the construction of the stilt house at Cambaya tends to be unable to hold the blowing of the hurricanes because of the light of materials and construction and the simple joint. Construction of roof which has a fairly wide span without a support beam between the roof truss, and the dimensions of the roof truss are not balanced with the wide, will cause deflection.



**Figure 2.** The settlement Pattern at Cambaya Coastal Area, Makassar



**Figure 3.** The Illustration of Settlement Characteristics of Cambaya Coastal Area, Makassar

On the wall construction, the high air-pressure occurs on the wall surface directly towards the wind direction. The stilt houses at the Cambaya coastal area have flat outside-wall surface without profiles so that the wind blows the wall and then to the side of the building and it does not give circulation effects which can lift up the building elements.

The stilt houses have the floor construction which does not connect the land directly inland so that they tend to have humidity due to the water and sea air. However, at the intertidal zone and over the sea-water, the air humidity is so high that it can fastens the process of the damage of the woods.

Generally, the stilt house use *umpak* foundation. With this *umpak*, the construction has stabilized structure, because the column structure only join upper the foundation. There is different with concrete foundation, if there is vibration, this building wiggle follows the earth gravitation. When earthquake comes, this building remains to be stable because can following the movement direction of earth gravitation, hence cannot make a broken column structure. Stilt houses over the water use *umpak* foundation and bamboo pole that is attached to the seabed to strengthen the building structure. The distance between the pole foundation average 2-3 meters, with wooden poles 15/15 and 20/20.

The stilt houses over the sea-water also have unique characteristics. These houses are very close each other; that is why, they bond each other to the boardwalk so that the construction of the buildings looks like a raft (bonding each other). This condition leads the stilt houses over the water to be stable. Hurricanes and the tidal waves cause the houses to move together and they are strong and compact. This kind of characteristics also creates closer relationship among the people; and, the social interaction among them becomes very close, too.

Basically, the construction of the stilt houses depends much on the construction load and the numbers of the poles to avoid the foundation displacement. However, the use of the light and simple materials in the construction does not support the solid and stability of the building structure. One of the main constructions that make the poles and the stilt houses at Cambaya coastal area rigid is *Pattolo*, that is, beam fastener under the floor and on top of pole.

The stilt houses at the intertidal zone and inland have been changed from their original shape. The place under floor is developed permanently, but the construction isn't built precisely. The brick walls are built without bonding the foundation, poles, and floor beams. They are built in order to function as the room

cover without considering the strength of the construction. That is why, these houses are not resistant to the earthquake, and they cause the damage force to become bigger when there are natural disasters (hurricanes, tidal waves, and earthquakes).

### Building Materials

Generally, the materials for the stilt houses at the coastal area are wooden materials because of the easiness to do the construction, the cheapness, the durability, and the resistance towards the onshore climate-condition. The woods are used to be the main construction of the building such as poles, floors, roofs, and walls. In the stilt houses over the water and at the intertidal zone, the second-quality woods are used as pole by considering that these woods can be used to the heavy construction, while the third-quality woods are generally used for the floors and the walls. From the point of view of the influence of the hurricanes, the characteristics of the woods which are relatively strong to press and pull are able to hold the lateral and pressing forces depend on wood dimension. At the coastal area, wooden materials are not strong enough to hold humidity and marine fungi which can damage the wood structure. Also, the coastal temperature tending to be extreme influences the expansion-and-depletion of the wood so that it lessens the strength of the construction.

Instead of the woods, bamboos are also used as the complement for the main construction on the foundation pole, the roof frames, the floors, and the walls. The bamboo materials are generally used at the wet area such as in the kitchen, the washing place, the bathroom because they have resistance to water. Bamboos are also relatively able to resist the lateral force (with the balance length and dimension). As the wooden materials, bamboos are also vulnerable toward insects and the so forth, which can break the inside of the bamboos. Zinc materials are also used as the roofs and walls; however, the characteristic of zinc which is easily corrosive becomes the main problem in the houses at the coastal area. Zinc materials are vulnerable to corrosion, especially in the salty coast-air.

Being viewed from the types of materials used in the buildings, the condition of the stilt houses at the three segments of location is vulnerable to damage because of the influence of the coastal climate which is aggressive and damaging, especially when there are tidal waves and hurricanes which can endanger the safety and the security of the buildings and the residents.

## CONCLUSION

The coastal climate becomes very extreme with the possibility of the natural disaster such as hurricanes, tidal waves, flood, abrasion, and earthquakes. This gives effects on the characteristics of the settlement at the coastal area. The traditional houses which were inherited from their ancestors are adaptive to the natural environment including the condition of the coastal climate and the natural disasters which might happen. The most adaptive houses are the houses which have pure typology appearing from the local wisdom or traditional typology which means no changes and no addition to the main buildings. However, the demanding needs and limited financial-abilities, the owners of the houses at the Cambaya coastal area develop their houses by built the space under floor of the stilt house in terms of easiness construction. The changes of the shape give effects on the low of quality, security and safety of the building.

The stilt houses at the coastal area need strong and solid constructions and adaptive shapes towards the coastal climate and disaster-potentiality. Based on the research, there are some findings which are evaluated as the adaptations to the characteristics of Cambaya coastal area among others are as follows:

- The use of the gable roof like which has resistance toward the blowing of wind enables run off for the rain on the slope side.
- The shape of the stilt house and the use of *umpak* foundation give a shaking impact on the structure of the building when there is an earthquake. This building wiggle follows the earth gravitation. That is why; the characteristic of this house is flexible. The *umpak* foundation is used to avoid the wood poles connect directly to the land which can cause humidity due to the water.
- The room over floor which is not developed permanently or which is empty without walls, can reduce the damage impact of the natural disasters (tidal waves and flood) due to the close of the circulation of the tidal waves.
- The basic floor plan of the stilt house which is a symmetric rectangular and has a continuous wall-separation make the structure more stable.
- The poles and the body of the stilt house are bond tightly by the construction of *Pattolo* connection which functions to join one pole and another pole. The stilt houses over the sea-water bond each other and also connect to the pathway as a raft so that the houses are still compact even though there are natural disasters (tidal waves and hurricanes).

This kind of characteristics also creates closer relationship among the people and social interaction among them becomes very close too.

#### REFERENCE

- Diposaptono, S. et al. (2008) *Hidup Akrab dengan Gempa dan Tsunami*. Populer. Bogor.
- Frick, H., Tri Hesti, M. (2006) *Pedoman Bangunan Tahan Gempa, Seri Pengetahuan Lingkungan-Manusia-Bangunan 4*. Kanisius. Yogyakarta.
- Kementerian Lingkungan Hidup (2007) *Status Lingkungan Hidup Indonesia*.
- Lippsmeier, G. (1994) *Bangunan Tropis*. Erlamngga. Jakarta.
- Papathoma, M., Dominey Howes, D. (2003) Tsunami vulnerability assessment and its implications for coastal hazard analysis and disaster management planning, Gulf of Corinth, Greece. *Natural Hazards and Earth System Science*, **3**, 733-744.
- Penghijauan Kota dan Kota Ekologis, serta Energi Terbarukan. Kanisius. Yogyakarta.
- Peraturan Menteri Negara Perumahan Rakyat No. 8/Permen/M/2007 tentang Pedoman Pembangunan Perumahan Swadaya.
- Rapoport, A. (1969) *House, form and culture*. Prentice Hall. Inc. London.
- Wunas, S. et al. (2007) Pengembangan Perumahan Swadaya di Wilayah Pesisir Sulsel. Kerjasama Lab. Perumahan Permukiman UNHAS dan KEMENPERA, Bidang Perumahan Swadaya.
- \_\_\_\_\_ (2006) *Arsitektur Ekologis: Konsep Arsitektur Ekologis di Iklim Tropis*.