HOUSING ADJUSTMENT AS ADAPTATION STRATEGY FOR THE FUTURE IN FLOOD PRONE SETTLEMENT

Case Study : Muara Angke Settlement, North Jakarta

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Abstract

Flood has become a threat in the northern part of Jakarta due to sea level rise, land subsidence, and extreme rainfall as impacts of climate changes. Muara Angke is a delta in North Jakarta surrounded by Java Sea in the north, Asin River in the east, and Adem River in the west, so that several times of flooding inundate this settlement. To overcome flooding, communities have been doing housing adjustment as adaptation strategy in order to remain living in this settlement. Housing adjustment has been a phenomenon recently to avoid flooding. The objective of this research is to identify techniques and designs of housing adjustment as adaptation strategy in flood prone settlement. This research was conducted with quantitative and qualitative methods to collect data from thirty five purposive respondents through observations and interviews. The results of this research shows that housing adjustment includes elevating the floor from the road, raise the ceiling, two-storey house, replace the floor and roof material. This adjustment has been contributing to avoid flood, and still allowing occupants to do their activities while flooding.

Keywords: Adaptation, flood, future, housing adjustment,

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1. The Threatening Flooding in Northern Jakarta

The coastal flooding became a big problem in the northern coast of Java Island, such as Jakarta, in the last two decades. It occurs due to several factors, such as: tidal waves, global sea level rise, storm surges, land subsidence, higher rainfall or water runoff from hinterland, and sediment deposition (silting) on the river bed and estuaries. Land subsidence in the period of December 1997 to September 2007 approximately was ranging from 1 to 15 cm/year in Jakarta (Abidin, et al., 2009). The greatest land subsidence can be found in Penjaringan, Tanjung Priok, and Cakung (Bimantara, 2012). Meanwhile, the sea level rise in the northen coast of Java average was 1.45cm/year during the years of 2005 to 2011 (Hadi, et al., 2012).

Muara Angke is a delta in North Jakarta where surrounded by Asin River in the east, Adem River in the west, and Jakarta Bay in the north. This delta had also several event of floods which be caused by land subsidence, heavy rain, spring tides, sea level rise, siltation of rivers and dike destroyed. The last major flood occurred in 1996, 1999, 2002, 2007, and 2013 (based on interviews with respondents). Due to current floods, the government has made a protection of settlements in the northen coastal of Jakarta, especially in Muara Angke, by building polder system. The government has provided levees, reservoirs, and pumps, in addition to having elevated the main roads in the settlements (Anita and Harun, 2013)

Impact of the coastal flooding insists the communities to adaptive the hazards by adjusting their houses to avoid the flood, so that they can stay at home during the flood. This paper will describe result of a short study on the fishermen's houses that have been adjusted such as elevating house, expansion of house, using materials easily to be dismantled, and change facade as desired and according to their economic ability. Findings of this research will contribute to the knowledge on housing adjustment, as adaptation strategy for the future in flood prone settlement.

The following are the study objectives :
a) to identify how to elevate the house; b) to identify ways of expanding houses; c) to identify the material used.

The selected study area is complex of the houses built early in Muara Angke. The houses were planned by Jakarta local government for fishermen or people who work in the field of fisheries in North Jakarta. Block K and Bermis were chosen for this study (see Fig.1) because there has been no research on housing adjustment in this area. Furthermore, these blocks will be retained as landed housing in Muara Angke Master Plan, while the surrounding slums will be converted

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into flat housings.

These data were collected through observation, measurement, and depth interview with 35 purposive respondents (15 respondents in Block K and 20 respondents in Block Bermis) selected based on the criteria that they have lived more than 10 years and have been flooded several times, including the great flood of 2007, and their houses have been renovated at least within the last 2 years.

2. Housing Adjustment as Adaptation Strategy

Floodwater having the potential to cause damage to the structure of a building, it can also significantly impact the lives of the residents. Fast flowing water or weakened structures could cause injury or even death. Physical health may suffer if floodwater is contaminated. Flood events in neighborhoods can lead to stress in humans. People will strive to maintain the standard they have, trying to cope with the pressure or threats in the surrounding environment, so that they can change the environment to adjust with their wishes, in order to maintain comfort (Bell, 1990 in Iskandar, 2012).

If the residents feel there is a gap between the actual condition of the house and a decent house in his opinion, they feel dissatisfied being at home and will renovate their houses, which is called housing adjustment (Crull, et al.,1991). But housing adjustment has several constraints include family's ability to solve problems, limited income, skills, knowledge, and discrimination (Morris and Winter, 1986 in Crull, et al., 1991).

Meanwhile, adaptation refers to changes that take place in individuals or groups in response to environmental demands. The Oxford Dictionary of Science defines adaptation as any change in the structure or functioning of an organism that makes it better suited to its environment. Adaptation strategies are more proactive in a sense as they are put into place to avoid turning natural hazards into disasters. If you know an area is prone to flooding, adaptation strategies would involve moving the population from those areas, or building dykes to prevent flooding, or ensuring houses in the area are able to withstand flood water (IRIN, 2013).

Therefore, resident's efforts to improve their houses such as elevating house, extend house, replacing the material is the act of housing adjustment, and it is adaptation strategies undertaken by the residents, so that they can stay comfortably in Muara Angke, although the area is prone to flooding .

3. Muara Angke Settlement

Muara Angke is a delta in North Jakarta surrounded by Java Sea in the north, Asin River in the east, and Adem River in the west. Geomorphology of the beaches is soft so that low soil bearing capacity and seawater intrusion process become high. Therefore, several times flooding inundates this settlement. Protection against flooding has been constructed by government through a polder system, consisting of levee, two reservoirs, and several pumps.

Muara Angke area was marshes and mangrove forests until the 1970s. Muara Angke was built on July

Fig. 1 . Muara Angke Settlement
(Source: UPT PPKP and PPI Muara Angke, 2011)

7,1977 by government of DKI Jakarta to accommodate the fisheries located in North Jakarta. This fishermen settlement was planned to be inhabited by owners of fishing boats, crews, fishing workers, salted fish laborers, and fish traders. Various facilities have been built such as market, terminal, schools, mosques, community health center, and fishing industries. The housing area is 21,16 hectares, while total land area of Muara Angke is 67 ha (UPT PPKP and PPI Muara Angke, 2011). There are some blocks of housing built by the government for fishermen in Muara Angke, such as Block H, L, K, and Bermis (Fig.1).

Previous research about housing adjustment in Muara Angke (Anita, J. and Harun,I.B., 2013), study location was Block H and L because these blocks were built earlier in Muara Angke about 1977. The size of houses that was originally 40m^2 had been increased to 100-170 m^2. Building coverage ratio that was initially 53% had been increased to 100%. All the rooms had been expanded (living, family, dining and kitchen) due to the increase of family members and the need to improve the comfort and safety against flooding. There are 40 houses of 319 houses (12.2%) in Block H and L with raising floor elevation more than 80 cm above the road to avoid flooding. According to 13 purposive respondents, the height of ceiling in ground floor is approximately 3,5 to 4,5 m (11 houses) because the respondents are confident that they will raise the floor again in the future. They used wood material for second floor (10 houses) because the cost is cheaper and easy to dismantle when they rise their houses in the future. Therefore, the common adjustment in Block H and L include the addition of rooms, enlarge the house; specially to avoid flooding

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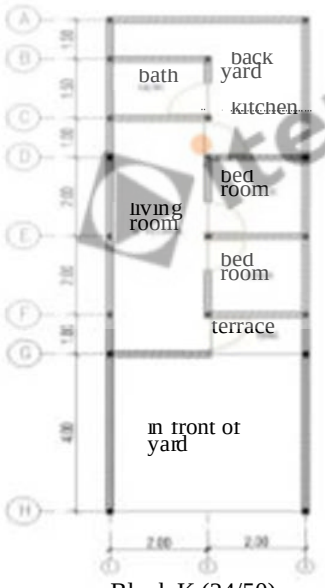
include the elevate ground floor, ceiling, and elevate into two-storey house.

Block K and Bermis were chosen to be the research location for this study because there has been no research on housing adjustment in this area. Furthermore, these blocks will be retained as landed housing (include Block H and L) in Muara Angke Master Plan, while the surrounding slums will be converted into flat housings. Housings in Block K were built in 1978 and Block Bermis were built in 1988. Early Houses in Block K and Bermis were different from Block H and L. Wall material in Block K of brick (stucco wall in Block H and L) and roofing materials in Bermis of tile (tin roof in Block H and L).

4. Analysis of Housing Adjustment in Block K and Bermis of Muara Angke

Initially there were 180 houses in Block K and 203 houses in Block Bermis. After several years, some houses were merged, two houses into one owner, so that the remaining houses are approximately 159 houses in Block K and 173 houses in Bermis. Initially all of houses were single storey houses, size of houses 24 m^2 with land area of 50 m^2 (4x 12,5 m^2) in Block K, meanwhile 21m^2 with land area of 60 m^2 (5x 12 m^2) in Block Bermis (see Fig.2).



Block K (24/50)

Fig. 2 . Original Floor Plan in Block K

Respondents were selected based on those who have lived more than 10 years to find their motivation why they change their houses and they have experienced flooding. Their houses were chosen as sample are the ones which have positive contribution for the occupants in terms of responding the flood. There were 35 respondents consisting of 15 respondents in block K (7 for single storey and 8 for two-storey houses) and 20 respondents in Bermis (9 for single storey, 9 for two-storey and 2 for three-storey houses).

All respondents said the main reason they changed the house because of flooding (100%) and they still want to stay at home despite flood. The next reason for the increase in family members, space requirements, and furnishings are not damaged, last reason for neighbors appreciated. Respondent characteristics are as follows :

- Respondent's income under 1.5 million rupiah per month (20%), 1.5-2.9 million (37.1%), 3-4.49 million (9%), 4.5-5.9 million (11,4%), above 6 million (5.7%).
- The livelihoods of respondents are fisherman (28.6%), entrepreneur (28.6%), do not have a job because they are old (21.4%), boat crews (10.7%), and port officials (10.7%).
- Heads of household are approximately 42-76 years old.
- Their educations were elementary school (60%), junior high school (14.3%), senior high school (22.9%), and baccalaureate (2.8%).
- The people come from different ethnicities, consisting of Bugis (40%), Java (31.4%), Banten (8.6%), Lampung (5.7%), Sunda (5.7%), Makassar (5.7%), and Chinese (2.8%).

4.1. Elevating Houses

a. Adjust house become two and three-storey house

The housing adjustment is done by occupants by elevating their homes to avoid flooding and they still want to stay at home despite flood. Generally they will change become two or three-storey houses if they have much money because they can live and carry out daily activities on the second floor in case of flooding.

There are approximately 159 houses in Block K and 173 houses in Bermis; consist of single-storey houses only 52.8% in Block K and 46.8% in Bermis; meanwhile two-storey houses 47.2% in Block K and 47.9% in Bermis; 0% three-storey houses in Block K and 5% in Bermis (see Table 1).

Table 1. Number of Storey House

Number of Storey House	Number of houses	
	Block K	Block Bermis
1 Storey House	84 houses – 52.8%	81 houses – 46.8%
2 Strorey House	75 houses – 47.2%	83 houses – 47.9%
3 Storey House	0 houses - 0%	9 houses - 5%

(Source: Field Observation, 2013)

b. Elevating floor elevation from the road level

In addition to increasing the storey of the houses, the occupants elevated the ground floor of their houses above the road, due to the government raising the roads. They had to elevate the floor elevation of

their houses, so that the houses were not lower than the road to avoid flooding. The number of houses with elevating floor which is above the road level are amounted to as many as 90% in Block K (143 houses) and 85% in Bermis (147 houses), floor height details can be seen Table 2.

Meanwhile the number of houses which are under the road are 10% in Block K and 15% in Bermis, because the occupants do not have enough money to raise their houses. According to some respondents whose houses are under the road, their houses frequent seepage (water infiltrate through the floor and wall of the houses) when heavy rains.

Table 2. The Height of Ground Floor of the Houses

The height of ground floor above the road	Number of houses	
	Block K	Block Bermis
0-39 cm	67 houses – 42.1%	9 houses – 54.3%
40-79 cm	52 houses – 32.7%	39 houses –22.5%
80-119 cm	23 houses – 14.5%	13 houses -7.5%
> 120 cm	1 houses – 0.6%	1 houses – 0.6%
Ground floor under the road	16 houses - 10%	26 houses - 15%

For houses elevated, enter to the house using a ladder and ramp for motorcycle and bicycle. Stairs leading to the terrace can be used by occupants as a place to sit and interaction with neighbours, because they no longer have a yard.

c. Elevating the ceiling of the houses

The ceiling of some houses are high enough. Referring to the 35 respondents, ceiling height 250-300 cm (17.1%), 300-350 cm (28.6%), 350-400 cm (31.4%), 400-450 cm (17.1%), 450-500 cm (5.7%). If the ceiling is high enough, the respondents would be easy to raise the floor of the house several times without having to dismantle the ceiling. All of respondents believe that they will elevate their houses in five to ten years later, because the road in front of their houses will be elevated to avoid flooding.

The high ceiling of the house is also beneficial to add coolness in the house because the temperature is hot enough in Muara Angke. Because of limited land, houses generally only have windows and vents in the front of the house, consequently fresh air coming into the house to be limited, moreover wide in front of the house only 4 meter in Block K and 5 meter in Bermis.

Commonly they use plywood ceiling, besides cheap, plywood ceiling can reduce the hot air from the roof and the noise from the sound of rain, it is also easily dismantled.

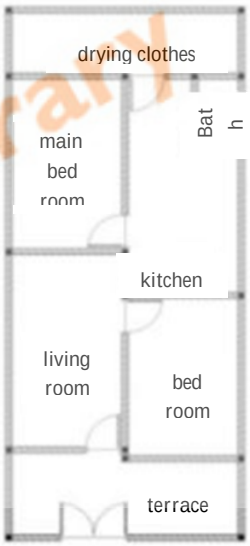
4.2. The Expansion of Houses

Building coverage ratio that was initially 48% in Bloc K and 35% in Bermis had been increased almost 100%. Limited land make residents spend all land to be built, so that there are no more yard to plant trees. According to 35 respondents, the size of houses that was originally 24 m^2 had been increased to 50 m^2 for single-storey houses and 78-200 m^2 for two-storey houses in Block K. There is a house which two plots are joined so that the size of house until 200m^2. Meanwhile in Bermis, it had been increased to 60 m^2 for single-storey houses and 120-372 m^2 for two and three-storey houses. There is a house which two plots are joined in three-storey house, the size until 372m^2.

All the rooms had been expanded (living, family, dining and kitchen). Houses which originally had 2 bedrooms in Block K and 1 bedroom in Bermis were modified to be 2-14 bed rooms. The bed rooms on the second floor can be rented by employee.

a. Single storey house

Generally single-storey house has living room, 2-3 bed rooms, kitchen, and one bath room (see Fig.3).



Block Bermis

Fig.3. Models of Floor Plan in Single-Storey House
(Source: Field Observation, 2014)

Some houses have terrace, drying clothes in back of the house (although generally drying clothes in front of the house), and family room. Living room and family room are often merged into one room. Family members who live in the house 2-9 people. Respondents often gather in the living and family room to watch tv and chat, sometimes married children often watch tv in their bed rooms.

b. Two-storey house

Respondent's income per month is not sufficient to meet the needs of the family, let alone the many respondents who are old and not working anymore.

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They need the extra income. While recently a lot of restaurants and apartments are built around Muara Angke, so many employees who need the rented rooms. Therefore, several houses add economic function such as stall on the terrace and rented rooms on the second floor (see Block K in Fig.4). According to 35 respondents, there are 4 houses that have rented rooms of 8 two-storey houses in Block K, while 5 houses that have rented rooms of 9 two-storey houses in Bermis.

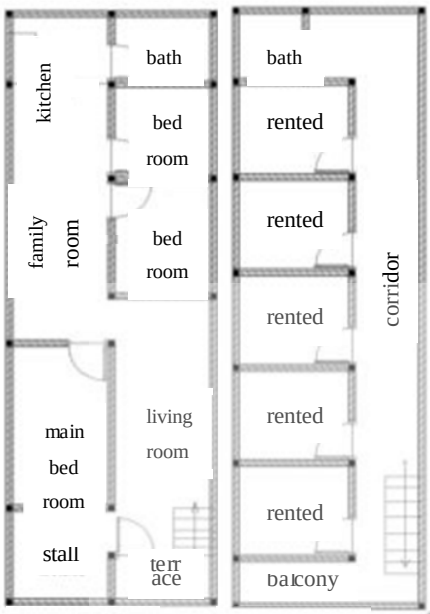

Fig.4. Models of Floor Plan in Two-Storey House
(Source: Field Observation, 2014)

House without economic function consists of terrace, living room, two bed rooms, dining room, kitchen, and bath room in the first floor; three bed rooms, family room, bath room, and balcony in the second floor. Generally balcony is used for drying clothes.

4.3. Using Materials Easily Dismantled

Land subsidence is quite significant in Muara Angke, causing occupants elevated the ground floor for several times, even they had to dismantle the roof of the house several times. Therefore, they tend to use materials that are easily dismantled.

According to 35 respondents, there are 17 houses as two-storey and 2 houses as three-storey houses; from those storey houses, 11 houses use wood material for the second floor, 7 houses use concrete, and 1 house use steel decking. Wood material, besides cheap, it is also easy to be dismantled when the respondent would improve their houses in the future. All of the columns are made of concrete, but the beams and floor of the second floor are made of wood. All of respondents believe that they will elevate their houses in five to ten years later. This method will be cheaper than using the concrete floor, because the concrete floor should be destroyed when the house will be elevated.

Original material is zinc roof in Block K and roof tile in Bermis, while the floor of stucco in Block K and terrazzo in Bermis. Recently, respondents tend to use asbestos as roof material (65.7% of 35 respondents), besides cheap, it is also easy to be dismantled, can reduce heat of sun shine and noise of rain. They use roof tile (20%), roof tile and asbestos (5.7%), concrete (5.7%), and zinc roof (2.8%).

Respondents tend to use ceramic tile for ground floor (91.4%), besides cheap, floor becomes cooler, and it is also easy to be cleaned after the flood. The rich respondents use granite tile (5.7%), otherwise the poor respondent uses stucco floor (2.8%).

4.4. Facade Changes According to Ability and Desire

Architectural styles of the house facades are very diverse. Although located in flood prone areas, the facades of the houses reflect the economic ability of respondents, their knowledge about house design, and of course reflect the level of their social life. Low-income respondents, facades of their houses are simple, just featuring doors and windows without using architectural details. Windows and doors are useful to continue the day lighting and fresh air into the house. Middle-income respondents, facades of their houses are diverse, not only functional to carry day lighting and fresh air into the house, but consists of minimalist and modern design, using more expensive materials, therefore looks more neat and elegant.

Low-income people's image of home, house as shelter, a place that provides protection from potentially damaging or unpleasant condition, it is the most basic need in a biological sense. It is primarily for the middle class, home is a safe place, as a means for self-expression and self-realization, an effective way to reflect personal values and their image of self (Becker, 1977).

House facades that respond to flooding are high form of the houses because of the high elevation of the ground floor and the ceiling. Some of the houses exposed the stairs in front of the two-storey houses. Vents are placed at the top of the window to beautify the high walls and also to enter fresh air and solar lighting into the house. Using of materials that are resistant to water, such as painted stucco wall and ceramic walls, painted frames of door and window to be resistant to water. The fences are also using painted stucco wall and painted iron so resistant to water.

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5. Conclusion

Impact of the coastal flooding insists the communities to adaptive the hazards by adjusting their houses to avoid the flood. Housing adjustment as adaptation strategy for them, so that they can stay at home during the flood. They do not have to move to another place even though Muara Angke is prone to flooding. Respondents said that they are welcome to stay in Muara Angke (although prone to flooding) due to its strategic location, close to public facilities, close to downtown, easy to transport, and easy to make money.

Housing adjustments were made by respondents can be an example for other flood-prone settlements, especially fishing settlement with low and middle-income people. Several strategies for the design of future settlements in flood-prone areas are as follows :

- Ground floor of the house should be high enough above the road level to avoid flooding.
- If possible, the house should have a second floor (two-storey house) that can be used as a place of refuge in the event of a large flood.
- The ceiling is high enough so that occupants can elevate the floor several times without having to dismantle the ceiling.
- Allows occupants to expand the house, if they need additional room and add the economic activity in the house, however they will be old and need the extra income, especially when their children come to live with them.
- Using materials easily dismantled as using wood or steel decking for the second floor.
- The building structure should be resistant to flooding such as using concrete columns, plastered brick walls, tiled floor so easy to clean it after flood.
- The facade of the house should consider openings such as door, window, vent, so that day lighting and fresh air can get into the house to reduce heat, however, the air temperature is usually quite hot in fishing settlement. House facades that respond to flooding are high form of the houses because of the high elevation of the ground floor and the ceiling.
- Houses should still have a yard to plant trees, there is strict control of the government so that the residents retain the yard as a green space to reduce flooding and increase the coolness in the environment.

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