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HOUSING ADJUSTMENTS AS A RESPONSE TO FLOOD AND LAND SUBSIDENCE IN MUARA ANGKE, NORTH JAKARTA

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Abstract

This study investigated housing adaptation strategies assumed by the inhabitants of a coastal settlement in Muara Angke, North Jakarta, which has been repeatedly suffering from flood due to incessant land subsidence, sea level rise, high tide, heavy rainfall, and river sedimentation. Initially a wetland dominated by mangroves, Muara Angke in 1970s was then developed by government of DKI Jakarta as a new settlement to accommodate the fishery community members in North Jakarta. Information on strategies of housing adjustment taken up by 120 purposefully selected households are collected through field observation and direct interview methods. The research findings showed that housing adaptation strategies adopted by the inhabitants of Muara Angke in response to flood and land subsidence are as follows: 1) raising the ground-floor level, 2) adding the ceiling-height to anticipate further land subsidence, 3) expanding floor areas vertically up to 2 or 3 storey, 4) replacing floor materials for easy maintenance, and 5) Utilizing light-weight ceiling and roofing materials for easy dismantle and re-assemble.

Keywords: housing adjustment, flood and land subsidence, Muara Angke, North Jakarta

1. Flood and Land Subsidence in North Jakarta

Since the 5th century under the reign of the Kingdom of Tarumanagara, during to the Dutch colonial period, and until today, flooding has become a latent problem for the area which is now developed into the capital city of Jakarta. Within the last two decades, major flood had occurred in Jakarta consecutively in the year 1996, 1999, 2002, 2007, and 2013 (Zaenuddin, 2013), mainly caused by several interrelated factors, including: sea level rise, high tide, heavy rainfall, river and estuaries sedimentation, embankment failures, and also from incessant land subsidence.

The rate of land subsidence in Jakarta varied between 15 to 25 cm/year (Abidin, et al, 2009). Land subsidence occurred due to excessive groundwater extraction as a dominant factor, aggravated by excessive building and construction loads, natural consolidation of alluvium soil, and tectonic activities. The highest rate of land subsidence can be found in Penjaringan, Tanjung Priok, and Cakung areas (Bimantara, 2012). Land subsidence has extended settlement areas which are prone to flood along the coast of Jakarta and makes them highly vulnerable to sea level rise effects. The average sea level rise in the northern coast of Java was 1.45cm/year, calculated based on data of the years 2005 to 2011 (Hadi, et al., 2012).

Muara Angke is a delta located in North Jakarta, Pluit village, Penjaringan sub district, surrounded by Asin River in the east, Adem River in the west, and Jakarta Bay in the north. Initially a wetland dominated by mangroves, in 1970s it was then developed by government of DKI Jakarta as a new settlement to accommodate the fishery community members in North Jakarta, consisted of fishermen, boats owners, crews, workers and others. Various facilities provided by the government are market place, bus terminal, schools, mosques, community health center, and fishing industrial facilities. Muara Angke covers a total area of 67 ha (Fig. 1), including 21.16 ha housing area consisted of housing blocks H, L, K, Bermis, and many others (UPT PPKP and PPI Muara Angke, 2011).

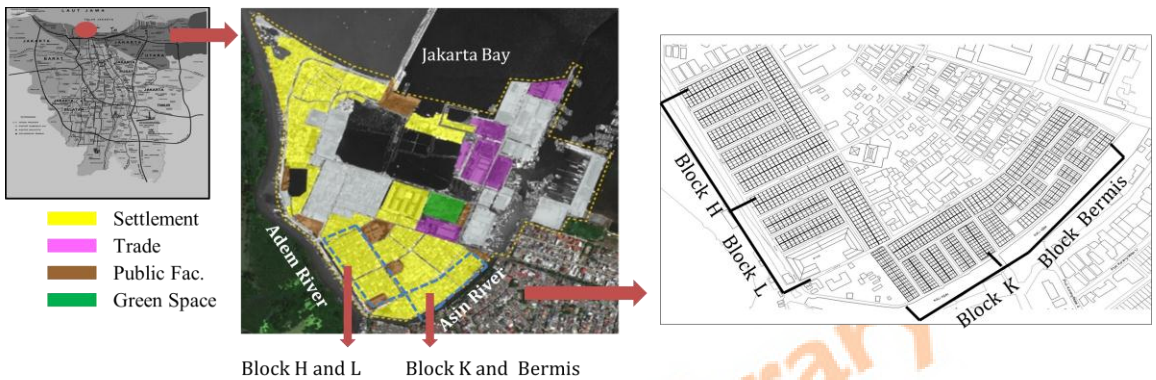

Figure 1. Map of Muara Angke and housing blocks H, L, K, and Bermis
(Source: UPT PPKP and PPI Muara Angke, 2011)

Muara Angke has the average sea level rise 1.45 cm/year, and land subsidence between 10 to15 cm/ year (Fig. 2) (Yoichi, 2009 in KORDI, 2012). Major floods had occurred in Muara Angke consecutively in the year 1996, 1999, 2002, 2007, 2012 and 2013 (Fig. 3).

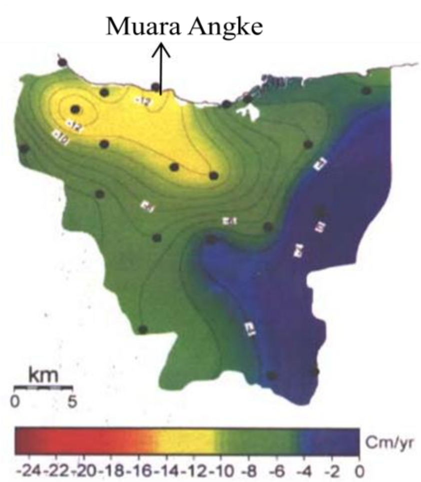

Figure 2. Land subsidence prediction study in Jakarta using GPS
(Source : Yoichi, 2009 in KORDI, 2012)

Flood in year 2011
(Source : UPT Muara Angke)

Flood in year 2012
(Source: foto.detik.com & merdeka.com.)

Figure 3. Muara Angke, flood in year 2011 and 2012

Constant incidents of land subsidence and flood have forced the residents of Muara Angke to adjust their houses, in order to adapt to and overcome with these critical conditions. This study investigated various housing adaptations carried out by the inhabitants, as their response to flood and land subsidence hazards in Muara Angke, North Jakarta. Four housing blocks were selected purposefully as research samples, namely block H, L, K and Bermis, based on the following considerations: 1) these housing blocks have underwent significant housing adjustment since the establishment until today, 2) according to Muara Angke Master Plan, these landed houses will be retained and not be demolished, while the surrounding slum areas will be redeveloped into multistorey housings.

2. Housing Adaptation and Adjustment

Incessant incidents of flood and land subsidence have significantly impacted the environmental quality of Muara Angke, as well as the quality of life of their inhabitants, in terms of life safety and security, physical and psychological health, and socio-economic stability. The inhabitants are forced to cope with all pressures or threats coming from their immediate surroundings, in order to achieved minimum standards of comfort that they can afford (Bell, 1990 in Iskandar, 2012).

The coping strategies adopted by the inhabitants of Muara Angke can be differentiated into two categories, namely housing adaptation and housing adjustment (Crull, et al., 1991), both are highly influenced by interrelated factors such as educational background, level of income, personal knowledge and skills (Morris and Winter, 1986 in Crull, et al., 1991). Housing adaptation refers to any changes in the structure or functioning of human behaviour at individual and group levels, as a response to certain environmental constraints, and in order to cope with real situations. Housing adaptation would involve for example temporary evacuation of the inhabitants from their house during incident of flood. Housing adjustment refers to any change made by their inhabitants to their house and surrounding environments, as an attempt to solve the real or potential environmental problems such as flood and land subsidence.

3. Research Method

Research data were collected through field observation, building measurement, and interview with 120 respondents, consisted of 37 (31.6%) respondents from Block H, 24 (20%) from Block L, 28 (23.3%) from Block K, and 31 (25%) from Block Bermis. The number of respondents for each block were determined proportionally according to the total number of housing units in each block (220 in Block H, 140 in Block L, 164 in Block K, and 184 in Block Bermis) and also based on the following criteria: 1) the inhabitants have occupied their house for more than 10 years, 2) they have experienced flood incident several times, including big flood in the year 2007, and 3) they have renovated their houses at least within the last 2 years. Field observation was carried out from January to July 2014, to map out various housing adjustments that have been carried out by respondents since they first resided in Muara Angke until today.

4. Characteristics of Research Respondents

Characteristics of Muara Angke's inhabitants who were selected as research respondents can be described as follows:

a) Most of the respondents firstly resided in Muara Angke between year 1975 to 1980 (40.8%); the rest were between year 1981 to1985 (17.5%); 1986 to 1990 (23.3%); 1991 to 1995 (10%); 1996 to 2000 (8.3%).
b) Reasons to reside in Muara Angke: close to workplace (43.7%); low housing price (21.3%); relocated by government (15.5%); better living condition (8%); close to relatives (7.5%); others (4%).
c) Ethnic of head of household: Buginese (37.5%); Javanese (25.8%); Betawi, Bantenese, and Sundanese (7.5%); Makassar and Chinese (4%); Lampung and Cirebon (2.5%); Batak, Padang, and Manado (0.8%).
d) Educational level of head of household : elementary school (40%); junior high school (15.8%); high school (37.5%); and baccalaureate (6.67%).
e) Age of head of household : 40 to 49 years (15.7%); 50 to 59 years (38.6%); 60 to 69 years (35%); 70 to 79 years (10%); 80 to 89 years (1%).
f) Monthly family income: < Rp 1.5 million (22.5%); Rp 1.5 to 2.9 million (41.7%); Rp 3 to 4.49 million (19.2%); Rp 4.5 to 5.9 million (5%); Rp 6 to 7.49 million (4.2%); > Rp 7.5 million (7.5%).

Educational level of head of household and monthly family income are strongly correlated to the size of the house after adjustment. The higher educational level of head of household has correlation to the wider house than the lower educational level, see Fig.4. It means that they graduated from baccalaureate and senior high school have wider houses than graduated from elementary and junior high school. The wider houses also means that they are two and three-storey houses. Similarly, the inhabitants with the higher monthly family income have the wider houses than the lower income.

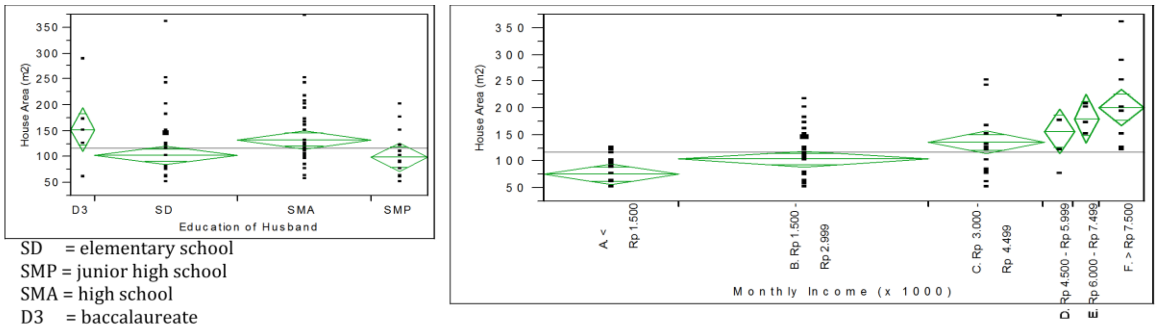

Figure 4. Educational level and monthly income are correlated to the size of the house

5. Condition of Original Houses in Muara Angke

Originally all types of houses built in Muara Angke were single-storey buildings, they were built by local government. Houses in Block H has 75 sqm plot with 40 sqm floor area, Block L has 62.5 sqm plot with 30 sqm floor area, Block K has 50 sqm plot with 24 sqm floor area, and Block Bermis has 60 sqm plot with 21 sqm floor area. Each house has a front and back yards, with building coverage ranges from 45% to 53% (Fig.5).

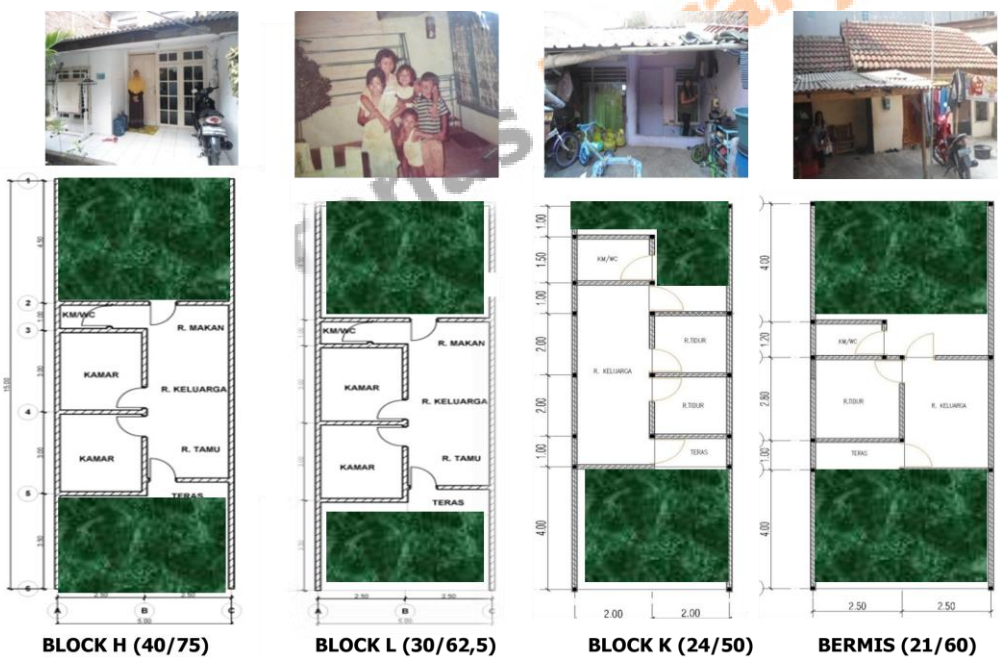

Figure 5. Original houses in Block H, L, K, and Bermis

6. Analysis of Housing Adjustments in Muara Angke

The research findings showed that housing adjustment strategies assumed by the inhabitants of Muara Angke in response to flood and land subsidence are as follows: 1) raising the ground-floor level, to catch up with the heightening of street level, 2) adding the ceiling-height to anticipate further land subsidence and street level heightening, 3) expanding floor areas vertically up to 2 or 3 storey for convenience and economic reasons, 4) replacing floor materials for easy maintenance, and 5) utilizing light-weight ceiling and roofing materials for easy dismantle and re-assemble.

6.1 Raising the ground-floor level, to catch up with land subsidence and the heightening of street level

Respondents have raised the ground level of their houses several times, in response to continuous land subsidence, risk of flood incidents, and the heightening of street level. In the latest adjustments, 13.4% respondents have raised ground floor level to 39 cm above street level, 33% to 40-79 cm, 44.3% to 80 -120 cm, and 9.3% > 120 cm. However, due to the heightening of street level conducted recently by the government, the latest conditions verified by field observation are as follows: 16.7% houses have ground floor under the street level, 54.2% have 0-39 cm above the street level, 18.3% have 40-79 cm above the street level, 10.8% have 80-120 cm above the street level (Fig.6). The process of heightening and re-heightening street level and raising and re-raising ground floor level can be described in Fig.7.

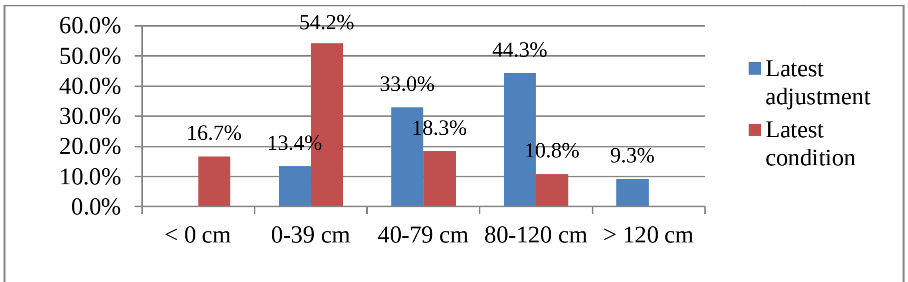

Figure 6. Latest adjustments and conditions of ground-floor level

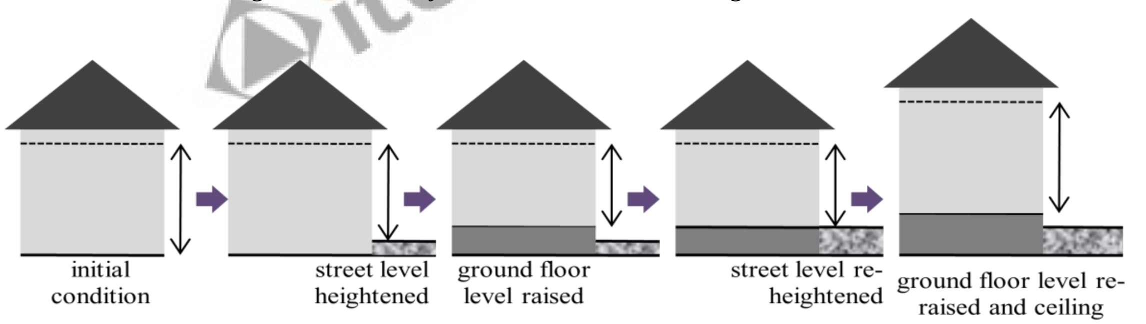

Figure 7. Process of heightening and re-heightening street level and raising and re-raising ground floor

6.2 Adding the ceiling clearance to anticipate further land subsidence and street level heightening

The heightening and re-heightening of street level, and the raising and re-raising of ground floor level, have significant impacts on house's ceiling clearance. The existing conditions recorded during the field observation shows various conditions of ceiling clearance as follows : < 199 cm (2.5%), 200-249 cm (20.8%), 250-299 cm (17.5 %), 300-349 cm (15.8%), 350-399 cm (23.3%), 400-449 cm (15%), 450-500 cm (5%), can be described in Fig.8. The inhabitants who own houses with high ceiling clearance (> 350 cm) expect to raise ground floor level several times without dismantling the ceiling. However, within five to ten years they anticipate to re-raise ground floor level as well as ceiling clearance, due to continuous re-heightening of street level as flood avoidance measures taken by the government. As a matter of fact, the inhabitants can take the benefit from high ceiling clearance in terms of thermal comfort, air circulation, and spatial volume.

Figure 8. Various conditions of ceiling clearance

6.3 Expanding floor areas vertically up to two or three-storey for convenience and economic reasons

The inhabitants expanded floor area of their houses vertically up to two or three-storey for several reasons: 1) to provide refuge area during flood incidents so that they can stay at home and do not have to evacuate to other places; 2) to provide additional rooms needed for family members; 3) to install spare rooms that can be rented for commercial purpose as additional source of income. There are some cases where two original plots were made into one new plot (Fig. 9).

Figure 9. Examples of two original plots combined into one new plot at Block Bermis

Radical transformation of original single-storey houses into two and three-storey houses in Muara Angke can be shown from the data as follows:

a) Block H: initially it had 220 single-storey houses, now it has 134 (60.9%) two-storey and 3 (1.36%) three-storey houses.
b) Block L: initially it had 140 single-storey houses, now it has 83 (59.3%) two-storey and 5 (3.6%) three-storey houses.
c) Block K : initially it had 164 single-storey houses, now it has 92 (56.1%) two-storey and 2 (1.2%) three-storey houses.
d) Block Bermis : initially it had 184 single-storey houses, now it has 102 (55.4%) two-storey, 4 (2.2%) three-storey, and 1 (0.5%) four-storey houses.

Examples of two or three-storey houses as results of floor area expansion are shown in Fig.10.

Figure 10. Two or three-storey houses as the results of floor area expansion

In expanding floor area of their houses, the inhabitants tended to occupy the whole plot. The original front and back yards disappeared, fully transformed into buildings. Some of the inhabitants also set up stalls to earn extra income from small trades (*warung*) or services (beauty salon, *bengkel*).

6.4 Replacing floor materials for easy maintenance

Learning from flood incidents occurred in the past, where ground floor were usually covered by flood water or water which are shipping from underground, the inhabitants changed the floor material from the original (stucco or terrazzo) into the new ones, such as ceramic tiles (80.8%) and granite tiles (5%), in order to avoid damage and easily clean-up the surface of ground floor. Those who cannot afford to improve floor area with new materials, they use new stucco floor on top of the old one (14.2%). Examples of those floor materials can be seen in Fig.11.

Stucco floor ceramic tile granite tile

Figure 11. The use of ceramic and granite tiles for easy maintenance

6.5 Utilizing light-weight ceiling and roofing materials for easy dismantle and re-assemble

Since the inhabitants had to repeatedly re-raise ground floor level, ceiling clearance, and also roof structure, they tended to use cheap priced light-weight materials for flooring, ceiling and roofing, so that they can easily dismantle and re-assemble them at any time needed in a convenient way. There are 71 two and three-storey houses of 120 selected houses, materials used for flooring at the second-storey are thick plywood (64.8%) and steel decking (4.2%). Materials used for ceiling generally are plywood (75%) and gypsum board (13.3%). Materials use for roofing generally are corrugated cement board (82.5%), roof tiles (12.5%), and corrugated zinc sheet (2.5%), which can be seen in Fig.12.

plywood ceiling steel decking Corrugated cement board roof tile Corrugated zinc sheet

Figure 12. The use of cheap priced light-weight materials for ceiling and roofing

7. Conclusion

It can be concluded that housing adjustment strategies of the inhabitants in Muara Angke are significantly depended on ranges of family income, educational levels and aesthetical preferences of head of the household. Families with range of income under 1.5 million rupiahs are generally facing some difficulties in making housing adjustments fitted to their needs. Family with range of income over 4.5 million rupiahs are able to make housing adjustment appropriately. Head of the household with higher level of education (high school and baccalaureate) are more knowledgeable and skilful in managing and executing housing adjustment plans, and more refined in their aesthetical preferences. It can be inferred that range of income, level of education, and aesthetical preferences are highly interrelated factors that determine the level of success of the inhabitants in making housing adjustments.

Housing adjustments by the inhabitants of Muara Angke in response to flood and land subsidence are as follows: raising the ground-floor level, adding the ceiling-height to anticipate further land subsidence and street level heightening, expanding floor areas vertically up to 2 or 3 storey, replacing floor materials for easy maintenance, and utilizing light-weight ceiling and roofing materials for easy dismantle and re-assemble.

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