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Self-Help Adaptation to Flooding in Low-Income Settlements in Chiang Mai, Thailand

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***Abstract*—**This study aimed to determine low-income housing adaptations for flooding, which causes living problems and housing damage, and the results from improvement. Three low-income settlements in Chiang Mai which experienced different flood types, i.e. flash floods in Samukeepattana, drainage floods in Bansanku, and river floods in Kampangam, were chosen for the study. Almost all of the residents improved their houses to protect the property from flood damage by changing building materials to flood damage resistant materials for walls, floors, and other parts of the structure that were below the base of annual flood elevation. They could only build some parts of their own homes, so hiring skilled workers or contractors was still important. Building materials which have no need for any special tools and are easy to access and use for construction, as well as low cost, are selected for construction. The residents in the three slums faced living problems for only a short time and were able to cope with them. This may be due to the location of the three slums near the city where assistance is readily available. But the housing and the existence in the slums can endure only the regular floods and residence still have problems in unusual floods, which have been experienced 1-2 times during the past 10 years. The residents accept the need for evacuations and prepare for them. When faced with extreme floods, residence have evacuated to the nearest safe place such as schools and public building, and come back to repair the houses after the flood. These are the distinguishing characteristics of low-income living which can withstand serious situations due to the simple lifestyle. Therefore, preparation of living areas for use during severe floods and encouraging production of affordable flood resistant materials should be areas of concern when formulating disaster assistance policies for low income people.

***Keywords*—**Flooding, low-income settlement, housing, adaptation.

I. Introduction

LOW-income settlements are hidden in vulnerable areas which are difficult to access and not suitable for living [1]. The residents in the low-income settlements face many intractable housing problems such as overcrowding, poor housing, lack of land tenure, poor infrastructure and public utilities. The settlements usually flood when there is a storm or heavy rain which causes the living problems, health issues and housing damage [2]-[4].

The studies of the IPCC have found that the climate in the 21st century will have increased rainfall, possibly causing big storms. Heavy rainfall events will become more severe and more frequent [5]. In addition, Shinawanno, who projected future climate changes in Thailand, has found that the average annual rainfall will increase by 15-25% in terms of distribution, intensity, duration, and frequency [6]. This means the risk of severe floods, flash floods and flood disasters may increase which could increase the living and housing damage problems of low-income people.

Many government agencies and private organizations have studied flood resilient housing techniques but modern technology may be required with high investment. However, this may not align with residents' lifestyles, social needs and occupations and may lead to unaffordable and unsuitable flood resilient housing [7]. In addition, assistance from government authorities has not reached all flood victims, and as such, some of them still suffer from floods. Therefore, transferring knowledge of housing improvements to apply to the low-income people's houses becomes the most sustainable and effective aid, but the knowledge for housing improvement [8] should be based on flood characteristics, affordability, and household problems during floods, and residents' behavior [9]. However, residents have tried to prevent and tackle the flood problems themselves using various methods under the economic and housing restrictions that exist. It is interesting how they improved their housing and what the results were. Surprisingly, little attention has been paid within the literature to understanding the ongoing processes of self-help methods that poor people use for improving their houses after floods, particularly of urban slum dwellers. Therefore, this paper addresses this deficiency through an examination of individual adaptation strategies employed by people living in three urban low-income settlements of Chiang Mai, Thailand, which are Bansanku, Samukeepattana and Kampangam. The residents in the three low-income settlements are regularly exposed to flooding from heavy rainfall and vulnerable locations. This study aims to determine the methods which low-income people in urban low-income settlements used for improving their flood-damaged houses. The individual initiative and self-help mitigation and redistribution practices under different limitations, which were used to prepare house and recover it from floods, should be studied. The research results can be used for suitable implementation of affordable flood resilient housing knowledge, which benefits various audiences including poor people, designers, construction industry, and government.

II. Methodology

Three low-income settlements i.e. Bansanku (21 households), Samugkeepattana (64 households) and Kampangam (61 households) were selected for this study, as shown in Fig. 1. These low-income settlements were over 10 years old with more than 20 households in each settlement and

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were also located in different flood prone areas with different flood characteristics i.e. flash flood, drainage flood and river flood. In addition, the residents gave interviews which were an important part of this study.

Household geographic information, drainage, and housing style data were collected by using a survey and the data was input into a geographic information system (GIS). Interviews and observations were carried out for collecting flood information (flood frequency, duration of flood, flood depth and flood flow velocity), flood impact (living problem and housing damage) and housing improving methods from 2001 to 2014.

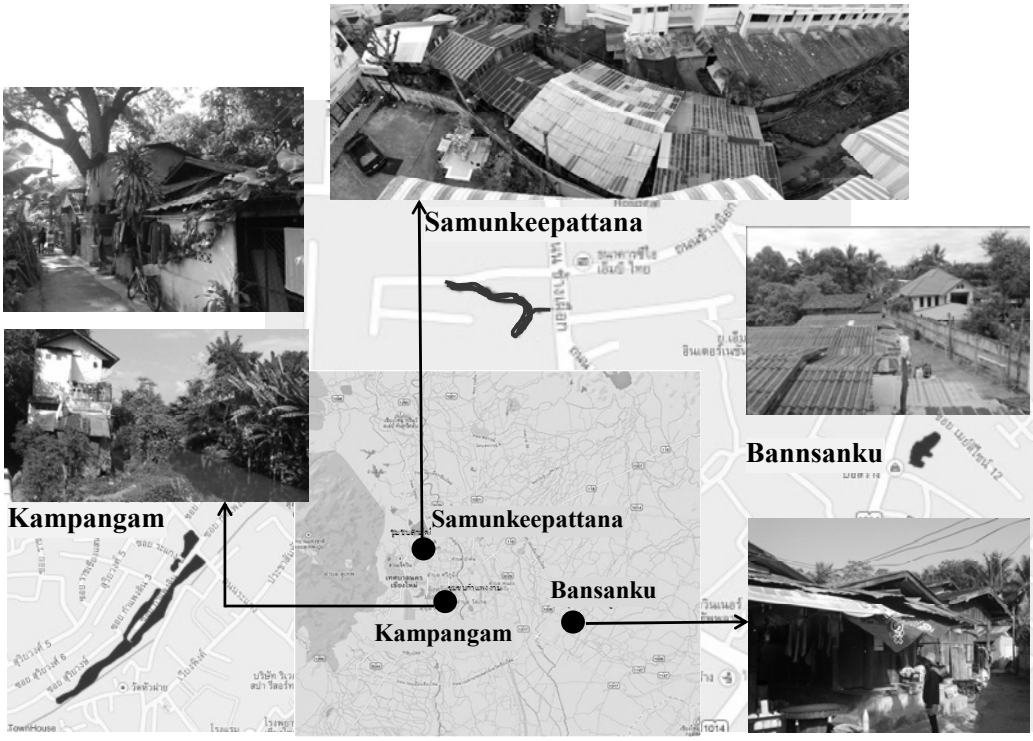

Fig. 1 The location of the 3 case study sites

III. The Floods' and Impacts^' Information

Bansanku is located in a basin area which causes drainage floods for about 10 days with a depth of 0.4-1.10 m., low flow velocity and slow rising. The residents in Bansanku start to have problems at a flood depth of 0.4 m, when the toilets and electricity become a serious problem, since the toilets in all the 1-story, elevated 1-story and 2-story houses are built on the ground floor. When the flood reaches a depth of 0.7-0.9 m, the electricity supply cannot be used. In 2001, floodwaters reached depths of above 1.4 m. Many main floors and utilities were disrupted, and the evacuation of homes became necessary for 85% of the residents in Bansanku. The damage to the housing in Bansanku is usually to the architectural parts, such as swell, decay and warp of doors and windows, and this damage begins at a flood depth of 0.4 m.

Kampangam is located beside Maekha canal which has flooded more than five times per year. The water slowly flows from the canal and covers the slum which can be called a river flood. In addition, the regular floods have low depth, about 0.3 m., and short duration, about two days, because it drains rapidly. Therefore, the residents of Kampangam usually suffer little from the regular floods, including those with 1-story houses made of non-permanent materials. However, they had fewer living problems at 0.7 m. of flood depth in 2011 than at 0.55 m. of flood depth in 2005 because many of the households in the community improved their houses.

The two low-income settlements are different from Samunkeepattana, which straddles the Khajae canal. It is in the flood path from Pui Mountain to the low land, which causes flash floods in Samukeepattana. Therefore, the flooding in Samunkeepattana has high velocity, depth, and frequency (15 times per year), but it has a short duration (only one day per flood). The regular flood of Samukeepatana causes slight living problems; however, the impact on both is increased by the rising of flood depth. The damage of building structures such as columns and beams were more usually found after the floods than the damage of architectural parts such as floors, walls, doors, and windows. After the flood in 2007, which had a depth of 1.15 m. and a flow of 3.4 m/s, most of the residents decided to improve their houses, causing the houses to be more resilient. Therefore, the houses were less affected in terms of living and housing damage by the flood in 2011 than the flood in 2001.

IV. Problem Solving during the Floods

The main problems during the flood usually were lack of living space and unusable toilets. The problems became more serious with increased flood depth until finally residents had to

evacuate from the low-income settlements. Shortage of drinking water and food rarely occurred during floods with the three low-income settlements, because there were short flood duration and the residents could access retail stores around their houses or public assistance. This is an advantage of low-income settlements in urban areas. In the case of problems with the toilets, they solved the problem by using the neighbor's toilet or defecating into plastic bags. Even when they cannot use electricity, residence can normally still live in their houses since they have fewer home appliances. The strong furniture, such as beds, tables, cabinets, and shelves, were adapted to become the floor for living when 1-storey houses flooded less than 1.00 m. In addition, they prepared to protect things by lifting them above the water or put them on the shelves, which were built on the wall (Fig. 2). However, the shelves cannot be built in every house due to a lack of structural strength, and therefore in some cases, property and furniture remained in the flood waters.

Fig. 2 Shelve preparation for protection of personal belongings

In severe floods, which the three low-income settlements faced in 2001 and 2011, residents had to evacuate from their houses to live at the nearest market, school or other place and adjust to living with no rooms, no toilet and no electricity. In the residents' opinions, they can live with the floods and do not want to move their houses anywhere else.

Fig. 3 Lifting the refrigerator above regular flood levels

V. Housing Improvement

In spite of their low income, the slum residents still try to protect their houses according to their ability by learning from problems. From the survey, existing housing styles can be divided into eight groups (A-H) by determination of the building materials' duration and the number of stories as shown in Fig. 4 (A). The most popular housing style is a 1-story house with permanent building materials (A-style), such as reinforced concrete, concrete block and hard wood, which is durable, low cost, and available at building material retail stores around low-income settlements.

In the past 10 years, many households in the three communities were improved. Household style and building materials were changed in 88.5% of households in Samukeepattana, 47.6% of households in Bansanku and only 29.7% of household in Kampangam, while the others just repaired their old houses. Therefore, the self-help improvement information can be divided into three categories, the first of which is changing only the housing form, such as transforming a 1-storey house with permanent structural and building materials (A-style) to an elevated 1-storey or 2-storey house with permanent structural and building materials (D- or G-style) as shown in Fig. 4 (B). The second group changed only structural and building materials, such as non-permanent structural and building materials to permanent structural and building materials, for example, C-style to B- or A-style, as shown in Fig. 4 (C). The third group updated both housing form and materials, as shown in Fig. 4 (D), which required building reconstruction such as from a 1-storey house with non-permanent structural and building materials (C-style) to an elevated 1-storey with permanent structural and building materials (D-style). The second group was the most popular within the three low-income settlements, which was used in about 51% of the total number of housing renovations, followed by the third group, which was 31%, and the first group, which was 18%, as shown in Fig. 5.

The third group was the most popular in Kampangam by changing F-style to H-style housing and C-style to E-style housing, but the second group was the most common in Bansanku by changing C-style to A-style housing. This explains why C-style houses cannot be found in Bansanku at the present. Only one household in Bansanku used the third method of both changing the housing form and the materials, and the first method was not found there. This is consistent with the improvement methods used in Samukeepattana, where the second group was the most popular means by changing to E-style housing. The first and the third group had similar improvement rates. The housing was likely higher than the highest flood levels in each community. Permanent structural materials and temporary architectural materials were usually selected for housing in Samukeepattana, permanent structural materials and architectural materials for the first floor of housing in Bansanku and almost all temporary materials for housing in Kampangam. Inexpensive and repairable building materials which can be found near the communities were selected.

Most of the housing improvements were made for avoiding damage from a flood similar to the previous flood, and were not aimed at prevention of future flood damage. The floor level of the houses were estimated to be about 25% higher than the highest flood water level, for example, the floor of a house that had been flooded to 0.5 m of flood depth was raised to 0.7 m. Therefore, if future floods are more severe, the

residents will probably have problems and have to evacuate from their houses. Some 83% of the residents improved their houses by themselves, or with the help of contractors. The cost was about 5,500 baht (155 USD) per time. They could not improve them immediately after the floods; however, they did it when they had sufficient funds or after they received assistance from the relevant authorities. In fact, the residents do not want to permanently renovate their housing, not only for financial reasons, but also due to lack of land ownership and the possibility of future eviction. In addition, they face severe floods infrequently, and so, the residents can cope during those situations and then accept repairing their houses after the floods.

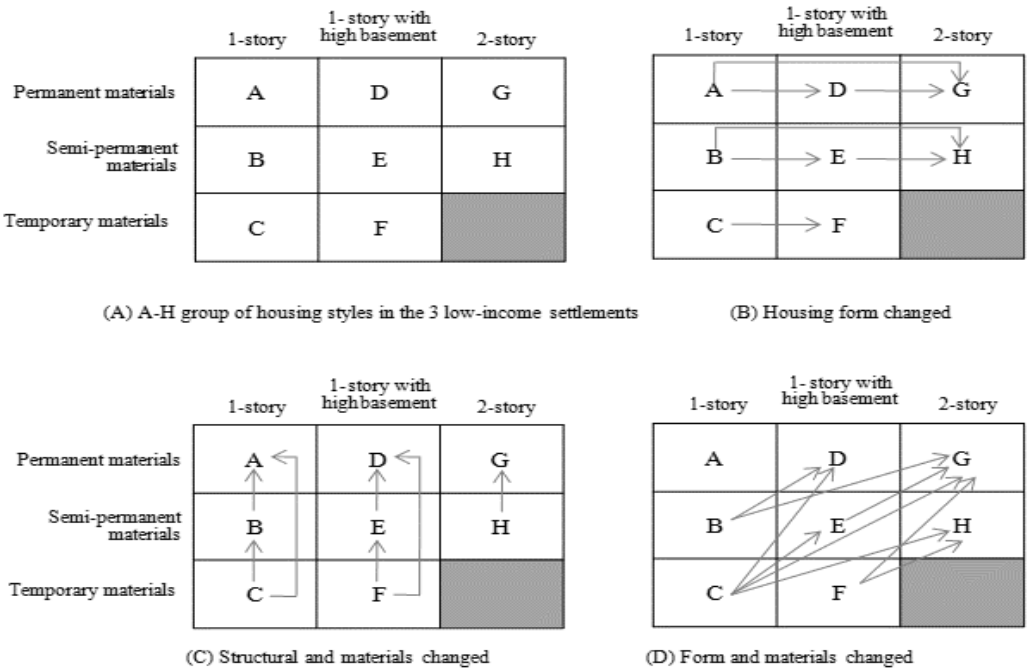

Fig. 4 Housing styles and improvement

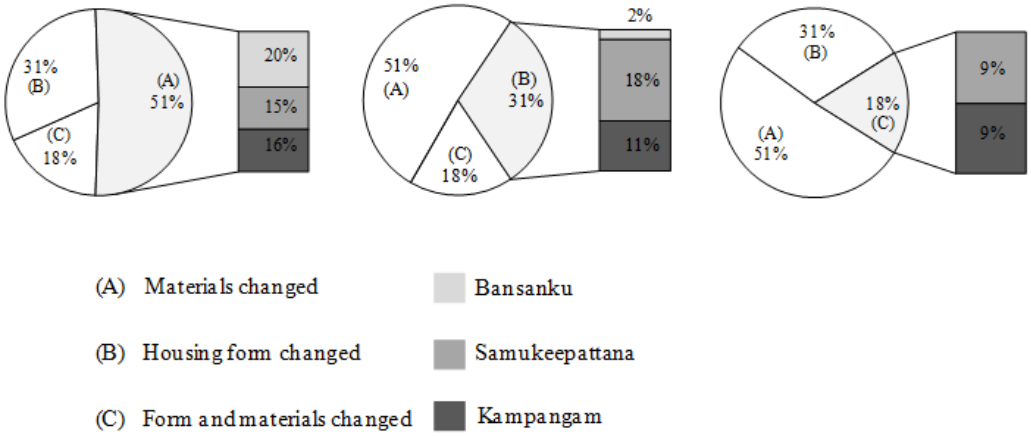

Fig. 5 Self-help improving methods

VI. The Ability to Reduce Problems After the Improvement

The improved houses reduced living problems during serious floods and prevented damage from the regular floods. During the latest severe flood in 2011, Bansanku, Kampangam and Samukeepattana were flooded with 0.9 m., 0.7 m., and 0.7 m. That year, 51% of households in Bansanku were affected but only 32% found housing damage after the flood. About 13% of households in Kampangam were affected which was less than the flood in 2005 with a flood depth of 0.55 m, as shown in Fig. 6. This was in line with the data from Samukeepatana which had less damage and problems that year, even though they experienced higher flooding. These showed that houses in the three low-income settlements were more resilient than before.

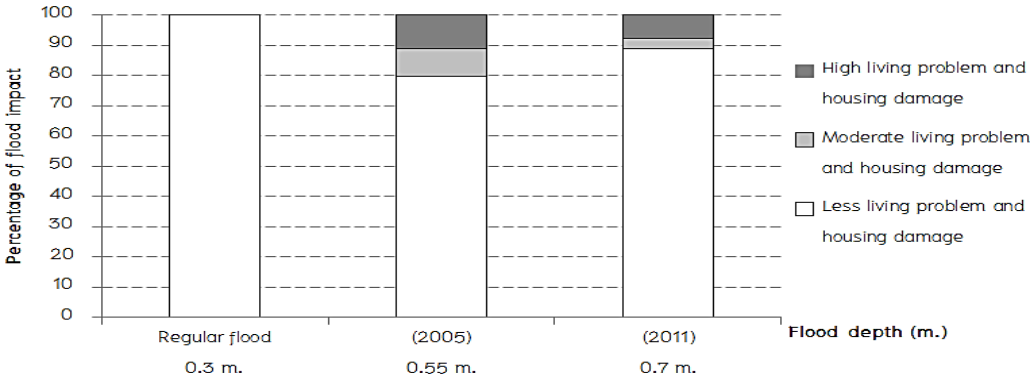

Fig. 6 Percentage of flood impact of Kampangam

VII. Discussion and Conclusions

The three low-income settlements are affected differently due to the various flood characteristics. The effects could be divided into two groups, which are living problems during the flood and damage to housing after the flood. The living problems usually are lack of living space and unusable toilets. Housing damage was found in the bottom 0.5 m of architectural parts of the houses in Bansanku. The houses in Samukeepatana usually had damage to temporary building structures not to architectural parts. The houses in Kampangam had less damage. However, the residents tried to protect their houses based on individual capability in spite of their economic problems. Their previous experiences and knowledge of flood characteristics were used for improving both housing styles and building materials. Therefore, the housing improvements in Samukeepattana included changing their housing style to 1-story elevated houses or 2-story houses, but the building materials were still temporary. This is consistent with the flood characteristics of high velocity and short duration. Most of the improvements in Bansanku and Kampangam included changing the wall and door materials to more flood-resistant materials and raising the floor depth to 0.5 m or creating a waterproof barrier to keep the houses from flooding.

Residents tried to construct their houses by themselves, but during some stages of building, they needed to hire contractors. This study did not find mutual help construction in the three low-income settlements; this may be due to urban lifestyle - the hustle and bustle of living, which is different from the lifestyle in rural areas. This may impact material selection for the houses, which were easy to find near the low-income settlements, easy to use for construction, did not need for any special tools, and were time-saving and low cost [10].

Residents did not worry about future floods, which will probably be more frequent and more intense due to instances of extreme precipitation [5]. Therefore, their improvements could only prevent damage in regular floods. If the floods become more severe, their houses will not withstand it. They will have to evacuate from their houses and come back to repair them after the flood. This is an outstanding characteristic of people with low incomes, who can endure serious situations and adapt their behavior to the environment, including having good relationship with the neighbors [11]. These are some different characteristics of urban people who have many problems when facing the flood. These characteristics suggest a new idea to help slum residents during severe floods by building public spaces, for example gazebos, at the public areas such as temples, school, or stadiums near low-income settlements. They can be used for relaxing in during normal situations, and be a safe place during floods.

The problems and damage that were found in this study may be different from those of low-income people in rural areas. This is due to flood characteristics, housing style and location [12]. For example, shortage of drinking water and food would probably occur during floods in rural areas since the low income settlements there are located far from the city so help from the related authorities would take a long time [13]. Therefore, food and drinking water stock should be a concern in rural places. These results can be used to establish flood policy and assistance grants to assist flood victims and reduce suffering from floods. The help should be focused on severe floods which may occur in the future [5] by making preparations to prevent both living problems during floods and housing damage. The public living areas during floods should be prepared and announced to the residents in each low-income settlement. Regarding housing damage, flood-resistant architectural building materials such as walls, floors, doors, and windows are important for slums which face drainage floods (high flood depths and long flood durations), so residents should be able to easily access them. The low-income settlements which face flash floods (high flood depth, high velocity, and short duration) should be concerned with the building structure. However, housing damage and problems in each community are different depending on the physical condition of the community and housing, and the severity of the floods, as can be seen from the three communities studied, therefore different types of efficient economical assistance should be offered.

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