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A COMMUNITY-BASED VULNERABILITY ASSESSMENT OF FLOODS IN URBAN AREAS OF KAMPUNG MELAYU, JAKARTA

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ABSTRACT

Flooding has become a serious problem in Jakarta. During floods of 2007, Kampung Melayu, East Jakarta was the worst hit by the floods. Community have different perceptions on disaster and have different effort to overcome the hazards. Therefore, local government and relevant institution should investigate this situation and make this information a valuable input in developing and implementing response plans in flood mitigation. This research is to explore the vulnerability of floods based on local people's perception. There were 83 households interviewed using questionnaire. Certain elements at risk related with physical and socio-economic aspects were identified. Physical information concerned the building structure and building contents. Several socio-economic characteristics were used as key indicators to analyze the vulnerability of people. Generally, the result of this research shows that the ability of people to cope with the flooding is linked with the capacity of the people itself. The capability of people to deal with flooding was influenced by several indicators based on their socio-economic characteristics. For example, lower income people will experience more suffering than the wealthier, because they cannot afford the costs of repair, reconstruction. Although the wealthier are likely to experience a higher degree of economic damage due to possessions of higher value. Base on the analysis, all coping strategies and flood measures are not enough to cope with flooding in the study area.

Keywords: Jakarta, Kampung Melayu, flooding, participatory studies, vulnerability assessment, risk perception

INTRODUCTION

Annual flooding is one of environmental issues in the Jakarta area due to the worsening river management both in the upland and lowland. Flood in Jakarta has been recognized since the Dutch occupation era in Indonesia. Historical record illustrates that some enormous floods have occurred that killed some people and destroyed properties i.e., year 1699, 1714, and 1854. While in the last few decades, the flooding occurred in 1918, 1942, 1996, 2002 and 2007; caused some damages and some people were killed and lost (Table 1).

Table1. History of Floods in Jakarta

Year	Affect
1699	Ciliwung river floods "Oud (old) Batavia" after Mount Salak erupts.
1714	Ciliwung river overflows after clearing forest areas in Puncak.
1854	"Nieuw (new) Batavia" is a meter under water, caused by the raging Ciliwung.
1918	Extensive flooding. The Dutch colonial government begins work in the Western Flood Canal.
1942	The Canal is completed, but Jakarta still floods.
1996	A flood sweeps through the capital. Approximately 10 people die.
2002	The Darthmouth Flood Observatory notes it as the largest flood in Jakarta's history, 25 people died.
2007	The greatest flood to hit Jakarta in the last three centuries.

Source: [*WHO*, 2007]

Flood in Jakarta is affected by several other factors, such as: morphological (approximately 40% areas of Jakarta Special Province is lowland area, some of them even below sea level), hydro-meteorological aspects (heavy rainfall and high sea tide during rainy seasons), land use change, decreasing the flow cross-section of the Ciliwung River because of garbage along the river and illegal settlement in the riverbanks, and also because of socio-cultural aspect, i.e: weak policy implementation, rapid urbanization, solid waste dumping and management.

Vulnerability assessments are necessary in order to reduce the impact of the next flooding event in Jakarta. Government already conducted many surveys to measure and assess flood damage, but the vulnerability assessment at the micro-level (based on community data) hasn't been done yet. Therefore, this research is addressed to identify the people's perception, identify certain elements at risk, and assess the vulnerability of each of the element at risk. The result of this research can be used as a valuable input for local governments for making appropriate actions, policies and programs in the context of flood hazard management in this study are in order to reduce the risk of the flood hazard and to apply it in urban areas of Kampung Melayu, Indonesia.

Jakarta, located on the northwest coast of the island of Java (6.22° S and 106.86° E), has an area of 661.52 km². The study area of this research is *Kelurahan* Kampung Melayu in Jatinegara District, East Jakarta, located along the Ciliwung River (Fig. 1). It divided into 8 *Rukun Warga* and 114 *Rukun Tetangga*. Geographically, Kampung Melayu located in the non-coastal area (± 15 Km from shoreline) and is relatively flat. The altitude of Kampung Melayu is between 9-18m above the sea level. Kampung Melayu with area 0.48 km² has high density of people. This area was dominated by unorganized housing (64%). The total number of population is 23,062 people in Kampung Melayu (7,394 households) or approximate 85% from all population are living in flood risk area, spread in 96 RT. They are most located in *Kampung Pulo* (*RW* 01, 02, and 03) and *Tanah Rendah* (*RW* 07 and 08) [*ACF*, 2006].

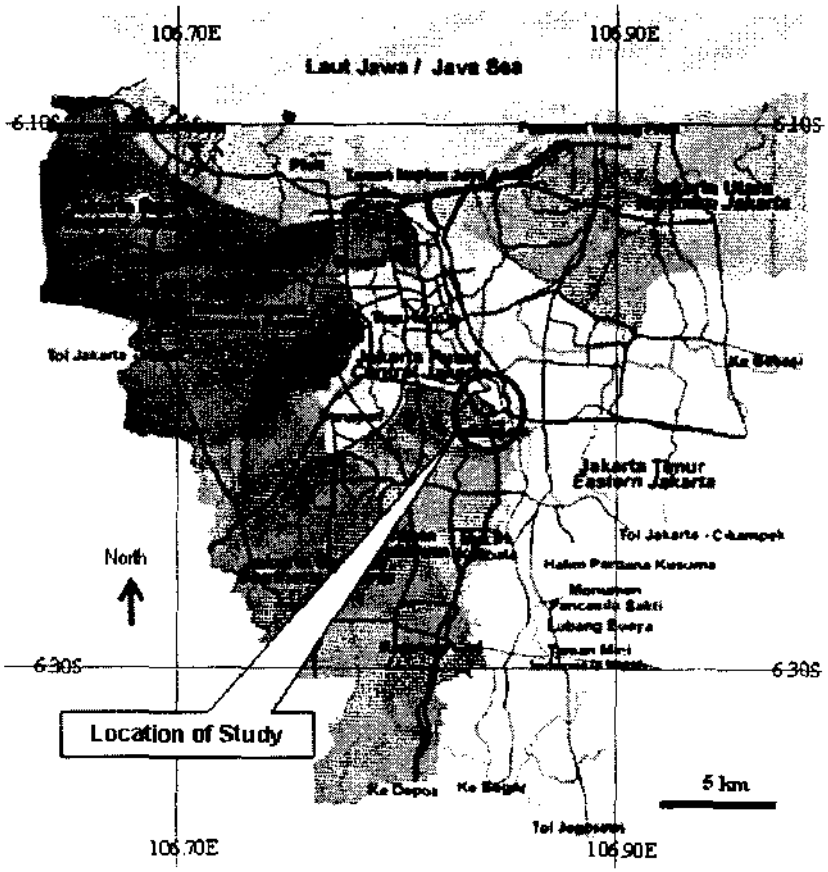

Figure 1. Study area of the research

THE METHODS

This research is focused on determining the people's perception about flooding risk, identifying and classifying certain elements at risk which would be affected by flood in study area, and assessing the vulnerability of the elements at risk (structural types of buildings, building contents and socio-economic aspects). A list of buildings with *building_id* and coordinate information for each *RW* was prepared. There were 8 *RW* in *Kelurahan* Kampung Melayu. Then from the list of building of each RW, author selected several sample of buildings randomly. Based on information gathered from literature review and discussion with government official in Kampung Melayu, *RW* 07, 08, 02 and 03 is considered as the most suffered from floods, for that reason the sample in this area is larger than other. Because author used different sampling fractions in the strata (*RW*), the sampling method in this research called non-proportional stratified random sampling. Overall, there were 83 point sample designed for field survey (Fig. 2).

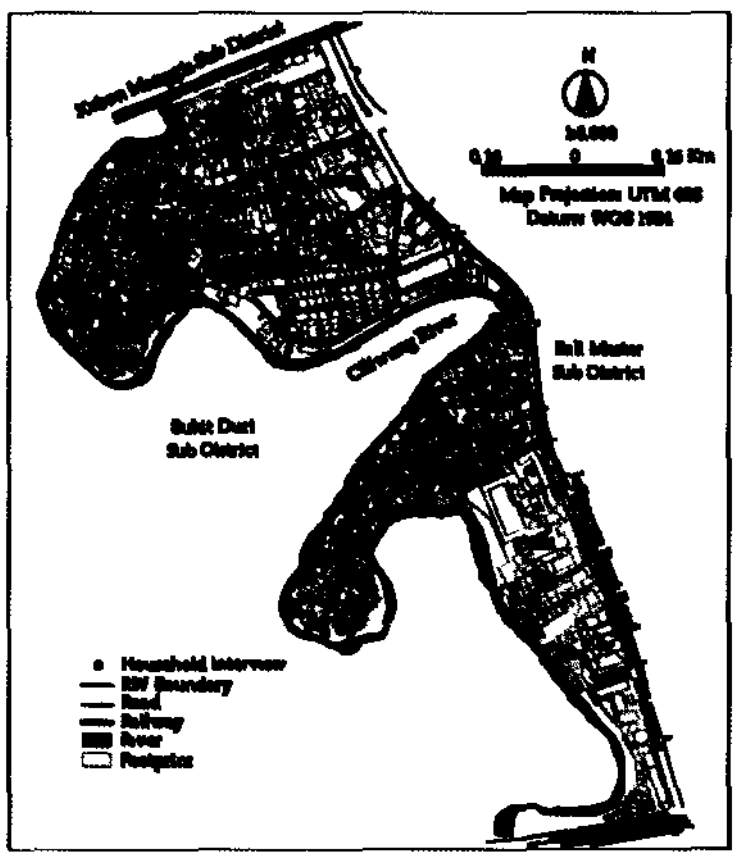

Figure 2. Spatial distribution of respondents in Kampung Melayu

Building inventory aimed to gain building information for database and to verify the respondents' answer during interview. The activities in building inventory were measuring the height of floor from street and above the surface and observing the physical aspect of building such as wall material, floor material, roof material, number of floor, etc. All information was stored in mobile PDA and added as an attribute for each building points. The attributes for building inventory were: *building_id, date, owner, function, wall material, floor material, roof material, number of floor, size, floor height from surface, floor height from the street and photo's number.*

The purpose of household interview using questionnaires was to get detailed information about element at risk including asset and damage estimation for each household, risk perception regarding flood in this area. In-depth interview and consultation were held with occupants of the buildings identified as being risk. Each interview lasted between 30 and 45 minutes.

There are tree parts in the stage of analysis: risk perception analysis, identification of certain element at risk, and vulnerability assessment (physical and socio-economic aspects). For vulnerability and risk perception analysis, author conducted spatial analysis using GIS software (ILWIS - Integrated Land and Water Information System) [*ITC*, 2001]. It was used to plot the physical element at risk (building material) and results from analysis. Flood extent and flood duration map was processed using ILWIS. Kriging methos was applied to interpolate the point data using Gaussian model. Risk perception map was generated from the flood extent and flood duration map. Statistical analysis used in this research includes descriptive statistics and cross tabulation analysis to get the chi square value.

RESULT AND DISCUSSION

Flood Occurrence in Kelurahan Kampung Melayu

There were 83 households interviewed during the fieldwork. From each of the households, data on flood-depths and flood-durations were gathered. The flood depths data was measured inside the house using the first floor as the reference. In order to produce the flood extent and flood duration map in ILWIS software, points in shape file were transferred into ILWIS format. Next, the water height and water duration dataset were interpolated using a kriging method. The experimental semi-variogram values for water depth and water duration dataset was build using Gaussian model, which is the best fit model for both dataset. Finally, using ordinary kriging method, the flood extent and flood duration of February 2007 flood was generated (Fig. 3). Based on this map, information about the water depth and water duration during flood event in February 2007 clearly depicted. The water

covered almost all of Kampung Melayu area in eight *RW*s. Water depth varies from 0–5.4m, while the water duration has range 0–15 days.

People's Perception on Flooding

Some information related with flood in the study area is found. Flooding comes annually every rainy season with fluctuating water heights, in the range of 10-100cm. The big floods with five years return period struck in 1996, 2002 and 2007. The flood of 2007 was the largest and the most destructive flood that ever happened in the area. People will stay in their house if water only inundates their first floor and only move their properties to safer places. The flood left mud with upto 50cm height with garbage and a horrible smell. To cope with this situation, the people cleaned up their house and surroundings together (*gotong royong*). This is the positive thing related with flood in this study area, which is an urban area where usually people only think about their selves.

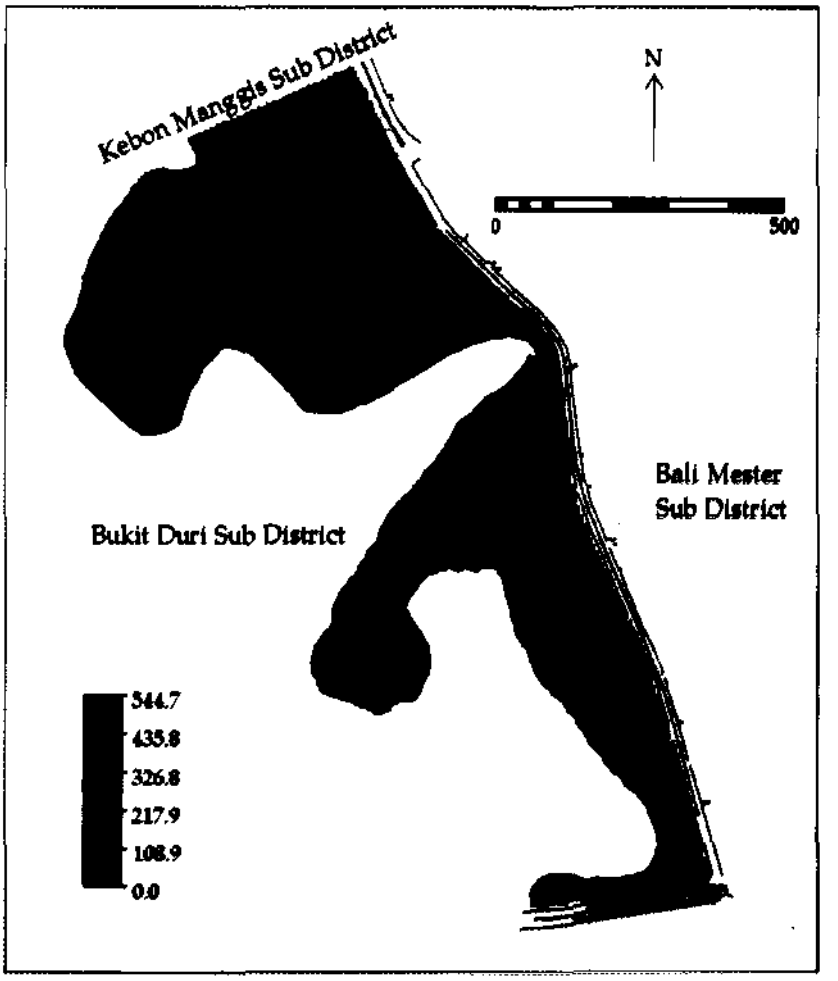

Figure 3. Interpolated map for the water depth during flood in February 2007

Since the majority of these communities live mostly on trading, this research revealed that proximity to the community's livelihood-rather than safety-was the main reason why they settle in these flood prone areas. Although the majority of the interviewed households are aware that garbage can causes the river to be flooded, this does not affect their behavior; their attitude is not to throw their trash in proper places; they still throw their waste into the river. The waste disposal management and houses in the riverbanks are serious problems found in this study area; therefore local people with government should cooperate to handle this problem if they want to reduce the impact of floods in this area. The information collected from the households' interview was summed up into a VCA (Vulnerability Capacity Assessment) matrix (Table 2) to see the vulnerability and capacity in three broad aspects, including physical/material, social/organizational and motivational/attitudinal.

Table 2: VCA (Vulnerability Capacity Assessment) matrix

Aspects	Vulnerabilities	Capacities
Physical/ material	1. Annual flooding during rainy season; the big flood every five years. 2. Poor housing along the riverbanks. 3. Low income family. 4. Lack of adequate skills and low education level. 5. The population density is high. 6. Poor garbage disposal system. 7. Lack of clean water and sanitation. 8. Dependent on moneylenders.	1. People build 2-story houses using construction materials that are locally available and cheaper. 2. Many people can swim. 3. Availability of public latrines. 4. Presence of Early Warning System. 5. Dissemination of EWS using several communication facilities like mobile phone (SMS) which is very effective. 6. Near Jatinegara traditional market (source of income).
Social/ Organiza-tional	1. The young children have to work to help their parents. 2. During flooding most of households cannot go to work. 3. Lack of participation in disaster management.	1. Presence of *Lurah*, head of RW and RT in dissemination of flood warnings. 2. Assistance from NGOs (for example: ACF). 3. People help each other to cope with the flood, for example: *gotong royong* to clean the canal. 4. Presence of SATLINMAS as the local disaster institution. 5. Presence of public kitchen during flooding.
Motiva-tional/ attitudinal	1. Most of respondents state that the flood is only a normal event. Flooding becomes part of their life. Intentional forgetting due to lack of alternative settlement options. 2. They keep throwing the garbage into the river.	1. Some of the young people trained by NGOS or organization that concerned with flood to help the community in preparation, during and aftermath the flooding.

Source: Fieldwork data (2007)

Flood Risk Perception

This section will explore the flood risk perception based on the local people's perception. The knowledge of local people will be a basis on determining the relationship between water depth, duration and flood intensity. During interviews, households were asked to determine the level of flood risk which is categorized as normal, manageable, unmanageable and disastrous with specific water depth and water duration for each risk perception category using open-ended questions. The answers collected from 83 respondents then inputted using worksheet in Microsoft Excel, the majority of answers related with water depth and duration then selected to represent each level of flood (normal, manageable, unmanageable and disastrous). The community's perception on flood intensity is presented in Table 3.

The terminology of "*normal*" in this case indicates that the community still perceives the flood as a natural event and they are already familiar with it because it happens every year during rainy seasons, usually from December until March. "*Manageable*" means although they accept this flood occurrence as recurrent natural event, they still can manage it, it starts to become disturbing because it will cause problems like lack of clean water, difficulties to work, etc. In this level, people prefer to stay in their flooded house rather than go to evacuation centre. Households who have two stories building or more will continue their daily activities mostly in the second floor.

Table 3. Community's perception on flood intensity

Water depth (cm)	Duration (days)			
	< 1 day	1 – 3 days	3 – 7 days	> 7 days
10 – 50	Normal	Normal		
51 - 100	Normal			Unmanageable
101 – 200			Unmanageable	Unmanageable
201 – 300	Unmanageable			
> 300				

Source: Fieldwork data (2007)

The "*unmanageable*" terminology means that people consider that they cannot deal with the flood because it becomes higher and it causes more problems. Usually the head of households didn't go to work in order to keep their family safe in the inundated house. During this level of flood intensity, most people decide to go to the nearest evacuation centre (shelter). "*Disastrous*" in this research represent the uncontrollable flood and all respondents prefer to evacuate themselves to the safer places. Later on, the criteria were processed using ArcView to create the map of flood risk perception based on household interview in Figure 4.

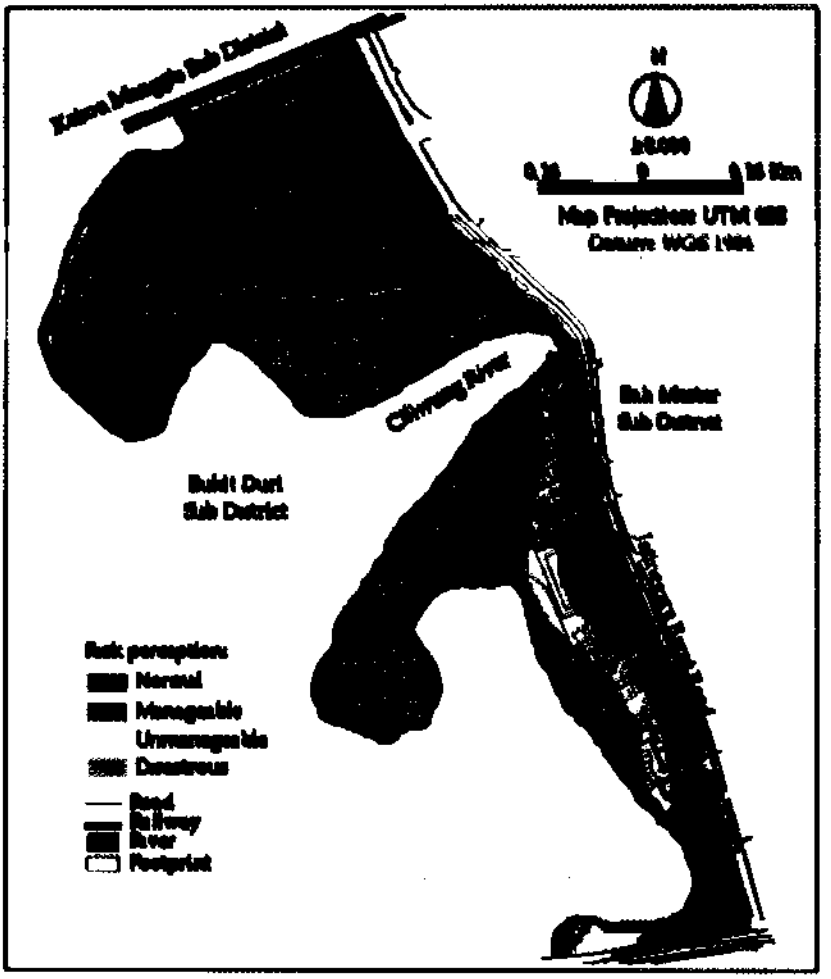

Figure 4. Flood risk perception based on household interview

Analysis of Elements Risk due to Flooding

Element at risk related with physical or structural of building collected during fieldwork through building inventory and households' interview. In physical aspect, information about wall material, floor material and roof material was gained. The result of this research found that most of households using concrete material for wall, floor, and roof.

Concrete wall they used was called "*tembok*" which is use brick as main material and covered with cement and plaster. This kind of wall material believed as the less damaged-wall-material during flood because its structure is solid and quite sturdy. There are mixed wall building found in this area which is combination of concrete wall material with plywood or bamboo sheet. Local people prefer to build

this kind of structure because they want to make their house resistant to annual flood with flood depth 10 – 50 cm with low-priced material. Cement and ceramic tiles was found as the most favourite floor material in this study area because this type of floor material is easy to clean after flood. Most of respondents use clay tiles as their roof material. From combination of wall material, floor material and roof material, five common structural type of building in this study area was found. More than a half of respondents in Kampung Melayu built the second-storey-house although they build it with low-priced material. This means they already have their own ways to minimize damage caused by floods that happen regularly in that area with considering of their own capacities.

Building Contents

Valuation of households' asset is very important to examine the building content vulnerability [*Sagala*, 2006; *Dutta* and *Tingsanchali*, 2003; *Wisner et al.*, 2003]. Building contents found inside the houses in Kampung Melayu include include furniture and appliances. From this research revealed that local people located their valuable properties – for example: electronic appliances, books and important documents, jewellery, etc - in the second floor to avoid the damage during the flood.They also decided to choose the furniture made from plastic that easier to move to safer place during flood. Most of total values of building contents are less than Rp 920,000. This value shows the value of building contents that could be damaged during flood.

Characteristics of the People at Risk

Some indicators such as: age and gender, occupation and income, households' size, educational level, length of stay and housing status were used to access socio-economic characteristics of the people in the study area. The capacity of households react upon the flood can be measured using those socio-economic indicators. Age of the respondents mostly 41-50 years old; consist of 49 male respondents and 34 female respondents. Most of female respondents are housewife while the male respondents are traders. Their income and educational level seems to be low; 74.7% of the interviewed households categorized as low income family and 51.8% of the respondents only achieved elementary level. There is relationship between income related to building structure and building contents. Their insufficient income and lack of formal education limit their capacity to improve their livelihood strategies, for example they can not compete and function effectively in the labor market. This research revealed that most of households own their houses and it force them to secure their asset with several coping strategies.

Analysis of Vulnerability Assessment

Vulnerability of Building Structure to Flood Vulnerability of building structure in this research refers only to the damage of building material (wall, floor and roof) without considering other parts of the building. During the household

interview, the percentage of damage with above mentioned codes were used and the respondents were asked to define the damage based on the condition of wall, floor and roof during the flood occurrence. Vulnerability for building structure in this research made in on scale from 0 to 1. The damage on structural building determined based on Nothing Happen - NH (0%), Half Collapse – HC (50%) and Collapse – C (100%) that is divided into seven values between 0 and 1.

The vulnerability of building structure found that among five structural types of building, the most prone to flood is the structural type 5 which is made from combination of mixed wall – mixed floor – asbestos roof. While the least vulnerable to flood is structural type 1 which is made from combination of brick wall - concrete floor - clay roof material.

Vulnerability of Building Contents to Flood

In analysis of building contents vulnerability, quantification of people's belongings found inside the houses was done using three lists of assets regarding to the three socio-economic levels. Subsequently, based on the building contents analysis, five classes of building contents vulnerability were generated: *very high*, *high*, *moderate*, *low* and *no vulnerability* (see Table 4). Finally, the map of building contents vulnerability is plotted spatially in Figure 5. There is a finding when the map of building structure vulnerability compare with the map of building contents vulnerability. It found that even the buildings located in relatively lower water height and have moderate vulnerability of building structure, the building contents vulnerability found higher. Therefore, it can be concluded that building contents vulnerability is also depend on the social status (income) of the households and the total assets found inside the houses.

Vulnerability of People to flooding

Vulnerability of people due to flood in this study area was investigated using several indicators, such as: age, gender, occupation, income, educational level, length of stay, and housing status. Those parameters were selected through literature review and the socio-economic characteristics found during fieldwork. The social indicators which can influence the social vulnerability in the study area were summarized in Table 5. A full research in social vulnerability is absolutely required in order to recognize and integrate the real root causes of social vulnerability in Kampung Melayu. Hopefully this information will encourage the local government, stake holders and policy makers, emergency planners, NGOs and local people in the study area to develop a comprehensive CBDRM before for the next flood coming.

Table 4. vulnerability class for each five structural types of building

Building Content Vulnerability Class	Vulnerability
No Vulnerability	0
Low Vulnerability	<=0.2
Moderate Vulnerability	<=0.5
High Vulnerability	<=0.8
Very High Vulnerability	<=1

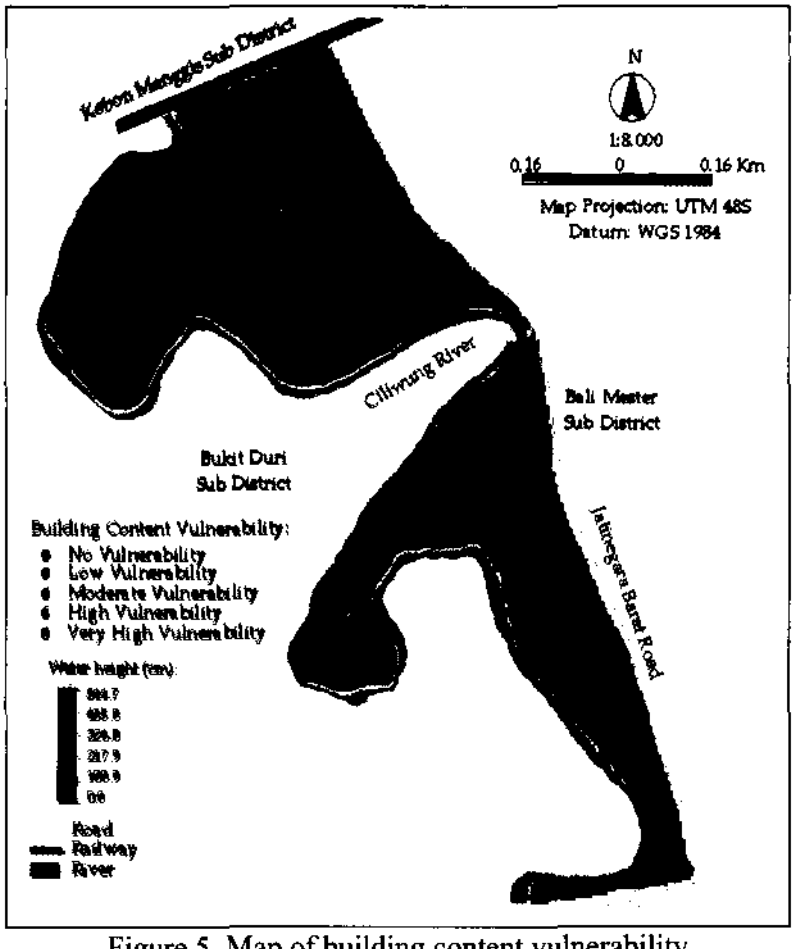

Figure 5. Map of building content vulnerability

Table 5. Socio-economic indicators influencing social vulnerability

Socio-economic characteristics	Description	Increases (+) or decreases (−) social vulnerability
Age	• Relates to the movement during evacuation or when the flood strikes: the elderly and the children need some assistance during that period.	Elderly (+) Children (+)
Gender	• Women frequently have more difficulties than men to recover from flood disaster, because of the responsibilities to take care of her family. • During flood events, women often need help from men to evacuate themselves to the shelters.	Woman (+) Men (-)
Occupation	• People, who are live on trading, depend on the source of income (traditional market and railway station); therefore they prefer to stay in this flood-prone area. • Street trader or people who do not have permanent job indicate to have low income and it makes them more vulnerable due to flooding.	Peddler, non-permanent job (+) Employee (-)
Income	• People with low income suffer more after the flood because they can not afford the costs of repair, reconstruction, or relocation. • Wealthier can recover more quickly from losses using insurance and additional financial resources. • Nevertheless, the high income people are more likely to register the highest magnitude of economic damage because they have more possessions, and of higher value.	Low income (+) High income (+/−)
Education level	• Education is linked to the socio-economic status (income). Higher educational attainment affects lifetime earning. • Limited education constrains the ability to understand warning information and access recovery information.	Little education (+) Highly educated (−)
Length of stay	• People who stay more than 20 years have a strong relationship with the neighbors as well as their wide social network. • People have more direct experiences from previous floods.	Longer stay in that area (-) New comer in that area (+)
Housing status	• Renters didn't have responsibilities to build their houses more than one floor in order to minimize the impact of the flood. • Owners able to build their houses more resistant to flooding and can receive financial support from the government for reconstruction.	Renters (+) Owners (-)

Flood Forecasting and Early Warning System (EWS)

In flood forecasting and warnings, *lurah*, the head of *RW* or *RT* plays an important role in the study area. Dissemination of warnings is distributed using several tools, such as phone, mobile phone, handy talkie (HT), mosque's speaker and door-to-door. Many people using mobile phone to send the SMS in order to distribute the flood warning to their friend or relatives. Mainly, the flood forecasting within this community is through monitoring the water height at several Watergates and there are four alert levels. This information has not followed the action plan for the community, nor the community preparedness plans. Individual households must take their own decision whether they must go to evacuation center or not. Many different sources of flood warnings can drive people into uncertainty and panic. This research also reveals that the warnings are not always trusted by the people. More reliable information is needed because it will influence people's response to flood.

Flood Management by Government

Flood management by the local government is not adequate to cope with the flood. It basically only focuses on the flood emergency response and not on the preparedness action before the flood is coming. The local governments and the local people should work together to design the community preparedness plans according to the existing flood forecasting and warning. Local people should be aware of their role in flood management.

CONCLUSIONS AND RECOMMENDATIONS

Base on the analysis and discussion metioned above, there are some points to be drawn in this conclusion.

1) Some interesting findings exist in this research related with people's perception. *First*, people help each other to clean up the house and surrounding before and after flooding (*gotong royong*). It is a positive thing related with flood risks in this study area and an unusual phenomenon in urban areas, where people are usually more individualistic. *Second*, the proximity to community's livelihood rather than safety is the main reason that people stay in this flood-prone area and *third*, the root causes of flooding based on people's perception, which are *banjir kiriman* from Bogor area, garbage and excessive rainfall. In risk perception, people determine the water height and duration of flooding which they perceive and consider to be levels that are: *normal*, *manageable*, *unmanageable* and *disastrous*. It is found that the flood height 10-50 cm with duration 1-3 days and flood water height 51-10 cm with duration less than 1 day were considered as *normal* event. These accounts may not match with the

hydrological or technical models, but however this is what the local people actually perceive and feel to be the flooding risk that communities suffer from.

2) From the physical/structural type of building aspect, there were five different structural type of buildings found in this study area. The building contents, which are people's goods and properties found and located inside the house, are grouped into one element at risk based on their value. The components of social elements considered as the key characteristics of the people at risk are age, gender, occupation, income, educational level, length of stay and the housing status.

3) It was found that the damage and vulnerability of the building structure is mainly determined by the material of the house. The least vulnerable is structural type of building 1 which is made from combination of brick wall-concrete floor-clay roof material while the most vulnerable is the structural type 5 which is made from combination of mixed wall–mixed floor–asbestos roof. It is found that damage is strongly linked to the socio-economic status (income) of the households. Buildings with more assets will possibly have a higher damage and also have higher building contents vulnerability even though the buildings located in a relatively lower water height and have more resistant building structure. For vulnerability of people, several indicators: age, gender, occupation, income, educational level, length of stay and the housing status were identified which can increase or decrease the vulnerability. There was no spatial analysis performed within this vulnerability assessment. Therefore, in order to have more detailed information about social vulnerability in this study area, a full research is absolutely required.

4) Through this research, it was found that since this is a flood-prone area, both community and local government already make some arrangements concerning their capacity to cope with the flood. Further analysis found that there are different coping strategies conducted by female and male respondents. One interesting finding is the key role of the lurah, head of RW or RT during dissemination of flood forecasting and warnings. The flood forecasting found in this community is commonly through water height monitoring in several Watergates with four alert levels. Due to the non-existence of action plan for the community, many households live in uncertainty and panic. This research also reveals that warnings are not always trusted by the people because sometimes this information has not been accurate. Flood management by the local government is not sufficient to address the flood risk in the study area because it still focuses only on the disaster response. Local government should pay attention to the preparedness action before flooding occurs in order to reduce the impact of floods.

Recommendations for future studies are as follows:

1) This research basically was aimed at utilising local knowledge, and did not consider other aspect; therefore further studies in this area need to include the hydrological and meteorological data, river morphology, elevation contours at a detailed scale, etc. as additional inputs to produce a better and more accurate result on flood hazard assessment.

2) Since this is a research involving community participation, in order to test the accuracy and reliability of the results obtained, they should be checked by the local people, through key persons (local traditional leader, administrative leader, and town planning institution) and FGD (Focus Group Discussion) in this study area.

3) Concerning the vulnerability of building structure assessment, the duration of the flood waters plays an important role, and it obviously influences the level of damage of the building structures; therefore the combination of water depth and water duration is needed for the next research.

4) Micro-level vulnerability and capacity assessment performed in this research could be enhanced by linking this analysis with a macro-level assessment of disaster and vulnerability contexts. Combination of micro-macro analysis would give a wider point of view and help assess how national socio-economic condition and political systems and processes are directly related to and could influence local vulnerability contexts.

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