Evacuation decision during the flood: a case from the 2013 Jakarta flood

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Abstract

We present the results of questionnaire survey to identify the flood awareness in Jakarta. Three locations were selected as the study areas to represent three different types of flood in populated city. First is the area along the river that frequently inundates by the overflow water during the rainy season. Second is the area that often inundates temporarily due to insufficient drainage and the third is an area near the coast that frequently flooded by the ocean water during the high tide. We hypothesized that those different types of flood may affects in determining the awareness, which we parameterized in the evacuation activity before and/or during the flood. The analyses indicated that the evacuation is indeed determined by the actual flood height –that reflects different types of flood, and its impact on the respondent's house. However, this result also emerges that the awareness is very low because people start the evacuation not before the flood arrives but after it impacts their house and after the flood height has been very dangerous to their safety.

1. Introduction

Jakarta has undergone frequent floods in every five years since 1996 (1996, 2002, 2007 and 2013). The last two events caused 87 deaths in 2007 and 47 deaths in 2013 respectively. Of the total number of casualty in 2013, some of them occurred in the central business region of Jakarta City, where a part of the flood canal's dike were collapsed and suddenly flashed the most important economic district with deluge including the presidential palace. Up to present, there was no systematic flood early warning and no official evacuation sites developed by the government. Thus, awareness and evacuation response is mostly based on people's judgment and their personal risk perception at the time of the flood. Noting this fact, we carried out questionnaire survey to determine the evacuation response of people during the flood. We aimed to demonstrate that evacuation response might be different depending on the type of flood, which represent the actual flood risk during the event.

We distributed around 600 questionnaires and collected around 448 valid results in three places (Fig. 1). These three places represent different types of flood namely riverine flood, local urban flood and coastal/tidal flood. Two villages located along the Ciliwung River were selected to reflect area that is prone to riverine flood, namely Cililitan and Manggarai. In these villages, flow capacity of the river has been decreased in the last three decades due to sediment and illegal settlements (Steinberg, 2007). This yields to the frequent floods with a height up to 9 meter once a heavy rainfall occurred in the upstream. The second study area located near the central business district namely Cikini District. Here, local urban flood with a height less than 0.5 meter often occurred due to insufficient city drainage and not well maintained water paths. The third area located nears the coast namely Pademangan District, where the tidal flood is frequently occurred during the high tide (up to 1 meter). Pademangan District has also

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undergone massive subsidence (up to 1.5 meter) since the last three decades (Abidin et al. 2011) and it was surrounded by rivers where the water surfaces area lower the mean sea level. The river flow is transferred to the ocean by using water pumping, which is not also well maintained.

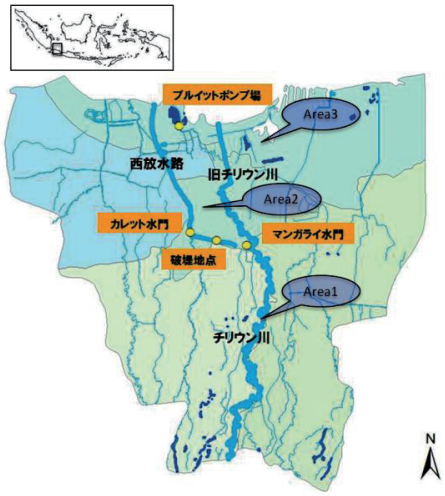

Figure 1. The location of study areas in the City of Jakarta, Indonesia.

2. Data and methodology

We developed set of questions consist of three major parts that are evacuation response, risk perception and socio-economic including the trash and garbage management problem. In addition, basic demographic data is also collected. The respondents are 'accidentally' selected, which means the haphazard sampling method is applied. The results of the questionnaire survey were analyzed by means of logistic regression analysis (Eq. 1) to identify factors contributed on decision to evacuate (fig. 2).

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 \ldots + \beta_p x_p \qquad (1)$$

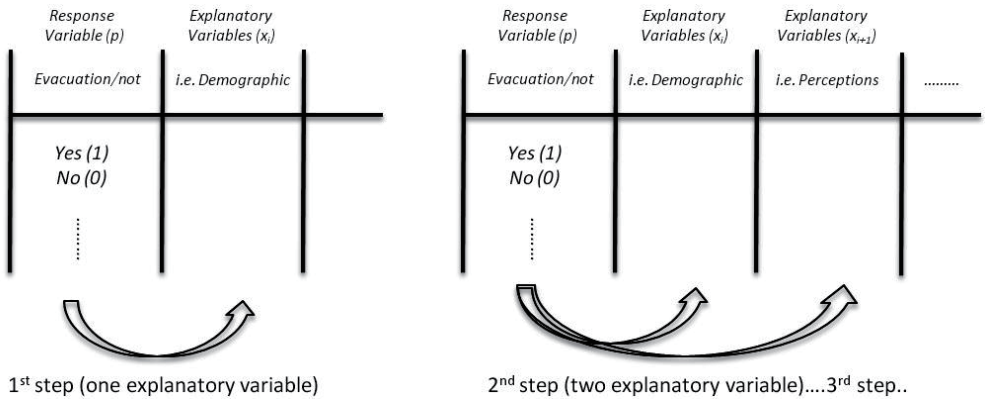

Figure 2. The data processing steps to analyze the influential aspects in the evacuation activity.

The tendency to evacuate is analyzed to be correlated with actual perceive risk (actual flood height and inundated or not, house damage and etc.), experiences (past maximum flood height, estimated return period and etc.), demographic (age, gender, occupation and etc.), ownership (house ownership, duration of stay, house material and etc.), risk perception (type of flood, estimated flood hazard/harmful or not, estimated height of dangerous flood and etc.), and early warning (availability, received it or not and etc.).

By referring to Fig. 2, we are first analyzing the influence of each component (single explanatory variable) in the evacuation activity (response variable), which we represent in binomial number; 1 for evacuate and 0 for not-evacuate. Next, we exercise the influence of the other factors by adding more explanatory variables in the Eq. 1 and check their contribution to improve the statistical correlation between the expected frequencies with the observed ones. The results of the regression are analyzed by means of various statistical coefficients and methods. Among them *G*-test (e.g. Hoey, 2012) is chosen to be presented in this paper.

3. Discussions

The low-income families mostly dominate the respondents in the first and third areas. Some of them live in illegal settlement along the Ciliwung River with the dominant demographic parameters are female (64%), elderly (35.9%) and unemployed (63.6%). This class represents the most vulnerable people in the society since they are more depending to the other class (i.e. young, male and etc.) in deciding and do the evacuation during the flood. In contrary, respondents in the second area are junior high school students who live in the central city and mostly come from the high-income family.

The general statistical description of the respondent and their primary responses in a closed-type question for the variables described in the previous chapter is given in Table 1.

Table 1. The statistical descriptions of the respondent and their primary responses on flood awareness

Variable	Number	Percentage	Variable	Number	Percentage
Age			*Home ownership*	197	43.97
< 20 years	148	33.04	Own	70	15.63
20 - 40 years	109	24.33	Parents	70	15.63
40 - 60 years	161	35.94	Brother	111	24.78
> 60 years	30	6.70	Tenant		
n	448		*n*	448	
Gender			*Evacuate or not*		
Male	110	35.95	Yes	199	46.06
Female	196	64.05	No	233	53.94
n	306		*n*	382	
Education			*Experience with previous flood*		
Never been at school	29	6.47	Yes	323	74.60
Elementary school	73	16.29	No	110	25.40
Junior high school	219	48.88	*n*	433	
High school	107	23.88			
S1/diploma	18	4.02	*Flood early warning availability*		
S2	2	0.45	Yes	142	34.89
n	448		No	265	65.11
			n	407	
Occupation					
Government	8	1.79	*Flood can treathening safety*		
Private	43	9.60	Yes	215	56.28
Unemployee	285	63.62	No	167	43.72
Self employee	91	20.31	*n*	432	
Unskilled labour	21	4.69			
n	448				

The breakdown of the general perception and knowledge about flood and the awareness in each area are given in Table 2. Here, we can see that most of respondents said garbage disposal into the river is the primary causes of the flood, regardless the type of the flood (Table 2). This may indicates that flood in Jakarta has been shifted from the purely natural phenomenon into the social driven (human-made) flood.

The respondent in each area can also identify the type of flood that occurs in their neighborhood. This reflects that people experienced not only the cause but also the characteristics of flood in each area. The evacuation response is found to be associated to the actual flood height and feeling worries/afraid. It explains the reason why most of respondent in area 1 evacuated while in area 2 and area 3 were not. In area 1, the flood height can reach up to 9 m, so the hazard is perceived to be harmful on property as well as the life. However, flood height in area 2 and area 3 exceed no more than 1 m yields less awareness and reduce pretension to evacuate. There is an exception in area 3 where feeling worries is the most dominant factor in the perception of flood hazard. This is because the respondent is perturbed by the appearance of animals, flood-debris and the potential of outbreaks during the flood.

Table 1. General findings from the questionnaire survey

No.	Variable	Area1 (%)	Area2 (%)	Area3 (%)
1	**Causes of the flood**			
	- Garbage disposal in the river	36.10	92.68	44.08
	- River sedimentation	13.74	0.00	3.29
	- Heavy rain	5.75	2.44	7.24
	- Flood in upstream	24.60	0.81	1.32
	- High tide	0.00	0.00	28.95
	- Others	19.81	4.07	15.13
	Total	100.00	100.00	100.00
2	**Types of flood**			
	- Riverine flood	89.54	33.93	22.00
	- Local Urban flood	10.46	66.07	30.00
	- Tidal flood	0.00	0.00	48.00
	Total	100.00	100.00	100.00
3	**Evacuation response**			
	- Evacuate	83.77	17.19	31.79
	- Not evacuate	16.23	81.25	68.87
	Total	100.00	100.00	100.00
4	**Reasons to evacuate**			
	- Actual flood height (velocity)	55.81	71.43	52.17
	- Worrines/afraid	41.09	28.57	17.39
	- Evacuation order	1.55	0.00	6.52
	- Solidarity	1.55	0.00	2.17
	- Convenient	0.00	0.00	21.74
	Total	100.00	100.00	100.00
5	**Reasons why flood is harmfull**			
	- Expected flood damage (house/life)	72.97	33.33	13.27
	- Worrines (desease, debris, animals)	23.42	33.33	84.69
	- Limited access to lifelines (water, electricity)	3.60	33.33	2.04
	Total	100.00	100.00	100.00

We continue the analysis by using logistic regression to check the influence of each variable in the questionnaire and the combination of them in affecting the evacuation response. The maximum likelihood *G* for the single parameter is shown in Fig. 3.

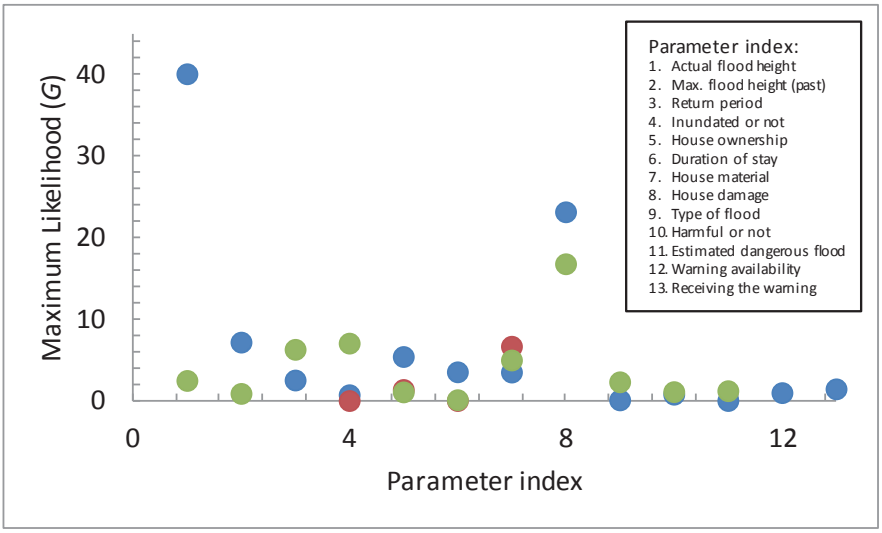

Figure 3. The result of *G*-test for each parameter in each area. Blue circles represent results from the area 1, green circles from the area 2 and red circles from the area 3 respectively.

In area 1, we found that the evacuation activity (evacuate or not) is mainly influenced by the actual flood height and with the actual perceived risk (whether the respondent's house is damaged or not). There is no significant influence of the early warning to urge people to evacuate. This is because of the term of 'early warning' refers to the chain of information about the water level between people in the upstream with people in the downstream. However, the information is sometime biased and yields distrust among people in the downstream about the validity of the warning.

In area 3, the actual perceived risk (house damage or not) is the most influential parameter to urge people to evacuate. This result underlies by the fact that the typical tidal flood in this area requires longer time to recede. Thus, people whom their house are damaged by the flood will be more convenient to stay in the evacuation shelter, particularly for elderly and jobless person.

In area 2, we obtained inconsistent answer on the above parameters. We supposed that this is because of the impact of flooding in their neighborhood is not severe; some of them are even not impacted at all. This situation makes them unable to answer the question appropriately.

4. Conclusions

The results we presented above highlight that decision to evacuate are highly depending on the actual perceived risk (the actual flood height and its impact on respondent's house). There is no influence of the community based flood early warning is found. It means people will evacuate not before the flood arrives,

but after the flood has been inundated their neighborhood and damages their house, or after they felt that flood height has been very dangerous for their safety. This result emerges that the flood awareness may still very low. Thus, education and socialization are urgently needed.

References

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