Journal of Natural Disaster Science, Volume 37, Number 2, 2016, pp35-47

A Comparison of the Reasons for Evacuation Behavior during Floods –Contrastive Effects of Disaster Consciousness –

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(Received: Nov. 15, 2015 Accepted: Sept. 16, 2016)

ABSTRACT

The state of so-called disaster consciousness has generally been seen as one of the typical determinants of evacuation behavior during floods. However, the preconception that a high level of disaster consciousness ought to lead to a high rate of evacuation, and that a low rate of evacuation is because of a low level of disaster consciousness, is overly simplistic.

In this paper, a counterexample from Thailand is given in which a high level of disaster consciousness leads to a low rate of evacuation, and this is then contrasted with a case from Japan in which a high level of consciousness leads to a high rate of evacuation. Using a questionnaire survey, unified data were collected. The investigation found that the respondents in Thailand tended to remain in their own homes during a flood disaster because of their high disaster consciousness. Consequently, in such a region, disaster risk management education that aims to raise disaster consciousness should be implemented after social unrest is quelled.

Keywords: evacuation, fear of human damage, fear of material damage, fear of theft

1. INTRODUCTION

The state of so-called disaster consciousness has generally been seen as a major determinant of resident evacuation behavior when there is some time before the actual disaster event occurs, such as with river floods. Japan, one of the study areas in this paper, is no exception. An examination of Japanese reports found that disaster consciousness was identified as a key determinant of evacuation success (e.g., Kawata et al., 1999; Miyase et al., 2009; Matsumoto et al., 2010; Saiga et al., 2011; Yoshida et al., 2011; Sugimoto et al., 2012; Tatsukawa et al., 2012).

While disaster consciousness has been an important consideration in evacuation procedures in both Thailand and Japan, low resident evacuation rates have often been incorrectly and simplistically ascribed to a lower level of disaster consciousness.

The oversimplification of this complex motivation is the primary focus of the research in this paper.

In other words, the central aim of this paper is to elaborate two cases of disaster consciousness: the first where a high level of disaster consciousness leads to a low evacuation rate (hereafter referred to as the "Negative Correlation Case: NCC"), and the second where a high level of disaster consciousness leads to a high evacuation rate (hereafter referred to as the "Positive Correlation Case: PCC").

In addition to disaster consciousness, previous research has found other determinant factors for evacuation preparedness. Nakamura (2008) argued that it was useful to hypothesize an "overflow model," in which residents decide on and carry out evacuation if their "disaster consciousness" and other "social factors" exceed a specified threshold value. Sorensen (2000) cited "fear of looting" as one of 32 major determinant factors for evacuation and empirically hypothesized that this contributes to reducing evacuation rates. However, the reduced evacuation rates observed in these papers were indirect effects that were externally observed.

This paper takes the view that the choice to "evacuate/not to evacuate" is a result of "actively choosing/not choosing to stay at home." Based on this view, in this study, we discuss the differences between the two contrasting cases ("NCC" and "PCC") using quantitative unified data.

2. FRAMEWORK OF THIS ANALYSIS

Our hypothesis regarding the relationships between several key concepts and terms is explained in the following sections. These relationships are also summarized in Fig. 1.

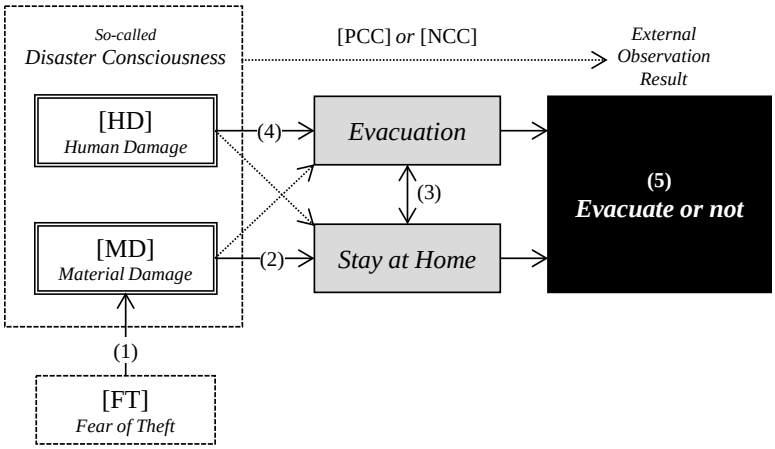

Fig. 1 Relationships between several key concepts and terms

2.1. Subject areas

There are many examples that could be used for this discussion of contrasting cases. However, as it is impossible to cover all cases, with reference to the reports discussed above, in this paper, we take Japan as an example of a "PCC" in which a high level of disaster consciousness leads to a high evacuation rate.

For an "NCC," in which a high level of disaster consciousness leads to a low evacuation rate, we refer to the reports by Henry et al. (2013; 2015) that found "a public fear of the risk of theft" (hereafter referred to as "Fear of Theft: FT") to be one of the background factors for the low evacuation rate during the 2011 Thai flood. "FT" could be seen to be related to a motive related to mitigating material damage (hereafter referred to as "MD") as opposed to a motive related to mitigating human damage (hereafter referred to as "HD") (Fig. 1(1)). This motive to mitigate "MD" could be interpreted as an intention to stay at home (Fig. 1(2)), but also as an obstruction to evacuation (cf. Fig. 1(3)). Therefore, Thailand is considered to be an example of the "NCC" in this comparative study.

2.2. The meaning of "not to evacuate" in the analysis

When facing a flood disaster, being certain that the disaster is going to occur corresponds to being conscious of the possibility of human and/or material damage. This psychological consciousness of the high possibility of human or material damage is often called a "high level of disaster consciousness." Therefore, from the viewpoint of mitigating "HD," "evacuation" is an effective measure (Fig. 1(4)).[1] On the other hand, from the viewpoint of mitigating "MD," "staying at home" is an effective measure to protect possessions. An important point to emphasize here is that "staying at home" inevitably corresponds to "no evacuation" (Fig. 1(3)).

There are three possible reasons for "no evacuation." First, residents actively choose "not to evacuate," although this situation may be rare. Second, residents "withhold a decision"; in other words, they are unable to choose "evacuation" because they do not have sufficient information to decide whether the disaster is serious enough for evacuation but they are extremely fearful and search for information to alleviate their fear. The above two possible reasons for "no evacuation" are common to most disaster scenarios, including the two cases in this study. Third, residents actively choose to "stay at home." To explain the differences between the "no evacuation" causes in our two subject areas, we refer to a third possible cause as it is presumed that a structure in which "FT" reinforces the intention to reduce "MD" is more characteristic of Thailand than of Japan.

Accordingly, it is not enough to only observe "evacuation/no evacuation" externally (Fig. 1(5)). To fully understand the causes of resident behavior, an analytical framework is essential for focusing on whether the action "to evacuate/not to evacuate" is a result of "actively choosing to stay at home."

2.3. Outline of the survey

The same questionnaire was conducted in Japan and Thailand. A summary of the survey is shown in Table 1. Based on a monitor list from an Internet research company (Rakuten Research), it was hoped that the sex and age distribution of the respondents would closely conform to the actual populations in the respective regions. However, as there were some shortages in a few age groups, 1,000 respondents from Japan and 400 respondents from the Bangkok region were selected based on the basic attributes shown in Table 2. Therefore, it is important to remember when interpreting the results for the aggregate analysis that the distribution of the respondents was based on an Internet survey.[2]

Table 1 Summary of the questionnaire survey design

	Japan	Thailand
Date	Dec.18, 2013 - Dec.25, 2013	Jan. 28, 2014 - Feb. 5, 2014
Sample Numbers	1000	400
Area	All regions	Bangkok
Sampling Method	Distribute the sex and ages of the respondents to conform as closely as possible to the actual populations in the respective regions based on a monitor list from an Internet research company (Rakuten Research).	
Answering Method	The respondents input the answers to each question on the web page to answer the questions.	

Table 2 Basic respondent attributes

			Japan		Thailand	
Sex		Male	499	(49.9%)	199	(49.8%)
		Female	501	(50.1%)	201	(50.3%)
Age		under 20	71	(7.1%)	15	(3.8%)
		20s	151	(15.1%)	120	(30.0%)
		30s	190	(19.0%)	99	(24.8%)
		40s	201	(20.1%)	122	(30.5%)
		over 50	387	(38.7%)	44	(11.0%)
Annual Income	Japan [mill.YEN]	under 200	330	(39.2%)	---	---
		under 500	314	(37.3%)	---	---
		over 500	198	(23.5%)	---	---
	Thai [mill.THB]	under 5	---	---	117	(31.2%)
		under 15	---	---	91	(24.3%)
		over 15	---	---	167	(44.5%)
Marital status		Married	602	(60.2%)	191	(47.8%)
		Unmarried	398	(39.8%)	209	(52.3%)
No. of persons living with the respondent		0	147	(14.7%)	18	(4.5%)
		1	239	(23.9%)	18	(4.5%)
		2	237	(23.7%)	72	(18.0%)
		3	226	(22.6%)	96	(24.0%)
		4	97	(9.7%)	91	(22.8%)
		5	39	(3.9%)	52	(13.0%)
		6	13	(1.3%)	21	(5.3%)
		7	0	(0.0%)	17	(4.3%)
		8	1	(0.1%)	7	(1.8%)
		9	1	(0.1%)	4	(1.0%)
		over 10	0	(0.0%)	4	(1.0%)
Type of house		Owned	705	(70.5%)	290	(72.5%)
		Rented	279	(27.9%)	73	(18.3%)
		Else	16	(1.6%)	37	(9.3%)
Occupation	Company employee		371	(37.1%)	193	(48.3%)
	Public servant		48	(4.8%)	32	(8.0%)
	Self-employed		81	(8.1%)	67	(16.8%)
	Housewife, househusband		186	(18.6%)	17	(4.3%)
	Student		90	(9.0%)	60	(15.0%)
	No occupation		96	(9.6%)	4	(1.0%)
	Other		128	(12.8%)	27	(6.8%)

The remainder of this paper is organized as follows. Section 3 examines the behavior of the respondents during past floods, and Section 4 identifies the factors that motivate people to stay at home during floods to clarify possible future behavior. Section 5 gives our conclusions and possible future research foci.

3. EVACUATION BEHAVIOR AND AWARENESS DURING PAST DISASTERS

3.1. Inundation damage

To clarify the behavior and awareness of the Thai respondents regarding past disaster experiences, the respondents were asked about their experiences during the 2011 flood. From July to November 2011, heavy rain fell on the Indochina Peninsula, resulting in disastrous flooding over an extremely wide area centered on the drainage basin of the Chao Phraya River. In the first 10 days of November, there was significant inundation damage in the densely populated capital, Bangkok. There were 813 fatalities, about 80% of whom drowned, while the remaining 20% died from related causes, such as electrocution (e.g., Komori et al., 2012; CRED, 2015). In the Japanese survey, on the other hand, it was possible to hypothesize about floods and other types of disasters, so the respondents were asked to describe their most serious disaster experiences.

There were 44 respondents from Japan and 330 from Thailand who could remember their flood evacuation experience. Respondents with vague memories were excluded. As shown in Table 3, only 64 respondents from Japan stated that their most serious disaster experience was a flood. Because the number of people with flood experience in the Japanese survey was smaller than that in the Thai survey, significant differences in the statistical tests were also recorded for the following aggregation results.

Table 3 Respondents' past disaster experiences

	Disaster experience questions in the survey			Total sample	
	Type of disaster experience		Evacuation		
Japan	Most serious disaster experiences	Experienced (flooding)	Evacuated	19	1000
			No evacuation	25	
			Don't remember	20	
		Experienced (else)		199	
		No experience		737	
Thai-land	The 2011 flood	Experienced	Evacuated	58	400
			No evacuation	272	
			Don't remember	2	
		No experience		68	

3.2. Fear of "HM" and "MD"

Figure 2 shows the responses regarding the occurrence/non-occurrence of inundation damage during flood experiences from both surveys. Seventy-five percent of the respondents in both surveys stated that some inundation damage occurred.

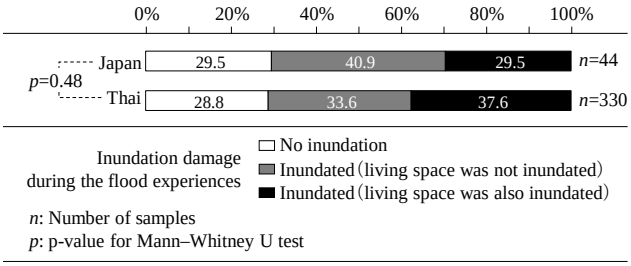

Fig. 2 Inundation damage during flood experiences

Figure 3 shows the responses from each survey regarding evacuation behavior during floods. There was a significant difference between the two surveys, with the Thai respondents showing a stronger tendency to refrain from evacuation.

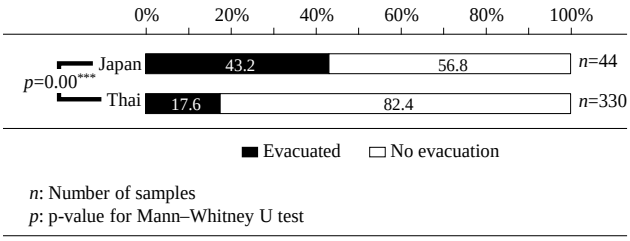

Fig. 3 Evacuation behavior during flood experiences

If, as reported, the inundation damage in both countries was about the same and the degree of fear regarding "HD" (Fig. 4[a]) was also about the same, it is difficult to conclude that the Thai respondents had extremely low disaster consciousness, even though the evacuation rate was low. Further, there was a wide gap between the degrees of fear regarding "MD" (Fig. 4[b]) between the two samples. This result indicated that it was difficult to directly observe the "evacuation" responses from the Thai respondents who stayed in their homes to reduce the "MD" they strongly feared.

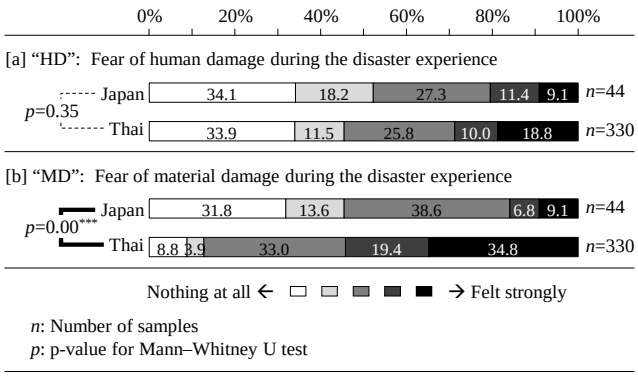

Fig. 4 Fears during flood experiences

3.3. Reasons for not evacuating

Figures 5 [a] to [j] show the reasons given for not evacuating by respondents who did not evacuate during the flood. In both surveys, using a five-level answer format, the respondents were asked to define the degree to which the reason related to their motives. There were similar response distributions in both surveys for almost every item. However, two items had ratings of only 20% and 30% in Japan compared to 70% in Thailand: "[e] I wanted to protect my own house and household possessions from material damage" and "[f] I thought that if I left my house vacant for a long period of time, the danger of theft would increase."

Based on the above results, it can be concluded that the anxiety regarding "MD" and "FT" in the Thai respondents was stronger than in the Japanese respondents. This result indicates that the Thai respondents neither ignored evacuation orders nor dismissed the impact of the disaster, but that they deliberately chose to stay at home because their fear of "MD" and "FT" was greater than their fear of human damage.

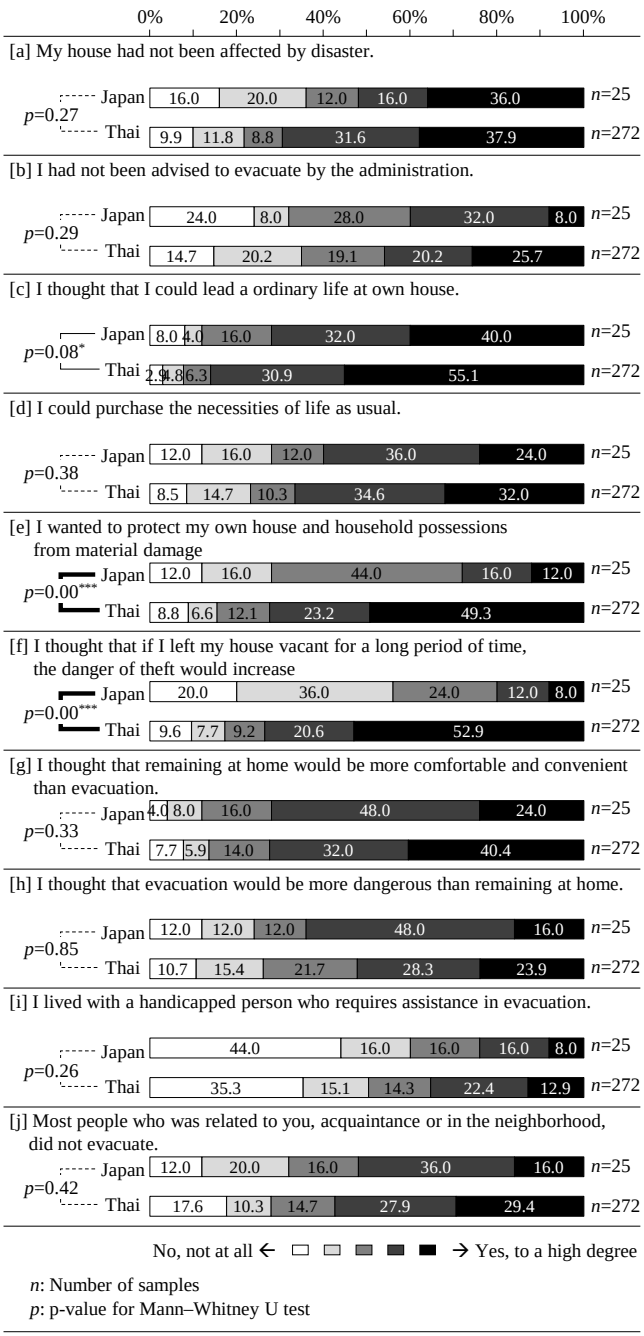

Fig. 5 Reasons for not evacuating

4. FACTORS BEHIND STAYING AT HOME DURING A FLOOD DISASTER

4.1. Analytical framework

As stated above, it was assumed that in addition to the fear of "HD" and the fear of "MD" in terms of resident behavior during a flood, in Thailand in particular, factors related to "FT" were also strong determinants. To verify this finding, it was not enough to set "evacuated/did not evacuate" as the dependent

variable as it was also vital to analyze whether they had a "positive intention to stay at home."

An analysis of "virtual situations with assumptions concerning flood behavior" (Table 4[2]) was conducted to clarify the respondents' behavioral inclinations (the inclination to stay at home). The respondents were asked to indicate their intended behavior in nine situations that had been developed by combining the three levels in Table 4[2](a) regarding the possibility of "MD" with the three levels in Table 4[2](b) regarding the possibility of "HD."

Table 4 Dummy variables as independent variables

			Dummy variables
Subject area		Japan	--
		Thailand	T
[1] Individual attributes	(a) Annual income	Low	L
		Mid	M
		High	--
	(b) "FT"	High	F
		None	--
[2] Virtual situation assumption	(a) Possibility of "MD"	None	--
		Fairly low	P1
		Extremely high	P2
	(b) Possibility of "HD"	None	--
		Fairly low	H1
		Extremely high	H2

The individual attributes of the respondents (Table 4[1]) were studied as independent variables. Of these, "(a) annual income" conformed to the categorizations shown in Table 2. Responses regarding "FT" were obtained, as shown in Fig. 6, which indicated that fear of the future, rather than fear during past flood experiences, was of greater concern. A stronger "FT" was found among the Thai than among the Japanese respondents.

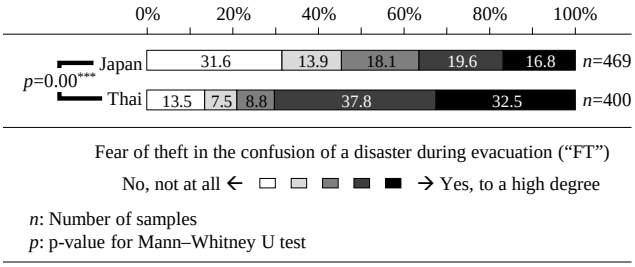

Fig. 6 Fear of theft during evacuation ("FT")

Logistic regression analyses were conducted to verify the extent to which the independent variables shown in Table 4 acted as determinants of a respondent's "inclination to stay at home" under the nine situations in Table 4[2].

There were 469 people in the Japanese sample, excluding those who had homes in locations and geographical conditions unrelated to the flood. As 869 responses were gathered for all nine situations, the logistic regression analysis data were expected to be 7,821 (869 times 9). However, after rejecting responses that failed to indicate annual income, 6,894 items of data were used in the analysis.

4.2. Regression analysis results

The independent variables were represented by dummy variables according to the patterns shown in Table 4. In the situational assumptions in Table 4[2], the interacting terms in the nine situational patterns were also considered. To clearly distinguish between the impact of the independent variables in

Thailand and in Japan, terms that interacted with "T" (the dummy variable representing the Thai sample) were also studied.

The analytical results are shown as Model-0 in Table 5. However, as many insignificant terms were included, a stepwise variable selection was conducted, the results of which are shown in Model-1. By plotting the sum of the coefficient values for the independent variables in Model-1, the results were interpreted (Fig. 7.) The presentation conditions and the situational assumptions for "MD" are shown on the horizontal axis, and the situational assumptions concerning "HD" are shown as differently shaped plots. The higher the plot on the vertical axis, the stronger the intention to stay at home. As can be seen, there was a significant difference in the tendencies in the Japanese (Fig. 7[1]) and the Thai samples (Fig. 7[2].)

Table 5 Results of the logistic regression analyses

		Model-0		Model-1	
		β	(Sig.)	β	(Sig.)
Const.		0.427	(0.002)***	0.313	(0.000)***
X	T	-0.821	(0.000)***	-0.675	(0.000)***
	L	-0.124	(0.199)	---	---
	M	-0.027	(0.778)	---	---
	L*T	0.353	(0.006)***	0.229	(0.007)***
	M*T	0.296	(0.024)**	0.269	(0.003)***
	F	-0.136	(0.089)*	-0.141	(0.078)*
	F*T	0.758	(0.000)***	0.762	(0.000)***
	P1	-0.104	(0.471)	---	---
	P2	-0.781	(0.000)***	-0.706	(0.000)***
	H1	-0.599	(0.000)***	-0.542	(0.000)***
	H2	-1.440	(0.000)***	-1.366	(0.000)***
	P1*H1	-0.155	(0.451)	-0.217	(0.042)**
	P1*H2	-0.090	(0.690)	-0.252	(0.052)*
	P2*H1	0.116	(0.584)	---	---
	P2*H2	0.351	(0.130)	0.296	(0.031)**
	P1*T	0.317	(0.128)	0.189	(0.074)*
	P2*T	0.411	(0.048)**	0.265	(0.029)**
	H1*T	0.544	(0.009)***	0.433	(0.000)***
	H2*T	0.568	(0.009)***	0.451	(0.000)***
	P1*H1*T	-0.069	(0.816)	---	---
	P1*H2*T	-0.231	(0.459)	---	---
	P2*H1*T	-0.268	(0.368)	---	---
	P2*H2*T	-0.113	(0.720)	---	---
		Sample size=6894 x^2=583.768 p=0.000 Hit ratio=0.648		Sample size=6894 x^2=579.773 p=0.000 Hit ratio=0.648 Backward stepwise (Wald)	
[Dependent variable] 1:Intend to stay at home under the presented situational assumption, 0: Else					

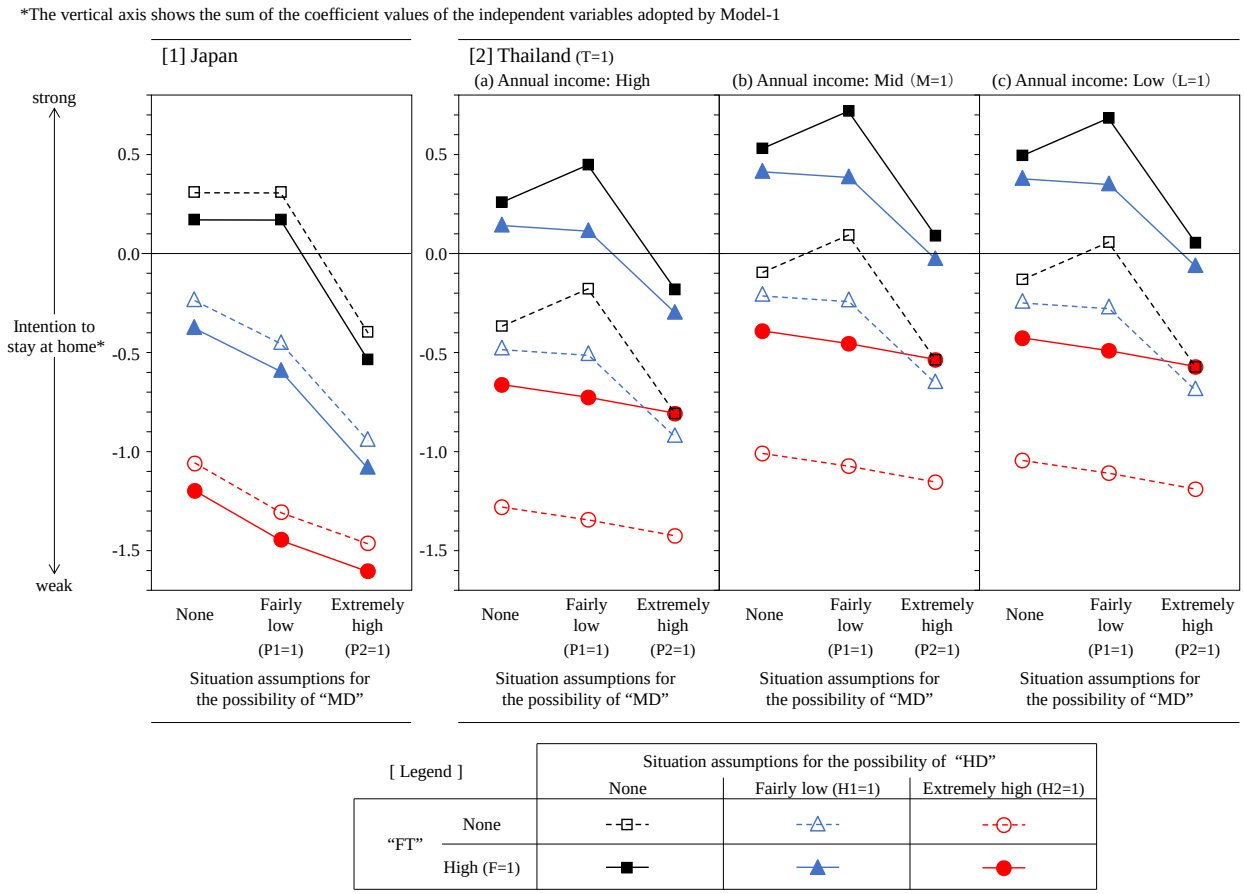

Fig. 7 Plotting the coefficients for the independent variables adopted by Model-1

a) Discussion of the Japanese survey sample

An examination of the Japanese survey sample results confirmed that as the situational assumptions for "MD" increased in severity, the intention to stay at home tended to gradually weaken. However, the greatest impact was found in the situational assumptions for "HD." When the possibility of "HD" was assumed to be "extremely high" or "fairly low," regardless of the assumed strength of "MD," the coefficient value was not positive (i.e., the probability that "staying at home" was chosen did not exceeds 0.5).

The coefficient value exceeded zero only when the situational assumption for "HD" was "none" and the situational assumption for "MD" was either "none" or "fairly low." Therefore, in the Japanese sample, if there was a possibility of "HD," it is possible that people would quickly evacuate their homes. Similarly, if people were cognizant of the possibility of severe "MD," even though there was no possibility of "HD," there was a high possibility that they would evacuate. Based on these results, they may be another background factor for the occasionally low evacuation rates during floods in Japan, as there appeared to be little knowledge regarding the possibility of "HD" or of "MD." Inversely, if the possibility of "HD or of "MD" can be correctly identified, prompt evacuation behavior would take place. Therefore, the many Japanese reports on "disaster consciousness" as a determinant of evacuation behavior appear to be premised on the judgment of the residents. In summary, in can be concluded that the results correspond to the "PCC" case.

Of the individual attributes in Table 4[1], "FT" was found to weaken the inclination to stay at home, but the range of its effects was slight compared to the range of the effects caused by "HD" or "MD." No significant gap was found for annual income.

b) Discussion of the Thai survey sample

In the Thai survey sample, annual income was significant, as shown in Fig. 7[2], from "(a)" to "(c)."

First, the overall plot trend in the Thai sample was higher than in the Japanese sample as shown in Fig. 6[1], indicating that the inclination to stay at home was stronger. This tendency was even more conspicuous for respondents with low income levels, and in particular "(b)" and "(c)."

This tendency—the more severe the "HD" situation, the lower the intention to stay at home—was the same as in the Japanese sample. However, the effect of the differences in the "MD" situational assumptions was different from the monotonic tendency observed in the Japanese sample. In other words, it was found that when the possibility of "HD" was "none," the inclination to stay at home was stronger if the possibility of "MD" was "fairly low" than when the possibility of "MD" was "none." In situations where the possibility of "HD" was "fairly low" or "extremely high," there was a gentler slope than that observed in the Japanese sample; however, the inclination to stay at home weakened as cognizance of the possibility of "MD" increased. Interestingly, in the Thai sample, the effect of "MD" on whether people decided to evacuate was not only smaller than it was in the Japanese sample, but also statistically significant under some specific conditions for reinforcement of the inclination to a purposeful decision to "stay at home."

The effect of "FT" knowledge was the reverse of that in the Japanese sample and the range of impact was greater. In Thailand, being afraid of theft was the major factor behind people's inclination to stay at home during a flood. It can be hypothesized, therefore, that when people on average or low annual incomes fear theft and the possibility of "HD" is slight (none or fairly low), the inclination to stay at home is extremely strong, meaning they are unlikely to evacuate.

Based on these results, in can be concluded that, unlike Japan, in Thailand, knowledge of the possibility of "HD" and "MD" is not necessarily directly connected to "evacuation," and that choosing to "stay at home" because of the possibility of "MD" and "FT" results in "no evacuation." These results correspond to the "NCC," as discussed earlier.

5. CONCLUSIONS

In this paper, we demonstrated the existence of an "NCC" case, which was contrasted with a "PCC" case. A questionnaire was conducted using a Japanese sample as an example of a "PCC" and using a Thai sample as an example of an "NCC." These results showed that a high level of disaster consciousness does not necessarily lead to a high rate of evacuation, and that a low rate of evacuation does not necessarily mean a low level of disaster consciousness. Based on the above discussions, we may conclude that these results support our hypothesis shown in Section 2.

The behavior was considered reasonable as "FT" was found to reinforce the intention to reduce "MD," which in turn led to a purposeful decision to "stay at home." The most important point is that such behavior should be interpreted as rational, logical, and practical. As found, depending on individuals' social condition, a high disaster consciousness could lead to a purposeful and rational decision to "not evacuate."

These results suggest that in Thailand in particular, consideration should be given to a reduction in social unrest, such as "FT," prior to any implementation of the type of disaster risk management education being aggressively pursued in Japan to raise disaster consciousness. While a reduction in "FT" over a short period may not be easy, it is advisable that efforts be made to achieve this goal. Future countermeasures in Thailand such as implementing police patrols or neighborhood watches in flooded areas would assist in reducing "FT."

In conclusion, countermeasures for smooth evacuation, such as improving evacuation warning systems, preparing evacuation sites, providing related education, and so forth, can only be effective after a reduction in obstructive factors such as "FT."

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI Grant Numbers 19760350, 16H03139.

NOTES:

[1] Resident behavior during a flood can be classified into three types: "Evacuation" refers to leaving the home in advance to avoid direct human damage by the inundation; "Sheltering" refers to staying at the evacuation destination until the inundation recedes; and "Refuge" refers to staying at a safer place because of difficulties/damage after the inundation recedes.

Needless to say, the degree of urgency and the determinants fundamentally differ between these three kinds of behaviors. However, "Sheltering" and "Refuge" are related to ensuring survival. Further, to survive, it is necessary to avoid human damage. Therefore, from the perspective of mitigating human damage, this research focused on evacuation behavior. The purpose of evacuation is to avoid direct human damage from the inundation.

[2] Of the two surveys, the data in Thailand were limited to residents living in the Bangkok area who also had Internet access. However, if the survey had included residents from the various social classes in regions outside Bangkok, the differences between the results of the Japanese and the Thai samples may have been more marked. As can be seen in Fig. 7, residents with low socioeconomic status placed priority on reducing "MD," so including outlying regions in Thailand would have given us a wider socioeconomic sample. Such a survey, however, would need to be conducted face to face as it would be unrealistic to conduct either an Internet survey or a paper questionnaire survey because of issues regarding technological access and literacy levels. We wish to continue this study, and see the design of a more comprehensive survey as a future challenge.

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