

Residents' Perception about Disaster Prevention and Action for Risk Mitigation: The case of the Tokai flood in 2000

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1 Introduction

The Tokai flood struck in 2000 in Nagoya City and adjacent areas. The affected areas were near the Shinkawa River and areas where levees were prone to overflow. One might think that such damage would not have happened if the embankment or pumping functions had been improved before the flood. Traditional measures to mitigate the effect of floods have included building dams, reservoirs, and embankments. Although these so-called 'hard' measures may seem effective, in reality they do not always prevent flood damage (Burton *et al.*, 1993). Hard measures are based on various calculations, such as the likelihood of heavy rainfall once every 100 years, which might cause damage greater than some pre-calculated value. In addition, hard measures require considerable amounts of money and construction resources. Therefore, both hard and soft measures, the latter of which raises the level of residents' preparedness against floods, must be considered. In other words, residents' preparedness against natural disasters is important.

How many people prepare against natural disasters? Past research has suggested that residents' preparedness against natural disasters is not enough for preventing natural disasters. Mizuno (1981) revealed, through a questionnaire survey with a multiple-selection method, that the percentage of residents who participated in disaster prevention activities was only 16.7%. Furthermore, those who conformed to the evacuation center in their region amounted to 31.7%. Hashimoto *et al.* (2001) showed that 19% of residents in the affected area perceived that their preparedness for evacuating due to disaster was insufficient. In addition, 78% residents in the area did not prepare at all for disaster. Despite the need for residents to be prepared, many do not prepare at all.

What kind of factors affect residents' preparedness against flood? This chapter focuses on the influence of psychological factors and home ownership in determining preparedness against floods, factors that are most often neglected by social psychologists.

2 Why are people unwilling to prepare for floods?

Some studies have found a link between home ownership and preparedness for disasters. Mulilis *et al.* (2000) showed that home owners prepared for tornados more thoroughly than did people living in rented accommodation. They concluded that home owners valued their property much more highly than the resources needed to prepare for floods; these home owners felt more compelled to prepare for tornados than did those who lived in rented accommodation. These findings suggest that flood anticipation and experience may not necessarily determine a person's preparedness for floods; rather, home ownership determines preparedness for disasters.

To improve residents' preparedness for floods, the source of this lack of correspondence between flood related perception and preparedness must be examined. However, little has been done to establish a statistically quantitative relationship between flood related perception and preparedness for floods. The impact of home ownership on preparedness for floods is also unclear. Quantitatively identifying some determinants of people's preparedness for floods may facilitate the promotion of flood risk management. Takao *et al.* (2004) identified four goals in establishing the factors that determine a person's preparedness for floods. The first goal was to examine the relationship between flood related perception (the level of fear of floods and flood anticipation) and preparedness. The second was to investigate the relationship between flood experience and preparedness. The third was to analyze the relationship between the amount of damage from a previous flood and preparedness. The fourth goal was to examine how owning a home affected a person's preparedness for floods. The next section contains a review of these goals described in Takao *et al.* (2004).

3 Questionnaire Survey

3.1 Method

a) Survey area and subjects

A questionnaire-based survey was conducted in Nagoya City's Nishi Ward and in Shinkawa Town (Fig. 1), areas affected by the Tokai flood. The flood claimed several lives; four houses completely collapsed, 98 houses partially collapsed, 11,142 houses were flooded above floor level and 21,852 were flooded below floor level. In Shinkawa Town, 2,391 houses were flooded above floor level and 1,244 below floor level. Questionnaires were sent to 5,979 residents of Nagoya City and Shinkawa Town. The questionnaires were not received by 235 people. Of the remaining 5,744 people, 2,051 (35.7%) responded.

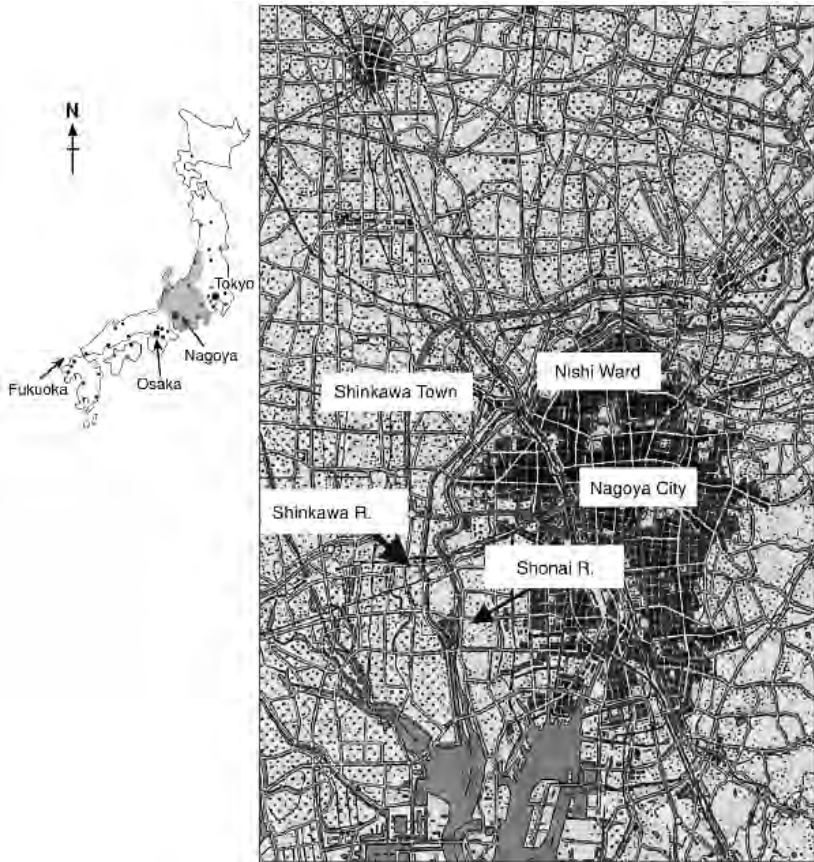


Fig. 1. Map of the surveyed area.

b) Survey methodology

Preparedness for floods was examined in terms of measures taken by the residents after the Tokai flood. Measures taken before include taking out insurance and checking the hazard map of the area, while measures taken after means taking special measures for future floods. The chi-square test was conducted to examine the relationship between these measures and such factors as flood experience, fear of floods, flood anticipation, and flood risk perception.

The respondents rated their flood experience by answering the question "Had you ever experienced a flood before the Tokai flood?". They were also asked to rate their flood related perception in terms of flood anticipation and their fear of floods. The respondents were asked to rate their flood anticipa-

tion using a two-point scale (yes or no) to respond to the question “Before the Tokai flood, did you ever think that you may have another flood in your area?”. In this study, term “flood anticipation” was based not on some objective criteria such as the cumulative amount of rain, but on the personal judgment of the respondents. They were also asked to rate their level of fear of floods using a three-point scale (very fearful, fearful, not so fearful). The respondents were also asked to rate the amount of damage sustained in the Tokai flood using a four-point scale (complete or partial collapse, flooded above floor level, flooded below floor level, no damage). They were asked about their level of preparedness: “Had you taken out an insurance policy, checked the hazard map of the area?”. A two-point scale was used and the respondents were asked to check the measures they had undertaken before and after the Tokai flood to prepare for floods. They were also asked about their preparedness after the Tokai flood: “After the Tokai flood, did you take measures against future floods?”. Again, a two-point scale was used. They were also asked to state whether they owned their home or lived in rented accommodation.

3.2 Results

a) Determinant factors of flood preparedness (Fig. 2)

Preparedness before the Tokai flood: taking out an insurance policy and checking the hazard map

The relationship between flood experience and residents’ preparation for floods was analysed. It was found that neither taking out an insurance policy nor checking the hazard map was associated with flood experience (taking out an insurance policy: $\chi^2(1) = 2.72$, n.s.; checking the hazard map: $\chi^2(1) = 1.51$, n.s.). This indicates that flood experience was not related to preparedness for floods. The relationship between risk perception, fear of floods and preparedness for floods was also analysed. The analysis showed that taking out an insurance policy ($\chi^2(1) = 1.47$, n.s.) and checking the hazard map ($\chi^2(1) = 0.27$, n.s.) were not associated with flood anticipation. Further analyses illustrated that taking out an insurance policy was associated with fear of floods (taking out an insurance policy: $\chi^2(2) = 6.70$, $p < 0.05$; Fig. 2(a)). The relationship between the residents’ fear of floods and whether or not they checked the hazard map, however, was not significant ($\chi^2(2) = 0.01$, n.s.). These findings indicate that those who were more fearful of floods were more likely to take out an insurance policy. In summary, there was no relationship between the residents’ preparedness for floods and their anticipation of floods.

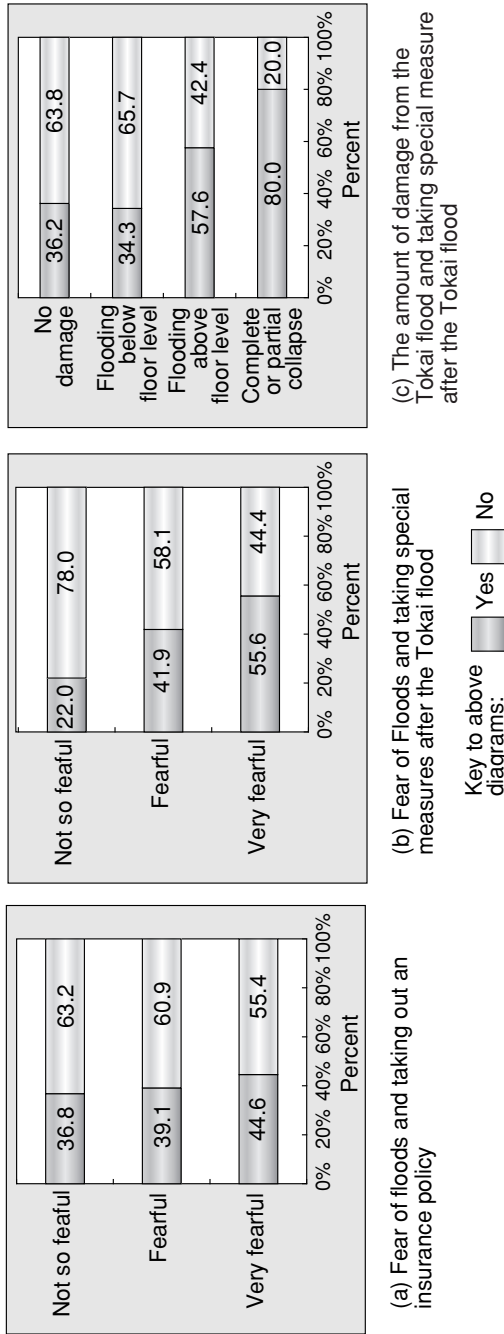


Fig. 2. The determinant factors of preparedness for floods.

Preparedness after the Tokai flood: flood anticipation, fear of floods, and amount of damage sustained in flood

We analysed the relationship between flood anticipation, fear of floods, and whether or not residents took special measures after the Tokai flood against future floods. In addition, we examined the relationship between the amount of damage sustained by the residents in the Tokai flood and whether they took special measures after the Tokai flood against future floods. The fear of floods was found to be related to taking special measures after the Tokai flood against future floods ($\chi^2(3) = 66.58, p < 0.01$) (Fig. 2(b)). However, anticipation of floods was not associated with taking special measures after the Tokai flood ($\chi^2(1) = 1.76, n.s.$). It was also found that the relationship between the amount of damage sustained by residents in the Tokai flood and whether they took special measures after the flood against future floods was significant ($\chi^2(3) = 74.52, p < 0.01$) (Fig. 2(c)). These findings indicate that those who feared floods to be high were more likely to take special measures against future floods. These results also show that those who had suffered serious damage from the Tokai flood were more likely to take special measures against floods than those who had not.

b) Determinant factors of flood preparedness: the difference in terms of home ownership (Fig. 3)

Preparedness before the Tokai flood: taking out an insurance policy and checking the hazard map

There was almost no difference in terms of the determinant factors between home owners and those living in rented accommodation, except for the relationship between fear of floods and preparedness. For example, neither taking out an insurance policy (home owners: $\chi^2(1) = 2.81, n.s.$; renters: $\chi^2(1) = 0.25, n.s.$) nor checking the hazard map (home owners: $\chi^2(1) = 0.17, n.s.$; renters: $\chi^2(1) = 3.15, n.s.$) was associated with flood experience. Thus, home ownership does not affect the relationship between flood experience and preparedness for floods. Furthermore, neither taking out an insurance policy (home owners: $\chi^2(1) = 0.22, n.s.$; renters: $\chi^2(1) = 0.03, n.s.$) nor checking the hazard map (home owners: $\chi^2(1) = 0.40, n.s.$; renters: $\chi^2(1) = 0.01, n.s.$) was related to flood anticipation.

The relationship between the residents' level of fear of floods and their preparedness was analysed. The analysis revealed a statistically significant relationship between the fear of floods and taking out an insurance policy for the residents who owned their homes and who were 'fearful' or 'very fearful' of floods (home owners: $\chi^2(2) = 7.10, p < 0.05$; Fig. 3(a)) (renters: $\chi^2(2) = 0.18, n.s.$; Fig. 3(b)). However, there was no relationship between

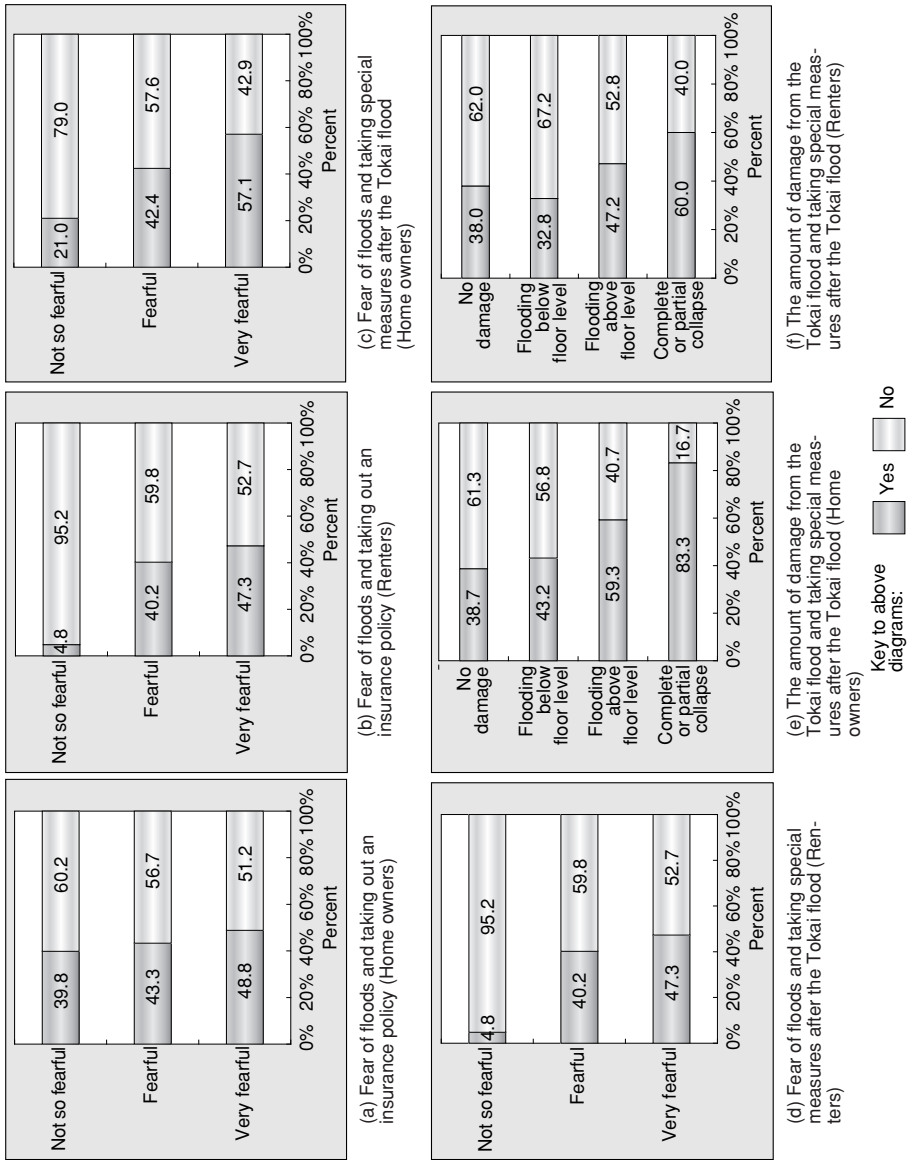


Fig. 3. The determinant factors of preparedness for floods: the difference in term of home ownership.

the fear of floods and checking the hazard map (home owners: $\chi^2(2) = 0.05$, n.s.; renters: $\chi^2(2) = 0.53$, n.s.).

c) Preparedness after the Tokai flood: flood anticipation, fear of floods, and amount of damage

In addition to preparation beforehand, for home owners there was a statistically significant relationship between the fear of floods and taking special measures after the Tokai flood against future floods. There was a statistically significant relationship between the fear of floods and taking special measures against future floods for the residents who owned their homes (home owners: $\chi^2(2) = 67.14$, $p < 0.01$, Fig. 3(c); renters: $\chi^2(2) = 1.16$, n.s., Fig. 3(d)). However, flood anticipation was not associated with preparedness after the flood (home owners: $\chi^2(1) = 2.18$, n.s.; renters: $\chi^2(1) = 0.17$, n.s.). This finding indicates differences in terms of home ownership concerning the relationship between the fear of floods and preparedness for future floods. For the home owners, there was a statistically significant relationship between fear and preparedness, while for the renters, the fear of floods was not related to preparedness.

There was also a relationship between the amount of damage sustained in the Tokai flood and taking special measures against future floods for the residents who owned their homes (home owners: $\chi^2(2) = 54.28$, $p < 0.01$, Fig. 3(e); renters: $\chi^2(2) = 3.69$, n.s., Fig. 3(f)). Residents who owned their homes and whose property was seriously damaged by the Tokai flood (i.e., those whose homes were flooded above floor level) took special measures after the flood against future floods (home owners: $\chi^2(2) = 54.28$, $p < 0.01$, Fig. 3(e); renters: $\chi^2(2) = 3.69$, n.s., Fig. 3(f)). However, those who suffered little damage (i.e., those whose homes were flooded below floor level) did not take any special measures and neither did those whose homes were not damaged by the flood.

3.3 Discussion

a) The effects of flood experience

Generally, it is believed that those who have experienced a flood are more likely to take special measures to prepare for future floods. However, this study found that flood experience and flood anticipation do not necessarily contribute to a person's preparedness for floods. This means that previous experience does not necessarily contribute positively to awareness about future floods and preparedness against them.

b) Effects of flood anticipation and fear of floods

There was a statistically significant relationship between the fear of floods and preparedness for floods, although flood anticipation was not related to

preparedness. It was also found that home ownership affected the residents' preparedness for floods and the relationship between the fear of floods and preparedness. Those home owners who were more fearful of floods were more likely to prepare for future floods than those who were less fearful of floods. In contrast, those who lived in rented accommodation did not necessarily improve their preparedness for floods, even if they were fearful of floods. This result suggests that emotional response has a stronger effect on preparedness for floods than cognitive response such as flood anticipation.

Sjöberg (1998) was the first to suggest the difference between emotional response and cognitive response in events that involve a certain amount of risk, such as traffic accidents or thunderstorms. Assuming the validity of these findings, it can be concluded, based on the results of this study, that cognitive response (e.g., flood anticipation) does not contribute to residents' preparedness for floods; rather it is the emotional response (e.g., fear of floods) that is strongly related to residents' preparedness. The results of the study are, however, insufficient to permit conclusions about the difference between emotional and cognitive reactions.

c) The effect of home ownership

A crucial factor found in this study to have determined preparedness for floods was home ownership. Thus Mulilis *et al.*'s (2000) conclusion that home owners feel more in control of their lives and tend to be more responsible than renters with respect to preparedness against tornados should not be surprising. A similar conclusion can be drawn in the case of floods. For home owners, there was a strong relationship between the fear of floods and taking out an insurance policy as well as taking special measures after the Tokai flood against future floods. In addition, there was a statistically significant relationship between the amount of damage in the Tokai flood and preparedness for floods among home owners. These results mean that residents who own their homes manage the risk of floods based on the amount of damage from previous floods. In contrast, the fear of floods and the amount of damage sustained in a previous flood by renters do not necessarily contribute to their preparedness for future floods. This is because those who own their homes are more likely than renters to want to protect their property from floods. This result implies that home owners invest more time and money in constructing their homes and acquiring household goods than those who live in rented accommodation. Therefore, home owners are likely to place more emphasis on their preparedness for floods and are likely to be more fearful of floods than renters.

4 Do flood risk perception and fear of floods directly affect preparedness against floods?

4.1 Hypothesis model of residents' preparedness against floods

It is generally believed that flood-risk perception and flood experience are directly related to preparedness against floods. Our findings, however, indicate that these do not always directly affect residents' preparedness. This suggests that other factors are related to the behavioral intention to prepare against floods. Therefore, we need to reconsider the determinant factors of residents' preparedness against flood in this chapter.

A prior psychological study categorized worry as an emotional response and risk perception as a cognitive one in events such as thunderstorms (Sjöberg, 1998). Those who perceive flood risk and fear of floods will try to reduce their worries because they feel uneasy in dangerous situations. If this hypothesis is right, both flood-risk perception and fear of floods should increase individuals' sense of self-responsibility and concern about floods because residents who perceive flood risk and who are afraid of floods, will voluntarily learn about floods or preparedness.

Both concerns about floods and the sense of self-responsibility should affect preparedness against floods. The sense of self-responsibility should increase the concern about floods because those who have the sense of self-responsibility need to check potentially dangerous areas on flood maps and taking out insurance policies themselves. Based on that thinking, we can predict that the sense of self-responsibility and the concerns about floods are related to the behavioral intentions about floods. Furthermore, the sense of self-responsibility should be related to the concern about floods. Such factors might affect residents' preparedness against floods.

Moreover, the residents' evaluations of flood policies are related to their own preparedness against floods. When the public administrators decide on flood prevention policies without explaining these to residents, the residents may not voluntarily accept their decisions. Prior social psychological studies have revealed that both those who perceived that public administrators listened to residents' opinions and those who perceived that they had explained their decisions were willing to accept these decisions (Takao, 2002; Takao *et al.*, 2003a; Tyler and Lind, 1992; Tyler *et al.*, 1997). In other words, those who evaluated the decision-making process for policies as being fair were willing to obey the decisions made by public administrators, including being prepared for floods (see hypothesis model in Fig. 4). The next section contains an analysis of the hypothesis model.

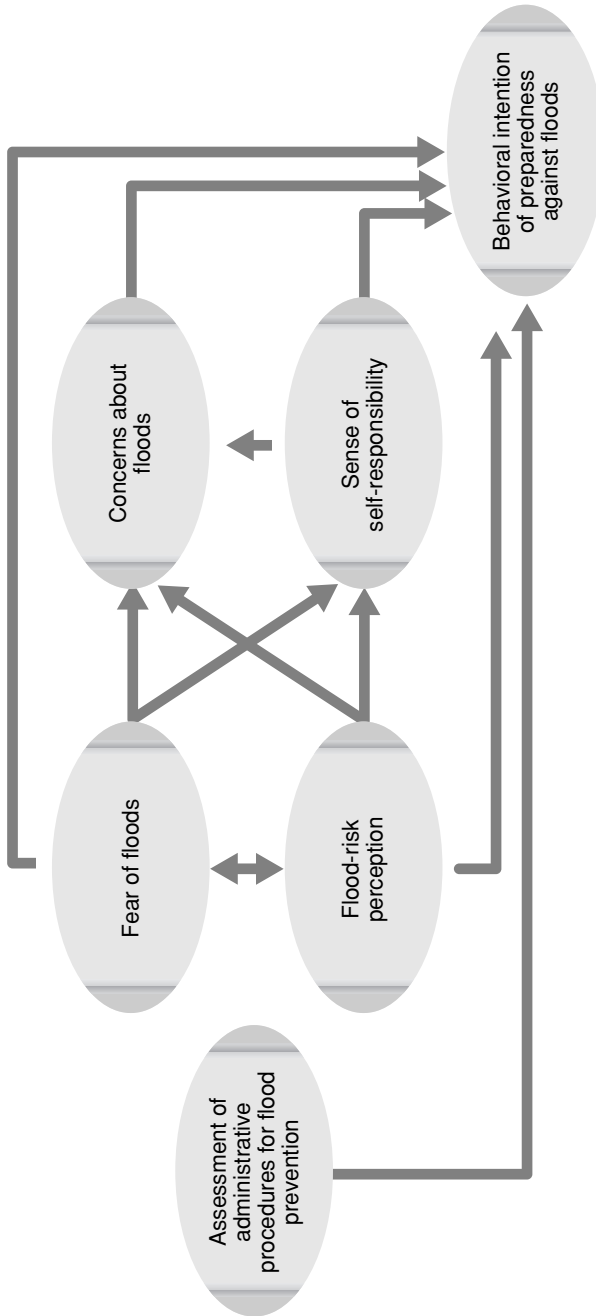


Fig. 4. Hypothesis model (Takao *et al.*, 2003b).

4.2 Methodology

A questionnaire-based survey was conducted in Nagoya City and adjacent areas (Fig. 1) in February 2002, 17 months after the disaster occurred. We mailed the questionnaire to 4,000 residents of Nagoya City and the adjacent areas of Shinkawa and Nishibiwajima Town. We received 3,036 replies (i.e., response rate of 75.9%). The following items were assessed using a 5-point Likert scale that ranged from “I strongly disagree” to “I strongly agree”.

a) Evaluation of flood administrative procedures

The respondents were asked to agree or disagree with the statements: “The administration explained their decisions to residents in making flood prevention policies”, and “The administration listened to residents’ opinions in making flood prevention policies”.

b) Flood risk perception

The respondents were asked to agree or disagree with “I think my home is capable of being damaged by flood”, “I think my home will be flooded above floor level”, and “I think my living area can be damaged by flood”.

c) Fear of floods

The respondents were asked to agree or disagree with “I feel a fear of floods when it rains” and “When I think about rain, I feel uncomfortable”.

d) Sense of self-responsibility

The respondents were asked to agree or disagree with “Residents should prepare emergency rations by themselves”, “Residents should prepare for floods because public agencies cannot protect all of them when unexpectedly heavy rainfalls occur”, and “If possible, residents should protect both their household goods and their lives”.

e) Concern about floods

The respondents were asked to agree or disagree with “I think we should check flood maps for potential areas of inundation”, “I had concerns about taking the measures recommended by public agencies”, and “Floods represent a serious threat for me”.

f) Behavioral intention of flood preparedness

The respondents were asked to agree or disagree with “I want to participate in a residents’ flood action group”, “I want to participate in disaster prevention activities in my town”, and “I want to participate in disaster prevention seminars or disaster prevention training”.

4.3 Results

We used structural equation modeling. Structural equation modeling is a statistical technique commonly used in questionnaire-based surveys to establish the causal relationship among variables. The values are standardized path

coefficients. The model was estimated using the covariance structure analysis in AMOS (Fig. 5). The results indicated that flood-risk perceptions, fear of floods, and sense of self-responsibility were not directly related to behavioral intention of preparedness against floods. The analysis also indicated that the fear of floods was not related to self-responsibility. Furthermore, flood risk perceptions were not related to concerns about floods. We modified the hypothesis model based on these results to create the one in Fig. 6.

The chi-square test revealed that the model was statistically significant. Generally, when there are more than a thousand sample models, chi-square tests indicate they are statistically significant. We also estimated its goodness of fit index (GFI), adjusted goodness of fit index (AGFI), confirmatory factor index (CFI), and root mean square error of approximation (RMSEA) in this study. Covariance structure analysis was conducted on the modified model. Values above 0.90 on the GFI, AGFI, and CFI are generally considered a good fit, as are values below 0.08 on the RMSEA.

The modified model yielded values of 0.953 on the GFI, 0.936 on the AGFI, 0.915 on the CFI, and 0.061 on the RMSEA and analysis indicated that the model was valid. The modified model indicated a strong correlation between flood-risk perceptions and the fear of floods. Flood-risk perceptions are strongly related to the sense of self-responsibility. Furthermore, the fear of floods is related to concerns about floods. The sense of self-responsibility is not strongly affected by assessments of administrative procedure on flood policies and the fear of floods. Thus, the sense of self-responsibility is determined mainly by flood-risk perceptions. The sense of self-responsibility determines concern about floods. Also, concern about floods is related to the intention to prepare against floods.

4.4 Discussion

These results mean that both the flood-risk perception and the fear of floods do not directly affect personal preparedness against floods. The perception of flood risk was strongly related to residents' sense of self-responsibility in being prepared against floods, but it was not related to their willingness to know more about them. However, their fear of floods was related to actual concerns about them; this was an important factor that affected their attitudes toward preparedness. This means that the sense of self-responsibility and the fear of floods were important factors that affected their concerns about floods. The results also indicated that residents' willingness to learn more about floods was an important factor that affected their attitudes toward preparedness.

Public administrators are generally trying to promote residents' aware-

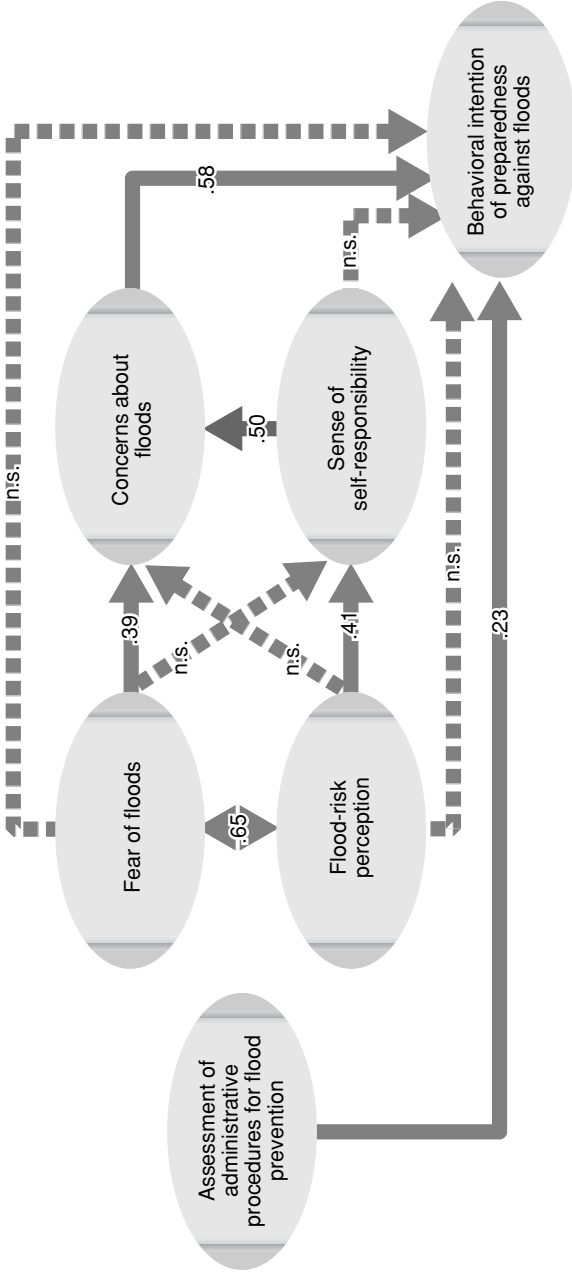


Fig. 5. Analyzed model.
Note: The values are standardized path coefficient. The sign of “n.s.” means that there is not statistically significant relationship.

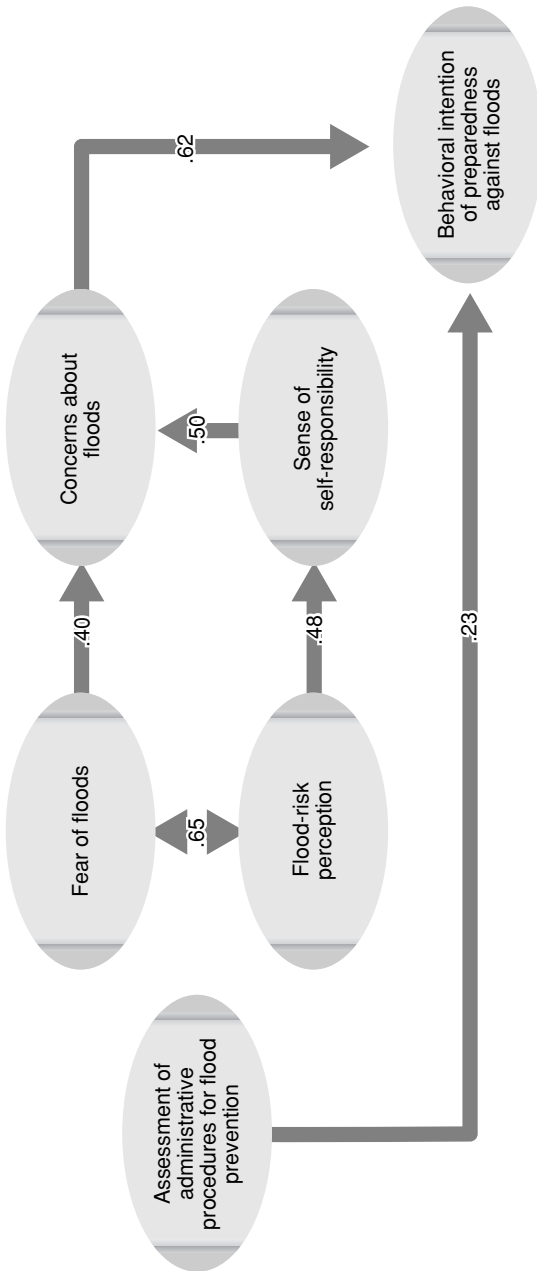


Fig. 6. Modified model.
Note: The values are standardized path coefficient.

ness of self-responsibility (e.g., Aichi Prefectural Government, 2000; Cabinet Office, 2002) because they cannot always protect all residents in time of unexpectedly heavy rainfalls. This study discovered that if residents were not individually responsible for their own preparedness, they did not demonstrate concern for floods. Moreover, if residents did not fear floods, they were not concerned about floods. We therefore need to construct a learning system whereby residents can have access to issues related to floods. The amount of information we give to residents should depend on their perceived level of flood risk and fear of floods. The system would motivate residents to participate in resident-based risk management systems.

5 Concluding Remarks

Our analysis shows that we should focus on residents' fear of floods and that the fact that residents' fear of floods and flood-risk perception are not directly related to preparedness against floods. It may not be right to value only residents' flood-risk perception and fear of floods. We should also pay attention to some psychological factors such as a sense of self-responsibility and concern with floods. Almost all learning systems for flood prevention for residents, however, have been focused on the sense of risk and fear of floods. Therefore, it is important that residents should learn about floods through a new education system that takes into account the models in this study.

However, this will not be easy to achieve. How should we do it? The above analyses suggest some important points for enhancing residents' preparedness. First, we should consider the relationship between flood-risk perception and sense of self-responsibility. The sense of self-responsibility is important because it corresponds with residents' intention of preparedness against floods. Although flood-related learning activities in general have tried to enhance residents' flood-risk perception, giving information about why residents have to take responsibility for preparedness is not enough. To give a currency to people's responsibility as residents, the Pafrics developed by the NIED project (refer to Part III) is equipped with some information about residents' responsibility on flood preparedness. One of the basic functions installed in the Pafrics is based on the analysed models in this study. This is a newly constructed flood learning system because it is based on some social psychological analysis. Second, we should not miss the relationship between the fear of floods and the concern with floods. A determinant of the concern with flood is important because it relates directly to residents' preparedness. Although traditional flood learning has tried to enhance residents' feeling of fear, even if fear of flood is enhanced, it is not enough to motivate

residents to prepare against floods. Actually, if residents are to prepare against floods, they need to know flood mechanisms. If residents were to take part in workshops that used PAFRICS, they might get an opportunity to reconsider resident-based flood prevention. Many scientists have emphasized the importance of resident-based disaster preventive plans, and our new education system will take an important step in that direction by providing residents opportunities to participate in such resident-based flood risk management.

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