

Flood Risk Communication by Local Stakeholders for Residents' Self-Protection in Urbanized Area

Case Studies of Toyooka and Tatsuno City in Hyoko Prefecture

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Residents' self-protection is nowadays defined as significant measures to keep people more stably protected from adverse consequences of flood. To build self-protection is relatively relied on how people perceive and evaluate their risks. Variety of risk information conveyed by local stakeholders through diverse activities are therefore influential to increase flood protection at local level. In this paper, relevant information needed to process self-protection, and role of local stakeholders in educating needed risk information were analyzed by questionnaire surveys in Toyooka and Tatsuno city, Hyoko prefecture. Eventually, a good communication strategy could be guided.

Key Words : *disaster self-protection, local risk communication, flood disaster in urbanized area*

1.Introduction

Flood disaster currently becomes more severe, particularly, flooding on urban basins which are nowadays intensifying due to rapid urbanization (Dey, Ashis K. and Kamioka, 2007)¹. In Japan, urban flood occurs almost yearly, e.g., the 1999 Fukuoka flood and the 2000 Tokai flood, the 2004 Toyooka flood, and the 2005 Tokyo flood (Keiichi Toda, 2007)². Due to flood frequently occurring, Japan has already developed flood protective measurements a long time ago, in particular structural measurement like dam, dyke, embankment, levees etc., but it came out that these kinds of measurements are not completely effective because the possibility of structural constructions to be broken can happen anytime. Like the 2004 Toyooka flood, the collapsed embankment and unworkable pump were happening during the extreme event that make floodwater rising rapidly. As a results 50% of collapsed houses impacted by Tokage typhoon were in Toyooka city (UNEP, 2005)³.

Therefore, self-protection, one component of disaster management has, currently, been pointed as the additional measure instead of only being reliable on government responsibility. Especially, where villages or towns already exist, flood damage must be kept as small as possible, and self-protection is one measure that can complement this objective. Namely, self-protection can keep people safer in case of structural construction broken and public assistance limited, and it also reduces monetary flood damages as well as the need for public risk management. Self-protection in Germany, for instance, could reduce 80% of flood damages (Grothmann, 2004)⁴.

This study aims at investigating how people perceive and minimize their risk through self-protective measures and how risk communication influences on residents' decision to process their threat as well as their ability to reduce their susceptibility. Thereby, the crucial factor was selected to be investigated is "Flood risk

communication”. Based on the assumption that “self protection” can be achieved by level of people’s knowledge and risk information that is related to resident’s capacity to evaluate their susceptibility, and people will eventually create some kinds of measures to minimize their adverse impacts. According to this assumption, risk information was pointed as an important element to help vulnerable people to find out their susceptibility and to encourage them to use their capability to tackle with flood. That is why many local stakeholders in vulnerable community nowadays play a vital role in conveying relevant risk information to local people through several means and activities such as meeting, flood prevention drills, map making, hazard map etc. In this way, risk communication operated by local stakeholders such as information conveyed by formal sectors like municipal government, community association (Chonakai, Jishubosaikai), school and formal sectors like neighbors, friends, and family members are targeted to be investigated its effectiveness in conveying the needed risk information. This study is going to find out which local stakeholders have high potential to communicate risk information that people virtually need.

In this study, Toyooka and Tatsuno city in Hyoko prefecture, defined as flood hazard areas and faced heavy flood in the past, were selected to be studied how people perceive risk and manage their vulnerability to cope with flood. The objectives of this study is to explore the protective measures created by vulnerable resident and to discuss the relationship between residents’ self-protection and the effectiveness of local risk communication operated by local stakeholders. Finally, the proper way to promote residents’ self-protection can be proposed.

2. Flood Risk Management by Residents’ Self-Protection in Toyooka and Tatsuno City

Toyooka and Tatsuno city are situated in the area of flood hazard zones in Hyogo prefecture where faced the heavy flood influenced by typhoon No.0423 (Tokage), and heavy rainfall in 2004 and 2006 respectively that resulted in 7 fatalities, 51 injures, and 4,066 collapsed houses in Tooyoka city⁴, and 2 fatalities in Tatsuno city. This statistical data reveals that risk management is really needed to be operated before the future flood. More than that, to protect vulnerable people successfully, residents themselves who have known well about their vulberability should be engaged in risk management as well.

(1) Flood Risk Management in Toyooka and Tatsuno City

Risk management basically means any sustained effort undertaken to reduce a hazard risk through the reduction of the likelihood and/or the consequence component of that hazard’s risk. Currently, flood risk management have been widely focused instead of only response and recovery measures because floods tend to be more severe and cause bigger damages.

In Toyooka and Tastsuno city, many sturctural and nonstructural measures have been constructed which mostly focused on controlling hazard like constructing a dam and/or embankment. However, the 2004 Toyooka flood have reminded that reliability on only structural measurement could make flood consequences worse because embankement was broken, and a water pump system was also out off order in the same time that resulted in many collapsed houses and affected people. Toyooka city nowadays not only constructs hardware measures but also emphasizes software measures like encouraging people to make their own evacuation map, planning to support elderly



Fig. 1 Evacuation signborad showing the direction to Shelters
Source: Obseveration on 16 February 2010, and Best Practice of Flood Hazard Map in Japan⁵⁾

people in case of the extreme event, and waste management planning after flood occurring. In this way, amount of risk information have been conveyed to residents through several means such as hazard map, sign board showing flood level in 2004, and information supports for evacuation (See figure, 1).

In Tatsuno city, floods occurred in the past have motivated people and involving organizations to consider risk management instead of only flood response and recovery. In this way, structural measures started being constructed such as dam and dykes. The most interesting measures in Tatsuno city is the measures that



Fig. 2 Tatami map

Source: <http://tatamimats.org>



Fig. 3 Dyke structure

Source: Taken by author (16/02/10)



Fig. 4 Dyke structure along Ibogawa river

Source: Taken by author (16/02/10)

engaged people in the process of operation, “Tatami Dyke”(see figure 3 and 4.). Tatami dykes was constructed in 1947 by the idea of city mayor emphasized scenery conservation, flood protection, and people participation. To complete this measure, people are needed to devote their labor force and their resources (Tatami map, see figure 2) by putting Tatami map on dyke structure located along Ibogawa river. From the interview with community leaders revealed that Tatami dyke was actually used in the past, but nowadays, it become one of tourism resources since dam constructed and flood tending to be less severe. More than that, most people living this area are elderly people, so they are not strong enough to complete this measure.

However, some communities still rely on Tatami dyke measure, and community leader and community members occasionally cooperate each other to practice operating it.

(2) Residents’ Self protection for Flood Risk Management in Urbanized Area

Self-protection could be defined as one part of risk management which concerns the ability or willingness of an individual and/or household to provide themselves with adequate protection, or to be able to avoid living or working in hazardous places (Cannon, 200)⁶.

Basically, self-protection is comprised of many kinds of measurement which have different potentials to cope with each flood situation. Therefore, to promote self-protection is significant to make understanding of flood situation in each area. Generally, there 3 levels of flood risks usually occurring in urbanized area- slow-onset flood, rapid-onset floods and flash flood,- which each level do need different measures to mitigate. For instance, self-protection against slow-onset flood usually caused by prolonged rainfall: people, at least, can prepare many kinds of basic measures to minimize their impacts such as preparing sand bag, pump for preventing flood, putting electric appliances like air conditioner on upper levels. For the extreme event (flash flood), measures should be made by residents are planning to evacuate, preparing stuffs in case of emergency like medicine, emergency number etc. (see table 1.)

From the questionair survey in Tatsuno and Toyooka city, it revealed that people have been well prepared for preventing and handling with their situation, namely, they have created several measures both simple and complicated measures. Particulary in Toyooka city, people have recently experienced heavy flood damages in 2004, people therefore realize needs of self-protection. Table 1 shows that making disaster insurance and storing food and water in case of emergency occupy a major proportion of self-protection in

Toyooka city, counted as 37.4% and 32.5% respectively, while, people in Tatsuno city have mostly prepared emergency hone number and also joy disaster insurance, counted as 18.5% and 15.6% repectively.

3. Theoretical Framework

According to research objectives, 2 relevant concepts -such as resident’s self-protective behaviors and risk communication for risk reduction- were applied to form the explanatory model which exhibits how self-protection can be initiated and how risk communication relatively influences on level of self-protection.

(1) Resident’s Self-protective Behaviors

People usually have different protective behaviors depending on how they perceive and evaluate their threat as well as their susceptibility. Transtheoretical theory related to the concept of risk management can explain that there are 4 levels of self-protection which could be illustrated as figure 5. The first level is pre-contemplation which means people in this level do not have any risk perception. Namely, they do not think they will be affected by flood hazards. Second level is contemplation: it means people can realize that they are living in flood hazard area, and potentially get affected from flood. More than that, if they already took some action to cope with their threat, they can be defined as level of action. And the last one, the highest level of self-protection, is level of maintenance. People in this groups always pay attention on their risks and properly modify their protective measures to cope with each flood situation. This concept will be used for evaluating level of self-protection among residents.

(2) Risk Communication for Risk Reduction

The main factor that make people behave to manage their risks differently is the level of their knowledge and capability. Some people have been well prepared because they can perceive their risk and evaluate their susceptibility, eventually, they are able to create some measures to minimize their impacts. Thereby, risk communication could be defined as a crucial factor that relatively increase residents’ risk perception. Bendimerde (2008)⁷⁾ also contended that risk communication is one of important method for risk reduction (see figure 6). Namely, disaster risk reduction (DRR) could be achieved in the condition of an overlap between three broad actions. Risk communication plays an action to integrate many kinds of

Table 1. Self-protection measurement in accordance to level of flood risks

Self-protective Measures		Toyooka (frequency/ percent)	Tatsuno (frequency/ percent)
Low Flood Risk (slow-onset flood)	1. Putting valuable things on upper levels, such as valuable furniture	34 (27.6%)	7(5.2%)
	2. Preparing sand bag, pump for preventing flood	6 (4.9%)	4(3.0%)
	3. Sharing mitigation information with family, relatives and/or neighbors	30 (11.0%)	15(11.1%)
	4. Putting electric appliances like air conditioner on upper levels	28 (22.8%)	5(3.7%)
Medium Flood Risk (rapid-onset floods)	5. Structural measures against inundation such as heightening board fences, etc.	7 (5.7%)	8(5.9%)
	6. Joining disaster insurance	46 (37.4%)	21(15.6)
	7. Planting trees for reducing volumes of floodwater	2 (1.6%)	5(3.7%)
	8. Cooperating to mitigate flood with building structural measures with Jisyubosaikai, NPO, governments, etc	11 (8.9%)	10(7.4%)
High Flood Risk (flash flood)	9. Storing food and water in case of emergency	40 (32.5%)	16(11.9%)
	10. Making a evacuation plan in case of emergency	32 (26.0%)	17(12.6%)
	11. Preparing emergency phone number	39 (32.5%)	25(18.5%)
Total		123	135

Source: Questionnaire survey, 2010

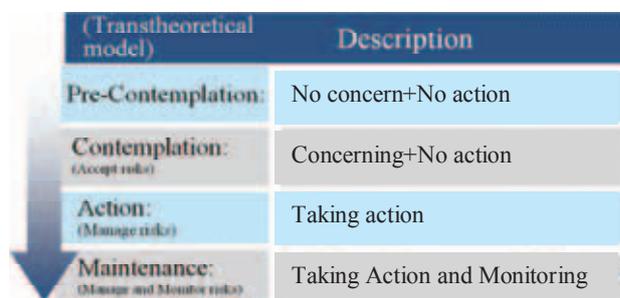


Fig. 5 Level of resident’s self-protection
Source: Adapted from the Transtheoretical Model and Risk Management Model

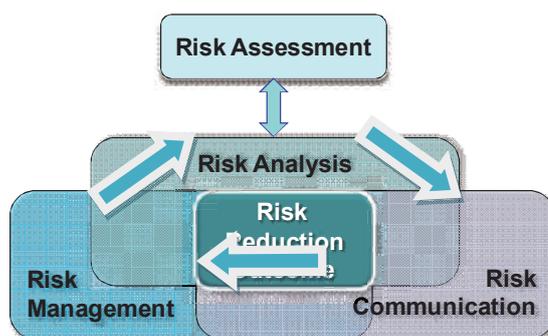


Fig. 6 Model of disaster risk reduction
Source: Bendimerad, 2008⁷⁾

risk from each people, and also educate risk to the person who cannot perceive. Moreover, risk communication can help the vulnerable group translate risks into an understanding of its impacts. Eventually, people will create some kinds of protective measures for controlling or minimizing their risk.

(3) The Study Model

Based on these 2 concepts, the study model could be formed based on the 2 assumptions (see figure 7).

Firstly, risk information is related to residents's motivation and capabilities to take self-protection. Hence, several kinds of risk information related to flood harms- such as causes of flood occurring in community, possibility of flood magnitude, history of flood events, timing of flood, vulnerable are to be flooded- are selected to tested in order to find out the specific risk information that potentially motivate people to process self-protection. More than that, knowing different risk information might influences on different level of self-protection as well. Namely,

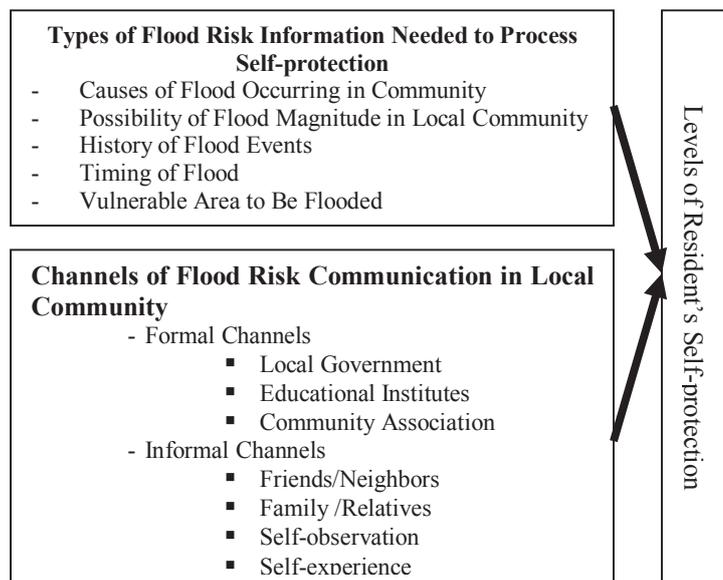


Fig. 7 The study model

people who know deeper risk information, they might be able to create higher quality of self-protection.

Apart from types of risk information, different information also need different means and processes to communicate effectively. It means good communication must represent that people can use those communicated information to increase their motivation and capability to take self-protection. In this way, several channels of flood risk communication operated by local stakeholders need to be tested so as to find out its effectiveness to convey each type of the needed information by divided into 2 main categories such as formal and informal channels.

To measure the significance of each types of information and effectiveness of each communication channel, it need to understand how people react to those information that they receive. In this way, the level of self-protection was invented by applied from the transtheoretical theory related to the concept of risk management. It represents residents' protective behaviors which could be classified into 4 levels (see figure 5.)

4. Research Methodology

Research methods comprised of several means and processes -such as documentary reviews, physical observation, questionair distribution, and interviews - which all focused on trying to explain how people manage their risks under the current environmental risk communication.

As mentioned above, this study was conducted in 2 cases such as Toyooka city and Tatsuno city. In Tatsuno city, 4 sub-district were chosen to be studied -such as Syojo area in Ibokawa cho, Higai area, Kawaracho area, and Kita-tatsuno area- which all are situated along "Ibokawa river" and are risky to be flooded. Field survey and questionair distribution have been operated during 6-7 February 2010. 525 questionairs were distributed in Tatsuno case, and 135 questionnaires or 30.48% of total distribution were repondsed. In addition, the interviews with 4 community leaders were also conducted in the issues of flood situations and the environmental risk communication.

In Toyooka city, 365 questionairs were distributed in the areas located along "Maruyama river" such as Izumi cho, Odai cho, and Saiwai cho, on 16 Febuary 2010, and 123 questionairs or 33.42% were repondsed. Additionally, the interview with the leader of Jishubosaikai was also conducted in the issue of role of the community association in educating risk information to vulnerable people.

5. Relationship Between Resident’s Self-Protection and Local Risk Communication by Multi Stakeholders

(1) Resident’s Protective Behaviors in Toyooka and Tatsuno City

To explain residents’s self-protective behaviour against flood dangers, at least, 3 questions were invented based on the situation that how people perceive the possibility of flood disaster that they may get affected, and the way they have managed their possible affects- such as “Do you think that flood disaster will happen to you in the future?”, “Have you created any self-protective measure to cope with flood”and “Have you paid attention on the level of flood risk and apply to your measures”. These questions were asked sequently, and the results were analyzed according to the concept of Transthoretical theory or protective beahavior. Eventually, residents’ self-protective behaviors or “**level of self-protection**” could be generated resonably.

In Toyooka and Tatsuno city, having different physical features and flood frequency, people also have different self-protective behaviors (see table 2). The results revealed that nearly half of sampling population in Toyooka city have self-protective measures, while less than a qualter of people in Tatsuno city have self-protection measures. In the another view, even though flood do not occur in Tatsuno city for long, a qualter of people in Tatsuno city (38.5%) still concerns their flood risk, on the contary, 40% do not concern at all.

This result implies that people in Toyooka city are more active than people in Tatsuno city, but it does not mean that people in Tatsuno city have less capacity to tackle with flood. Due to flood seldom occurring, people, therefore, less consider the importance of self-protection.

(2) Relationship Between Resident’s Self-Protection and Local Risk Communication

Nowadays, there are many local organizations in Tatsuno and Toyooka city provide risk information for people such as settling hazard map, flood drills, map making, etc. These attempts aim at making people familiar with flood. However, the results revealed that there are specific information needed for self-protection and each information have different proper sources to convey.

2.1) What kinds of risk information should be communicated?

The success of risk communication is relatively depeneded on the right information that is actually needed for vulnerable people. To find out the needed information, it can be simply measured by evaluating the level of self-protection between the people who know and do not know each type of risk information. There are 5 types of flood risk information asked the people whether or not they know, such as information of flood magnitude represtred by the question “If flood disaster occurs in your area, can you evaluate how much effect will you get?”, information of History of flood events in community represented by the question “ Do you know flood events occurring in your area in the past?”, information of vulnerable area represented by the question “Do you know the most dangerous place in your community to be effected by flood disaster?”

The results of field suvey were analyzed by SPSS with T-test techniques under the hypothesis that people who know and do not know each type of risk information will have different level of self-protection, and the statistical hypothesis could be set as follows:

Table 2. Level of people’s self-protection in Toyooka and Tatsuno city

Level of Self-protection	Toyooka City (frequency/percent)	Tatsuno City (frequency/percent)
-Do not have risk perception of flood hazard	44 (35.8%)	54(40%)
-Do have risk perception of flood hazard and consider self-protection needed	25(20.3%)	52(38.5%)
-Have actually made the protective and preparative measure	39(31.7%)	27(20%)
-Always pay attention on flood risks and properly modify their measures for each situation	15(12.2%)	2(1.5%)
Total	123	135

Source: Questionnair survey, 2010

- $H_0: \mu_1 = \mu_2$
 $H_1: \mu_1 \neq \mu_2$
 μ_1 : Average score of level of self-protection of the people who have risk information
 μ_2 : Average score of level of self-protection of the people who do not have risk information

The results (see table 3 and 4) revealed that different study areas need different information to process self-protection. Namely, information of flood magnitude related to people’s life and assets and information of history of flood events occurring in community are significantly associated with level of residents’ self-protection in Toyooka city because there is a significant difference of self-protection levels between people who know and do not know those information. Hence, residents who were educated these kinds of information have relatively had motivation and capability to process protective measures . In case of Tatsuno city, people need to be communicated with information of vulnerable area to be flooded because flood do not occur in this area for long, so they basically would like to know the area with flood dangers.

Table 3. Information for self-protection in Tatsuno city

Types of Flood Disaster Information	Level of self-protection (Mean)*		Sig. Value
	Knowing People	Unknowing people	
Cause of flood	1.77	2.04	0.458
Flood magnitude	1.83	1.77	0.846
History of flood events	1.89	1.7	0.206
Timing of flood	1.85	1.8	0.682
Vulnerable area to be flooded	1.95	1.63	0.024

Table 4. Information for self-protection in Toyooka City

Types of Flood Risk Information	Level of self-protection (Mean)*		Sig. Value
	Knowing People	Unknowing People	
Cause of flood	2.2	1.88	0.44
Flood magnitude	2.53	1.28	0.005
History of flood events	2.28	1.46	0.008
Timing of flood	2.3	2.08	0.249
Vulnerable area to be flooded	2.31	1.97	0.09

*. The mean difference tested by T-test is significant at the .05 level

* Explanation: Mead scores 1 - 1.75 = do not have risk perception on possibility of flood disaster occurring in their area

1.76-2.50 = People do have risk perception and consider self-protection needed for their safeguards

2.51-3.25= People have actually made self protection by creating mitigation and preparative measures

3.26-4= People always pay attention on flood risks and properly modify their to cope with each situation

2.2) Which stakeholders in local community can communicate risk information effectively?

In order to find out the best channel to communicate the needed risk information, people need to be asked where those information come from or which sources of information they communicate with?, then the effectiveness of each communication channel could be evaluated by measuring the level of self-protection among people who have a different reliable risk information source.

The analysis could be carried out by SPSS with ANOVA techniques under the hypothesis that different channels of risk communication have different potential to convey risk information, and the statistical hypothesis could be set as follows:

$$H_0: \mu_{\text{Local government}} = \mu_{\text{Chonaikai/Jisyubosai}} = \mu_{\text{Neighbor's situation}} = \mu_{\text{Experience}} = \mu_{\text{Family/Relatives}} = \mu_{\text{Friends/Neighbors}}$$

$$H_1: \mu_A \neq \mu_B, \text{ At least one pair}$$

μ = Average score of “level of self-protection”

The statistical test by ANOVA proved that different information do need different proper sources to convey (sig. value 0.004). In Toyooka city , the result come out that activities organized by chonaikai and local government are the best channels to educate information of “**flood magnitude**” (see figure 8). It means that people, who received information of flood magnitude from Chonaikai/Jishubosaikai, local government, have been able to use that information to evaluate their susceptibility and motivate themselves to create protective measures. While information of “**history of flood events**” are effectively communicated by chonaikai/Jishubosaikai and family sector (see figure 9). People who were communicated by these two stakeholders have high level of self-protection (sig value 0.000).

In cases of Tatsuno city, it was found that people did not have any distinctive information source to convey information of flood vulnerable area based on the result of statistical test ANOVA (sig value 0.048), and level of self-protection among

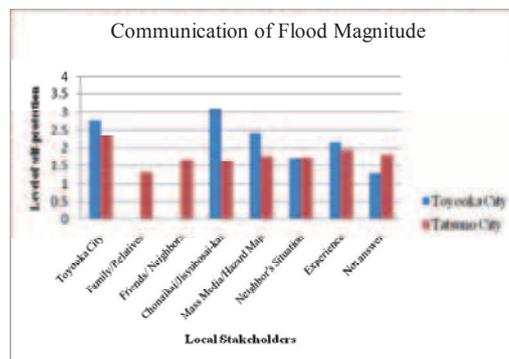


Fig 8 The effectiveness of communication channels to convey information of flood magnitude

people who were communicated by each local stakeholders are almost same. Namely, it can make people just perceive their risk, but it is not influential enough to make them take action. (see figure10).

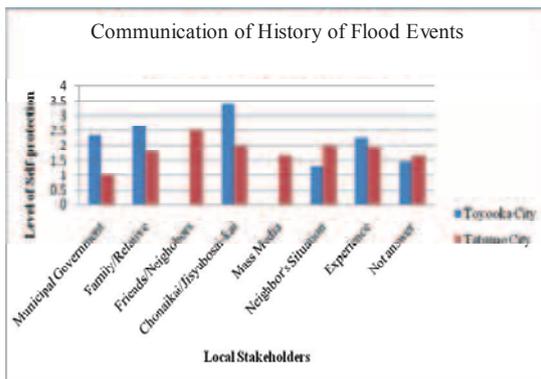


Fig 9. The effectiveness of communication channels to convey information of history of flood events

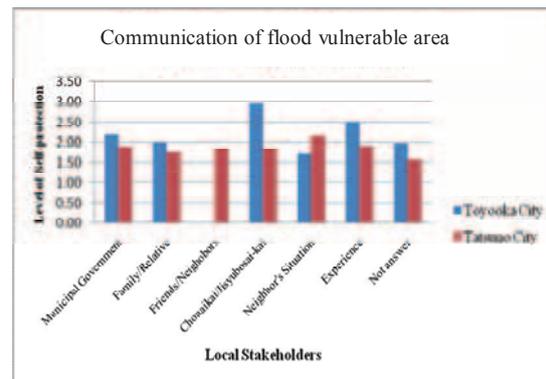


Fig 10. The effectiveness of communication channels to convey information of vulnerable area

5. Conclusion

This study demonstrates that people in 2 different flood prone areas have different behaviors in managing flood risks. Residents in Toyooka city are more active to process self-protection than people in Tatsuno, namely, nearly half of sampling population have created their own flood protection with several measures for each flood situation, while most people in Tatsuno city have just concerned about flood dangers, but they don't actually take an action.

Considering an influence of risk communication on residents' motivation to take self-protection measures, it was found that people in 2 study areas do need different flood risk information to process their own flood protection, and different information also have different proper sources to communicate. In Toyooka city, people need information of flood magnitude and flood history in their community, and the most effective stakeholders to convey these information are Chonaikai, municipal government and also role of family. While people in Tatsuno city need information of flood vulnerable area, and the effective stakeholders to convey this information cannot be identified clearly because people have several channels to receive information, and the effectiveness of each channel is the same, namely, it is not high influential enough to motivate people to take self-protective measure. To design a good communication strategy for enhancing level of self-protection, the right information must be communicated through the right channel.

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