

Title: **Issues of Tsunami Evacuation behavior in Japan: Residents Response in case of Chilean Earthquake in 2010**

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Abstract:

Chilean Earthquake occurred at 27th February in 2010. Japan Meteorological Agency(JMA) issued the tsunami warning after about 18 hours from earthquake occurrence to all shoreline of the Pacific coast in Japan. According to the tsunami information, the height of the predicted tsunami was over 3 meters at some areas. However, there were only a few areas inundated by Chilean Tsunami. Therefore, the rate of residents who evacuated among residents who live in areas where evacuation order was issued by city office was 3.8%(63,216/1,685,750) published by Fire and Disaster Management Agency(FDMA). By the way, the number of these evacuees is the number of residents who evacuated to evacuation places reserved by each city offices. In this paper, we carried out questionnaire survey to residents who live in coastal area in order to reveal why the rate of evacuee was very low. And we discussed issues to urge residents to evacuate.

Questionnaire Survey

We carried out questionnaire survey in the end of March 2010 to grasp residents' behaviors when tsunami warning was issued. This questionnaire survey was carried out in Kamaishi City, Iwate Prefecture. We sent questionnaire sheets to 8,491 households that live in coastal area by mail and collected them from 2,334 household by mail (collection rate was 27.5%).

Kamaishi City was attacked and by the past tsunamis such as Meiji-Sanriku Earthquake Tsunami in 1896, Showa-Sanriku Earthquake Tsunami in 1933 and Chilean Earthquake Tsunami in 1960. And it is predicted Miyagiken-oki Earthquake will occur in the near future and a lot of casualties will occur by tsunami. Therefore, our research group has been practicing disaster education to Kamaishi people of various attributions such as children, their parents and community leaders (Katada & Kanai, 2008). So if our implementations were effective to Kamaishi people, the rate of evacuees ought to be higher than other cities.

Knowledge and Risk Perception about Tsunami Disaster

According to results of the questionnaire, approximately 96% of residents who answered the questionnaire knew the Chilean Earthquake Tsunami in 1960 before 2010 Chilean Earthquake occurrence (Fig.1), approximately 66% of them knew the earthquake and tsunami that are predicted to occur in near future (Fig.2) and approximately 80% of them thinks that there is a high probability that the predicted earthquake and tsunami occurs in near future (Fig.3). In brief, residents who answered the questionnaire had the knowledge about past and predicted tsunamis, the risk perception about tsunamis.

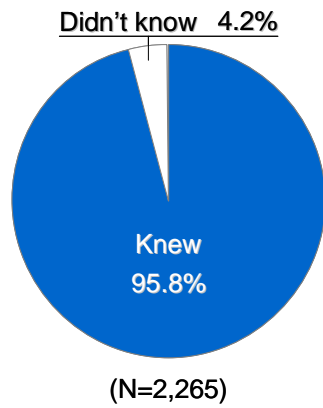


Fig 1: The rate of residents who knew the Chilean Tsunami in 1960 before 2010 Chilean Tsunami

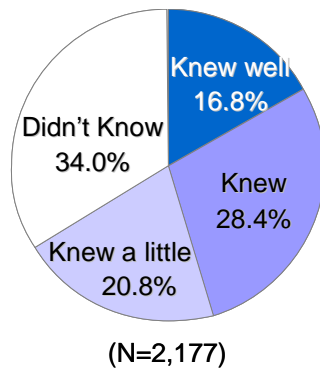


Fig 2: The rate of residents who knew the earthquake and tsunami that are predicted to occur in near future

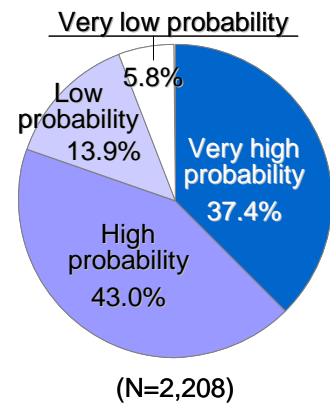


Fig 3: The rate of residents who think that it is high/low probability that the predicted earthquake and tsunami will occur.

Evacuation Behavior at 2010 Chilean Tsunami

Kamaishi City announced the evacuation order to residents who live in areas predicted to inundate with tsunami, after JMA announced the tsunami warning. Fig.4 shows the rate of residents who live in area where the evacuation order was announced. According to Fig.4, the rate of residents who live in area where the evacuation order was announced was approximately 47%. By the way, the rate of residents who didn't know whether their houses were the target of evacuation order or not is 16%. In this paper, it is purpose to reveal the actual situation about tsunami evacuation after getting tsunami warning and evacuation order. Therefore, we use data of residents who live in area where the evacuation order was announced for the analysis of follow.

Fig.5 shows the rate of the residents' behavior after getting the tsunami warning and the evacuation order. According to Fig.5, the rate of residents who went out their house to evacuate from tsunami is approximately 45.5%. By the way, the rate of residents who evacuated to shelters or evacuation place reserved by Kamaishi City is 14%. This rate is higher than the evacuee rate (3.8%) published by FDMA. Therefore, it is revealed that Kamaishi people evacuated more than other place. However, the rate of residents who stayed home to check the tsunami information from TV is approximately 37%.

JMA issued the tsunami warning at 9:33 28th Feb. 2010. According to this warning, it was predicted that first tsunami came at 13:30 in Kamaishi City and the height was 3 meters. And JMA lowered the tsunami warning level step by step at 19:01, 21:13, 23:36, 1:07 1st March,

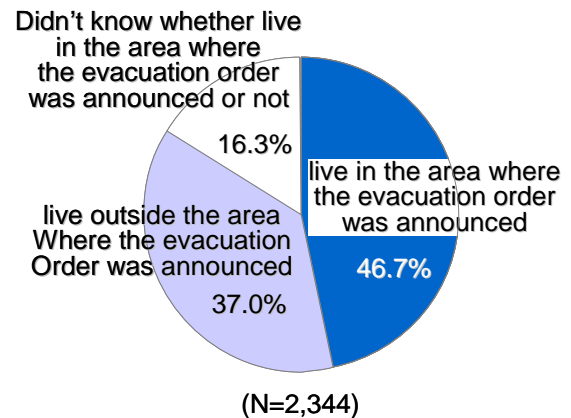


Fig 4: The rate of residents who live in area where the evacuation order was announced

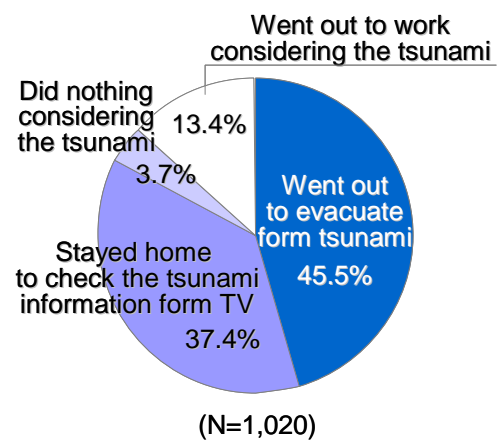


Fig 5: The rate of resident' behavior after getting the tsunami warning and the evacuation order

and released all warning at 10:15. Therefore, Kamaishi City announced the evacuation order from 9:34 to 1:07 1st March. Fig.6 shows the frequency distribution of the number of evacuees. According to Fig.6, the peak rate of the evacuee is the period from 13:00 to 14:00. This period was the time predicted first tsunami comes. After that, the rate of evacuees decreases slowly. And, the rate of evacuees is only 4.6% at the period from 23:36 to 1:07. This period was the time that Kamaishi City released the evacuation order.

Conclusion: Issues of Tsunami Evacuation

Issues of tsunami evacuation behavior based on human psychological characteristic have been reported (Katada, *et al.*, 2005). Although Kamaishi City carried out various disaster educations, some issues of tsunami evacuation were verified from results of questionnaire survey. Those are as follows;

1. Residents of approximately 37% who stayed home to get the more corrective information.
2. Most of evacuees went out based on the predicted time that first tsunami would come, and came back right after the predicted time.

According to this issue, we suggest some countermeasures to urge residents to evacuate. Those are as follows:

1. To give knowledge about tsunami characteristics in order to understand that tsunami warning is uncertain.
 - There is probability what higher tsunamis than height of predicted tsunami come.
 - First tsunami is not always the highest tsunami.
 - Tsunamis come again and again at an earthquake event.
2. To change the attitude toward tsunami risk and tsunami/evacuation information

Recently, Japan have experienced that tsunami didn't come or came only very small tsunami even if tsunami warning and evacuation order issued. In other words, All Japanese have experienced that tsunami warning was wrong again and again. According to repetitions of these experiences, almost residents criticize the government for fail of tsunami warning when tsunami doesn't come even if tsunami warning is issued. We suggest changing the attitude as follows; Even if tsunami warning was failed, residents didn't criticize the government, and might be delight not to have been attacked by tsunamis. Now, the main purpose of disaster education in Japan is that residents get the knowledge about tsunami, and improve the tsunami risk perception. However, the disaster education hereafter needs to urge residents to change the attitude toward tsunami risk.

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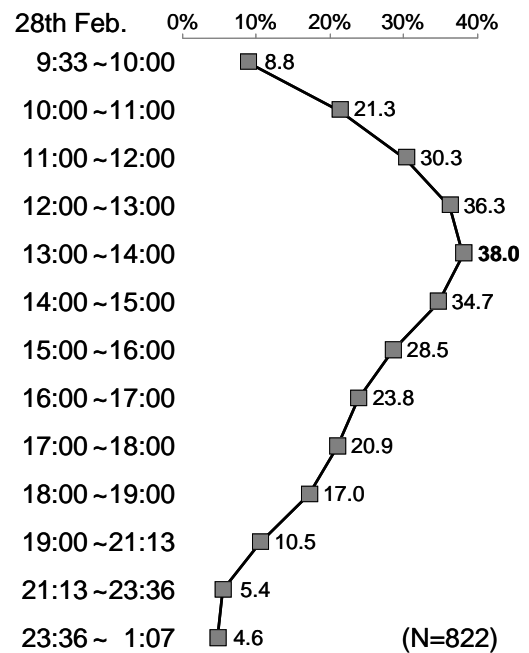


Fig 6: The frequency distribution of the number of evacuees