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# **PEOPLE'S AWARENESS OF NATURAL DISASTER RISKS: DIFFERENCES ACROSS REGIONS AND GENERATIONS**

### **Abstract:**

Abstract: Natural disasters have profound impacts on the sustainability of societies. Japan is a nation surrounded by the sea, and some regions are prone to suffer from natural disasters such as earthquakes and tsunamis due to geographical characteristics. To develop and maintain a sustainable society, appropriate preventive measures should be incorporated into the social system, taking into consideration the people's awareness of natural disaster risks. For this purpose, the present study investigated people's sensitivity to risks induced by natural disasters, specifically focusing on a tsunami disaster.

The investigation focused on the 2011 East Japan Earthquake off the Pacific Coast, and included five different participant groups: a group of residents (approximately 40 to 70 years old) who directly suffered from the tsunami damage, two student groups (university and high school) located at the damaged regions, and two university student groups that were located in unaffected regions in Japan. The investigation was conducted by a questionnaire asking the participants to evaluate the safety or dangerousness of five different tsunami heights by using a five-point rating scale. The obtained data were subjected to a psychometric analysis calculating tsunami height thresholds regarded as safe.

As a result, the lowest threshold of tsunami height regarded as safe was 0.94 meters for the group of residents in the damaged region. In contrast, the group of high school students in the damaged region revealed the highest threshold for the safe tsunami height, indicating that they do not feel danger until the tsunami height rises over 2.7 meters. Therefore, the residents in the damaged regions have the highest sensitivity to the risks posed by a tsunami, while the high school students in the damaged region have the lowest cautiousness despite the fact that they experienced the same disaster. Among the groups of university students, those who lived in the unaffected areas located furthest from the damaged region showed the highest threshold value of 2.56 meters, suggesting that they have very low risk sensitivity to tsunamis. These results clearly indicate that younger people and those who have not experienced a tsunami disaster are less conscious of the risks involved.

Based on these differences in people's risk awareness for natural disasters, appropriate preventive measures and educational programs should be incorporated into the social system in order to develop and maintain a sustainable society, and these should consider generational and environmental differences of residents.

### **Keywords:**

Awareness of Natural Disaster Risks, Environmental difference, Generation difference, Disaster Preventive Measures, Sustainable society

**JEL Classification:** H84, Q54, I00

## Introduction

Natural disasters have profound impacts on societies' sustainability. Japan is a nation surrounded by the ocean, and some regions are prone to natural disasters (e.g., earthquakes and tsunamis) due to geographical characteristics. From 2000 to 2009, the nation experienced 20.5% of the world's earthquakes with magnitude 6.0 and above (Cabinet of Office, Government of Japan, 2011). Seismic-induced tsunami can exercise an overwhelming influence on the populous coastal areas. In fact, the 2011 Tohoku Earthquake that triggered a massive tsunami wave caused crucial and fatal damage to Japan's north-eastern seaboard.

In a report investigating the tsunami warning system used during the 2011 Earthquake, the Japan Meteorological Agency (JMA) summarized the system's problems. More specifically, the announcements in numerical representation of underestimated value of tsunami height (i.e., 5 or 6 meters) in the initial forecast and all measured values in tsunami observation including too small values (i.e., 0.2 meters) may have misled people and caused delays or interruptions in evacuation (JMA, 2013). To prompt the population to protect their lives by avoiding tsunami height underestimates, the Agency introduced an improved version of the warning system in 2013, which uses qualitative terms such as "high" and "huge" to represent an estimated tsunami height (instead of the conventional quantitative representations) for when the alleged tsunami's scale is uncertain and difficult to determine precisely. These qualitative terms correspond to quantitative values defined by the Agency's internal criteria: "high" for a tsunami height from 1 meter to 3 meters, and "huge" for a tsunami higher than 3 meters. In the new system, within 15 minutes following to the initial announcement, the Agency will issue updated information to replace qualitative representations with the quantitative terms based on the analysis of earthquake magnitude and observed tsunami height (JMA, 2013).

Qualitative representation of information allows varied interpretations by the receiving individuals. According to the author's previous studies (Gyoba, 2014; Gyoba, 2015), university students living far from the region affected by the 2011 Tohoku Earthquake tended to overestimate the tsunami height as compared to those living inside the damaged region. These studies also revealed that, middle-aged and elderly citizens who directly suffered earthquake damage had an estimated numeric value of "huge" tsunami nearest to JMA's internal standard (Gyoba, 2014; Gyoba, 2015).

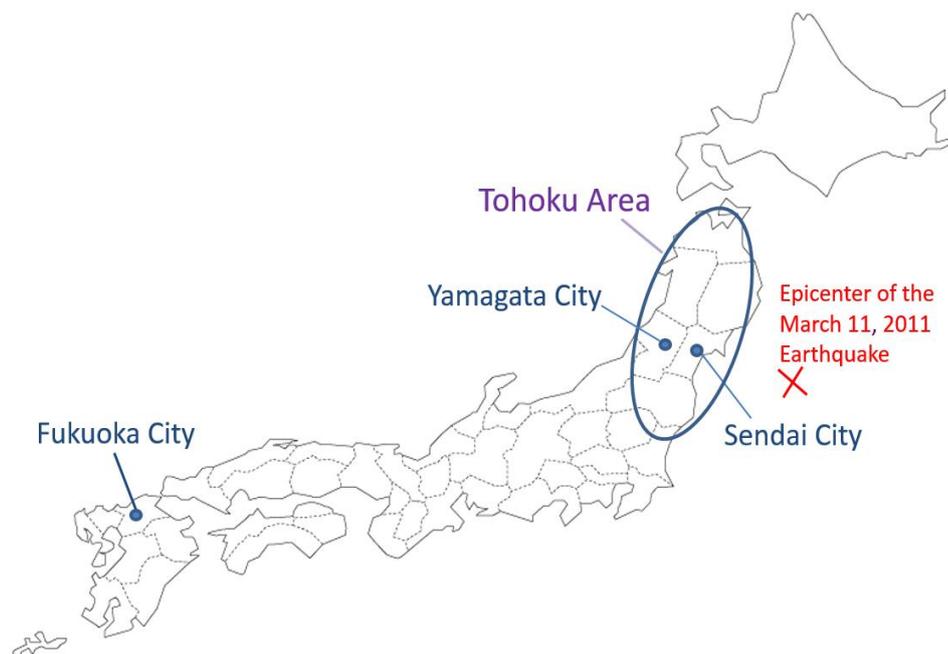
To follow up these results, this study investigate people's sensitivity to risks associated with tsunamis differed by height. A sense of danger of attack by natural disasters differs depending on region, climate, culture, history, and other natural or social environments. Geographical dimensions, exposure to disaster, community characteristic, disaster prevention schemes, and knowledge of natural disasters have greatly influence individuals' sense of crisis awareness. For example, residents living in disaster-prone districts have a higher consciousness of natural hazards and its related damages (Hirose, 2004). Looking into the evacuation behaviors in the 2011 Earthquake, people living in the Sanriku region with a riashore line with experiences of huge tsunamis in

the past few decades started evacuating more quickly than those who live in the lowland coast areas with no experience of tsunamis. For instance, 90 % of the population in Kamaishi City, which is in the Sanriku region, evacuated quickly; 60 % of the residents began evacuating less than 10 minutes after the earthquake, whereas only 30 % of the individuals in Natori (a city extending across the maritime plain) began evacuating within 30 min of the earthquake. (CeMI, 2011; Saparsi et al, 2013).

Young students who acquired knowledge on tsunamis through their parent have a high consciousness of tsunami-related risks (Kanai & Katada, 2006). As compared to adult citizens, junior and senior high school students were less sensitive to natural disasters; they were also less interested in past tsunami events and were less prepared for natural disasters (Yoshida & Ushiyama, 2008).

Aiming to explore difference in individuals' risk awareness, this study focused on the difference of tsunami height, generation, region, and experience with natural disasters. As detailed in the method section below, this research compared the answers on the degree of safety of tsunamis at different heights obtained from five different participant groups: the residents directly affected by the 2011 Tohoku Earthquake, university students and high school students living inside the damaged region, and university students living outside the region.

**Figure 1. Locations of cities where the participants in the present study live.**



## Method

The investigation was conducted from May 13 to June 24, 2013 through a questionnaire, which asked participants about their perceived risk in respect to different tsunami heights. The number of data obtained from the respondents was 597 in total. This included 57 from residents living in Sendai City who suffered damage from the

2011 Earthquake (34 residents from the coastal region and 23 residents living in provisional housing located inland), 117 from students of a Sendai high school, 159 from undergraduates of universities in Sendai, 65 from undergraduates of a university in Yamagata City, and 199 from undergraduates of a university in Fukuoka City.

Sendai is one of the cities heavily damaged by the 2011 Earthquake and Tsunami. Yamagata is 70 km west of Sendai, while Fukuoka is located 1075 km south-west of Sendai.

The question was provided in a closed-ended form with a five-point rating scale. Each participant was asked to rate the risk associated with tsunami by selecting one of the 5 options on the rating scale for each of the 5 different heights of tsunami: below 1 meter, from 1 to 2 meters, from 3 to 5 meters, from 6 to 9 meters, and 10 meters or above. The rating scale consisted of five options ranging from very safe, safe, neither safe nor dangerous, dangerous, to very dangerous. Details of the question and a sample answer are shown below.

*Please suppose that you are now in the area less than 3km from the sea. Then please evaluate the degree of dangerousness you feel for each tsunami expressed in numerical height value.*

a) *Below 1 meter*

1. *Very safe* 2. *Safe* 3. *Neither safe nor dangerous* 4. *Dangerous* 5. *Very dangerous.*

b) *From 1 to 2 meters*

1. *Very safe* 2. *Safe* 3. *Neither safe nor dangerous* 4. *Dangerous* 5. *Very dangerous.*

*(snipped)*

e) *10 meters or above*

1. *Very safe* 2. *Safe* 3. *Neither safe nor dangerous* 4. *Dangerous* 5. *Very dangerous.*

## Results

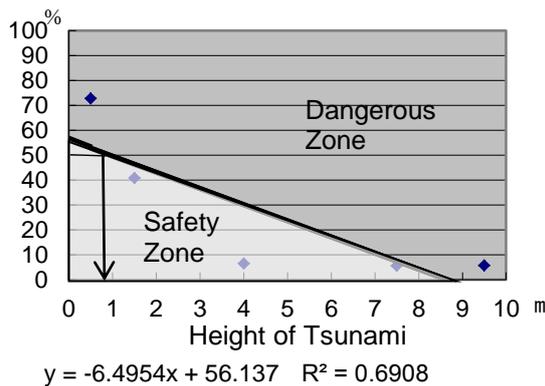
To analyze the results, a psychometric approach was applied to the data using the following procedure.

First, the evaluation data for each tsunami height were organized into two polar categories: one deemed as safe and the other as dangerous. The former category contained the percentages from "1 Very safe" and "2 Safe," while the latter category included the percentages of "4 Dangerous" and "5 Very dangerous." The percentage of "3 Neither safe nor dangerous" was divided depending on the ratio of (1+2) to (4+5) and incorporated into the two categories, respectively. In this fashion, we calculated the average percentages of dangerous estimations for each tsunami height, as seen in Figures 2 to 5 for the five different groups. A regression line was then derived from the scatter plots in each group. By using the regression line, the tsunami height corresponding to 50% of dangerousness was identified as the "threshold" (a critical level of dangerousness), as indicated by an arrow in each figure.

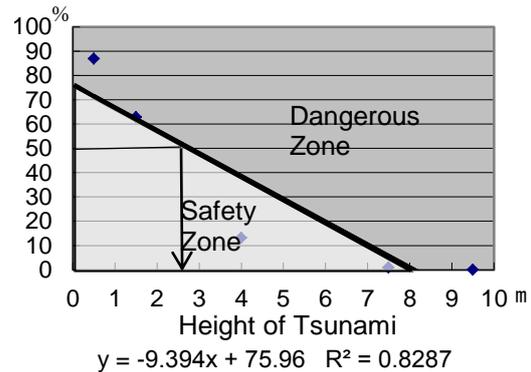
As a result, the lowest threshold of dangerous tsunami height was 0.94 meters residents living in Sendai. They were found to be most sensitive to tsunami threats, since the sensitivity is generally defined as the reciprocal of the threshold in the psychometric approach. On the contrary, the high school students in Sendai demonstrated the highest threshold of dangerous tsunami height, indicating that they do not feel threatened until the tsunami height is over 2.7 meters. Comparing the university student groups, the highest threshold value of 2.56 meters belonged to undergraduates from Fukuoka being located most far from the regions damaged by the 2011 Earthquake.

These results indicate that there is a decreasing sensitivity to tsunami threats in the order of residents affected by the 2011 Earthquake, university students in Yamagata, university students in Sendai, university students in Fukuoka, and high school students in Sendai.

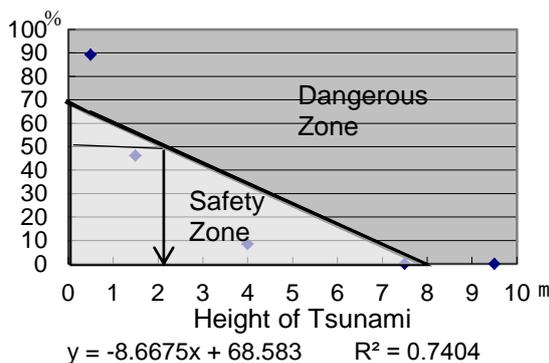
**Figure 2. Residents in Sendai who directly suffered from Earthquake (Threshold of Tsunami Danger : 0.94m)**



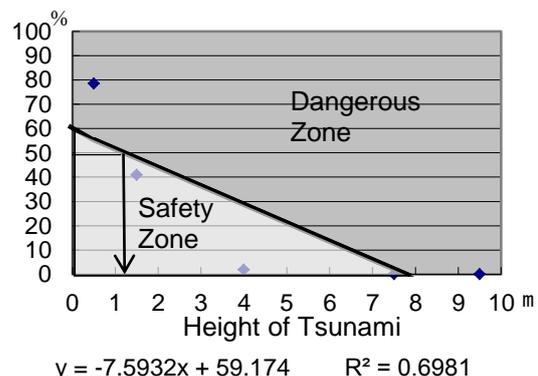
**Figure 3. High School Students in Sendai (Threshold of Tsunami Danger : 2.76m)**



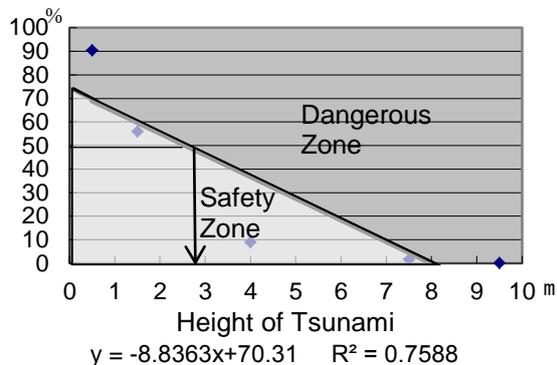
**Figure 4. University Students in Sendai (Threshold of Tsunami Danger : 2.14m)**



**Figure 5. University Students in Yamagata (Threshold of Tsunami Danger : 1.22m)**



**Figure 6. University students in Fukuoka(Threshold of Tsunami Danger : 2.56m)**



## Discussion

From the results, the threshold of dangerous tsunami height was the lowest for residents of the affected Sendai communities. It means that individuals who have experienced tsunami aftermaths are very sensitive and conscious of danger even for tsunami smaller than 1 meter. Our recent investigation on the subjective estimations for the new tsunami warnings in terms of qualitative representations (such as “high,” or “huge”) revealed that populations in the devastated areas had estimates nearest to JMA’s internal standard (Gyoba, 2015). This finding suggests that individuals with experiences of that even lower tsunami may cause a severe damage and consequently made the estimate of tsunami heights more cautiously based on knowledge and experience.

Among the university student groups, the highest threshold value of 2.56 meters was from the undergraduates of a Fukuoka university, which is located furthest from the affected region. The high school students in the damaged region also demonstrated the highest threshold of dangerous tsunami height, where they tend to feel safe until the tsunami height is over 2.7 meters. The high school students from the affected region are least cautious in spite that they know the occurrence of the same disaster when they were junior high school students. These results clearly indicate that younger individuals and those who have not experienced a tsunami are less conscious of the risks involved. This thus reaffirms the previous research that junior and senior high school students demonstrated lower sensitivity to natural disasters and lower preparedness for natural disasters (Yoshida & Ushiyama, 2008).

Based on these differences in individuals’ risk awareness for natural disasters, appropriate preventive measures and educational programs with suitable evacuation plans should be incorporated into the social system in order to develop and maintain a sustainable society. For this purpose, it is especially important to consider the generation differences carefully, along with regional variations and natural disaster experiences.

For the future, we are planning to investigate the behavioral reactions (including biological responses to the tsunami warning information) in the participant groups of various generations and regions and to analyze the crisis awareness in combination with the results of this study more in detail.

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