

# Human Casualty and Behavior due to the Great East Japan Earthquake in 2011

**M. Miyano, E. Ikuta, T. Takahashi, T. Doi, S. Ito, M. Omichi & T. Shigaki**

*Osaka City University, Japan*

**R. Nobuhara**

*Kyoto University of Education, Japan*

**H. Kitamoto**

*Mimasaka University, Japan*

**Y. Kawakatsu**

*Osaka City Government, Japan*

**K. Kamita**

*Land Brain Co.,Ltd., Japan*



## SUMMARY:

In this study, we conducted the interview and questionnaire survey in Miyako City and Kamaishi City, Iwate Prefecture that suffered severe tsunami damage due to the Great East Japan Earthquake on March 11, 2011. Through these investigations, we sought to clarify the Great East Japan Earthquake in terms of human casualties and to focus upon the behavior of those who suffered through the earthquake and its tsunami. From the survey, it was confirmed the courses of evacuation at the inundation area and behavior during and after the earthquake.

*Keywords: Tsunami Casualty Evacuation*

## 1. INTRODUCTION

The Great East Japan Earthquake (M9.0) occurred at 2:46 p.m. on March 11, 2011 off the coast of Tohoku district, Japan. This earthquake caused huge tsunami and extensive damages over the wide area including Iwate, Miyagi and Fukushima Prefectures. In this study, we conducted the interview and questionnaire survey in Miyako City and Kamaishi City, Iwate Prefecture that suffered severe tsunami damage due to the earthquake. Through these investigations, we sought to clarify the Great East Japan Earthquake in terms of human casualties and to focus upon the behavior of those who suffered through the earthquake and its tsunami.

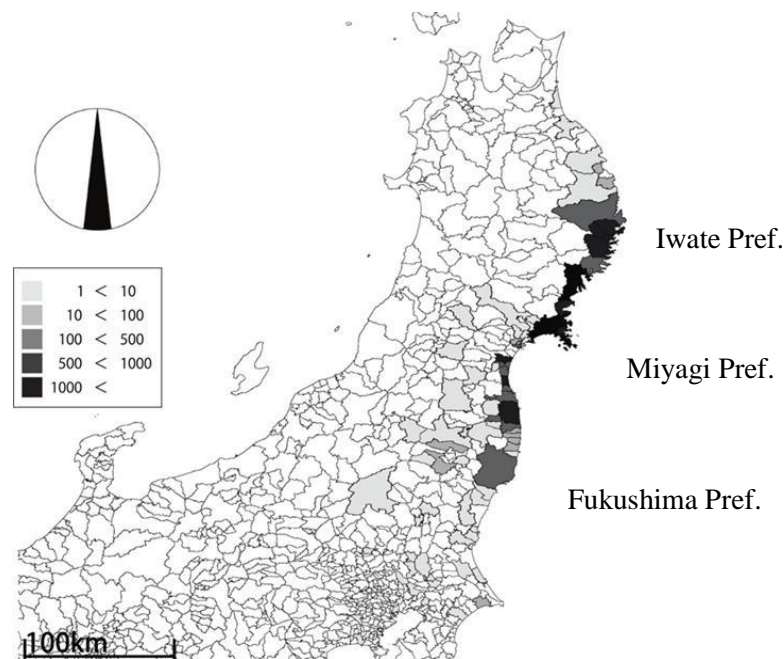
In Taro district, Miyako City, they constructed the seawall 10 meters in height to protect their town from tsunami and built evacuation passage to the perch. However, in this event, one of the seawall was destroyed and almost of all houses in the town were washed away by the tsunami. Over 100 people lost their lives in this town. On the other hand, many people could refuge to the perch through the evacuation passage. Death rate in the main residential area was relatively low because the seawall hindered tsunami invasion. It seemed that the elderly were the main victims of the tsunami. This is the same tendency in other disaster due to tsunamis such as the 1946 Nankai earthquake and the 1993 Hokkaido nansei oki earthquake in Japan. On the other hand, death rate of children is not so high. This is one of characteristic in this tsunami disaster.

## 2. DAMAGE DUE TO THE GREAT EAST JAPAN EARTHQUAKE

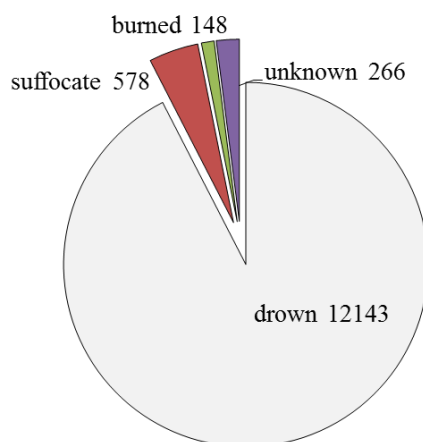
About 20,000 people had been reported dead or unaccounted in the Great East Japan Earthquake Disaster. Most of all victims of this earthquake were distributed in the coastal area of Iwate, Miyagi and Fukushima Prefecture (Figure 1). (after Fire and Disaster Management Agency. (2011))

Over 90% of the dead was caused by drowning due to the tsunami as shown in Figure 2.(after National Police Agency, (2011))

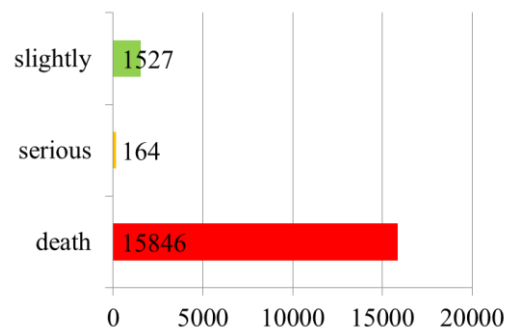
Figure 3 shows a characteristic of the damage extent of casualty in the tsunami disaster. The difference between life and death was clear and accurate in this figure. This is a distinguishing trait from other disasters. (after National Police Agency, (2012))



**Figure 1.** Distribution of the dead



**Figure 2.** Cause of death



**Figure 3.** Number of casualties  
(at the point of Feb. 3, 2012)

### 3. INTERVIEW SURVEY

The targeted areas of this survey, Miyako City and Kamaishi City were one of the most terribly damaged areas in Iwate Prefecture. Interview surveys were conducted from May 30 till Jun 1, 2011 in Miyako City and from Jun 11 till Jun 14, 2011 in Kamaishi City. The questionnaire for interview consisted of 40 questions. In the questionnaire, first ten questions pertained to condition and situation of respondents at immediately after the earthquake. Next 21 questions were to know the respondent's behavior after shaking. The last 9 questions confirmed the knowledge about tsunami.

#### 3.1. Private attributes of the respondents

Table 1 shows the respondents' private or personal attributes at the time of the earthquake. Number of respondents in Miyako City was 100 and in Kamaishi City were 135. The ratio of gender and age in two areas was slightly different. Many respondents were their homes or work places at the earthquake. Some of respondents were driving a car.

**Table 1.** Number of subject by interview survey in attribution

	ITEM	MIYAKO CITY	KAMAISHI CITY
A	Male	45	84
	Female	51	51
B	-60 years old	31	52
	61-70	29	47
	71-	34	9
C	Home	66	76
	Work place	13	31
	Public facilities	3	9
	Outdoors	4	10
	Others	9	12

A: Gender, B: Age, C: Whereabouts at the earthquake

#### 3.2. Behaviour after the earthquake

Human behaviour for evacuation from tsunami was clarified through this investigation. Many people started to take refuge after the shaking. Table 2 shows required time for evacuation. After the result of this table, over 80% of evacuees evacuated to the safety places within 10 minutes.

**Table 2.** Required time for evacuation

TIME	MIYAKO CITY	KAMAISHI CITY
- 5 minutes	51(66.2%)	72(63.2%)
6 - 10	17(22.1%)	26(22.8%)
11 - 30	4(5.2%)	14(12.3%)
31 -	3(3.9%)	2(1.7%)
Unknown	2(2.6%)	0(0%)
Total	77(100%)	114(100%)

**Table 3.** Measures for evacuation

MEASURES	MIYAKO CITY	KAMAISHI CITY
On foot	43(43.0%)	76(58.0%)
Run	8(8.0%)	18(13.8%)
Bicycle or Bike	2(2.0%)	5(3.8%)
Driving a car	28(28.0%)	21(16.0%)
Boarding a car	18(18.0%)	11(8.4%)
Others	1(1.0%)	0(0%)
Total	100(100%)	131(100%)

Over about 50% evacuees took refuge by on foot in both cities. On the other hand, many people evacuated by cars as shown in Table 3. It is very important problem to think about right and wrong to use a car at the evacuation from tsunami. Table 4 shows the destination of evacuation. Almost all of evacuees took refuge to the places those were decided for evacuation places of outdoor or indoor. In Taro district, Miyako City, they constructed not only the seawall 10 meters in height but also evacuation passage to the perch to protect their lives as shown in Photo 1 and 3. However, the tsunami overflowed into residential area (Photo.2; Miyako City).

**Table 4.** Places for evacuation

PLACES	MIYAKO CITY	KAMAISHI CITY
Evacuation places of outdoor	43(46.7%)	62(52.5%)
Evacuation places of indoor	33(35.9%)	40(33.9%)
Upstairs of home	4(4.3%)	2(1.7%)
Others	12(13.1%)	14(11.9%)
Total	92(100%)	118(100%)



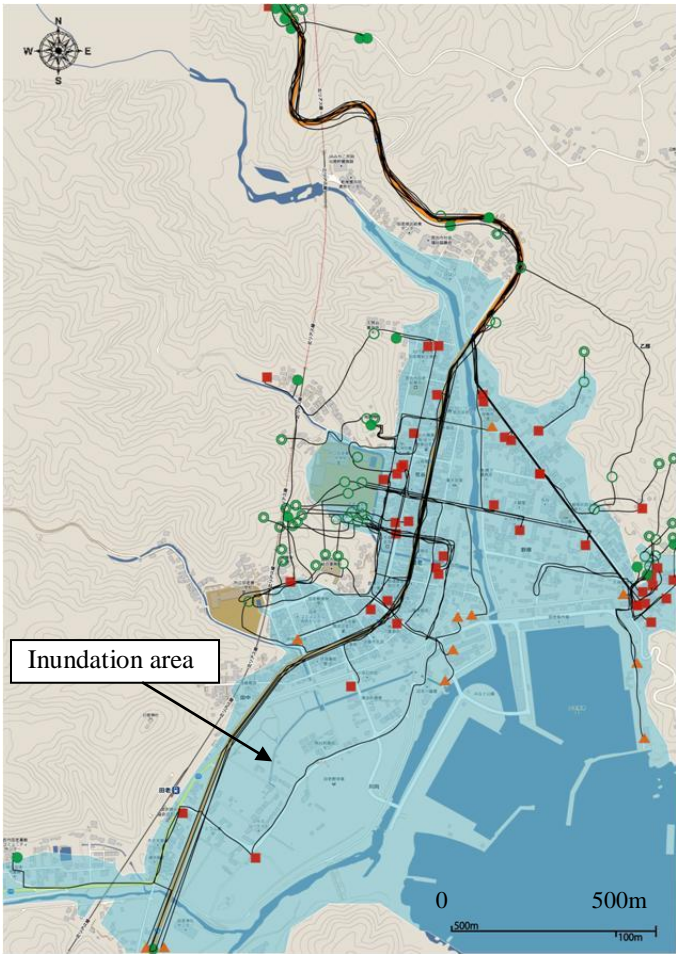
**Photo 1.** Seawall in Taro district



**Photo 2.** Overflowed after the tsunami



**Photo 3.** Evacuation place in Taro district



**Figure 4.** Evacuation courses in Taro district, Miyako City

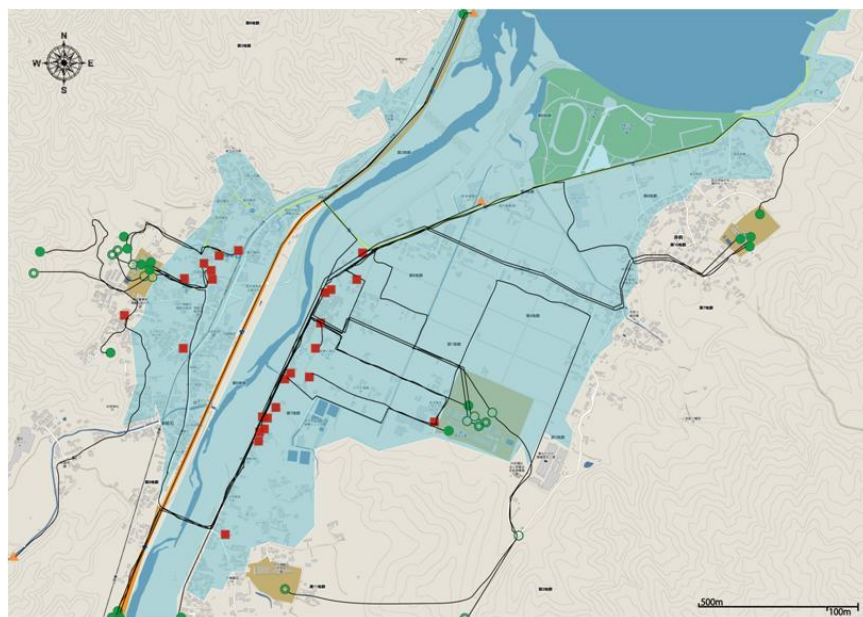
- : Home      ▲ : Office, etc.
- : Evacuation place (at the first)
- ⊙ : Evacuation place (at the second)
- : Evacuation place(final)



Figure 4 shows the courses of evacuation at the Taro district in Miyako City, together with the zone submerged by tsunami. According to this figure, it can be seen that many people headed toward the higher places around the district, specifically to the evacuation places such as shown in Photo 3. Taro suffered tsunami damage in 1896, 1933 and 1960. After the 1933 Tsunami, they constructed seawalls ten meters tall. Mostly, this seawall was efficient facility as in case of the 1960 Tsunami which caused by Chile Earthquake. However, too extreme case as this tsunami of 2011, it did not function adequately. 144 people died or missing in this tsunami, and death ratio of Taro was 5.5%.



**Photo 4.** Devastated area in Taro (Official report by Miyako City)



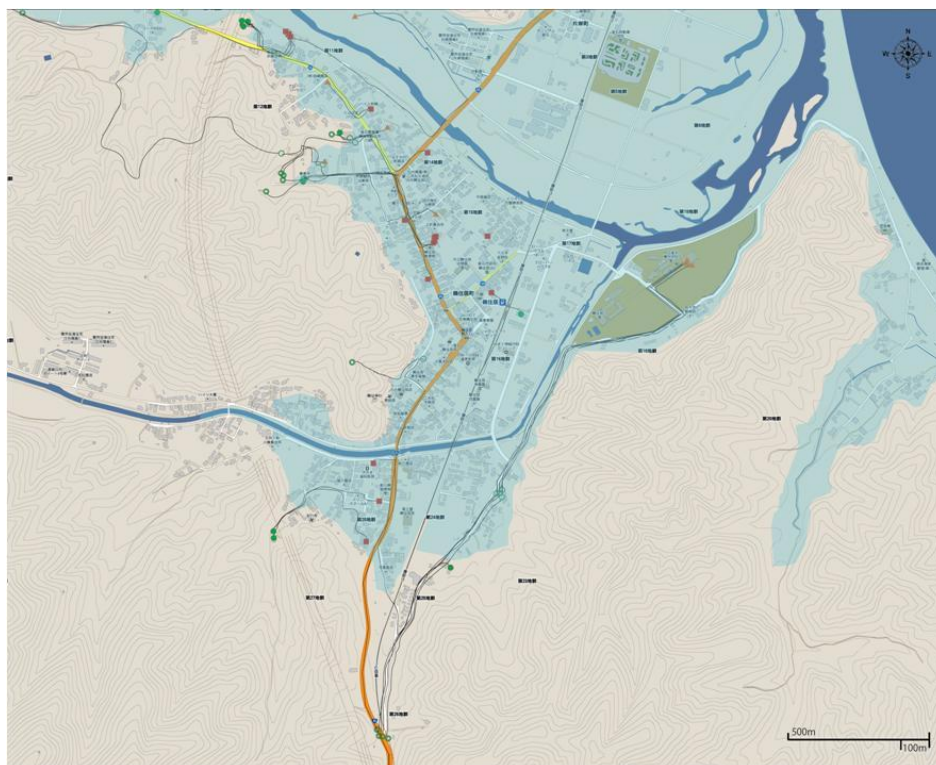
**Figure 5.** Evacuation courses in Tsugaruishi district, Miyako City

In Figure 5, it shows the courses of evacuation at Tsugaruishi district. Tsugaruishi is another district that we surveyed in this study. In this district, 177 dwellings were washed away (ratio 21.7%) and 263 dwellings were completely destroyed (ratio 32.3%). 31 persons died in this tsunami. Many People evacuated to the school which located at higher places. Some people went more safety places after the first evacuation. Average evacuation speed was calculated in each generation as shown in Table 5. Evacuation speed varies from generation. It can be seen the tendency that evacuation speed is slow down as aging.

**Table 5.** Evacuation speed on foot in case of Miyako City

Age(years old)	-49	50 - 59	60 -
Speed(km/h)	9.4	9.0	6.3

Figure 6 shows evacuation courses in Unosumai district, Kamaishi City. In this district, junior high school students led pupils of elementary school on their way to evacuation place. Every student and pupil succeeded to take refuge to safety places.



**Figure 6.** Evacuation courses in Unosumai district, Kamaishi City

#### 4. CONCLUSION

From the investigation, it was clarified that almost all of dead caused by drown and number of injured person was quite few rather than death. That is a characteristic of casualty due to tsunami disaster. Human behaviour especially evacuation from tsunami was investigated by the result of interview survey. After the results, in Miyako City and Kamaishi City, many people evacuated immediately after the earthquake. They headed toward evacuation places located higher and safety area. They recognized what they have to do at the huge tsunami disaster.

The way of recovery of district should be discussed as to move upper place or return back their original place. Seawall height should be reconsidered. If overflow allow, evacuation buildings are required ; 4 stories or higher reinforced concrete building, parking lots, government or public buildings, etc.

#### REFERENCES

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