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Tsunami Disaster Tradition before the 2011 Great East Japan Earthquake and the Effectiveness of Casualty Reduction

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Abstract

In Japan, tsunami disaster tradition has been conducted to transfer memories and learned lessons of past tsunami disasters. However, the effectiveness of tsunami disaster tradition to casualty reduction has not quantitatively clarified ever. This paper presented the results of interregional comparative evaluation of awareness of past tsunami event in affected area just before the 2011 East Great Japan Disaster occurring and analysis relationship between tsunami disaster tradition and actual tsunami evacuation of survivors in Rikuzentakada City and Kesennuma City in the disaster. This paper is organized based on authors' previous studies. The results are summarized as follows. 1) Respondents who recalled the past tsunami event in Iwate at the earthquake occurrence are more than in Miyagi and Fukushima. 2) Rikuzentakada City residents have known 1896 and 1933 Sanriku Earthquake Tsunami more than Kesennuma City. 3) Survivors answered the survey almost have learned past disaster occurred in their area through family and relative, and mass media. 4) In Rikuzentakada, Family conversation about disaster and cognition of 1933 Showa Sanriku Earthquake Tsunami disaster have promoted tsunami evacuation behavior in the 2011 disaster. 5) However, we could not find significant correlation between tsunami disaster tradition and evacuation behavior in Kesennuma survey.

Keywords: Tsunami Tradition, Tsunami Evacuation Behavior, the 2011 Great East Japan Earthquake, oral tradition, family conversation

1. Introduction

There are many types of physically or morally "Tsunami tradition media" such as monument, folklore, place name, tsunami boulder, remains etc. in Japan. The were made for handing down experiences of past tsunami disaster and learned lessons to future ages.

However, how many people knew history of past tsunami and learned lesson such as how to evacuate and where they should build houses based on local experience before the 2011 Japan tsunami has not been clarified. Almost existing researches related tsunami tradition focused area distribution of tsunami monument and the constructing process [2, 3, 4]. It is not clear awareness of past tsunami disaster by affected people as initial condition before the event.

This paper describes the results of awareness of past tsunami before the tsunami in the area affected by the 2011 Great East Japan Earthquake disaster and relationship of disaster tradition and tsunami evacuation behavior. We present problems concerning tsunami tradition based on analysis results and discussion in this study. This paper summarizes the results in authors' previous studies [5,6,7].

2. Method

In this study, we use three questionnaire survey data as follows:

1) Survey data of earthquake and tsunami evacuation in the Great East Japan Earthquake disaster (by Cabinet Secretariat and Cabinet Office, Government of Japan) [8]
2) Questionnaire survey data in Rikuzentakada City (by the authors) [6]
3) Questionnaire survey data in Kesennuma City (by the authors) [7]

First data was investigated to 12,000 survivors in the 2011 Japan disaster by Cabinet Secretariat and Cabinet Office (hereinafter referred to as the Cabinet Office Survey). The survey has asked whether the survivor recalled that a past tsunami have attacked his / her resident area or not. Cabinet Office provided the data of the question to us.

Other two surveys were conducted by the authors in previous studies. The Rikuzentakada survey posted 1,560 survivor households which lived in temporary houses and disaster public houses (November, 2016), and the Kesenuma survey posted 2,850 survivor households which lived in temporary houses, disaster public house and collective relocation areas (December, 2017). We have collected 357 answered sheets in Rikuzentakada and 981 sheets in Kesennuma (rate of collection: 22.9%, 34.3%). In this paper, we mainly analysis awareness of the 1896 Meiji Sanriku earthquake tsunami and the 1933 Showa Sanriku earthquake tsunami (five points likert scale). Both cities adjoin each other in north and south, but Rikuzentakada City belongs Iwate Prefecture, and Kesenuma City belongs Miyagi Prefecture.

3. Results and Discussion

3.1 Awareness of past tsunami events: comparing with three prefectures

Fig. 1 shows the proportion of survivors who had remembered a saying that past tsunami had come their living areas (black bars), or not (white bars) when the 2011 earthquake occurring used the Cabinet Office Survey data. "line" also shows the rate of both in each prefecture [8].

The proportion of survivors who had remembered the past tsunami higher than not in Iwata, but the proportion of survivor who had "not" remembered the past tsunami in Miyagi and Fukushima. The survey result is assumed to take the common view that "tsunami does not attack their living area" among almost of coastal Miyagi and Fukushima inhabitants. It proves past tsunamis cognition of three prefectures inhabitants is high awareness to the west and low awareness to the south in macro view.

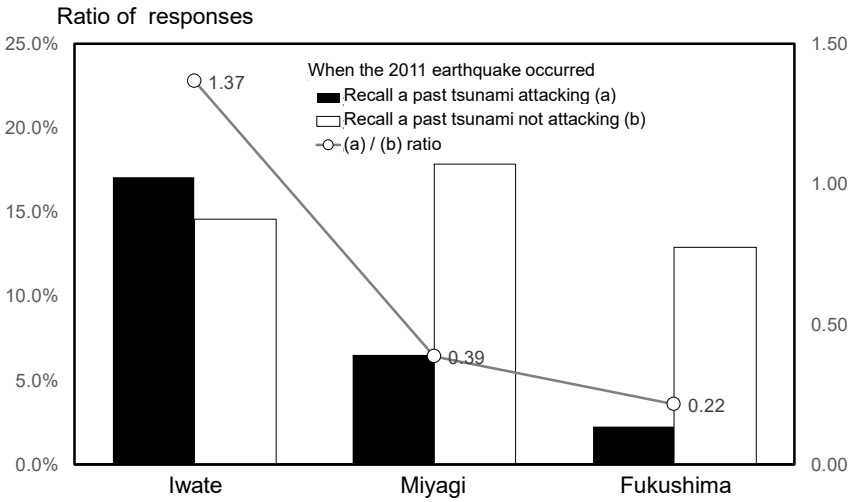

Fig. 1 – Recalling or not of past tsunami when the 2011 Great East Japan Earthquake Disaster occurred.

3.2 Awareness of past tsunami events: comparing with Rikuzentakada and Kesennuma

Fig. 2 illustrates the proportion awareness of the 1933 Showa Sanriku Earthquake Tsunami and the 1886 Meiji Sanriku Earthquake Tsunami before the 2011 earthquake occurring used Rikuzentakada survey and Kesennuma survey data [8]. The proportions are separated natives and non-natives of each city in Fig, 2.

The proportion of respondents who have known past tsunamis are aroud 40 – 50 % in Rikuzentakada, and around 20 – 40 % in Kesennuma (Fig. 2). The awareness proportions of Rikuzentakada are higher than Kesennuma in both the 1886 Meiji tsunami and the 1933 Showa tsunami. And, the awareness proportions of natives is also higher than non-natives in all bars. The result that Kesennua respondents have known past tsunami is less than half is a big problem because tsunami often attack the area in the past begore the 2011 tsunami.

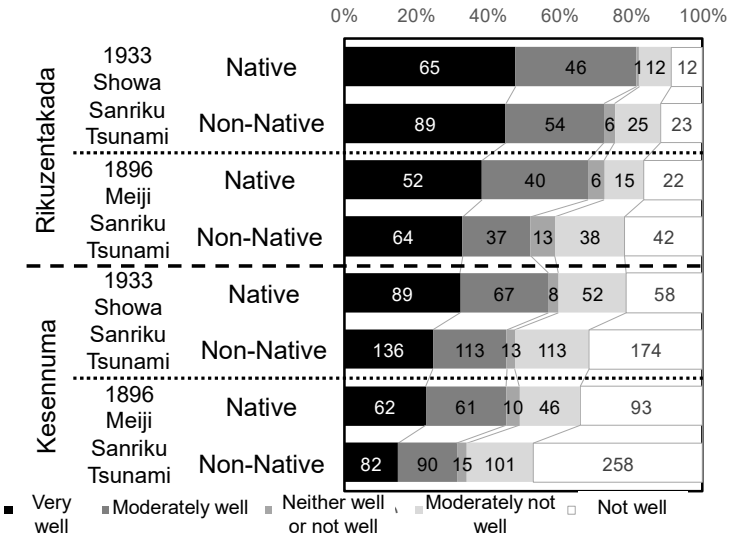

Fig. 2 – The awareness proportion of past tsunamis in Rikuzentakada and Kesennuma Cities before the 2011 Great East Japan Earthquake Disaster occurring.

3.3 Information source of past tsunami events

Fig. 3 shows what information source respondents knew the 1933 Showa Sanriku Earthquake Tsunami and the 1886 Meiji Sanriku Earthquake Tsunami before the 2011 earthquake occurring used Rikuzanakada survey (multiple answers.) [8] The proportions of "Parent", "Mass media" and "Grandparent" are high in the both events. "Parent" of the 1933 Showa tsunami is the highest in the both cities. However, in the 1886 Meiji as older event, "Mass media" is the highest in both cities. The results prove that main and basic source of disaster tradition is "Parent" and home, and limitation of tsunami tradition by folklore is within three generation. In case of the past tsunami over 90 years since occurring, respondents have known from mass media than from family and folklo.re

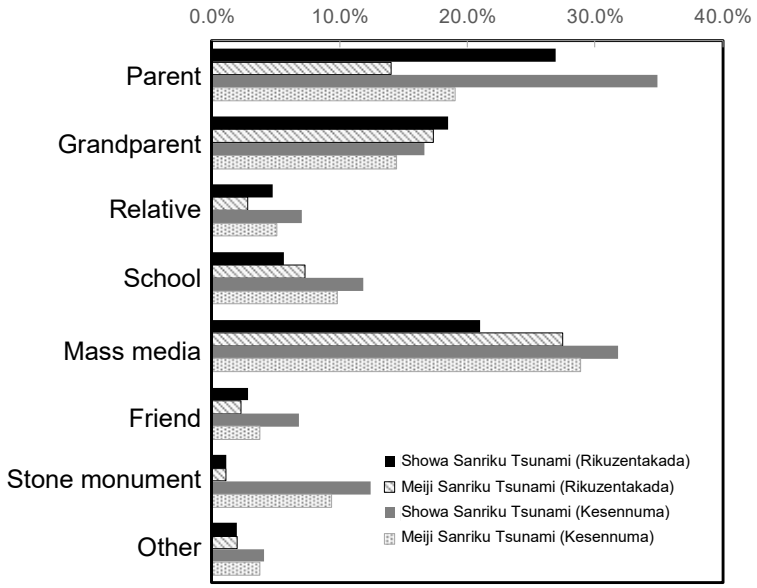

Fig. 3 – Information source respondents knew past tsunami events in Rikuzentakada and Kesennuma Cities before the 2011 Great East Japan Earthquake Disaster occurring.

3.4 Relationship between tsunami tradition and evacuation behavior

A logistic regression was calculated to predict respondent have evacuated or not (dummy variable) based on situations of preparedness and awareness with stepwise selection method using Rikuzentakada survey data (Table 1). [6] Independent variables which are indicated numerical numbers in Table 1 shows are at significant level of 0.01 or 0.05 (chi-square = 12.137, df=2, -2 log-likelihood = 198.474, Cox-Snell R^2 = 0.077, Nagelkerke R^2 = 0.102). R^2 value of this model is not high, but the accuracy is 61.2 %. Both "family conversation of preparedness" dummy and "awareness of the 1933 Show Sanriku Tsunami" dummy were significant predictors of evacuation. On the other hand, preparedness and hazard risk awareness were not significance to evacuation behaviors. It appears that tsunami folklore affected to evacuation behavior in Rikuzentakada in the 2011 tsunami.

Table 1 – A logistic regression which predict evacuation behavior in Rikuzentakada of the 2011 Great East Japan Earthquake Disaster

	B	SE	Wald	p value	Exp(β)
constant	-0.907	0.334	7.364	0.007	0.404
decision of evacuation place					
decision of evacuation place of family					
comfirmig hazard map					
frequency of disaster conversation of family **	0.700	0.338	4.284	0.038	2.015
frequency of disaster conversation in the neighborhood					
belonging to disaster community team					
particapant of disaster drill					
tsunami occurrence					
tsunami attack your house					
tsunami attack living area					
awareness of 1933 Showa Sanriku Tsunami **	0.962	0.354	7.393	0.007	2.618
awareness of 11896 Meiji Sanriku Tsuinami					
awareness of 1tsunami stone monument					

A multiple linear regression was calculated to predict start time of evacuation based on situations of preparedness and awareness with backward selection method using Kesennuma survey data (Table 2) [7]. Independent variables which are indicated numerical numbers in Table 2 shows are at significant level of 0.01 or 0.05 (adjusted multiple correlation coefficient (R^2) = 0.123, F=0.000, $p < 0.05$). Negative values (fast evacuation) of standardizing coefficient in order of absolute value were “danger recognition at quake occurring (-0.214)”, “imaging of tsunami occurring before 2011 (-0.160)”, “real-time information of estimated tsunami height (-0.157)”, “tsunami warming / major tsunami warming (-0.124)”, “decision of evacuation place before 2011 (-0.104)” and “indoor receiver by local government (-0.102).” As opposed to Rikuzentakada case study, it appears that tsunami folklore did not affect to evacuation behavior in Kesennuma in the 2011 tsunami.

3.5 Discussion

We found that tsunami disaster tradition and the family conversation have correlate with promotion evacuation behavior in Rikuzentakada, but did not found such a relationship in Kesennuma. The results was caused by deference of the proportion of past tsunami awareness between two cities. Based on Fig. 1of section 3.1 and Fig. 2 of section 3.2, Kesennuma, Miyagi habitants had known the past tsunami events more less than Rikuzenrakada, Iwate habitants. We have concluded that Iwate had worked actively tsunami tradition. For example, Iwate prefectural government have well planned the guideline of tsunami stone monument erection such as design, content of epigraph and location after the 1933 Show Sanriku Tsunami, but Miyagi prefectural government did not consider that.

Table 2 – A multiple linear regression which predict evacuation behavior in Kesennuma of the 2011 Great East Japan Earthquake Disaster

		coefficient	SE	standizing coefficient	p value
constant		5.562	0.417		0.000
demografics	age				
	residence years				
	hometown (Kesennuma, dummy)				
	gender				
inforation source	TV				
	radio				
	mobile phone (including smartphone)				
	internet				
	public-relations vehicle				
	indoor receiver by local government	-0.830	0.444	-0.102	0.062
	loud speaker by local government				
	neighborhood				
	polic / fire department				
information content	estimated tsunami height **	-0.640	0.225	-0.157	0.005
	estimated tsunami arrival time				
	observed tsunami height				
	observed tsunami arrival time				
	inudation situation with the area				
	inudation situation in other areas **	0.845	0.290	0.161	0.004
	evacuation order				
	tsunami warning / major tsunami warning *	-0.591	0.264	-0.124	0.026
awareness	1960 Chile Tsunami				
	1933 Showa Sanriku Tsunami				
	1896 Meiji Sanriku Tsuinami				
preparedness	decision of evacuation place	-0.158	0.090	-0.104	0.081
	decision of evacuation place of family				
	freqency of disaster conversation of family				
	frequency of disaster conversation in the neighborhood				
	comfirmig hazard map				
	particapant of disaster drill				
	preparing emergency bag				
	disaster class / lecture				
cognition	tsunami occurrence **	-0.244	0.094	-0.160	0.010
	tsunami attack your house				
	tsunami attack living area				
	tsunami occurrence at shaking				
	housing damage occurrence at t shaking				
	human damage occurrence at shaking **	-0.293	0.079	-0.214	0.000

5. Conclusion

This paper presented the results of interregional comparative evaluation of awareness of past tsunami event in affected area just before the 2011 East Great Japan Disaster occurring and analysis relationship between tsunami disaster tradition and actual tsunami evacuation of survivors in Rikuzentakada City and Kesennuma City in the disaster. The results are summarized as follows.

1) Respondents who recalled the past tsunami event in Iwate at the earthquake occurrence are more than in Miyagi and Fukushima.
2) Rikuzentakada City residents have known 1896 and 1933 Sanriku Earthquake Tsunami more than Kesennuma City.

3) Survivors answered the survey almost have learned past disaster occurred in their area through family and relative, and mass media.
4) In Rikuzentakada, Family conversation about disaster and cognition of 1933 Showa Sanriku Earthquake Tsunami disaster have promoted tsunami evacuation behavior in the 2011 disaster.
5) In conclusion, the authors' studies have demonstrated that it is important to promote past disaster tradition in communities for reducing casualties and making the intention of tsunami evacuation.

Further consideration will be needed to yield any findings about case analysis in other area and other disasters.

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