

Capacity of the temples and shrines for using as evacuation places and shelters against the tsunami hazard: the case study for the coastal area of Muroto, Kochi-Prefecture in Japan

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ABSTRACT

This research focuses the capacity of the temples and shrines for using as evacuation places and shelters. Firstly, we suggested the investigation form by collecting the research data of the cases of the temples and shrines which had utilized as an evacuation places after the Great East Japan Earthquake and Tsunami. And we conducted the case study on the one of the hugest possible damaged area by the next tsunami (Nankai Trough Earthquake) in Muroto, Kochi prefecture in middle-west Japan. We evaluated 25 temples and shrines by the investigation form which we suggested with the previous research data. All 25 temples and shrines have the outdoor spaces for possible using as the temporary evacuation and emergency staying. There are 12 temples and shrines which were allowed their indoor spaces to be utilized as the evacuation shelter. By the interview research, we investigated the stocks of foods, water, beddings and facilities on the 10 temples and shrines, and the community activities which would help to make cooperation between these built heritage and the local community.

Keywords: tsunami; local culture heritage site; resilient built heritage; Nankai Trough Earthquake; evacuation planning

1 INTRODUCTION

1.1 Research Background

The tsunami occurring after the Great East Japan Earthquake on March 11, 2011 severely damaged the designated public evacuation shelters such as schools and community centres, resulting in an insufficient number of evacuation shelters. Previous studies have showed that undamaged temples and shrines that were not designated as evacuation shelters were used as evacuation shelters to support life. (Michiko et al., 2012 and Takeyuki et al., 2011) These studies surveyed the temples and shrines in the regions where there was an outbreak of fires due to tsunamis. They confirmed whether the temples and shrines were used as evacuation shelters and how their firefighting equipment such as water tanks helped in the firefighting activities of the city. (Hiroki et al., 2015) This study found that temples and shrines can be used as temporary evacuation shelters and shelters and disaster prevention bases for activities such as firefighting.

This is because temples and shrines that have experienced many great earthquakes and severe tsunami damages in the past are located at places that will potentially suffer less damage. The possibility that mountain roads are suitable as emergency evacuation routes and that temples and shrines have habitable spaces such as main hall, kitchen, and tatami rooms, some of them have been officially designated as

evacuation shelters and shelters during disasters. (Satoshi et al., 2012)

The Nankai region has experienced a significant earthquake at intervals of approximately 100 years and suffered damages from tsunamis.

It is expected that the Nankai Trough Earthquake will occur in the future. Therefore, the Cabinet Office has cited Muroto city, Kochi Prefecture among the five districts considered as Special Enhancement Areas for the Tsunami of the Nankai Trough Earthquake. The maximum height predicted for tsunamis is 24 m if a shock of seismic intensity 7 occurs; this is the highest class for the prefecture. Muroto city has currently designated 14 facilities as public evacuation shelters, but these facilities are not sufficient to accommodate all the evacuees. (Muroto City Tsunami Disaster Prevention Map, 2015)

Table 1 shows the designated evacuation shelters of Muroto city and number of evacuees who can be accommodated in the shelters, number of evacuees estimated by Muroto city, number of evacuees who cannot be accommodated, and the accommodation possible rate. From this, the problem of inadequate accommodation for evacuees in the disaster shelters designated by Muroto City is expected to continue.

Table 1. Number of evacuees who can be accommodated in the designated evacuation shelters and number of evacuees in each area, number of evacuees who cannot be accommodated and

accommodation possible rate for Muroto city.

Area	Capacity of evacuation shelters	Number of evacuees	Accommodation possible rate (%)
Sakihama	170	1348	12.6
Muroto	1439	3250	44.2
Muro Misaki	1497	3392	44.1
Kiragawa	728	1800	40.4
Hane	1043	1578	66

1.2 Objectives of the Study

We targeted Muroto city in Kochi prefecture in this study based on the above facts. The lack of evacuation shelters and shortage of stocks are challenges assuming enormous damage due to the Nankai Trough Earthquake. Our objective was to find out the number of people who can be accommodated, stocks, evacuation routes, and evacuation center management assuming that temples and shrines are utilized during disasters caused by tsunamis. We also evaluated how temples and shrines can be used as disaster prevention shelters during tsunami disasters.

2 TEMPLES AND SHRINES TARGETED FOR THE SURVEY AND RESEARCH METHODS

2.1 Information on the temples and shrines targeted for the survey

The temples and shrines selected for this survey were;

(1) Located outside the tsunami inundation area, 15 m above the sea level, and within a distance of 300 m from the coast and,

(2) Selected as the evacuation shelter for the district in the resident's workshop conducted by Muroto city in 2011.

A total of 25 temples and shrines satisfied either (1) or (2). Table 2 shows the temples and shrines that were targeted for the survey, whether they are selected as evacuation shelters in that district, height above the sea level, and distance from the coast. The reason for selecting temples and shrines of (1) was because the standard height above sea level for evacuation has been set to 15 m in Muroto city. The time for a tsunami to reach the Muroto city coastline is 0 to 5 minutes. If the time available for evacuation is set to 5 minutes and walking speed is considered as 1.0 m/s, the distance up to which people can be evacuated is 300 m. The temples and shrines of (1) were selected based on the above reasons.

There was a shortage of shelters to accommodate evacuees in the Hane area, but since there were no temples and shrines in the region fitting the conditions set in (1) and (2), we decided to exclude this area from the present study.

Table 2. Temples and shrines that were targeted for the survey, whether they are selected as evacuation shelters in that district, height above the sea level, and distance from the coast.

Area	Name of temple/ shrine	Selected as evacuation shelters	Height above the sea level (m)	Distance from the coast (m)
Sakihama	Hozen-ji	O	27	129
	Sakihama Hachimangu	O (a hill behind)	12	271
	Hamamiya-shrine	O (a hill behind)	12	331
	Dainichi-dera	O (a graveyard of the temple)	16	447
	Myogen-gu	O	65	1050
	Isobe-shrine	O	16	140
	Tenjin-gu	O	16	210
	Chudo-ji	O	20	294
	Iwato-shrine	X	21	242
	Ichiki-shrine	O	22	335
Muroto	Sugio-shrine	O	19	590
	Tsusho-ji	O	35	375
	Houdo-ji	X	18	997
	Yasaka-shrine	O	26	310
	Hachioji-gu	O (a hill behind)	15	310
	Yasaka-shrine	O	17	102
	Sugio-shrine	O (a hill behind)	40	258
	Koufuku-ji	O	20	229
	Meijoraiei-ji	O	19	138
	Zendo-ji	O	18	198
Muro Misaki	Ouji-gu	X	23	160
	Suzuki-shrine	O	18	186
	Kansyo-ji	O	20	266
	Ondahachiman-gu	X	26	321
	Taniguchi-shrine	O	20	330
Kiragawa				
Hane	n/a	-	-	-

2.2 Research methodology

To conduct a field survey of all the temples and shrines of Muroto city, interview-based surveys of the chief priests present in 10 of the 25 temples and shrines were formulated. In the survey, we checked the both internal and external areas, evacuation routes and guidance lights, and availability of fire protection equipment in the temples and shrines. In the interview-based survey, we surveyed the food stocks, year of construction, emergency drills, and relationship with the residents of the surrounding locality and nearby temples and shrines.

3 ESTIMATION OF THE NUMBER OF EVACUEES BASED ON THE ACTUAL SURVEY.

3.1 Information on the external area size

We measured the size of the external area of all the temples and shrines with the actual survey. The external areas within the premises that can be used as evacuation shelters were identified. The number of people who can be temporarily evacuated to temples and shrines was calculated by considering the space required as 1 m²/person. Table 3 shows the external area of temples and shrines and the estimated number of people who can be evacuated.

3.2 Information of the internal area size

For the temples and shrines that were targeted in the present study for survey, we confirmed the locations within the temples and shrines for evacuees to live during their evacuation, such as the main hall and kitchen that were determined by the chief priests, and interior spaces that we could survey for 12 temples and shrines during the survey.

The area required per person to live during evacuation at temples and shrines was set to 1.62 m²/person. (Taku et al., 2009) Table 4 shows the size of internal area of temples and shrines and the estimated

number of evacuees who can live in the area.

Table 3. Size of the external areas of temples and shrines, and estimated number of people who can be evacuated.

Area	Name of temple/ shrine	Size of the external areas (m ²)	Number of possible evacuees who can live in
Sakihama	Hozen-ji	406	406
	Sakihama Hachimangu	2790	2790
	Hamamiya-shrine	252	252
	Dainichi-dera	568	568
	Myogen-gu	135	135
	Isobe-shrine	110	110
Muroto	Tenjin-gu	168	168
	Chudo-ji	340	340
	Iwato-shrine	697	697
	Ichiki-shrine	24	24
	Sugio-shrine	133	133
	Tsusho-ji	51	51
Murto Misaki	Houdo-ji	125	125
	Yasaka-shrine	82	82
	Hachioji-gu	332	332
	Yasaka-shrine	59	59
	Sugio-shrine	282	282
	Koufuku-ji	123	123
Kiragawa	Meijoraiei-ji	300	300
	Zendo-ji	168	168
	Ouji-gu	539	539
	Suzuki-shrine	40	40
	Kansyo-ji	406	406
	Ondahachiman-gu	954	954
	Taniguchi-shrine	96	96

Table 4. Size of the internal area of temples and shrines and estimated number of evacuees who can live in the area.

Area	Name of temple/ shrine	Size of the internal areas (m ²)	Number of possible evacuees
Sakihama	Hozen-ji	41.65	25
	Dainichi-dera	89	55
Muroto	Chudo-ji	63.75	39
	Tsusho-ji	58	36
	Houdo-ji	83	51
Murto Misaki	Koufuku-ji	94.11	58
	Meijoraiei-ji	169.07	104
	Zendo-ji	298.1	184
	Sugio-shrine	63.28	39
Kiragawa	Ouji-gu	99.8	62
	Kansyo-ji	159.1	98
	Ondahachiman-gu	59.3	37

4 SITUATION OF STOCKS, FACILITIES, RELATIONSHIP WITH SURROUNDING RESIDENTS AND NEARBY TEMPLES AND SHRINES BASED ON THE INTERVIEW-BASED SURVEY

We conducted an interview-based survey with the chief priests of 10 temples and shrines targeted for the survey and confirmed information on stocks, equipment, and relationship with the residents of the surrounding locality and nearby temples and shrines.

4.1 Information on stocks

We checked the availability of food, water, futon, and other stocks. Tables 5 and 6 show the stocks in temples and shrines where we conducted the interviews.

Table 5. Results of the interview-based survey (1)

Area	Sakihama	Muroto		Murto Misaki	Kiragawa	
Name of temple/ shrine	Hozen-ji	Chudo-ji	Tsusho-ji	Koufuku-ji	Ondahachimangu	
Selected as evacuation shelters	O	O	O	O	O	
Date of investigation	5 th Aug. 2016	3 rd Aug. 2016	18 th Nov. 2016	3 rd Aug. 2016	17 th Nov. 2016	
Results of stocks	Food	only for family's daily	n/a	Instant noodle 2 boxes	n/a	only for family's daily
	Water	a cistern	a well	only for family's daily	n/a	only for family's daily
	Futon	10 sets	3 sets for visitors	only for family's daily	4 sets	5 sets

Table 6. Results of the interview-based survey (2)

Area	Sakihama	Muroto	Murto Misaki		Kiragawa	
Name of temple/ shrine	Dainichi-dera	Houdo-ji	Meijoraniei-ji	Zendo-ji	Kansyo-ji	
Selected as evacuation shelters	O (a graveyard)	O	O	O	O	
Date of investigation	16 th Nov. 2016	14 th Nov. 2016	4 th Aug. 2016	4 th Aug. 2016	3 rd Aug. 2016	
Results of stocks	Food	only for family's daily	n/a	n/a	only for family's daily	n/a
	Water	to preserve dried food offerings for emergency using	n/a	n/a	n/a	n/a
		only for family's daily	only for family's daily	only for family's daily	n/a	only for family's daily
	Futon	10 futon sets 25 floor cushions	5 futon sets 50 floor cushions	3 futon sets	3 futon sets 100 floor cushions	3-4 futon sets

4.2 Facilities of temples and shrines

We confirmed the year of construction, availability of heating appliances, restrooms, and bathrooms in the temples and shrines. Tables 7 and 8 show the stocks in temples and shrines where we conducted the interviews.

4.3 Relationship with the residents of the surrounding locality

Temples and shrines that were used as evacuation shelters during the Great East Japan Earthquake had a strong association with the residents of the surrounding locality involving the temple priest and patrons supporting the temples and shrines. This bond made identification of the evacuees easy, and the residents felt safe¹⁾ as they shared a bond with the chief priests of the temples and shrines. It is known that during disasters, the association between the temples and shrines and residents of the surrounding locality is a factor that helps in collecting information and giving mental relief to the residents. Therefore, we conducted an interview-based survey for the temples and shrines of Muroto city targeted in the present study to find out the relationship between the temples and shrines and the residents of the surrounding locality.

At all the 10 temples and shrines where we conducted the interview-based surveys, the chief priests and patrons supporting the temples and shrines became acquainted during Buddhist memorial services and local festivals. We found that seven temples and shrines out of the total 10 regularly conducted emergency drills after they were selected as evacuation shelters of the district at the workshop held in 2011.

Table 7. Results of the interview-based survey (3)

Area	Sakihama	Muroto		Murto Misaki	Kiragawa	
Name of temple/ shrine	Hozen-ji	Chudo-ji	Tsusho-ji	Koufuku-ji	Ondahachiman-gu	
Selected as evacuation shelters	O	O	O	O	O	
Date of investigation	5 th Aug. 2016	3 rd Aug. 2016	18 th Nov. 2016	3 rd Aug. 2016	17 th Nov. 2016	
Construction and restoration year	Meiji 34 Re-roof: 2006	Taisho ara Re-roof: 1975	A residential: 1978 A main hall: 1972	1965	Originally in Edo era Rebuilt in 1998	
Results of building condition and facilities	Air conditioner	1 at main hall 4 air fans	3 air fans 1 kerosene oil stoves 1 fan heater 1 warm carpet	1 for every room in residential area 2 kerosene oil stoves 5 air fans	Only in office	
	Wash room	1 at residential area	4 at residential area	3 toilets for men, 4 toilets for women on two floors	2 toilets for men, 2 toilets for women	1 at office 1 at main hall
	Bath	1 at residential area	1 at residential area	1 at residential area	1 at residential area	1 at office area

Table 8. Results of the interview-based survey (4)

Area	Sakihama	Muroto	Murto Misaki		Kiragawa
Name of temple/ shrine	Dainichi-dera	Houdo-ji	Meijorai-ji	Zendo-ji	Kansyo-ji
Selected as evacuation shelters	O (a graveyard)	O	O	O	O
Date of investigation	16 th Nov. 2016	14 th Nov. 2016	4 th Aug. 2016	4 th Aug. 2016	3 rd Aug. 2016
Construction and restoration/ retrofitting year	Main hall: 1942			Main hall: Edo era (17C)	
	Re-roof: 2000	Approx. 1980	Main hall: 1984		Taisho era (19C)
	Reception room: 2003	No retrofitting (RC frame)	Residential area: 1985	Restoration of main hall: 1971	
Results of building condition and facilities	Residential area: 2003			mortuary room: 1995	
	1 at main hall			1 at main hall	9 air fans
	1 at reception room	No air conditioner	1 at residential area	1 at mortuary room	5 kerosene oil stoves
	1 at residential area	5 kerosene oil stoves		5 kerosene oil stoves	1 air conditioner at residential area
				6 air fans	
Wash room	1 at main hall	2 toilets for men	1 at main hall	1 toilet for men	1 at main hall
	2 at residential area	1 toilet for women	1 at residential area	1 toilet for women	1 at residential area
		2 at residential area			
Bath	1 at residential area	1 at residential area	1 at residential area	1 at residential area	1 at residential area

4.4 Relationship with other nearby temples and shrines

During the Great East Japan Earthquake, temples and shrines belonging to the same religious sect in the Kanto and Kansai regions delivered the necessary supplies to the temples and shrines that were used as evacuation shelters and had formed voluntary organizations. In addition, they exchanged relief supplies such as food with the temples and shrines that were used as evacuation shelters in the surrounding areas. We found that during disasters, the community associated with a particular temple or shrine supplied relief materials and engaged in voluntary activities. Therefore, we conducted an interview-based survey for the temples and shrines of Muroto city targeted in the present study to find out the relationship between the temples and shrines with other nearby temples and shrines.

We conducted an interview-based survey and found that 7 out of the 10 temples conducted Buddhist memorial services and festivals with other nearby

temples and shrines belonging to the same religious sect. For example, Tsusho-ji, Myoujorai-ji, and Dainichi-dera celebrated festivals together.

The region between Yasuda and None areas in the southern part of Kochi prefecture houses temples of Jodo Shinshu belonging to the Aki sect. Once or twice a year, the chief priest brings all the people together so that they can get to know each other. Fig. 1 shows the organizational chart of the Jodo Shinshu Honganji sect. Four temples, Kansyo-ji, Koufuku-ji, Housen-ji, and Houdo-ji of Jodo Shinshu were surveyed in the present study.

5 CONCLUSIONS

Table 9 shows the designated evacuation shelters, number of evacuees who can be accommodated only in the internal spaces of the temples and shrines surveyed, number of evacuees in each area, number of evacuees who cannot be accommodated, and accommodation possible rate. From Table 9, the accommodation rate increases when temples and shrines are used as evacuation shelters: for Sakihama area from 12.6% to 18.8%, Muroto area from 44.2% to 46.1%, Muroto-misaki area from 44.1% to 57.3%, and Kiragawa area from 40.4% to 47.9%. We found that there was a shortage of evacuation shelters required to accommodate all evacuees during an evacuation in all the areas when an earthquake occurs.

Table 9. Designated evacuation shelters of Muroto city, number of evacuees who can be accommodated only in the internal spaces of the temples and shrines surveyed and number of evacuees in each area, number of evacuees who cannot be accommodated and accommodation possible rate.

Area	Name of temple/ shrine	Number of possible evacuees	Number of maximum evacuees against tsunami	Number of evacuees who cannot be accommodated	The possible accommodation rate (%)
Sakihama	Sakihama DRM Center	30			
	Sakihama Nursary	143			
	Hozen-ji	25	1348	1095	18.8
	Dainichi-dera	55			
	Total: 253				
Muroto	Muroto high school	564			
	Otani community hall	197			
	National Muroto youth hall	678			
	Chudo-ji	39	3398	1833	46.1
	Tsusho-ji	36			
	Houdo-ji	51			
	Total: 1565				
Murto Misaki	Muroto central park	200			
	Prefectural Muroto gym	1297			
	Sugio-shrine	39			
	Koufuku-ji	58	3392	1448	57.3
	Meijorai-ji	104			
	Zendo-ji	184			
	Ouji-gu	62			
	Total: 1944				
Kiragawa	Kiragawa primary school	270			
	Kiragawa community hall	428			
	Kiragawa DRM center	30	1800	937	47.9
	Kansyo-ji	98			
	Taniguchi-shrine	37			
	Total: 863				

There were no temples and shrines of Muroto city with stocks, and facilities such as emergency supply storehouses where stocks can be stored must be

arranged to utilize the temples and shrines as evacuation shelters during disasters. However, temples and shrines have offerings, and there are some reports where offerings of temples and shrines have been used during the Great East Japan Earthquake. In the Dainichi-dera of Sakihama area, we were informed during the interview-based survey that the offering was changed from perishables to dry bread for effective storage after they saw images of the temples that were used as a shelter during the Great East Japan Earthquake. Temples and shrines have offerings, and this may be useful in times of disaster.

There were five places where emergency drills are held for understating the evacuation routes to the temples and shrines, and it is likely that the residents will be aware of the evacuation routes to temples and shrines during disasters.

We found that all temples and shrines provided the required space for evacuation centre management. Due to the presence of the Aki sect, it is considered that exchanging goods and grasping the damage situation become easy.

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