

Paper:

Evacuation from Tsunami and Social Capital in Numanouchi Ward, Iwaki City

Michimasa Matsumoto^{*,†} and Kaori Madarame^{**}

^{*}International Research Institute of Disaster Science, Tohoku University
6-6-11-901-2 Aoba, Sendai, Miyagi 980-8579, Japan

[†]Corresponding author, E-mail: matsumoto@irides.tohoku.ac.jp

^{**}MINDSHARE Inc., Tokyo, Japan

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This study investigates the relationship among peacetime human relations, that is, formation of networks, social capital accumulated as a result of human relations, and group evacuation (in units of neighborhood groups, Tonari-gumi) in Numanouchi ward. Located in Iwaki City, in Fukushima Prefecture, Japan, Numanouchi ward was partially destroyed by the Great East Japan Earthquake. The study found that there are differences in the formation of networks, social capital, and group evacuation between the Numanouchi and Suwahara areas. The study also found that there is a (slight) difference in the processes followed in group evacuation and the factors influencing the choice of processes in both areas.

Keywords: network, social capital, evacuation

1. Introduction

1.1. Raising of Problems

Iwaki City, in Fukushima Prefecture, Japan, was partially destroyed along the coastal area by the Great East Japan Earthquake on March 11, 2011. The city faced additional damage caused by harmful rumors regarding the accident at Tokyo Electric Power's Fukushima Dai-ichi Nuclear Power Plant the next day. The city continued to face damage long after the accident. About 300 people in Iwaki City died in the tsunami, of which 200 were from the Toyoma district¹ where Numanouchi ward is located. According to the residents, Iwaki City had never faced a large tsunami before the Great East Japan Earthquake.² When the tsunami due to the Chilean Earthquake in 1960 hit the city, it only had three victims, with none in Toyoma district.³

The "unexpected tsunami" made the people of Iwaki City develop and implement a tsunami evacuation drill

system. Annual drills began in 2013, shortly after the disaster, in Numanouchi ward⁴ as well. Based on a guideline issued by Iwaki City, Numanouchi ward established a system for the evacuation of the residents in neighborhood groups. However, since their memories faded with time, their fear of the tsunami began to lessen, and the development of the evacuation system was no longer a priority. This was a problem raised in a regional committee meeting and by committee board members. Although people were taught to evacuate on foot during the drills, the tsunami alert for the earthquake that occurred on November 22, 2016 caused traffic congestions in various places, since people evacuated by car. Fortunately, Toyoma district and Iwaki City had no victims. However, since "the traffic congestions in various places indicated that the city could not learn from the evacuation drill conducted on November 5," the city established a "subcommittee for tsunami evacuation by cars." A lower branch of the Iwaki City Disaster Preparedness Committee met to discuss car usage for tsunami evacuation.⁵

While the improvement and enhancement of the precision of the evacuation system in the manner mentioned above are important, it is necessary to understand the process of evacuation. This is the focus of this study. The idea arose when the authors attended a disaster preparedness meeting to talk about evacuation by car, held in another district.⁶ The chairperson of a disaster preparedness organization said, "Automobiles are private properties. So, we (the district committee or voluntary disaster preparedness committee) cannot direct people to abandon their cars for evacuation." Before establishing an evacuation system, it is important to understand how to get involved in the decision-making process in the concerned district. The severe damage as a result of the Great East Japan Earthquake could be partly attributed to the fact that people were "made" to participate in the "evacuation action led by the government." Thus, this study examines the problem of "governance."⁷

1. As explained in detail in Section 2.1, Toyoma district consists of Numanouchi ward, Usuiso ward, and Toyoma ward.

2. Matsumoto [1, 2] studied the relationship among tsunami evacuation, people's experience, and the knowledge of disaster in Iwaki City and surrounding areas.

3. From "Testimony and Record of Great East Japan Earthquake in Iwaki City" published by Iwaki City.

4. The group unit of Numanouchi ward is called the Numanouchi ward committee, which is similar to neighborhood associations.

5. From "Guideline of evacuation by cars in tsunami disaster" on the web page of Iwaki City. <http://www.city.iwaki.lg.jp/www/contents/1504053042591/index.html>

6. Yotsukura district in northern Iwaki City.

7. It is necessary to focus on the relationship between peacetime and emergency, with close attention to evacuation. However, the drills are con-

The study also examines the “unit” of group evacuation, namely, the neighborhood group. It is difficult to establish an evacuation drill system at the level of a neighborhood association or a self-government association,⁸ because the configuration of residents is diversified with the diversification of lifestyles. It is difficult to treat people belonging to one neighborhood association as a single unit. This is related to the governance problem mentioned above. The neighborhood association level should be divided further because it is also necessary to re-examine and re-develop the regional governance of “information transfer” and “decision-making.” Activities of neighborhood associations for local residents, those of firefighting parties and disaster preparedness associations for prevention of disaster and crime, and those of voluntary disaster preparedness organizations developed to compensate labor shortage due to the decreasing birthrate and aging population have stagnated and weakened. While existing organizations have supported “public,” “common,” and “private” structures, their efforts for the benefit of the “community” are weakening. However, it is difficult to require “family,” the smallest social group and most intimate sphere, to address the missing function of “common.” Though non-profit organizations (NPOs) may be able to work in large cities such as Tokyo or Sendai, in provincial cities, where not many people move in or out, these organizations would find it difficult to work because the local residents “do not believe people coming in from outside.”⁹

Therefore, the commons’ missing function should be carried out by a group unit in which “people see and know each other.” The authors call this tentative group unit the “neighborhood group.” It consists of several neighboring households and some others. “Disaster preparedness neighborhood groups” have also been established.¹⁰

The aim of this paper is to study the relationship among peacetime human relations (the formation of networks), social capital accumulated as a result of human relations, and group evacuation (in units of neighborhood groups).

ducted with any further consideration of this relationship. The same problem is seen in nuclear disaster preparedness drills and evacuation processes. More details are presented in Section 1.2. “Active” evacuation arises from interactions with the “natural environment” or “regional society” in each area. Ichiko [3] indicated that the establishment of an evacuation system led by residents is a “bottom-up” approach.

8. We now have problems not only in the form of an increase in the number of disasters, but also in the form of the difference in people’s physical functions due to aging. Because of the problems, it is difficult to find situations immediately after occurrence of a disaster and prevent damages, if evacuation is made by integrating all Numanouchi ward committee, neighborhood associations, and self-government associations (for example, Katada et al. [4] and Akaike et al. [5]). In addition, Murosaki and Koda 2013 [6] discussed that merging cities, towns, or villages could lower the capacity for disaster preparedness.
9. This is a comment by the chairperson in response to a questionnaire survey of the neighborhood association heads in Fukushima City in November and December 2009.
10. For example, Nakamura and Imai [7] indicated that, when a disaster occurred, people would mostly rely on “family” or “themselves” but “neighbors” come in second place. The “disaster preparedness neighborhood group” that started in Tokyo [8] in 2012 is an example that indicates the importance of neighbors. Yamamura [9] proposed “support by neighbors” that lies between “self-support” and “mutual support” and discussed its necessity in a neighborhood group. Yamamura claimed that the local government could not support people on everything but that it was important to create a “disaster preparedness neighborhood group” where neighboring households would support each other when a disaster occurs.

The study focuses on the neighborhood group as the unit in group evacuation for the establishment of a disaster preparedness system for group evacuation of a bottom-up type in Numanouchi ward.

The rest of this chapter reviews the extant literature. Section 2 provides an overview of Numanouchi ward. It lists out the number of people and households, explains the condition of the neighborhood groups, and reviews the disaster preparedness system that was put in place after the Fukushima Offshore Earthquake. Section 3 explains the disturbance that follows immediately after a tsunami alert is issued. This overview is based on interviews with the president of Numanouchi ward and the neighborhood group head about people’s reactions to the Fukushima Prefecture Offshore Earthquake. The chapter also discusses the results of a questionnaire survey of all households in Numanouchi ward, which was conducted to understand people’s reactions to the Fukushima Prefecture Offshore Earthquake and the Great East Japan Earthquake. Section 4 discusses the relationship between network and social capital on the one hand and the evacuation of residents in Numanouchi ward on the other hand. Section 5 outlines the remaining problems, examines the knowledge of disaster statistics, and provides directions for future studies.

1.2. Literature Review

The point of this paper is to study a community and its governance, and discuss how network and social capital, which are elements of governance, are related to evacuation behaviors in the community. This paper studies the Numanouchi ward community and its neighborhood groups using a covariance structure analysis (SEM: structural equation models).

Madarame, Matsumoto, and Sugiyama [10] observed: “People who live in the same neighborhood group have connection with others. People also develop connection with others through their children, spouses, and families. Those people thus have a chance to know and talk with others. Then they can gradually establish relationships with others by exchanging of greetings, chatting, helping each other, and participating in various activities.

It is difficult to know the personality of a person who has few opportunities to communicate with neighbors. Therefore, once a negative impression of the people (such as ‘not sociable’), the impression could spread in the community. If we have someone who we need to care for in daily life, we would consider that we should help him/her for evacuation in case of occurrence of a disaster. On the other hand, if we have insufficient communication with others and therefore connection with others is weak or absent, we could be ignored by others during evacuation or isolated after evacuation.”

Based on their observation, we focus on the network, social capital, evacuation, and governance for the establishment of an evacuation system. Some studies¹¹ have ei-

11. Most studies on both networks and evacuation involved evacuation simulations, as seen in Ito et al. [11]. Urata et al. [12] conducted a study to

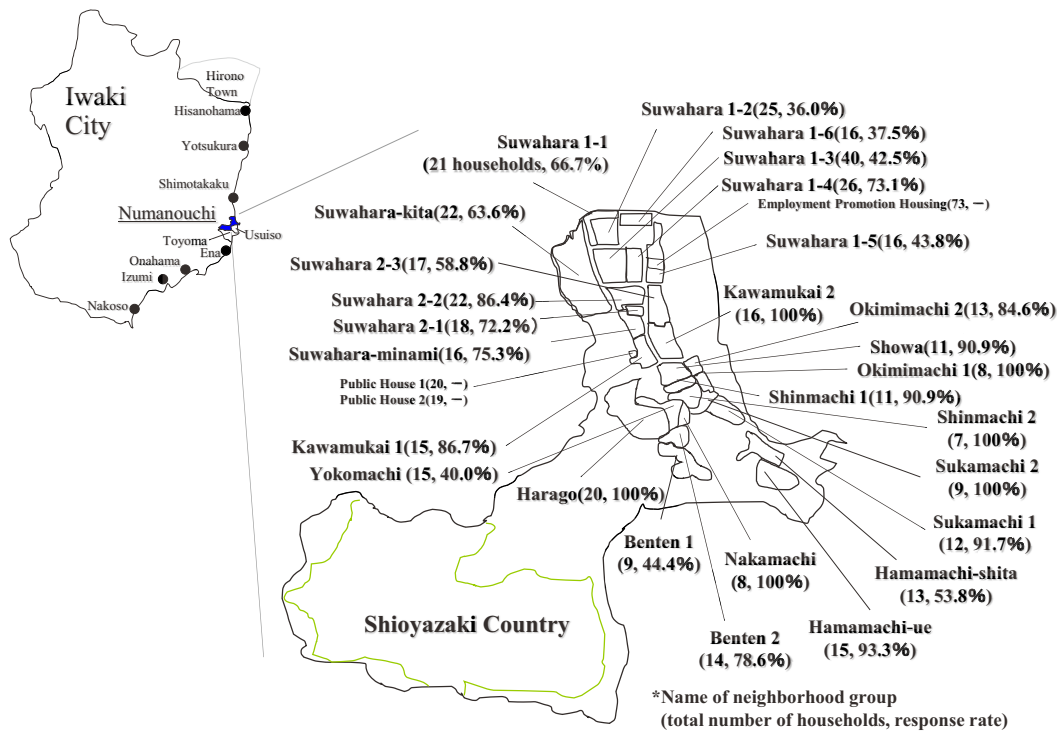


Fig. 1. Numanouchi ward and its neighborhood groups.

ther examined the relationship between network and evacuation, or the relationship between social capital and evacuation. However, no study has examined the relationship among all three elements.

Yoshihara [17] argued that evacuation drills had become a matter of formality (“Trap of evacuation drills with participation of people”). This study focused on the evacuation and confusion after the accident at the nuclear power plant caused by the Great East Japan Earthquake. Yoshihara argued that the confusion was because the nuclear disaster preparedness drills conducted before the disaster were only a matter of formality. The drills were conducted by the local government and electric company, and the residents merely followed the directions.¹²

Evacuation based on “information transfer and

verify that a network could lead to evacuation. They focused on the influence of others on people’s choices to start evacuation. One of their findings was that households that had a network to support others had a better effect on evacuation. It was also pointed out that social capital before the occurrence of an earthquake could affect people’s disaster preparedness approaches and their post-evacuation life (for example, Kawawaki [13] and Fujimi et al. [14]). Kakimoto et al. [15] focused on people’s behavior during evacuation. They found that calling out for river conditions and evacuation affected evacuation behaviors and discussed that peacetime collaboration in the local community could have a positive effect on emergency actions, such as persuasion and guidance for evacuation. In addition, some studies referred to resident organizations (village and settlement) as units for people to recognize an evacuation alert or call out for evacuation. However, only a few studies related the unit to the social capital developed in the region. For example, according to Meyer [16], there are 195 papers written during the period 1998 to 2015 on “social capital in disaster research,” but only a few of them focused on “evacuation” and “social capital.”

12. Matsumoto [18] discussed the involvement of the residents of Naraha town and Tomioka town, Futaba county, Fukushima Prefecture, next to Tokyo Electric Power’s Fukushima Daiichi Nuclear Power Plant, in the nuclear power disaster preparedness drills and evacuation after the accident at the plant on March 12, 2011.

decision-making” cannot be realized if drills are not in accordance with the governing structure prevailing in peacetime. Peacetime can be evaluated in terms of people’s networks and social capital can be considered as a result of network accumulation over time. The present study has a characteristic in this point of view.

2. Overview of Numanouchi Ward, Iwaki City

2.1. Damage and Activity in Numanouchi Ward After the Great East Japan Earthquake

Iwaki City, where Numanouchi ward is located, is in the southernmost region of Fukushima Prefecture. The east-to-west and north-to-south distances are about 39 km and 51 km, respectively. The area is about 1,231 km² in all. Numanouchi ward is situated in Toyoma district (Toyoma ward, Usuiso ward), which is located at the center of the coastal area in Iwaki City, that extends over 60 km (Fig. 1). Numanouchi ward has 30 neighborhood groups¹³ and the population is about 2,000 (Table 1). The number of households was 716 before the earthquake and increased to 780 in 4 years after the earthquake. Numanouchi ward is divided into Numanouchi¹⁴ and Suwa-

13. There were three groups until 2016. However, since some people moved after the earthquake, the number of neighborhood groups decreased and some groups could not function as intended. Therefore, the neighborhood groups were reorganized. Several neighborhood groups located close to each other were integrated to one group and a committee member was chosen from the newly formed group (Fig. 2). This paper was written before the reorganization.

14. According to Fig. 1, the neighborhood groups in Numanouchi on the lower (south) side are Hamamachi-ue, Hamamachi-shita, Sukamachi 1,

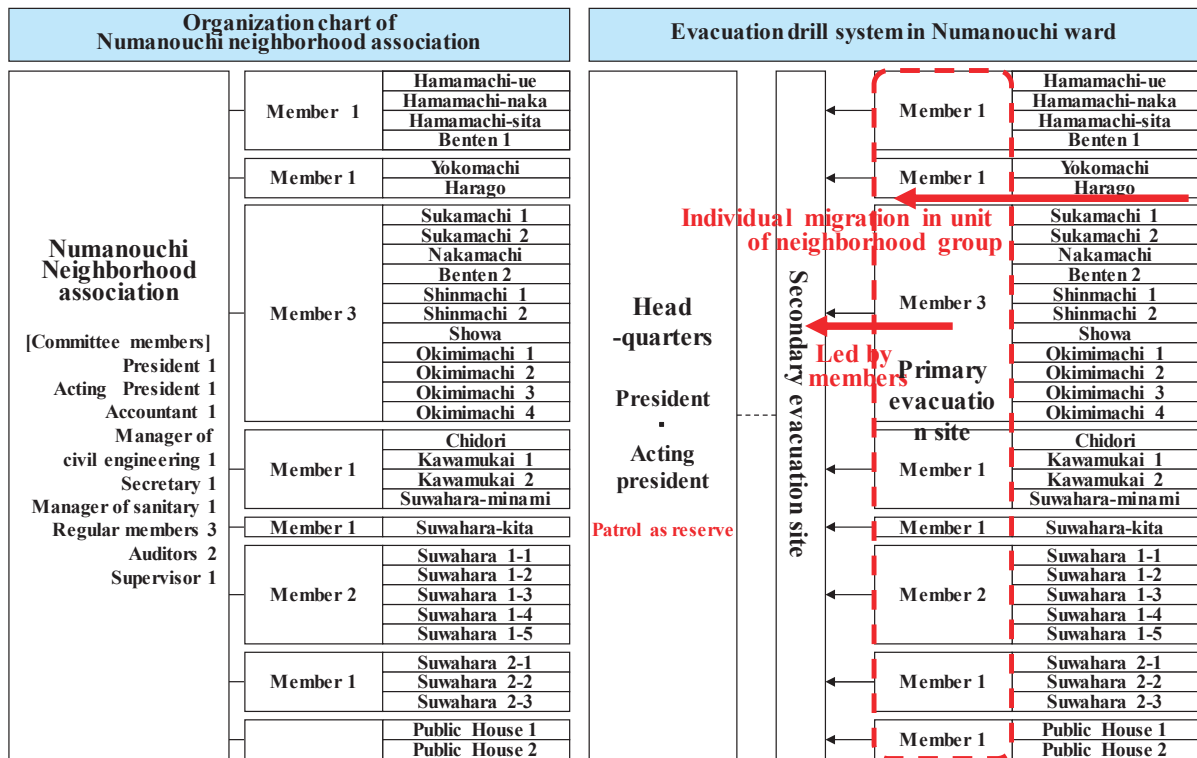


Fig. 2. Neighborhood association and evacuation drill system in Numanouchi ward, Iwaki City.¹⁷

Table 1. Population of Numanouchi ward, Iwaki City.

Year	Number of households	Population		
		Total	Male	Female
1998	318	1,309	641	668
1998	669	2,129	1,057	1,072
2009	716	2,142	1,051	1,091
2011	725	2,053	1,013	1,040
2012	728	2,039	1,005	1,034
2013	743	2,008	993	1,015
2014	780	2,069	1,035	1,034
2015	911	2,222	1,192	1,030

*As of October 1

hara areas. The former was established a long time ago. The latter was formed about 30 years ago when extended families of people living in Numanouchi ward as well as people of other parts of the city moved in.¹⁵

Toyoma district faced severe destruction as a result of the tsunami after the Great East Japan Earthquake. However, there were 111 victims in Usuiso ward, (259 households with 766 people when the disaster occurred)¹⁶ and 83 victims in Toyoma ward (644 households with

2,147 people when the disaster occurred), while Numanouchi ward (720 households with 2,082 people when the disaster occurred) had only 5 victims.

2.2. Evacuation Drills After the Earthquake

Iwaki City had 300 tsunami victims in all, of which about 200 died in Toyoma ward and Usuiso ward. Numanouchi ward participates in the General Disaster Preparedness Drill (tsunami evacuation drill) conducted by Iwaki City on an annual basis after the Great East Japan Earthquake. The local government develops a “district disaster preparedness plan,” which the committee members of Numanouchi ward discuss, in order to determine an evacuation drill system (Fig. 2).

Numanouchi ward follows a process of “evacuating people in the same neighborhood group by calling out to each other.” Before the evacuation drill, the neighborhood group head checks the participants under the direction of the Numanouchi ward committee. On the day of the evacuation drill, the neighborhood group head guides the participants to a temporary evacuation site, and then the Numanouchi ward committee members guide them to a secondary evacuation site. This bottom-up type evacuation system is thus developed within the framework of the peacetime organization of Numanouchi ward. The structure of “information transfer” and “decision-making” in peacetime is the same as the structure for disaster during an emergency.

Sukamachi 2, Nakamachi, Yokomachi, Harago, Benten 1, Benten 2, Shinmachi 1, Shinmachi 2, Showa, Okimimachi 1, and Okimimachi 2. The others (on the upper (north) side) are the neighborhood groups in Suwahara area.

15. From Madarame, Matsumoto, and Sugiyama [19].

16. From National Census 2010.

17. Since the evacuation drill was conducted before the reorganization of the neighborhood group, the system was almost the same as that of 2015.

3. Response to the Fukushima Prefecture Offshore Earthquake

The Iwaki City disaster preparedness drill in which the Numanouchi ward committee participated was held on November 5, 2016. At 5:59 on November 22, 2016, an earthquake of magnitude 7.3 on the Richter Scale occurred off the shore of Fukushima Prefecture. A tsunami alert and warning were issued for the residents of the Pacific coast of Tohoku area, including Iwaki City. For the coastal area of Iwaki City, the tsunami alert was issued early in the morning. People began to leave in their cars, thereby causing heavy traffic congestions in various parts of the city, without taking advantage of the evacuation drill which strongly suggested “evacuation by walk, in principle.” A similar situation arose in Numanouchi ward. People were supposed to evacuate under the direction of the neighborhood group head, but most of them left in their cars. This chapter examines the data gathered from a survey of the president and the neighborhood group heads of Numanouchi ward, focusing on the actions taken after the Fukushima Prefecture Offshore Earthquake. The chapter also looks at the results of a questionnaire survey of all households in Numanouchi ward.

3.1. Occurrence of Earthquake and Response to Tsunami Alert-Hearing Survey to Numanouchi Ward President and Survey to Neighborhood Group Heads

The interview survey of the president of Numanouchi ward¹⁸ revealed the following. There was confusion during the evacuation, which took place rather early in the morning. The parking lot of the Bentensama shrine was supposed to be used as the evacuation site. However, that morning, it was filled with cars. Elderly people had evacuated in their ordinary clothes because they usually woke up before 5:00 am, but people aged between 30 and 50 were in their pajamas. Therefore, it was necessary to reconsider the evacuation drills. One good thing that happened during the evacuation was that all households in Hamamachi were called out by both committee members and some neighborhood group heads. In the Hamamachisita Group, the neighborhood group head was supportive. The wife of a committee member made three trips to take the elderly and the disabled by car to Bentensama. However, there were also several matters to reflect on. For example, one of the residents said, “The evacuation drill was not entirely effective.” In addition, the Kamiyasaku Community Center, the secondary evacuation site, was not open during the evacuation. When the president of Numanouchi ward was asked about it, he said that it was not the evacuation site, which increased the confusion among the people.

A questionnaire survey was conducted among the neighborhood groups¹⁹ and showed that more than 80%

of the neighborhood group heads in Numanouchi ward evacuated with their families by car.

3.2. The Overview and Analysis of the Survey Results

Based on the results of the survey in the previous section, it was necessary to understand the situation of each household in Numanouchi ward with respect to evacuation. Thus, a questionnaire survey was conducted to clarify whether the households actually followed the rules for the establishment of an evacuation system, that is, the “group evacuation in units of neighborhood groups (hereinafter referred to as “group”) by communicating with each other,” and why they preferred group evacuation or individual evacuation. Thus, the following items were used in the survey: communication with people in the neighborhood group, communication with people outside the neighborhood group, relationship with the entire Numanouchi ward area, participation in local activities, behavior during the Great East Japan Earthquake, participation in the evacuation drills conducted after the Great East Japan Earthquake, and behavior during the Fukushima Prefecture Offshore Earthquake.

A questionnaire detention survey method was employed for the survey. The authors explained the aim of the survey to the members of the Numanouchi ward committee and asked the neighborhood group heads to distribute and collect the questionnaires. The survey was administered to the householders (or people in close relationships with the householders) of 438 households in Numanouchi ward. People living in disaster public housing and employment promotion housing were excluded. The survey was conducted in February-March 2017. Completed surveys were collected from 305 households and the collection rate was 69.6%.

3.3. Results

To analyze the survey results, we used Assum for Windows to test the differences in the percentage across the entire Numanouchi ward area. The test results are presented using ▲ ▼ for significance level of 1%, △ ▽ for significance level of 5%, ↑ ↓ for significance level of 10%, and ∴ ∴ for significance level of 20%. Numanouchi area and Suwahara were chosen as the analysis axes.

3.3.1. Profile of Respondents

This section presents the basic features of the respondents, such as age, number of people living together, and the number of years of living in Numanouchi ward.

(1) Age

Table 2 presents data on the age of the respondents. Householders (or people in close relationships with

alert, a questionnaire survey of 60 heads of new and old neighborhood groups was conducted to ask about their “evacuation responses (recognition of alerts, response, and methods and sites of evacuation),” “response at the evacuation site,” and “evaluation of evacuation drills.” The survey period extended from early December 2016 to mid-January 2017. Overall, 54 answers were collected (response rate of 90%).

18. The survey was conducted for the president of Numanouchi ward (whom we call “E”) from 2:00 pm to 3:00 pm, on December 4, 2016 at the Numanouchi ward public hall.

19. To understand how the resident organization responded to the tsunami

Table 2. Age²⁰ (respondents had to choose single answer: SA).

	N*	20s	30s	40s	50s	60s	70s or older	Un-known
Numanouchi ward	305	0.7	5.6	11.5	19.3	32.1	23.3	7.5
Numanouchi area	136	–	3.7	8.8	16.9	36.0	↑30.1	∴4.4
Suwahara area	169	1.2	7.1	13.6	21.3	29.0	↓17.8	10.1

N*: Number of samples

Table 3. People living together with the respondent (respondents had to choose multiple answers: MA).

	N*	SL	C	Pa	GC	B/S	O	La
Numanouchi ward	305	60.3	47.5	18.7	10.2	3.3	0.7	9.2
Numanouchi area	136	∴53.7	45.6	∴23.5	△16.2	4.4	0.7	11.8
Suwahara area	169	∴65.7	49.1	∴14.8	5.3	2.4	0.6	7.1

N*: Number of samples, SL: Spouse, lover, C: Child, Pa: Parent, GC: Grandchild, B/S: Brother/Sister, O: Other, La: Living alone

Table 4. Number of years of living in Numanouchi ward (respondents had to provide specific numbers).

	Number of samples	Average
Numanouchi ward	271	35.27
Numanouchi area	124	▲46.66
Suwahara area	147	▼25.65

householders) in Numanouchi ward in their 60s accounted for 32.1%, while 23.3% were in their 70s, and 19.3% were in their 50s. The difference between the areas was largest for the number of people in their 70s.

(2) People living with the respondent

Out of the total, 60.3% of the respondents lived with their “spouse or lover” and 47.5% lived with their “child” (Table 3). In Numanouchi area, there were many households where three generations of families, with “parent” and “grandchild” lived together.

(3) Number of years of living in Numanouchi ward

The average number of years of living in Numanouchi ward was 35.3, while that in Numanouchi area was 46.7, and that in Suwahara was 25.7. 20 years longer than the average in Numanouchi ward (Table 4).

3.3.2. Network

The network refers to the relationships between the respondents and people both within and outside their neighborhood groups. The number of people included only those who either supported or took care of the respondent, and those whom the respondent could consult. It did not

Table 5. Number of households with which the respondent communicates and cooperates (respondents had to provide specific numbers) on a regular basis.

	Number of samples	Average
Numanouchi ward	189	1.94
Numanouchi area	87	↑2.37
Suwahara area	102	↓1.57

Table 6. The extent to which the respondent is taken care of (MA).

	N*	Ki	Vo	Ha	Ca
Numanouchi ward	305	45.6	27.9	24.3	34.1
Numanouchi area	136	△55.9	∴33.1	27.2	↑41.2
Suwahara area	169	37.3	23.7	21.9	∴28.4

N*: Number of samples
 Ki: Kindly taking care even for private matters
 Vo: Voluntarily solving a problem that arises in the neighborhood group
 Ha: Having a leadership in various events
 Ca: Caring for people who have a hard time to get used to the community

include those that the respondent merely knew. The number of people outside the neighborhood group included the people that the respondent communicated with.

(1) Households in the neighborhood group

The number of households in the neighborhood group includes only those with which the respondent has a strong connection, that is, those households that the respondent communicates and cooperates with on a regular basis. The average number is 1.9 in Numanouchi ward, 2.4 in Numanouchi area, and 1.6 in Suwahara (Table 5).

(2) People who take care of others in the neighborhood group

The survey examined four types of people who took care of others in the neighborhood group. In Numanouchi area, the percentage of the respondents who chose “Kindly taking care even for private matters” is the highest (55.9%). The percentage of those who chose “caring for people who have a hard time getting used to the community” is the second largest (41.2%). Those who chose “voluntarily solving a problem that arises in the neighborhood group” accounted for the third highest (33.1%) (Table 6).

(3) Households outside the neighborhood group

The survey counted the number of households outside the neighborhood group that the respondent communicated with. The average number in Numanouchi area is 4.1, which is much larger than the average number in Suwahara (2.3) (Table 7).

3.3.3. Social Capital

Social capital refers to the relationships developed through a network over time. In this study, we measured respondents’ “participation in activities and events” and “organizations and groups that the respondents belonged to.”

20. In Tables 2 to 14 presented in the study, the unit of % is used unless specified. “–” in the tables indicates no answer received (0%) for the corresponding item.

Table 7. Number of households outside the neighborhood group that the respondent communicated with (respondents had to provide specific numbers).

	Number of samples	Average
Numanouchi ward	200	3.08
Numanouchi area	85	∴ 4.12
Suwahara area	115	∴ 2.31

(1) Participation in activities and events

Among the respondents, 69.8% participated in “mowing and cleaning,” 43.9% attended the “summer festival,” 36.1% participated in “evacuation drills,” and 31.1% attended the “general meeting” (Table 8). The rates were higher in Numanouchi area than in Suwahara particularly for “general meetings,” “Obekka Festival,” and “evacuation drills.” In Suwahara, the largest number of people chose “mowing and cleaning.”

(2) Organizations and groups to which the respondents belonged

Table 9 shows the data on the organizations and groups to which the respondents belonged. Nearly 40% of the respondents chose “None,” while 12.5% chose “sports association,” 11.1% chose “disaster preparedness association,” and 9.8% chose “organizations for children and child-raising organizations.” In Numanouchi area, a majority of the people chose “Kirakukai,” “Parishioner’s organization,” and “Sports Association,” while in Suwahara a majority of the people chose “None.”

3.3.4. Evacuation Situation

We study the behavior of people in Numanouchi ward in their response to tsunami alerts for the Great East Japan Earthquake and the Fukushima Prefecture Offshore Earthquake. In doing so, we focus on people with whom the respondent evacuated and the respondent’s behavior during the evacuation. We also investigate people’s participation in tsunami evacuation drills after each earthquake.

(1) Great East Japan Earthquake

(i) People with whom the respondent evacuated

Almost 80% of the respondents evacuated with “family” (76.3%), while 20.2% evacuated with a “neighbor.” Very few respondents evacuated either with relatives, friends, and others, or on their own (10%). In Numanouchi area, the majority of the respondents evacuated with a “neighbor” (Table 10).

(ii) Behavior during evacuation

In Numanouchi ward, 25.4% of the respondents chose “did nothing,” while 23.1% chose “called out to people in the same neighborhood group for evacuation.” In Numanouchi area, a relatively large number of people chose “evacuated together to the temporary evacuation site” (Table 11).

(2) Participation in evacuation drills

Among the respondents, 17.0% participated in all evacuation drills in Numanouchi ward after the earthquake, 32.5% participated sometimes, and 43.9% participated in only a few drills (Table 12). A majority of the respondents in Numanouchi area participated in all the drills, while a majority of the respondents in Suwahara participated in a few drills.

(3) Fukushima Prefecture Offshore Earthquake

(i) People with whom the respondent evacuated

As many as 83.6% of the respondents evacuated with their “families,” which was slightly higher than the number of respondents who evacuated with their families during the Great East Japan Earthquake. While 10.2% evacuated with a “neighbor,” which was 10 points lower than for the Great East Japan Earthquake (Table 13), 9.7% evacuated “alone,” which was 5 points higher than for the Great East Japan Earthquake. The overall tendency shows that more people evacuated alone or with their families after the Fukushima Prefecture Offshore Earthquake than after the Great East Japan Earthquake.

(ii) Behavior during evacuation

A majority of the respondents chose “did nothing,” (54.4%), and the rate was 30 points higher than for the Great East Japan Earthquake (Table 14). Only 15% chose “called out to people in the same neighborhood group for evacuation,” which was lower than for the Great East Japan Earthquake, probably because the Fukushima Prefecture Offshore Earthquake occurred early in the morning, and the alert was issued around the same time. In Numanouchi area, 20.0% chose “called out to people in the same neighborhood group for evacuation” and 6.3% chose “evacuated half-way with people in the group and then continued to evacuate individually.” In Suwahara, 57.3% chose “did nothing” (57.3%).

4. Social Capital and Evacuation

4.1. Idea of Modeling

The main aim of the analysis was to find a relationship among network, social capital, and evacuation, as discussed by Madarame, Matsumoto, and Sugiyama [10].

This section explains the variables in this study (Fig. 3). “Network” is a latent variable that consists of observable variables such as “number of households outside neighborhood group to communicate with,” “number of households in the neighborhood group to communicate with and seek support from,” and “degree of involvement in taking care of others in the neighborhood group.”²¹ For the former two, the number of households was counted. For the latter, several questions were asked to calculate

21. Networks consist of nodes and ties in the context of the social network theory. In this paper, for example, the “number of households outside the neighborhood group to communicate with” and the “number of households in the neighborhood group to communicate with and seek support from” are nodes. The “degree of involvement in taking care of others in the neighborhood group” is a tie.

Table 8. Activities and events in which the respondents participated (MA).

	N*	1*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*
Numanouchi ward	305	69.8	43.9	36.1	31.1	19.0	17.7	16.1	13.1	6.2	1.6	6.6
Numanouchi area	136	↓63.2	43.4	△45.6	▲42.6	△25.7	△25.7	▲30.1	▲20.6	∴9.6	2.2	∴3.7
Suwahara area	169	∴75.1	44.4	28.4	▼21.9	↓13.6	11.2	▼4.7	7.1	∴3.6	1.2	8.9

N*: Number of samples, 1*: Mowing of Benten River side and cleaning of Suwahara Park, 2*: Numanouchi summer festival, 3*: Evacuation drill in Numanouchi ward, 4*: General meeting of people living in Numanouchi ward, 5*: Suwa Shrine Mikoshi Festival, 6*: Suwa Shrine Shishi Festival, 7*: Obekka Festival(Gongensama), 8*: Atago Shrine Mizushugi, 9*: Training for Shishi Festival, 10*: Others, 11*: None

Table 9. Organizations and groups to which the respondents belonged (MA).

	N*	1*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*	12*	13*	14*
Numanouchi ward	305	12.5	11.1	9.8	8.5	8.2	6.6	5.6	4.6	3.9	2.3	1.0	0.7	3.0	36.7
Numanouchi area	136	↑17.6	△14.7	10.3	△14.0	10.3	△11.0	6.6	△7.4	3.7	2.2	1.5	1.5	△5.9	27.2
Suwahara area	169	↓8.3	8.3	9.5	4.1	6.5	↓3.0	4.7	∴2.4	4.1	2.4	0.6	-	↓0.6	△44.4

N*: Number of samples, 1*: Sports Association, 2*: Disaster prevention association, 3*: Organization for children and child raising organization, 4*: Kirakukai, 5*: Firefighting party, 6*: Parishioner’s organization, 7*: Groups for hobby or study, 8*: Social Welfare Council, 9*: Young men’s association, 10*: NPO or volunteer group, 11*: Welfare commissioner, 12*: Youth guidance committee, 13*: Others, 14*: None

Table 10. People with whom the respondent evacuated (this question was meant only for respondents who were evacuees: MA).

	Number of samples	Family	Neighbor	Relatives	Friend	Others	Alone
Numanouchi ward	173	76.3	20.2	5.8	5.2	3.5	4.6
Numanouchi area	87	75.9	∴26.4	3.4	6.9	1.1	3.4
Suwahara area	86	76.7	∴14.0	8.1	3.5	5.8	5.8

Table 11. Behavior during evacuation (this question was meant only for respondents who were evacuees: MA).

	N*	1*	2*	3*	4*	5*	6*
Numanouchi ward	173	8.7	23.1	16.2	6.9	16.2	25.4
Numanouchi area	87	9.2	21.8	17.2	6.9	19.5	25.3
Suwahara area	86	8.1	24.4	15.1	7.0	12.8	25.6

N*: Number of samples
 1*: Checked presence/absence of people in the group
 2*: Called out to people in the same neighborhood group for evacuation
 3*: Called out to people in the same neighborhood group for evacuation and evacuated individually
 4*: Evacuated half way together with people in the group and then continued evacuation individually
 5*: Evacuated together with people in the group to the temporary evacuation site
 6*: Did nothing

the total score out of a maximum of 8 by simply summing “yes = 2” and “no = 1.” “Social capital”²² is a latent variable that consists of observable variables such as “number

Table 12. Participation in evacuation drills after the earthquake (SA).

	N*	Al	So	Pa	Un
Numanouchi ward	305	17.0	32.5	43.9	6.6
Numanouchi area	136	△23.5	36.0	35.3	5.1
Suwahara area	169	↓11.8	29.6	↑50.9	7.7

N*: Number of samples, Al: Always participated, So: Sometimes participated, Pa: Participated in few, Un: Unknown

Table 13. People with whom the respondent evacuated (this question was meant only for respondents who were evacuees: MA).

	Number of samples	Family	Neighbor	Relative	Alone
Numanouchi ward	226	83.6	10.2	7.5	9.7
Numanouchi area	95	78.9	▲20.0	4.2	11.6
Suwahara area	131	87.0	▼3.1	9.9	8.4

of activities and events participated in” and “number of organizations and groups belonged to.” “Evacuation”²³ is a latent variable, explained by “type of people with whom a person evacuated” and “type of behavior during evacuation.” For both observable variables, the numbers given

22. Many have discussed methods of measuring social capital. Putnam’s measurement items include the group one belongs to, participation in organizations and volunteer activities, relationships with friends, social trust, participation in voting, and occurrence of NPOs, among others. There are also discussions (for example, by Van Deth [20]) on a measurement index and definition for the multi-dimensionality of the concepts composing social capital (participation, network, trust). In this paper, we do not offer such discussions. Instead, we limit social capital to people’s participation and sense of belonging. Thus, we studied the “number of activities and events participated in” and the “number of organizations and groups belonged to.” As discussed in endnote 21, the network is considered as a node and trust is considered as a tie. Both are integrated into a network.

23. “311 evacuation” is the evacuation from the Great East Japan Earthquake and “1122 evacuation” is the evacuation from the Fukushima Prefecture Offshore Earthquake.

Table 14. Behavior during evacuation (this question was meant only for respondents who were evacuees: MA).

	N*	1*	2*	3*	4*	5*	6*
Numanouchi ward	226	8.4	15.0	9.7	3.5	7.5	54.4
Numanouchi area	95	4.2	20.0	12.6	6.3	9.5	50.5
Suwahara area	131	11.5	11.5	7.6	1.5	6.1	57.3

N*: Number of samples
 1*: Checked presence/absence of people in the group
 2*: Called out to people in the same neighborhood group for evacuation
 3*: Called out to people in the same neighborhood group for evacuation and evacuated individually
 4*: Evacuated half way together with people in the group and then continued evacuation individually
 5*: Evacuated together with people in the group to the temporary evacuation site
 6*: Did nothing

Table 15. Goodness of fit.

	RMR	GFI	AGFI	CFI	RMSEA
Numanouchi ward	0.14	0.95	0.91	0.86	0.08
Numanouchi area	0.20	0.92	0.86	0.84	0.09
Suwahara area	0.12	0.95	0.91	0.90	0.06

4.2. Analysis

The goodness of fit is close to 0 for the Root Mean square Residual (RMR), close to 1 for the Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit Index (AGFI), where $GFI \geq AGFI$, close to 1 for the Comparative Fit Index (CFI), and less than 0.1 for the Root Mean Square Error of Approximation (RMSEA). Therefore, the model is suitable for the entire Numanouchi ward area, Numanouchi, and Suwahara (Table 15).

4.3. Discussion

The model discussed is meant for the entire area of Numanouchi ward. However, as seen in Section 3, Numanouchi area and Suwahara have significantly different features. Thus, we apply this model to Numanouchi area and Suwahara in this section (Table 16).

A characteristic of the relationship among the latent variables in Numanouchi area is that the relation from network to social capital is relatively weak (low t-value). The observable variables related to “network” indicate the following. The relation from network to the “degree of involvement in taking care of others in the neighborhood group” and the “number of households outside the neighborhood group to communicate with” is relatively weak (low t-value) and the relation from network to the “number of households in the neighborhood group to communicate with and seek support from” is also weak with less than 1% significance level. The “number of activities and events” is strongly involved in the development of “social capital.” Based on the relations of both latent variables, it can be inferred that people in Numanouchi area relied on the relationships they had developed thus far, and the relationships did not seem to expand. They were intimate and closed relationships. There was a strong relation from “1122 evacuation” to the observable variables of “311 evacuation” and to “type of behavior during evacuation” and a relatively weak relation from “1122 evacuation” to the frequency of participation in evacuation drills conducted after the earthquake.²⁵

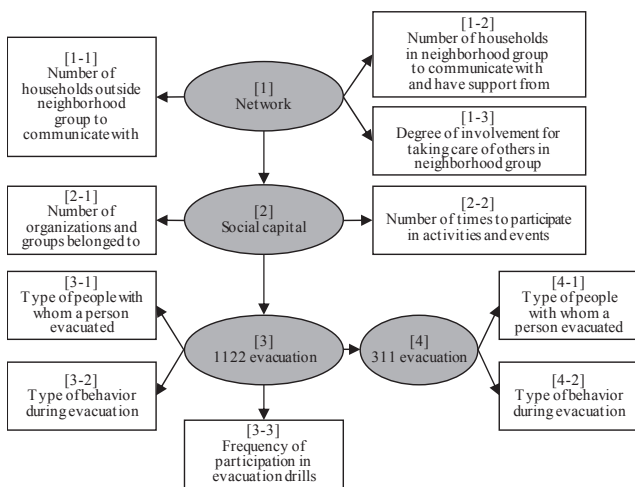


Fig. 3. Relationship among network, social capital, and evacuation.

in the answers were counted, though we set “evacuated alone = 1.” For “frequency of participation in evacuation drills,” another observable variable, we set “always participated = 3,” “sometimes participated = 2,” and “participated in few = 1.”

Missing values were processed as follows. For “number of households in the neighborhood group to communicate with and seek support from” and “number of households outside the neighborhood group to communicate with,” we set “no answer = 0.” For “degree of involvement in taking care of others in the neighborhood group,” we simply summed the answers, if any, to the four items. For “frequency of participation in evacuation drills,” we set “no answer = 1.”²⁴

24. The following are assumed in this setting: 0% “no answer” for the “number of households with which the respondent communicates or cooperates” or the “number of people outside the neighborhood group with which the respondent communicates” is assumed to mean that there was no respondent who did not know the answer to these questions. “No answer = 1” for “frequency of participation in evacuation drills” means that not knowing whether the person participated in an evacuation drill in the past several years after the Great East Japan Earthquake is scored “0.” This assumption places fairly strong restrictions. Although samples containing missing values can be omitted from the analysis, we prepared

the setting as described in the text since the omission could make the comparison between Numanouchi and Suwahara difficult.
 25. In this model, the time course is “network” (formation of connection) → “social capital” (accumulated experiences of these activities) → “1122 evacuation.” Furthermore, the factors of “1122 evacuation” were chosen to be “methods of evacuation after recognizing 1122 evacuation alert,” “participation in evacuation drills (conducted after the earthquake),” and “311 evacuation” as lessons. Therefore, we have “1122 evacuation” → “311 evacuation.” Intuitively, the reverse relation, “311 evacuation” → “1122 evacuation,” can be considered, but it worsens the goodness of fit slightly (RMR = 0.17 and GFI = 0.94 for the

Table 16. Results of covariance structure analysis.

Path	Numanouchi ward			Numanouchi area			Suwahara area		
	Estimated value	t-value	Probability	Estimated value	t-value	Probability	Estimated value	t-value	Probability
[2] ← [1]	0.79	3.76	***	0.79	1.68	0.09	0.77	3.51	***
[3] ← [2]	0.64	4.29	***	0.53	2.44	0.02	0.91	4.07	***
[4] ← [3]	0.70	4.44	***	0.75	3.26	0.00	0.62	2.91	0.00
[1-1] ← [1]	0.47	3.84	***	0.48	1.71	0.09	0.49	3.66	***
[1-2] ← [1]	0.37	–		0.22	–		0.53	–	
[1-3] ← [1]	0.44	3.76	***	0.45	1.70	0.09	0.43	3.40	***
[2-1] ← [2]	0.40	4.77	***	0.32	2.54	0.01	0.48	4.43	***
[2-2] ← [2]	0.73	–		0.74	–		0.65	–	
[3-3] ← [3]	0.43	–		0.38	–		0.50	–	
[4-1] ← [4]	0.59	–		0.67	–		0.52	–	
[4-2] ← [4]	0.80	6.12	***	0.77	5.24	***	0.81	3.51	***
[3-1] ← [3]	0.45	4.75	***	0.59	3.49	***	0.28	2.64	0.01
[3-2] ← [3]	0.67	5.48	***	0.76	3.66	***	0.42	3.61	***

*** in the table indicates a significance level of less than 1%.

For the model for Numanouchi area, one may say, “The human relationship is not new but has a long history. Anyway, people have mutual relations developed so far. They also have experience of the Great East Japan Earthquake. So, they called out to those whom they knew for 1122 evacuation no matter whether they participated in the evacuation drills.”²⁶

For Suwahara area, the relation among the latent variables indicates the following: network → social capital → 1122 evacuation. The relation from “network” to the observable variable “number of households in the neighborhood group to communicate with and seek support from” and the relation from “social capital” to the “number of activities and events participated in” are (relatively) strong, as seen in the previous model. Attention should be paid to “1122 evacuation,” as it is most strongly related to “311 evacuation” as seen for Numanouchi area. It is second most strongly related to “frequency of participation in evacuation drills” and the relation from 1122 evacuation to the “type of people with whom a person evacuated” is weak.

For Suwahara area, one may say “People do not have old relation with each other. While keeping the relation (not as strong as in Numanouchi area), they experienced 311 and participated in the evacuation drills. This helped them for 1122 evacuation. However, they did not evacuate with others or called out for evacuation (partly because their human relationship was weaker than in Numanouchi area).”

As seen above, although Numanouchi area and Suwahara are located in Numanouchi ward, they have slightly different evacuation processes, in which different factors are involved. It is not possible to characterize their features only by looking at the entire area of Numanouchi ward. This highlights the necessity for the reconsidera-

tion of the “unit” of evacuation groups, to establish an evacuation system.

5. Results and Remaining Problems

The aim of this paper is to study the relationship among network, social capital, and evacuation, by considering that human relationships (network) and accumulated human relationships (social capital) are factors affecting group evacuation and the choice of neighborhood groups as units of group evacuation.

Section 2 provided an overview of Numanouchi ward, which was the target area of this study. Numanouchi ward consists of two areas: Numanouchi area, and the newly developed Suwahara. The chapter summarized the governance structure in Numanouchi ward. It also presented the people’s response to the tsunami evacuation drills conducted on an annual basis after the earthquake. The homology between the peacetime governance and evacuation drill system was discussed. Section 3 detailed the confusion caused by the tsunami alert after the Fukushima Prefecture Offshore Earthquake on November 22, 2016. It also presented findings from the survey conducted among the president and heads of neighborhood groups in Numanouchi ward. A questionnaire survey was conducted for all households in Numanouchi ward to gather information on their reaction to the tsunami alerts and peacetime human relationships. The differences between Numanouchi area and Suwahara in the context of network, social capital, and evacuation were clarified in the study. Section 4 presented a covariance structure analysis (SEM) to study the relationship among network, social capital, and evacuation. The relations among the latent variables of “network,” “social capital,” “311 evacuation,” and “1122 evacuation” in Numanouchi ward, Numanouchi area, and Suwahara were studied. It was shown that Numanouchi area and Suwahara, although located in

entire area of Numanouchi ward). Thus, we employed “1122 evacuation” → “311 evacuation.”
 26. This result is partially in agreement with the results of Kakimoto et al. [15] (See Note 11).

Numanouchi ward, had different processes of evacuation in which different factors were involved. In Numanouchi area, “the human relationship is not new but has a long history. Anyway, people have mutual relations developed so far. They also have experience of the Great East Japan Earthquake. So, they called out to those whom they knew for 1122 evacuation no matter whether they participated in the evacuation drills.” In Suwahara area, “people do not have old relation with each other. While keeping the relation, they experienced 311 and participated in the evacuation drills. This helped them for 1122 evacuation. However, they did not evacuate with others or called out for evacuation.”

The results show that there are different forms of group evacuation in Numanouchi area and Suwahara. This suggests that two kinds of evacuation drills and two kinds of evacuation systems would be necessary. Although we did not mention this in the paper due to limited space, the analysis indicated that the evacuation in units of “neighborhood groups” was not the same in both areas.²⁸ Since we used the covariance structure analysis, we could not calculate using the neighborhood group as a unit. However, if we analyze each response, we may be able to categorize each into several group evacuation patterns and develop an evacuation system using these categories.

For the establishment of an evacuation system, the authors are building a “neighborhood group record” and a “neighborhood group evacuation map” in collaboration with the Numanouchi ward committee.²⁹ Details will be discussed elsewhere, but the “record” shows basic features of a neighborhood group such as sex and age, participation in activities and events, and characteristics of the group, such as the situation of the “311 evacuation” or “1122 evacuation.” The “map” is a residential map of the neighborhood group and has space for the people of the group to record information (such as details of elderly people living alone, children staying alone during the day, or physically disabled elderly living alone.) The record and map are being created as a part of the activity of the Numanouchi ward committee in FY2018. At the neighborhood group head meeting dated April 14, 2018, the president of Numanouchi ward asked the heads for “support for the realization of a safe and secure town.” However, one neighborhood group head from Numanouchi area said, “It means nothing. It would be faster if people evacuate on their own.” A neighborhood group head in Suwahara area said, “I know the importance. But even if we have a map, the information is too individualized for the head to smoothly guide the people for evacuation.”

The aim of this paper is to re-examine governance concerning group evacuation, and the unit for evacuation. The creation of the neighborhood group record and map is an action taken in furtherance of this aim, but we should also find ways to take various opinions like the ones mentioned above into account. If a direction is given from “upper level” people, and if the upper level is simply

changed from the local government to the Numanouchi ward committee, lessons from the Fukushima Prefecture Offshore Earthquake may not be learned. According to the president of Numanouchi ward, the committee members, neighborhood group heads from several areas, the welfare commissioner, the social welfare council members, and firefighting parties will gather and discuss the “record and map” sometime before the summer of 2018. One of our tasks in the future is to make a specific proposal for the creation of the “record and map.”

In conclusion, we would like to make a proposal for the development of disaster statistics. It is becoming difficult to quantitatively survey a neighborhood group because of privacy issues. In the present study having had full support from the Numanouchi ward committee, the committee members and the neighborhood group heads handed over the survey sheets to each of the residents and the answer rate reached almost 70%, which was extraordinarily high compared to surveys conducted by mail. Understanding the peacetime situation is important to establish a disaster countermeasure system. Therefore, we should consider ways to grasp the peacetime situation. It is necessary to carry out a survey and collect data on peacetime relationships among people and each household’s participation in activities and events. The data need to be collected once in several years, like the national census. Then the collected data need to be used as feedback by the Numanouchi ward committee to create a database not only for countermeasures against disaster but also in planning ordinary activities and events.

The issue of privacy has enhanced survey respondents’ awareness of their rights and leads them to ask researchers what benefit they can derive from taking the survey.

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Name:
Michimasa Matsumoto

Affiliation:
Associate Professor, International Research Institute of Disaster Science (IRIDeS), Tohoku University

Address:
6-6-11-901-2 Aoba, Sendai, Miyagi 980-8579, Japan

Brief Career:
2002- Japan Consumer Marketing Research Institute
2007- Fukushima National College of Technology
2013- Tohoku University

Selected Publications:
• "Survey analysis of coastal areas in Fukushima prefecture: The real situation and changes in the devastated communities," Ochanomizu-shobo, 2015.

Academic Societies & Scientific Organizations:
• Japan Society for Urbanology (JSU)
• Japan Association of Regional and Community Studies (JARCS)
• Japan Society of Civil Engineers (JSCE)



Name:
Kaori Madarame

Affiliation:
Operation Division of Community Improvement, MINDSHARE Inc.

Address:
Net2 Mita Building, 3-2-8 Mita, Minato Ward, Tokyo 108-0073, Japan

Brief Career:
2011- Fukushima National College of Technology
2018- MINDSHARE Inc.

Selected Publications:
• "An effect of community relations in Numanouchi on tsunami evacuation," Japan Association on Urbanology Annual Report, Vol.51, pp. 285-294, 2018.
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Academic Societies & Scientific Organizations:
• Japan Society for Urbanology (JSU)