



A COMMUNITY-LED SUPPORT FOR TSUNAMI EVACUEES IN THE 2011 TOHOKU EARTHQUAKE

K Shimada⁽¹⁾

⁽¹⁾ Associate Professor, The University of Shiga Prefecture, Shimada.k@office.usp.ac.jp

Abstract

In the wake of the unprecedented high-level tsunami caused by the 2011 Great East Japan Earthquake (GEJE), many local governments in the Pacific region of Miyagi and Iwate prefectures were in a state of dysfunction. After the 2011 GEJE, the Japanese government proposed to develop a self-help/mutual-help in community at the initial stage of coming large-scale disasters.

This paper examines the two small districts of Iwate and Miyagi where self-help and mutual help were distinctively seen after the 2011 GEJE occurred. The two districts of Iriya in Miyagi prefecture and Usuzawa in Iwate prefecture are both located slightly off from the tsunami affected areas, and experienced less damage in the community. The two districts are in agricultural areas with plenty of natural water that make the two districts wealthy with rich agricultural products.

Although the locals in these districts were worried about their own life during the disaster, they were willing to help the tsunami evacuees escaping from the devastated areas. In the case of Iriya, the locals worked for the evacuees together with the local government and the local agricultural association. Because of the large extent of local participation, Iriya district was able to accommodate 918 tsunami evacuees (that is about 50% of the local population) from the outside. In the case of Usuzawa, the locals ran the private evacuation center and accommodated 439 tsunami evacuees in the district (that is, about 7 times as much as the local population.).

In both districts, the locals worked dedicatedly for the evacuees. One of the reasons for this community achievement is that they had worked together closely in the community events and forest fires. Those precious experiences made the people naturally involved in mutual help. In addition to the closeness among the community members, the second reason is that they had alternative water and heat sources, and food stocks. These back-up resources made the locals feel safe even in their isolation and dedicated to the tsunami evacuees.

Keywords: natural disaster; tsunami; self-help; mutual-help; alternative sources

1. Introduction

This paper explores two local communities (Iriya district in Minami Sanriku town in Miyagi prefecture and Usuzawa district in Otsuchi town in Iwate prefecture) that were able to support tsunami evacuees when the 2011 Great East Japan Earthquake (GEJE) occurred in March 11, 2011. The two communities took the initiative to give support to the evacuees.

In the preparatory interviews conducted, the local people often mentioned, “We are able to survive for a week or so if we are isolated from electricity and water.” Just after the earthquake, the two communities provided massive support to the tsunami evacuees by providing food (rice balls, in particular), water, shelter, heaters and blankets.

Residents in the above two districts joined the public water system and used it as a main source of water. In addition, they have kept using the conventional water sources from a creek or underground.



Namely, they had secured alternative water sources. This enabled the people to continue their daily life and support the tsunami evacuees while the electricity and public water were stopped after tsunami.

Each house in the two districts had an independent propane gas system for cooking (a gas stove connected with a gas cylinder by a rubber gas tube). The gas supply system is quite simple and independent there. Therefore, the gas stove was able to be used even at the initial stage of the 2011 GEJE disaster. In addition, firewood stoves were widely used in those districts. The firewood stoves were suitable for their communities as the firewood could be collected in the forests nearby their communities. The firewood stoves had been used for both cooking and heating houses.

In addition, many of the people in those districts were full-time or part-time farmers growing rice and vegetables. Much amount of rice was stored in the house and vegetables were still grown on the fields in those districts when the 2011 GEJE occurred.

The paper explores necessary alternative sources to continue the people's daily life with the case studies of the two districts adjacent to the 2011 tsunami affected areas. In addition, it examines to what extent these alternative sources and individual food stock enabled the local people to support tsunami evacuees.

2. Related work

Taniguchi points out the importance of ground water as an alternative source of water when the public water system stops.[1] Taniguchi explores the water use in Otsuchi town, Iwate prefecture at the time of the 2011 GEJE and suggests that it is important to use the groundwater as an alternative source of public water system at the time of natural disaster.

Earlier than Taniguchi's research, Ando points out the wide use of the groundwater when the Kobe Earthquake occurred in 1995.[2] Most of the groundwater was pumped up by the electricity at that time, so only the conventional manual pumps were able to be used during the blackout of the Kobe Earthquake. Some of the evacuees took out the electric pumps from the wells and got water by a bucket with a rope. The ground water was shared with everyone who needed it in Kobe.

The Japanese government published a White Paper on Disaster Management of Japan in 2014 that recommended mutual help in the community at the initial stage of large scale of natural disasters.[3]

Japanese people used to get groundwater by a manual pump for their daily use. However, groundwater became less useful when the public water system was launched across Japan. Many of wells were entirely closed for safety reasons, and most of the rest have been continuously used with an electric pump with the small remainder still used by manual pumps.

However, there was a limit to groundwater use when the electric supply stopped because it is not easy to get enough water quickly for a lot of people using manual delivery. In this regard, creek water can meet the people's need in a short time. The case of Iriya district of Minami Sanriku town is a good example. The locals in Iriya were able to conduct a wide range of community-led support for tsunami evacuees during the 2011 GEJE. Plenty of water from the creeks enabled the locals to provide support. However, no further research has been published yet.

Other than alternative water sources, no existing literature can be seen for the alternative sources during the emergency. Otsuka et al. evaluated the community resilience in cities when the electricity was shut down.[4] However, they did not include any other essential sources such as water and heat energy sources in their evaluation. Therefore, no comprehensive evaluation for alternative sources during the emergency has been conducted.

It can be seen in Shimada's work in the brief example of Iriya district of Minami Sanriku town when the 2011 GEJE happened; however, no further research has been published yet.[5]



3. Methodology

With a large amount of food stock, alternative water sources and alternative heat sources, it is not difficult to imagine that the people in those districts were able to survive in isolation. The paper sets those three as essential factors of self-help and mutual help at the initial stage of the disaster (Fig. 1).

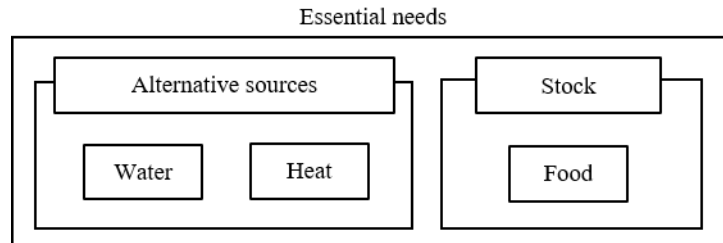


Fig.1 – Essential needs in isolation

In this research, the interviews and the questionnaires were conducted in addition to the field work. In Iriya district, 10 people were interviewed: the then 8 Administrative Unit leaders (Gyousei-ku cho) and the then 2 Administrative Sub-unit leaders (Han cho). Each interviewee was selected from the different Administrative Unit. On the other hand, 3 locals were interviewed in Usuzawa district: the leader of the Usuzawa Traditional Deer-dancing Conservation Association (Usuzawa Shishi odori Hozon Kai) and 2 residents (Fig. 2). Each interview was done in an hour with a semi-structured form (Fig. 3).

Iriya district	8: Administrative Unit leaders
	2: Administrative Unit sub-leaders
Usuzawa district	1: Leader of Usuzawa Traditional Deer-dancing Association
	2: Residents

Fig. 2 – Interviewees in Iriya and Usuzawa

- How could daily life be continued without electricity and water?
- What alternative sources were used for water, heat, and foodstuffs?
- What were your contributions to the evacuation center?

Fig. 3 – Questions on the interview

All interviewees were community members who gave support to the tsunami evacuees. The contents of the interview are: the situation in the community without electricity and the public water during the initial stage of the disaster, the use of alternative sources in everyday life before the disaster and how alternative sources worked at the initial stage of the disaster. To support the facts from the interviews in Usuzawa district, the questionnaires were conducted for all households in the district. Seventeen out of 18 households gave their feedback on the questionnaires. The contents of the questionnaires are the same as the one of the interview in Fig. 3. The general information and statistics of those towns were collected from Minami Sanriku local government office and Otsuchi local government office.



4. Limitation of this study

It should be noted that the interviews were conducted between 2017 and 2019, more than 6 years after the 2011 GEJE. Therefore, memories of the interviewees might be inaccurate. On the other hand, the people in the tsunami affected areas had grief for the disaster and were not able to talk about the disaster for a long time. In this regard, the interviews were successfully done after 6 years of the disaster without any refusal of the interviewees.

The number of interviewees (10 people) in Iriya district is not enough to generalize the situation of Iriya (alternative water sources and heat sources, and food stock) considering the total population (1898 people). The number of interviewees in Usuzawa district is not enough to explore the detail of the community-led support for tsunami evacuees. Further research should be done in this regard.

In addition, the paper is seeking to find necessary alternative sources to continue the people's daily life. It also examines to what extent these alternative sources and individual food stock enabled the local people to support tsunami evacuees. The result in this paper cannot cover all of categories of local resilience in the existing literature.

5. Case studies

The analysis was done for the alternative sources of water and heat, and for the amount of food stock in the two districts shown in Fig. 4. (A: Usizawa district of Otsuchi town, Iwate prefecture, B: Iriya district of Minami Sanriku town, Miyagi prefecture, black cross shows the epicenter of the earthquake at 2:46 pm on March 11, 2011.). These alternative sources and food stock are for people's daily life.



Fig. 4 – Studies areas

(Modified from Map of Japan, Geospatial Authority of Japan)

5.1 Iriya district, Minami Sanriku town

5.1.1 Outline of Iriya district

Iriya district is located in the lower mountainous area (from 20 to 450 m above the sea level, the residential area is from 20 to 180 m), about 3 km from Shizugawa Bay. The district is adjacent to the border of Tome city at its north and west ends, and is adjacent to the border of Kesen-numa city at its northeast end. With plenty of natural water from the creeks, farming has been done for a long time.



The locals have been using the groundwater at their premise. Iriya district is adjacent to Shizugawa district, a devastated area by tsunami (Fig. 5). Shizugawa district is facing the Shizugawa bay (shown in light blue on the map).

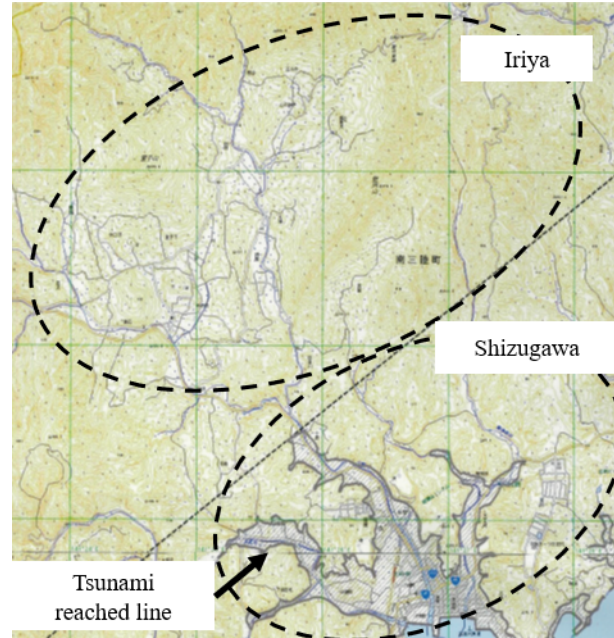


Fig. 5 – Iriya district and tsunami line
(Modified from Tsunami affected area map in Geospatial Authority of Japan)

The population of Iriya district was 1898 people as of February 2011 (just before the GEJE disaster). Iriya district consists of 10 Administrative Units, and each Unit is run by a Unit leader (Gyosei-ku cho) appointed by Minami Sanriku town office. 938 tsunami evacuees were accommodated in Iriya district (Table 1).

Table 1 – Three evacuation places in Iriya (on March 18, 2011)

EVACUATION PLACE	NUMBER STAYING
Houses	518
Elem. school	350
Public Hall	70
TOTAL	938

Source: Minami Sanriku Town Office

The evacuees were accommodated in houses of the district in addition to the two designated evacuation centers, Iriya Elementary School and Iriya Public Hall. Comparing with the two designated evacuation centers, more evacuees were accommodated in the houses in Iriya.



Table 2 – Minami Sanriku town top 5 evacuation places (On March 18, 2011)

	EVACUATION PLACE	NUMBER STAYING
1	Public General Gym	1500
2	Asahigaoka CC	699
3	Shizugawa Elem. Sch.	654
4	Utatsu Elem. Sch.	530
5	Iriya houses	518

Note: Asahigaoka CC shows Asahigaoka Community Center
Source: Minami Sanriku Town Office

Table 2 shows the top 5 evacuation places in Minami Sanriku town as of March 18, 2011. Except for the houses in Iriya in the 4th place, the other four places were designated evacuation centers. It can be said that community-led support for the evacuees was done widely. The support started just after the earthquake. In addition to accommodating the tsunami evacuees, the people in the district provided various support: donating food and blankets, making onigiris (rice balls) for the evacuees, sharing water with everyone, and carrying the rescue supply etc.

5.1.2 Community-led support in Iriya district

Just after the Earthquake of 2:46pm on March 11, the Administrative Unit leaders of Iriya district came to Iriya Public Hall, and had a Unit leaders' meeting to address the disaster. They decided to support the tsunami evacuees: the local people donated food and warm blankets to the Public Hall, then they made onigiris at the Unit Hall located in each Administrative Unit. The local people recognized that it was natural to make onigiris for the people who were suffering from the disasters. They had had a long tradition to work together in the community when the forest fires occurred in the district.

The locals were able to cook rice as there were propane gas stoves and large pots for rice cooking in each Administrative Unit Hall as well as Iriya Public Hall. The gas stoves and the large pots were stored for community festivals. People in the 10 Administrative Units made 400 onigiris each a day and brought them to Iriya Public Hall. It came to 4000 onigiris in total every day.

44.7% of the households in Iriya district were farmers. Many of the families had much food stock at home.[6] Therefore, the locals were able to donate rice and vegetables to the evacuees. However, food shortage occurred on the third day (on March 13) because they provided the evacuation centers outside of Iriya with many onigiris.

There were plenty of natural water in Iriya, which then offered water for the people outside of the district, in particular, in Shizugawa district.

5.1.3 Alternative measures

5.1.3.1 Alternative water sources

There is no official record of the natural water users in Minami Sanriku town office. However, when the groundwater quality check was offered by the town office in the emergency time of the 2011 GEJE, 101 houses took it. So, at least 101 houses had access to the well in the community. With regard to the creek water users, there is also no official record of that in the town office; however, according to the interviews



conducted, 5 out of 10 families used it. Groundwater users were also 5 out of 10 families (multiple answers available) in the interviews. Two out of 5 groundwater users used an electric pump and were not able to get groundwater during the blackout caused by the tsunami. Eight out of 10 interviewees had an alternative water source (groundwater or creek water), and 6 out of 8 offered their water to everyone for free (Table 3). Further research is needed to identify the total number of alternative water (groundwater and/or creek water) users in Iriya district.

Table 3 – Alternative water source availability

YES	NO
8	2

5.1.3.2 Alternative heat sources

Alternative heat sources are categorized into the following two: cooking heat and room heat. With regard to cooking heat, most of the Iriya people had been using propane gas for cooking. So, the people were able to use the gas stove for cooking just after the earthquake. Quite a few people had been using a firewood stove in/outside of the house. Six out of 10 interviewees had a firewood stove at home, and all 6 used it when 2011 disaster happened (Table 4). They were able to save the propane.

Table 4 – Firewood stove as an alternative heat source for cooking availability

YES	NO
6	4

With regard to house heating, among 10 interviewees, the firewood stove users were 2, charcoal stove users were 4, kerosene heater users were 2 and the diesel generator (for electric appliances) user was 1 (Table 5). One interviewee was not able to access to the alternative heat for cooking and house heating, and stayed in the Iriya Public Hall for evacuation.

Table 5 – Alternative heat sources for house heating availability

Woodfire stove	Charcoal heater	Kerosene heater	Diesel generator	No heater
2	4 (3)	2	1	1

Note: The number in the brackets shows only charcoal was available for heating.

5.1.3.3 Extra food stock

All 10 interviewees had food stock at home, and 5 out of 10 had kept rice for more than one year consumption. Eight people including those 5 offered a large amount of rice to Iriya Public Hall (Table 6). Rich food stock enabled the Iriya people to accommodate a large number of evacuees (918 evacuees).



Table 6 – Contribution of food stock to Iriya Public Hall

YES	NO
8	2

5.2 Usuzawa district, Otsuchi town

5.2.1 Outline of Usuzawa district

Usuzawa district is a small community along the River Kozuchi, and is located about 3.2 km from the mouth of the Otsuchi Bay.

Usuzawa district is located at the skirt of mountains and its elevation is in between 10 and 16 m high. The name of “Usuzawa district” is unofficial, and it is a part of Usuzawa Administrative Unit (between Kozuchi No. 18 Division and 125, Kozuchi No. 25 Division). Usuzawa district is located at the area of the so-called Usuzawa-sawa creek flowing into the River Kozuchi. There is no official census of Usuzawa district, therefore, no statistics of household and the population there. According to the interviews of the locals, Usuzawa district is composed of 18 families (63 people).

The residents of Usuzawa district have been using natural water from Usuzawa-sawa creek. The residents had also used groundwater at the well in their premise. When the 2011 GEJE occurred, tsunami came along the River Kozuchi at about 700m before Usuzawa district. Usuzawa was not directly affected by the tsunami (Fig. 6).

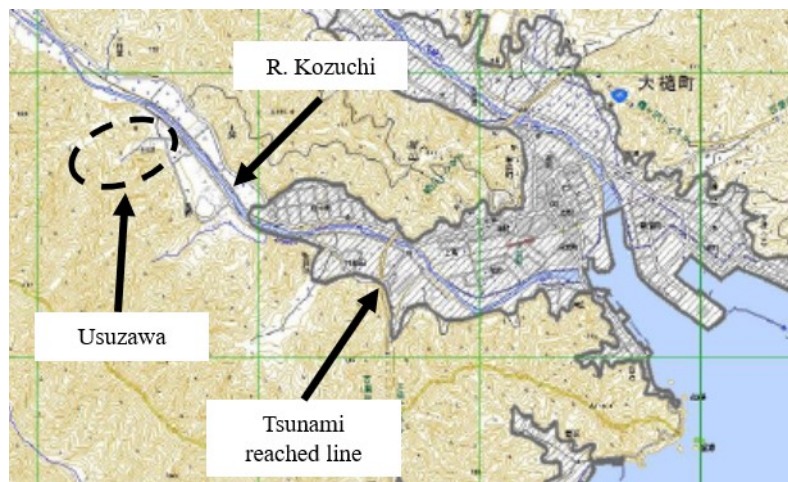


Fig. 6 – Usuzawa district and the tsunami reached line
(Modified from Tsunami affected area map in Geospatial Authority of Japan)

On the other hand, the town center of Otsuchi experienced catastrophic damage and the then mayor and many senior managers and staff were swept away by tsunami. Therefore, administrative function collapsed in Otsuchi. In addition, the electricity and public water supply stopped after the disaster.

The total number of the people who evacuated to Usuzawa district was 439 on March 23 (Table 7).



Table 7 – Evacuation numbers in Usuzawa

	Shishi-Odori Hall	Houses	TOTAL
March 13	186	-	186
March 23	196	243	439

Soucee: Otsuchi Town Office

5.2.2 Community-led support in Usuzawa district

In the afternoon of March 11 after the earthquake, more and more people came into the Usuzawa Shishi-odori Densyo-kan (Usuzawa Traditional Deer-dancing Conservation Hall: Usuzawa Hall). All the Deer-dancing members were the residents of Usuzawa district, therefore, the Hall was a common space for the residents in Usuzawa.

The Usuzawa Hall was not the officially designated evacuation center for tsunami at that time. However, the members decided to offer the place for the evacuation and the support for the people staying there.

About one hour after the earthquake, the community members brought food and warm blankets to the hall and started making onigiris (rice balls) for the evacuees in the Usuzawa Hall. A plenty of creek water was available, and some residents had firewood stoves at home. The community members had food stock at home. The Hall had propane gas stoves and large pots. Therefore, the people were able to make onigiris for the people in the evacuation center while the electric supply and the public water supply stopped. According to the statistics of Otsuchi town office, the hall accommodated up to 196 evacuees.

5.2.3 Alternative measures

5.2.3.1 Alternative water sources

The residents in Usuzawa district joined the public water supply system of Otsuchi town. At the same time, they had been using natural water from Usuzawa-sawa creek. The creek water intake is located at just upward of Usuzawa dam. Before the public water supply system being launched in Usuzawa, natural water was the main water source for everyday life. The creek water in Usuzawa has been maintained by the local users, not by the town office. Usually, the natural water is taken into multiple stair-like square water basins inside of the washing hut in each house.

The locals are still using this natural water to wash vegetables, cool watermelons or water the garden. However, the creek water supply has not been stable and when heavy rain occurred, the water got muddy. The water supply became smaller when it did not rain for a while. Therefore, the locals set up a well at each house in 1970s and their hybrid use of water started. When the public water system was launched, the locals gave up using groundwater and closed the well.

Ten houses are still using creek water in Usuzawa. A the time of the tsunami disaster in 2011, the public water supply stopped for three weeks in Usuzawa; however, 10 households were able to use the creek water for their daily life. They also allowed the others to use water for 3 weeks. Therefore, all of the residents in Usuzawa were able to access an alternative source of water (Table 8).



Table 8 – Alternative water source availability in Usuzawa district

YES	NO
17	0

5.2.3.2 Alternative heat sources

The people used a firewood stove for cooking in addition to the gas stove during the emergency in Usuzawa (Table 9). For room heating, they used the firewood stove or a traditional charcoals heater. No family could get the alternative heat sources (Table 10).

Table 9 – Alternative heat source for cooking availability

YES	NO
7	10

Table 10 – Alternative heat source for rooms availability

Woodfire stove	Charcoal heater	Kerosene heater	No heater
6	6 (5)	6	0

Note: The number in the brackets shows only charcoal was available for heating.

5.2.3.3 Extra food stock

Eight out of 17 families had been growing rice or vegetables in this district. The amount of stored rice was at least 5.7 ton in the district when the earthquake occurred. Seven out of 8 families, which offered agricultural products to the Usuzawa evacuation center, were farmers. The amount of rice offered was 400 kg, and vegetables were also provided to the Usuzawa Hall (Table 11).

Table 11 – Contribution of extra food stock to Usuzawa evacuation center

YES	NO
8	9

6 Discussion

As shown in Table 12, quite high ratio of alternative water users can be seen. Eight out of 10 interviewees in Iriya and 17 out of 17 respondents in Usuzawa were able to access alternative water sources. Alternative water source users were well developed in the two regions. In Iriya, 6 creek water users and 6 groundwater users with multiple answers, and 4 users had both groundwater and creek water accesses. In Usuzawa, all 17 respondents were able to access to creek water; however, all 17 did not have an access to groundwater. It can be said that Iriya is more resilient in water security. As mentioned earlier, groundwater was preferable for the



residents as creek water was not stable for its supply. If Usuzawa residents could prepare groundwater for an emergency, Usuzawa district will be more resilient.

As for alternative heat sources for cooking, all of the interviewees in Iriya and 17 out of 17 respondents in Usuzawa were able to cook with a propane gas stove at the initial stage of the 2011 GEJE. It can be said that the two districts were resilient in heat sources for cooking. Moreover, 6 out of 10 interviewees in Iriya and 7 out of 17 respondents in Usuzawa used the firewood stove as a second heat source for cooking.

Regarding alternative heat sources for house-heating, 9 out of 10 interviewees in Iriya had them whereas all 17 respondents had them in Usuzawa. Both districts are resilient in heat sources for house-heating. However, 4 out of 9 alternative heat sources users in Iriya and 6 out of 17 alternative heat sources users in Usuzawa used a charcoal heater.

In terms of food stock, it cannot easily evaluate if the food stock is enough with the results of this research. The number of food stock (more than 10 kg of rice as a food stock) holders is shown in Table 12. However, it should be reviewed how much they should store rice for an emergency.

Table 12 – Alternative sources and food stock availability

	Alternative Water sources	Alternative heat sources		Food stock (More than 10kg rice)
		Cooking	House-heating	
Iriya	8/10	10/10 Propane 6/10 Firewood	9/10 (4 Charcoal)	7/10
Usuzawa	17/17	17/17 Propane 7/17 Firewood	17/17 (6 Charcoal)	14/17

To address community isolation for future disasters, the studied two districts are resilient in water, heat and food. It is discovered that propane gas stoves are resilient for the earthquakes. Quite a few houses had firewood stoves and the stoves well worked as a secondary heat source for cooking and heating. In particular, if the stoves are used in the communities near the forest, it is a sustainable heat source in an emergency as the locals can collect firewood easily. Charcoal was also used in the districts during the 2011 GEJE, but it should be used appropriately with ventilation. Its combustion gas is very toxic and needs to be handled very carefully. In this regard, charcoal is not suitable for use in an emergency when a lot of people might operate the charcoal heater without the correct knowledge. Much food stock, in particular rice, is very important for everyone in the community and for the active support to disaster evacuees. The two districts in the case studies are located in the agricultural areas where a large storage can be easily found at home.

It is found in the two districts that alternative sources (in water and heat) and food stock made the locals maintain their daily life and also encouraged them to work for the tsunami evacuees. It helped the public rescue teams reduce their workload at the initial stage of the 2011 GEJE.

7 Conclusion

The importance of alternative sources of water and heat are identified through the two case studies above. While the closeness of the community members is important for mutual help, it is also important to maintain the people's daily life in the community. To do so, alternative sources of water and heat are essential in



addition to the food stock. When people secure their daily life, they can work together for the tsunami evacuees in the evacuation center and can accommodate the people at home.

Although alternative source of water and heat are found essential during the isolation of the initial stage of the disaster, there are some points to be addressed: charcoal heaters, that have been used in the two districts, are better replaced by safer heaters. Water quality in the creeks and the wells should be checked in a designated period so that the people can drink water safely.

Further research should be done in the other areas to generalize the findings in this paper.

8 Acknowledgement

The author would like to express his gratitude to the local people in Iriya and Usuzawa districts with whom he conducted the interviews and questionnaires. In particular, special thanks to Mr. Shin-ichi Saijyo in Iriya and Mr. Teruo Toubai in Usuzawa who gave the author valuable information and abundant help.

The author would also like to thanks for the project in Research Institute for Humanity and Nature (RIHN) entitled “Change of Local Communities and Reconstruction of Community Cultures after Disasters in Japanese Archipelago”, which allowed me to use the fund for this research. This papar would not be published without the support of its project leader, Professor Tohru Nakashizuka.

9 References

- [1] Taniguchi M (2013): Importance of groundwater as security [in Japanese], *Journal of Groundwater Hydrology*, 55(1), 5-11.
- [2] Ando M (2002): A Study on the practical use of wells in the Great Hanshin-Awaji Earthquake Disaster [in Japanese], *Journal of Architecture, Planning and Environmental Engineering*, 557, 233-240.
- [3] Cabinet Office (2014): *White Paper on Disaster Management of Japan [in Japanese]*, Ch.2, 4-12.
- [4] Otsuka K, Ikaga T, Murakami S, Kuzuki R and Kawayoke T (2017): Proposal of monetary value for resilience improvements by introducing a community energy system [in Japanese], *Journal of Architecture, Planning and Environmental Engineering*, 82 (735), 471-479.
- [5] Shimada K (2019): Community-led support for tsunami survivors at the initial stage of the Great East Japan Earthquake disaster in Iriya, Minami-sanriku town, Miyagi pref., Japan [in Japanese], *Papers of Workshop of the Great East Japan Earthquake*, ISSS, No. 8 (2019.8), 7-10.
- [6] Tohoku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries of Japan (2010): Green wave Iriya [in Japanese], https://www.maff.go.jp/tohoku/nouson/murazukuri/file/pdf/2010_iriya.pdf viewed on 20 January 2020.