



Original paper

Disaster Education Based on Community of Practice — A Case Study in Okitsu, Kochi prefecture —

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Received: 03/12/2012 / Accepted: 25/06/2013 / Published online: 30/06/2013

Abstract The Great East Japan Earthquake increased awareness of disaster preparedness and mitigation in communities throughout Japan which are facing similar catastrophic disaster risks. One such community is Okitsu, a small coastal village located in southeastern Kochi prefecture, which is at risk of tsunami. In Okitsu, even before 2011, participatory tsunami management has been successfully promoted by various stakeholders (e.g., local residents, school pupils, government officials, and disaster experts). This effort has resulted in benefits in terms of both hard construction and soft countermeasures. In this paper, we discuss the disaster education in Okitsu, from the perspective of community of practice. In contrast with conventional views of learning, the theory focuses not on internalization of knowledge or skills, but on participation in the community of practice. We focus on three major concepts of the theory: artifact, practice, and identity. Close and mutual reinforcing triangular relationships between artifact, practice, and identity are shown to contribute significantly to the achievements in disaster education in Okitsu. Nonetheless, these factors also create some negative outcomes, such as the reliance on a limited number of active participants. Thus, as co-participants in the community, we are planning a new approach, the *single-person drill*, for tsunami evacuation that uses new artifacts (e.g., small video cameras, GPS equipment) in order to make changes in the triangular relationships. In this drill, artifacts record the whole process of a specific single evacuee, which results in personal conditions being more carefully taken into account.

Key words disaster education, tsunami evacuation, community disaster mapping, community of practice, single-person drill

1. INTRODUCTION

The Great East Japan Earthquake and resulting tsunami that occurred on March 11, 2011, tore through the country's northeastern coastal communities, destroyed the lives of thousands more and caused widespread destruction. In Miyagi, Iwate, and Fukushima, whole communities were wiped out by the ferocious power of the tsunami. On top of the current known death toll of 15,883 people, a further 2,671

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are still listed as missing (National Police Agency 2013), and 309,057 are living in temporary accommodations (Reconstruction Agency 2013). The Cabinet Office of Japan (2011) estimated that the double disaster cost the country 16.9 trillion yen, and more than 23 trillion yen would be needed for reconstruction over a decade. The tsunami gave the country and the international development community reason to reflect on what disaster mitigation practices should be taken to protect Japanese lives and properties from future disasters, especially along the eastern coastal areas where catastrophic Tokai, Tonankai, and Nankai earthquakes are expected to occur.

Because of the high occurrence of natural disasters, Japan has become one of the most advanced countries in disaster management. Previously, hard construction of facilities and equipment were the primary approaches, but in recent years a greater focus has been given to soft countermeasures of disaster education, evacuation drills, and similar practice. All these efforts have contributed to improve performance in terms of citizens' continuous participation. Among these practice, disaster education has been widely acknowledged as playing an important role in raising awareness and promoting local disaster management.

After the Hanshin-Awaji Earthquake that happened in 1995, general attitudes to disaster management shifted from a primarily hard construction-based approach to include additional social countermeasures. Participatory approaches to disaster education were introduced into schools and communities to promote risk awareness among students, parents, and ordinary people. Several successful tsunami evacuation cases during the Great East Japan Earthquake showed the contribution of regular disaster education. For example, Noda village kindergarten, located only 500 meters from the coast in Iwate, achieved a 100% evacuation rate of 94 children under the age of 5 (Chunichi Web 2011). Similarly, the elementary and junior high schools in Kamaishi, with a total enrollment of 2,979 students, achieved a 99.8% evacuation rate (Kahoku Online Network 2011).

Although disaster education in Japan has improved dramatically, three problems remain. These problems include both deficiencies in and importance placed on (i) participatory disaster education, (ii) soft countermeasures, (iii) community disaster maps and disaster management manuals. In the following sections, we discuss the characteristics and relationships of the three problems by analyzing a case study of disaster education. We adopt a social theory of learning, specifically the community of practice proposed by Lave *et al.* (1991).

2. COMMUNITY OF PRACTICE

Lave *et al.* (1991) argued that a community of practice is a set of relations among persons, activity, and the world, over time and in relation with other tangential and overlapping communities of practice. Wenger (1998) furthered the idea of community of practice and characterized it in terms of its internal dynamics by using two concepts, which were practice and identity, to discuss participation as a way of learning in corporations and organizations. In the traditional activity theories and situated learning theories, physical objects were also considered as important components in participation (Ueno *et al.* 2006), but were seldom analyzed theoretically (Ito *et al.* 2004).

In this study, it is necessary to take physical objects into consideration because issues of disaster management exist in natural circumstances. From the same point of view, human established organizations such as the Tsunami Management Council, whose objective is to make policies to protect citizens' lives and properties, could absolutely be seen as physical objects. The reason is that not only the Tsunami Management Council is one of the most representative organizations in the disaster management field in Japan, but also its tremendous influence on disaster mitigation even exceeds those real physical ones, such as flood protection levees, tsunami evacuation facilities and so on. A similar organization called "Okitsu Disaster Education Committee" (hereinafter, the Okitsu DEC) has been established in the

Okitsu community, where case studies in this paper were carried out.

So, we apply a concept of artifact, which is regarded as important as the other two concepts of practice and identity, to the theory of community of practice. The three fundamental concepts of the theory, artifact, practice, and identity are summarized below. Based on this theoretical framework, we talk about the three problems of disaster education as a single issue, and discuss their characteristics and relationships from a holistic perspective.

In the concept of artifact, physical objects are involved, such as computers or tables, as well as events such as Halloween or Christmas. Because these events repeat over time, they can be seen as stable objects that have the same functions as physical ones (Sugiman 2006). In the field of disaster management, artifact indicates hard construction such as levee, evacuation shelters, highly earthquake-resistant buildings and bridges, as well as soft countermeasures such as hazard maps, community disaster maps³ and disaster management manuals. In addition, organizations such as the Tsunami Management Council, traditional strategies such as the *tsunami tendenko*⁴, also can be classified as artifact. For example, officials and common consensus such as “we have to inform the Tsunami Management Council before implementing an evacuation drill”, or “we have to evacuate quickly according to *tsunami tendenko*” indicates that organizations and strategies, while not visible, have the same functions as objects that exist physically. Thus, artifact contains physical objects as well as intangible ones.

With artifact, people have the potential ability to participate in practice, especially under cooperative circumstances. Wenger (1998) pointed out that the concept of practice connotes doing, but not just doing in and of itself. Practice is doing in a historical and sociocultural context that gives structure and meaning to what is done. Needless to say, as part of practice, the production and reproduction of artifact is included. In the field of disaster management, the implementation of tsunami evacuation using artifact such as evacuation shelters, and highly earthquake-resistant structures can be considered as practice. Also, discussions about constructing new evacuation shelters with the Tsunami Management Council are certainly practice.

Through practice, people create relationships with other people or artifact, during which their identities will be changed. That is, according to Wenger (1998), identity is not equivalent to self-image. Identity in practice is defined socially, not merely because it is reified in a social discourse of the self and of social categories, but also because it is produced as a lived experience of participation in specific communities. In the field of disaster management, if the Tsunami Management Council, the artifact in this example, were to implement the practice of tsunami evacuation drill by using an evacuation tower, various stakeholders would be involved. For example, employees in the local construction company who constructed the evacuation tower, local leaders who were in charge of the tsunami evacuation drill, and residents who participated in the tsunami evacuation drill, and so forth. During the practice, the identities of all stakeholders would transform gradually by creating relationships and networks with other people or artifact.

In this paper, community of practice means the close relationships and wide networks formed in a certain practice with identities and artifact. This definition is different from the traditional concept in the literature, which only includes human aspects. In our consideration, the theory of community of practice

³ Normally, a hazard map contains scientifically calculated hazard information and is used as the basic materials that the administrative agencies utilize to provide disaster prevention services, which can be used to establish a warning system and the evacuation system, as well as evidence for land use regulations. A community disaster map is mainly made by local residents themselves, or sometimes in cooperation with disaster experts, which has the main objective to inform the residents living within the damage forecast area of the presence of danger in an understandable form. However, in this paper, we focus on the dynamic process of map making, instead of the contents, that are, what eventually had been written on the maps.

⁴ According to Yamori (2012), *tsunami tendenko* refers to an “everyone for him/her-self” mindset, which calls for a quick tsunami evacuation without waiting for others, not even one’s parents or children.

requires special attention to artifact, which is the key component to the formation of a social practice. Similarly, in the community of practice, identities include the formation and maintenance of relationships between people and artifact are able to cooperate through mutual practice.

3. CASE STUDY

3.1 Methodology

In this section, we introduce a case study of disaster education in the Okitsu community, Kochi prefecture, Japan. Qualitative and quantitative methods are flexibly used to analyze archival materials, interview transcripts, and questionnaire surveys. Archival materials are collected from Okitsu Elementary School. In addition, we collect news reports on disaster education from the media such as Asahi, Yomiuri, Mainichi, and Kochi newspapers during the period from January 2000 to December 2011. We summarize all of the information in chronological order to examine trends and differences over time relating to disaster education.

We interviewed teachers in Okitsu Elementary School, and several local community leaders as well as government officials in the Disaster Management Department. Through these interviews, we gained more detailed information, especially on the background of the initial stages of disaster education in both Okitsu Elementary School and the community, which further elucidated the current situation.

At the same time, we conducted a questionnaire survey with the cooperation of Okitsu DEC mentioned in the former session. From the survey results, we collected data on the current state of disaster education and risk awareness of local residents, especially their attitudes toward tsunami evacuation. Finally, by using quantitative analysis, we expanded upon the qualitative findings on the characteristics of disaster education.

3.2 Overall situation

Okitsu, located in the southwestern coastal area of Shimanto town in Kochi prefecture, has a total area of 3 km². Its southern boundary is formed by Tosa Bay, famous for its clean water and beautiful beaches, which attract lots of beach visitors during the summer season. There are 552 households and a total population of 1,014 in the community, with high percentage of the population (48%) over the age of 65 (Shimanto Town 2012). The Okitsu community is made up of 3 subunits, called Omuro, Gobun, and Urabun. Omuro has 159 households and 305 residents, mainly involved in fishery. Urabun has 199 households and 327 residents, who also primarily make their living on fishery. Gobun is an agricultural area with 194 households and 382 residents, with *myoga* ginger and peppers, among others, being the primary crops.

Okitsu is completely surrounded by mountains to the northwest and the sea to the southeast, as shown in figure 1. Along the Tosa Bay, there are no roads leading to nearby towns. The only lifeline is Road No. 52, the Kubokawa-Okitsu road, which provides Okitsu residents with access to the surrounding areas. Road No. 52 is a classic example of a narrow, winding mountain road, which has more than 140 curves in its 18 km length. The road can easily be shut down by a landslide or earthquake.

Because of the tectonic interaction and collision of the Eurasian Plate and Philippine Sea Plate, the seismic activities in Okitsu are among the highest in Japan, with more than 11 large earthquakes whose magnitude were greater than 7 and resulting tsunamis in recorded history (Sangawa 2011). One of the most devastating tragedies was the Ansei-Edo Earthquake in 1855, memories of which were passed down in the form of monuments to the victims as well as narrative stories. Because of its situation, Okitsu is subjected to two types of disaster risks. One risk is isolation, the other is tsunami.

Before the Great East Japan Earthquake, estimates predicted that a 12-meter high tsunami would arrive

within 18 minutes after the occurrence of an anticipated Tokai, Tonankai, and Nankai earthquake. But according to the latest estimates, a tsunami of more than 25 meters high could occur if a magnitude 7 earthquake occurs (Kochi Prefecture 2012). Obviously, with this information in mind, the priority of disaster management in Okitsu is how to help people to survive tsunami and isolation.

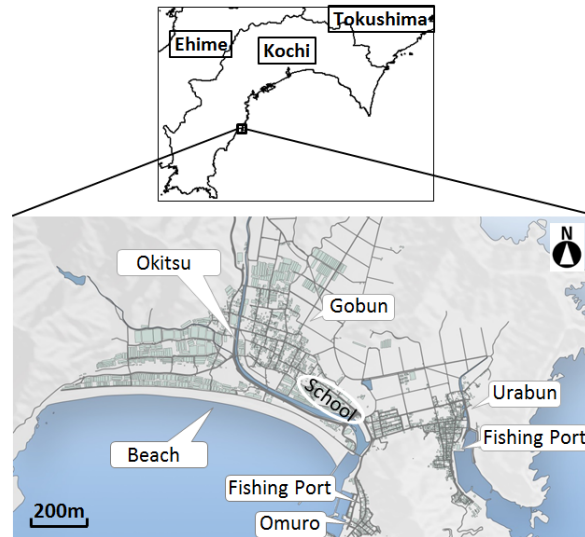


Fig.1. Map of Okitsu

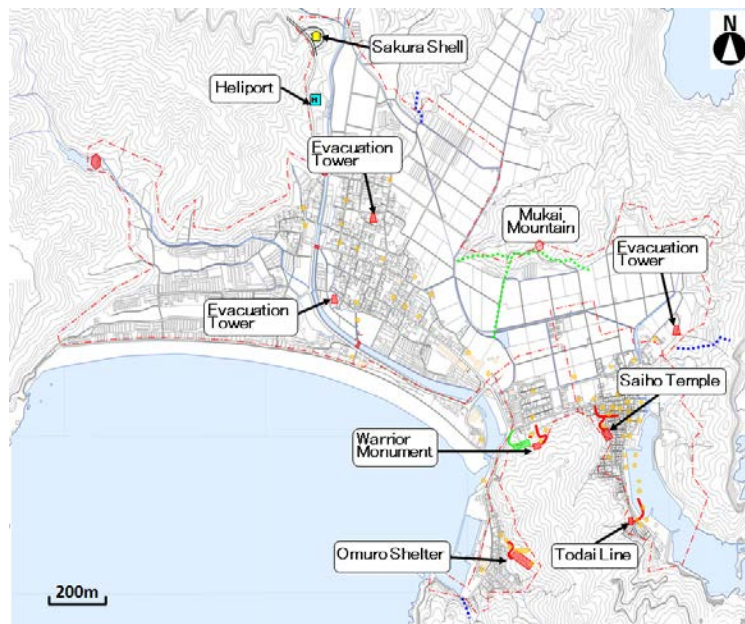


Fig.2. Okitsu evacuation facilities

3.3 Disaster management

Currently, because of great efforts of residents, evacuation facilities in Okitsu can hold almost 1,582 people, much higher than the total population in the community. From figure 2, we can see that 10 facilities have already been established. In each facility, there are emergency supplies which could allow residents to live during a long-term evacuation if Road No. 52 was shut down. In addition, there are prefabricated cottages to protect evacuees from rain or wind. In these cottages, there are blankets, mattresses, and stoves. Disaster management activities such as evacuation drills and community cooking have been organized several times by using these facilities in the past.

Since 2011, the Okitsu community has learned about tsunami evacuation experiences from the disaster-affected areas in Tohoku and assimilated much specialized knowledge from disaster management experts energetically. For example, a heliport was constructed to transport injured people rapidly to hospitals. Moreover, to ensure evacuation for a second time from shelters situated 15 meters above the sea level to higher ground, residents accepted suggestions from experts to rebuild several roads and to repair existing facilities. At the same time, the storage of emergency supplies and materials were enriched, and evacuation drills were carried out more frequently than before.

3.4 Disaster education

In this section, we summarize the history of disaster education in Okitsu into three phases by using information from archival materials, interviews, and questionnaire surveys.

3.4.1 The first phase (before 2004)

In memory of the 1st anniversary of the Hanshin-Awaji Earthquake and the 50th anniversary of the Showa Nankai Earthquake that occurred in 1946, and also to prepare for future anticipated earthquakes triggered by the Nankai Trough, Okitsu began to organize evacuation drills in 1996. At first, the drills were mainly conducted by the Fire Department in Shimanto town, but were gradually taken over by the Disaster Management Organization in Okitsu, which was a subordinate unit of the former. However, the goals of the drills were not aligned with the real needs of local residents.

According to the Asahi Newspaper (2002), both residents and local government realized the importance of constructing evacuation shelters. For example, one of the community leaders said, "If tsunami comes, both people and their properties, even the whole community, will be completely destroyed. What's worse, the seawater cannot drain out because it will be blocked by the levee. We really need to construct evacuation shelters. But we don't have the money." Some residents said, "Our only lifeline, the Road No. 52, will be totally destroyed by a large earthquake. Isolation is the biggest threat to us." Local government officers said, "Right now, we don't have any disaster management plans for Okitsu community."

Okitsu Elementary School started to make community disaster maps in 2004. According to our interview, during their study, teachers focused only on teaching the skills and knowledge of map making, that is, they played the roles of those who teach. On the other hand, pupils were treated entirely as those who learn. Their efforts in the classroom did not have any connection with other practice in the local community.

3.4.2 The second phase (2005-2010)

Disaster education in Okitsu Elementary School started in August 2005. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) instructed the Kochi Metropolitan Board of Education

to recommend one school to conduct participatory disaster education. The MEXT mandated that the education should be done in cooperation with the local community. In addition, 1.3 million yen was provided as a single-year budget. Fortunately, Okitsu Elementary School was selected, even though there were only 46 students at that time. Meanwhile, Okitsu community started to repair fishery port and evacuation shelters by using special funds provided by the local government. Thus, the school and local community were easily banded together to engage in promoting disaster management practice.

With consideration to give back the achievements of disaster education to the local community, the headmaster and community leaders established the Okitsu DEC in October 2005. They invited the headmaster of Okitsu Junior High School, town councillors, members of the senior citizen club to join it. Tanisawa (2012) pointed out that Okitsu would not have cooperative disaster management practices had the Okitsu DEC not been established to involve various stakeholders in the community.

Indeed, historical conflicts between the Omuro, Gobun, and Urabun regions greatly hindered the cooperative efforts on many local issues. For example, besides the differences in sources of livelihood, 3 subunits were completely divided on the benefits and risks of allowing the construction of a nuclear power station near Okitsu in the 1980s.

However, since disaster education has been introduced, emotional conflicts between residents were largely mitigated by pushing them to concentrate on a common goal, that is, protecting themselves from emergency conditions. The former headmaster at Okitsu Elementary School told us, “Whatever seriously the strategies of local disaster management have been criticized by pupils, people do not blame them. Pupils are just kids. Kids don’t have any economic or political interests when pointing out problems. So, in the disaster education, we deliberately urged pupils to give out their own ideas and suggestions. That’s why many disaster facilities were actually constructed based on opinions of pupils.”

Their disaster management activities include issuing newsletter, rescue drills for injured people, community disaster mapping, community cooking, night-time camping and so on. Through disaster mapping, pupils discovered many problems in the community. For example, they noted that bridge piers were in disrepair, even though located on the evacuation road leading to shelters; that steep routes were difficult for older people and would be easily damaged in the event of a large earthquake; and that the kindergarten and daycare center were located at the seaside, even if both groups were considered to be vulnerable people during disasters.

In the end of 2007, the Okitsu DEC convened a symposium on disaster education. They invited residents, local government officials, disaster management experts and the media. The pupils specifically pointed out every dangerous place on their disaster map. In response, one of the community leaders said, “Resolutions to disaster risks, especially the relocation of the kindergarten and senior daycare center are urgently demanded by all the residents.” Amazingly, the local governor made an improvised announcement at the symposium, saying, “I promise that the relocation of the kindergarten and the daycare center will be accomplished by the end of 2009.”

In addition, other facilities which were potentially at risk, such as dilapidated bridges and evacuation roads, were reconstructed after serious discussions with local government. Without such collaboration with the school, community, and government, pupils’ efforts probably would not be considered in local disaster management practice. In 2008, the Okitsu community disaster map got the highest level award from the Disaster Prevention Minister of Japan in the 4th Disaster Mapping Contest (General Insurance Association of Japan 2007). One year later, in 2009, an improved version of the map received the Koshien Disaster Management Award from Disaster Reduction and Human Renovation Institution, which is a famous disaster memorial museum established in 2001 to commemorate the Hanshin-Awaji Earthquake (Hyogo Prefecture 2009).

Okitsu became a well-known community for its advanced disaster education, both in Kochi prefecture and beyond. The total number of visitors to Okitsu from 2005 to 2010 amounted up to 446 persons. This

means that 74 persons visited per year, or 6 persons per month, on average. Visitors built a wide network on disaster education with the Okitsu community, which furthered the development of disaster management on both sides.

3.4.3 The third phase (2011-present)

Although Okitsu is located far away from northeastern coastal areas in Japan, the Great East Japan Earthquake had a large impact on the village which forced the community to revise disaster education and to reevaluate past achievements. At the same time, the school, community, and local government started to find new measures to promote disaster management under the new tsunami estimation.

Even before the revised result of the tsunami estimation was issued, Okitsu residents set out to construct and to reinforce evacuation facilities. Also, the disaster experts increased participation in ways such as sharing academic knowledge and practical experiences, giving lectures to pupils and residents, proposing suggestions to local leaders, inviting victims who had experienced the devastated tsunami in 2011 to talk about tsunami evacuation skills, among other activities. However, people in the community seemed to have deeper anxiety about their own evacuation abilities. For example, what are the biggest problems around my house? How to prepare for tsunami evacuation by myself alone? How do the community plan's disaster management activities enhance community resilience? To find out answers to these questions, we need to know exactly what people think about disaster management in the community. In January 2012, we conducted a questionnaire survey with the support of Okitsu DEC. In order to show the urgent problems and important achievements in disaster education in Okitsu, we only illustrated related data of the questionnaire survey.

In general, 255 families responded out of a total of 552 families surveyed, resulting in a comparatively high response rate of 46%. For more specific results, see Sun *et al.* (2013).

In response to the question "What would urge you to evacuate", table 1 shows that 81.1% of residents will evacuate quickly after a big earthquake. The rate is much higher than the survey data of tsunami evacuation in the Great East Japan Earthquake which was 57% (Central Disaster Prevention Council 2011). This indicates the effectiveness of disaster risk management in Okitsu community.

Table.1 What would urge you to evacuate?

	Omuro	Gobun	Urabun	Total
earthquake	87.2%	78.4%	80.9%	81.1%
tsunami warning	8.5%	14.4%	8.5%	10.9%
wireless radio warning	4.3%	6.2%	7.4%	6.3%
neighbor calling	0.0%	0.0%	2.1%	0.8%
people's evacuating	0.0%	1.0%	0.0%	0.4%
tsunami	0.0%	0.0%	1.1%	0.4%
others	0.0%	0.0%	0.4%	0.4%
total	100%	100%	100%	100%
respondents	47	97	94	238

Nonetheless, 81.1% is not a rate which has actually been verified through a real disaster, but just

indicates the intention of local residents that may have been exaggerated a bit. Furthermore, although exaggerated, it does not mount up to 100%. Considering the characteristics of tsunami risk in Okitsu, people should better evacuate quickly to shelters when there is a big earthquake. Yet, 10.6% of residents will not evacuate unless they receive a tsunami recommendation or a mandatory evacuation order. What's worse, 6.1% of residents will wait for the information that might be released through the community wireless radio. As a matter of fact, it is rational for people to actively collect information about earthquake and tsunami, though the serious problem of "waiting for more information rather than making a quick evacuation" (Katada *et al.* 2005; Yamori 2010) exists in Okitsu community.

Similarly, from the following two questions, the serious problems in the third phase can be seen more explicitly. The two questions were designed based on the basic style of the "crossroad game," a tool for disaster education proposed by Yamori *et al.* (2005). One of the questions was, "Suppose that when a big earthquake occurs, your child is at school but you are at home. Then the community wireless radio calls for an emergency evacuation. Would you go to pick up your child or evacuate first?" Answer: (i) I would pick up my child first; (ii) I would evacuate first. The other question was, "Suppose a ferocious tsunami will come within 20 minutes. In this situation, which do you think local voluntary firefighters should do first: perform their duty to call for evacuation, or evacuate first?" Answer: (i) They should perform their duty first; (ii) They should evacuate first.

Figure 3 shows the results of the former question. We can see that more than 40% of respondents would choose to pick up their children at school. This means that the importance of "tsunami tendenko" (Yamori 2012) has not been completely understood and accepted in Okitsu, even though experiences of the Great East Japan Earthquake have shown it to be an important code to escape from a ferocious tsunami. In Omuro specifically, 50% of its residents would go to pick up children. When taking the aging population characteristic of Okitsu into consideration, we can easily suppose that if the "child" were replaced by an "elderly person" when other settings remained the same, much more serious consequences would turn out.

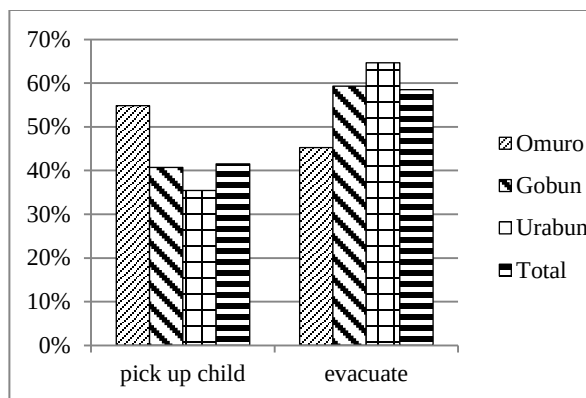


Fig.3. Pick up child or evacuate? (N=212)

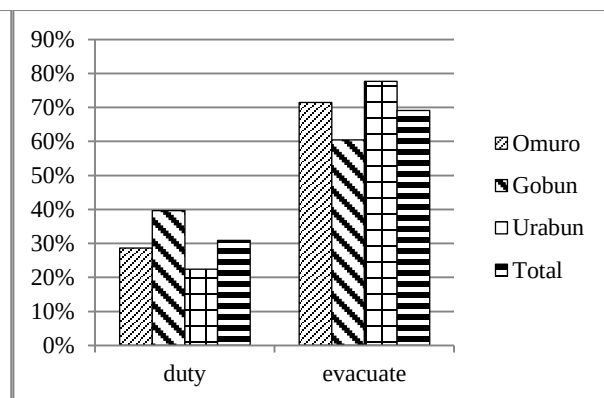


Fig.4. Do duty or evacuate? (N=223)

There are many reports on the delayed cases of tsunami evacuation during the Great East Japan Earthquake (e.g. Weathernews Inc. 2011; Survey Research Center Co., Ltd. 2011). Lots of people, who had once evacuated to safe places, returned to dangerous places again. Just because they were concerned about the conditions of their families, relatives, etc., which eventually caused tragedies that would have been avoided. In Okitsu, the fact that up to 40% of residents showed more or less difficulties to successfully evacuate cannot be ignored.

From figure 4 we can see that although more than 70% of respondents think that local voluntary

firefighters should evacuate first, there are still nearly 30% that believe that they should do their duties to call for evacuation first. Thus, opinions toward voluntary firefighters during emergency condition vary and a consensus has not been achieved. According to the risk characteristics of the Okitsu community, if voluntary firefighters took the time to call for evacuation first, they would likely fail to evacuate and might be engulfed by the tsunami. Under this supposition, the problem of varied opinions on the question of voluntary firefighters' evacuation should be considered seriously.

Various opinions are also reflected in the qualitative data. For example, one of the local voluntary firefighters told us that since 2011, two pieces of new principles of disaster risk management have been informed by the superior department, that is, the headquarter office of local voluntary firefighters of Shimanto Town. One is "do not go and close the water gate right after a big earthquake", the other one is "call for evacuation when you are evacuating." However, when we asked "do the local residents know them?" The voluntary firefighter showed a little embarrassment: "Maybe they know, I think."

Also, different opinions are found from the results of the open-ended question. The opinion from a local voluntary firefighter is: "This question bothered me for a long time. As a voluntary firefighter, I know exactly that I should do the duty first. But according to different time or special conditions, I also think that I have to protect myself first. I know it is really difficult to do both at the same time, but I do hope there will be a perfect way for me to protect myself and local residents from tsunami." On the other hand, "I do not think the voluntary firefighters will give elderly people a hand under emergency conditions" is the opinion from an aged person.

To resolve this dilemma and to alleviate various opinions, approaches should be introduced such as investigating the residential distributions of local voluntary firefighters and residents in each subunit, selecting an evacuation route which could guarantee the biggest effectiveness of "call for evacuation when evacuating" (Yamori *et al.* 2012), or making discussions individually and specifically.

4. THEORETICAL CONSIDERATION

With the theory of community of practice, we discuss disaster education in the Okitsu community based on 3 concepts, which are artifact, practice and identity. We analyze the close relationships among the concepts, which have played important roles in increasing the effectiveness of disaster management practice. From the historical literature on disaster education, we found that cooperative efforts of various stakeholders have made great contributions to community resilience. Negative outcomes, however, have been created such as reliance on a limited number of active participants. In the following contents, we discuss the theoretical considerations of the fundamental characteristics of disaster education.

4.1 Two disaster maps

Two different types of community disaster maps were used in the first and the second phases in Okitsu, though they were all called disaster maps and made by pupils at Okitsu Elementary School. In the first phase, during the map making process, teachers played the role of *those who teach* by passing on knowledge and skills. On the other hand, pupils played the role of *those who learn* by receiving information. Thus, the functions of this kind of disaster maps, the so-called artifact in the theory of community of practice, were that they supported the stereotypical identities of the participants without forming connections to the local community. Participants were constrained strictly in the classroom.

In contrast, during the second phase, the process of making disaster maps acquired legitimacy from participating in the practice of disaster management. Because of this characteristic, lots of new artifact emerged in the process of cooperation with various stakeholders such as residents, government officials,

disaster management experts, and the media. A key example was the relocation of the kindergarten and the daycare center. Other examples include the cooperative networks created, such as the Okitsu DEC, which eventually became stable artifact and generated new practice in the local community.

As a result of the community disaster map, artifact has motivated new disaster management practice, which in turn created new artifacts. For example, evacuation shelters have been used to carry out evacuation drills. Discussion of disaster management issues with experts is obviously a type of practice, which has the potential to create more artifacts such as evacuation routes. Through these kinds of interactions, the identities of stakeholders were gradually changed during the process of practice. For example, problems in disaster management, which were pointed out by pupils through disaster mapping, have been addressed by residents and government officials. These serious issues eventually resulted in new construction, such as the building of evacuation facilities, during which the identities of various stakeholders were changed. Specifically, the identities of pupils have been transformed from *those who learn* in the classroom to co-participant in the local community. Similarly, the identities of residents who engaged in the disaster management practice have been transformed from uninterested individual to co-participant, as was also the case of other stakeholders such as school teachers, government officials, and the media.

In terms of community disaster maps or hazard maps, Yamori *et al.* (2011) pointed that it was important to pay attention to interactions and mutual relationships among various stakeholders. That is, to see how these issues have been changed during practice, not merely the contents that were written. In Okitsu, the disaster map played the important role as artifact to transform the identities of many stakeholders through disaster management practice.

4.2 Disaster education committee

Established in 2005, the Okitsu DEC was initially created by the MEXT and operated smoothly with the cooperation of the school and community. More importantly, the initial instruction from the MEXT ordered the headmaster of Okitsu Elementary School to serve as the single chair of the project, but in order to apply the achievements of disaster education to the local community, the headmaster and one of the community leaders suggested having double chairs on the committee.

After 1 year's practice, both the school and community wanted to continue disaster education, even though the mandate from the MEXT had expired. Therefore, both chairs worked together to appeal to the local government and ultimately received official support. This indicated how the Okitsu DEC was able to bring together the school and community. As mentioned in section 2, if practice is repeated many times, it gradually becomes stable artifact (Sugiman 2006). That is to say, through the practice of disaster management, Okitsu DEC has already become artifact. For example, the school and community have to "coordinate with the Okitsu DEC before conducting tsunami evacuation drills."

However, negative influences from disaster education have also accelerated rapidly and steadily, along with the positive achievements. From the questionnaire survey, we found that compared to the period before the Great East Japan Earthquake, Okitsu residents were more likely (i) to be discouraged from attempting to evacuate because of the extremely severe tsunami estimates, (ii) to rely on the existing evacuation facilities rather than to enhance the community resiliency through participating in disaster management activities, and (iii) to leave tsunami management to the administrator or a limited number of local residents. For example, the Okitsu DEC and accomplished evacuation shelters have hindered the enhancement of risk awareness among residents. These residents have formed a tendency to depend on others to practice disaster management activities, and to rely too much on existing infrastructure such as levee for preventing tsunami. At the same time, the identities of stakeholders have become static, which completely divided active participants from uninterested ones. Thus, close relationships among the three concepts of the community of practice have also produced negative outcomes in the triangular system.

4.3 Single-person drill

To overcome these difficulties and to further disaster education in the Okitsu community, we suggest a new approach, called the *single-person drill* for tsunami evacuation.



Fig.5. Single-person Drill



Fig.6. Screenshot of multiscreen movie

From figure 5, we can see that during the drill, a single evacuee, generally an elderly person, with GPS equipment, heads for a designated evacuation shelter from his/her house. A group of school pupils record the whole process of the evacuation for their lessons of disaster education. Two pupils use video cameras to record the evacuee's behavior from two different angles. One pupil measures how long the evacuation takes by using a stopwatch. Also, another pupil writes down anything he/she observes during the evacuation (e.g., a steep evacuation path for elderly persons, or a bridge that would collapse after a great earthquake). Finally, the evacuation route recorded by the GPS sensor will be shown on a GIS map, and will have a tsunami inundation simulation graphic being overlapped on the GIS map, so that the survivability of a targeted evacuee can be seen easily.

It should be a good chance for pupils to participate in the *single-person drill* by managing the process to further their disaster education. With video records, we cooperated with a TV program production company to make a kind of movie, which was named as “multiscreen movie of single-person tsunami evacuation drill” (see figure 6). The multi-screen movie is divided into 4 parts. The first part shows the first camera's video, then at the diagonally opposite is the part of the second video, the third part shows pupils' comments, and the forth part is the GIS map. A clock in the middle shows the elapsed time. All the 4 parts interlock all the way from the beginning to the end. On the multi-screen move, problems of single-person's tsunami evacuation are collected compactly which has the similar function of clinical records.

Single-person drill aims at overcoming the difficulties mentioned above, by shifting tsunami evacuation from a general, non-urgent condition to a specific, concrete task that can be accomplished by an individual resident. The drill also contributes much to the improvement of existing evacuation facilities, because an actual experience of evacuation provides the chance to understand both the strength and weakness of the facilities. It also promotes co-learning of tsunami risks by intergenerational participants, such as elderly evacuees and young collaborators. It is important that the *single-person drill* combines both the active intervention of our researchers in the local community and the neutral research activity of data collection, such as data on evacuation behavior of local residents, data for checking effectiveness of existing facilities, and so on. Through the drill, the negative outcomes produced by those three concepts could be mitigated by motivating an increasing number of uninterested residents into disaster management activities.

5. FUTURE TASKS

In this study, we discussed disaster education in Okitsu from the perspective of the theory of community of practice with 3 fundamental concepts. It is important that various stakeholders, including people outside the local community, participate in the disaster education to gradually change the mutual relationships among artifact, practice and identity. From a certain perspective, the validity of this paper is threatened by the mutual relationships. Because when we introduce the practice of *single-person drill* through research papers or share reports with other stakeholders such as the media, experts majored in other fields, on the one hand, could be changed.

On the other hand, we have the potential to influence disaster education by doing action research, which was proposed and developed by Lewin (1948). Action research is an approach through which the participation of researchers and local residents is used to achieve the betterment for a certain community. The *single-person drill* was created as a new approach of action research, which aims to promote the resiliency of community as well as to involve more people in preparation for future disasters. Currently, it is difficult to estimate whether it can achieve the initial goals. However, anecdotally one participant commented, "It is very good. I can evacuate successfully before tsunami comes. I also enjoyed communications with kids. I'm very happy to do the drill!"

ACKNOWLEDGEMENTS

The authors thank teachers at Okitsu Elementary School as well as staffs of Disaster Management Department in Shimanto town for their assistance and support, especially members of Okitsu Disaster Education Committee for their generous cooperation and valuable input.

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