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Collaborative Community Weather Information for meteorological disasters: A case study of Nakajima School District, Ise

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Abstract In Japan, various improvements in severe weather information have been carried out. However, residents can't sufficiently use them for local disaster prevention. In general, weather information is announced by the experts and users simply receive the information. The present study breaks this one-way relationship and focuses on the establishment of bi-directional one through collaborative construction of weather information to suit local needs among relevant groups, that is, this study is the trial of novel weather information system from the point of view of risk communication.

This collaboration takes a form that various relevant members consider the details of weather information together and share disaster risk through weather information (Collaborative Community Weather Information (CCWI)). This case study of the collaboration was conducted among the local meteorological office (Japan Meteorological Agency), the local government and the residents of the study area: Nakajima school district, Ise City, which is in the central Japan. Through this collaboration, the contents of collaborative community weather information were constructed by the residents and discussed their details by each representative. Results showed that most of the participants regarded this collaboration positive and three kinds of significant bi-directional risk communication were found in the discussion.

Key words Weather information, Risk communication, Collaboration, Community disaster prevention.

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1. INTRODUCTION

As science and technology have developed, various issues between technology and society have arisen. "The Science, Technology and Society Studies (STS)" has discussed some models to these issues. Amid mounting criticism of the deficit model (the idea that it is necessary to teach scientific information to laypeople) first introduced in 1985 in "The Public Understanding of Science" by The Royal Society (The Royal Society of London 1985), various democratic models of the relationship between science/technology and society were introduced. One such example is the context model (Wynne 1991), which took the assumption of mutual communication for public understanding of science. This model was built upon the idea that laypeople do not have expert knowledge, but can nevertheless understand science in context, such as their relationships and situations that differ depending on their individual situation, way of thinking, and experience. Another example is the citizen participation model, which was built to utilize local knowledge of citizens for decision making, and which facilitates the decisions and judgment of citizens.

In Japan, especially such issues that affect our daily lives include BSE (Bovine Spongiform Encephalopathy), genetically modified foods, matters relating to the human genome, and various ways to guarantee the safety of nuclear power plants (Kobayashi et al. 2002). With increasing availability of technology, it has recently become more widely transparent and the demand for social rationality such as the public regulation of technology has risen. In other words, more emphasis has been placed on the importance of communicating technology to the general public that comprise a society, in addition to exclusively making judgments based on by objective scientific data.

Weather information used for disaster prevention (hereafter simply "weather information" unless otherwise noted[1]) is a representative of science technology in daily life that has developed with consideration of user-friendliness by the improvements in science technology. There are several local initiatives that use weather information and some of them are summarized as studies or reports. For example, the Cabinet Office (2004-2005) in Japan compiled local efforts of storm and flood disaster prevention using community power. These studies indicated that most local efforts involve evacuation measures during storm and flood disasters, and are not directly related to weather information. Of the 20 cases examined, there were only two cases where the communities conduct their own disaster responses using weather information, such as the quantity of precipitation. Other local efforts include the collection of local disaster information (Katada and Kanai 2010; Yamada et al. 2008), setting up criteria for voluntary evacuation (Katada and Kanai 2010; Niihama City (Cabinet Office 2004-2005)), meteorological disaster imagination game for residents (Uematsu et al. 2011), sharing information on local situations caused by weather phenomena (Sayo Town Disaster Investigation Committee on Typhoon No. 9 2010), and provision of storm and flood disaster hazard maps (Katada et al. 2011).

What is common among these efforts is that they are not about weather information itself; instead, they focus on the relationship between residents and disasters centering around weather information (origin), not on the relationship between the residents and weather information. For example, suppose there is a local effort to take preventative measures using weather information. In this case, residents do not examine the contents and the role of the weather information. Instead, although they must understand the weather information, they simply take cues from it and become

aware of the relationship between themselves and the disasters. This characteristic is also found in disaster reporting by the media. A typical report such as "A heavy rain warning has been issued for XXX City. The residents of XXX City are asked to be cautious about water immersion and flood..." requires the residents to be already aware of the relationship between themselves and the disaster, and the weather information itself merely instigates such awareness. Initiatives such as those above are very important for disaster prevention, and have considerable potential. Current disaster prevention efforts are reinforcing the idea that weather information is something to be received, emphasizing the relationship between users and disasters as mediated by weather information, not that between residents and weather information (i.e. the information composers) such as the residents take part in the construction of weather information itself. Here, weather information is not viewed as a mediator between information composers and users. Instead, it is viewed as an agent to communicate on behalf of its composers.

Collaborative construction of weather information which this manuscript deals with is an approach that aims to improve the social usages of weather information from the perspective of risk communication. Under this model, information users and composers discuss the information on even ground, and consider the social usage of weather information. In other words, it aims to create mutual disaster risk communication between weather information composers and users through weather information and to facilitate co-composition of weather information. In this manuscript, Takenouchi et al. (2015) was revised in English and added the subsequent situation of the practical field.

2. RELATIONSHIP BETWEEN WEATHER INFORMATION AND SOCIETY

There is little understanding and awareness of weather information among the general public (Japan Meteorological Agency 2011). Furthermore, some people tend to wait for weather information due to their heavy dependence on it (Katada et al. 2005). However, improvements in weather information, such as introduction of landslide disaster warning information and emergency warnings in Japan, refinement of models, and increasing image resolution, are conducted mainly by experts and those who take part in the construction of weather information. Therefore, improvements have focused on the content of the information rather than the social system between information composers and users except for little information such as tornado warning in Japan using information provided from outside. In other words, the participation of residents in construction of weather information has not been considered. This is also true for recent discussions that have taken place concerning the role of emergency warnings (Japan Meteorological Agency 2014), in which only the context of information composers and the governments are included. This situation may appear to consider nonprofessional users in that it aims at the utilization of information within a locality. According to past studies on people's understanding of weather information and their awareness of danger, however, weather information is not fully understood (For example, Japan Meteorological Agency 2011; Ushiyama Laboratory at the Center for Integrated Research and Education of National Hazards of Shizuoka University 2013), and it is quite different from the user's context model.

Takenouchi et al. (2014) have pointed out that the conventional relationship between weather information's composers and its users reinforces one-way risk communication, and that we need new efforts for changing this relationship. Takenouchi et al. also introduced the collaborative

construction of weather information in a citizen participation model, which is conducted through the cooperation and discussion among various relevant member. On the risk communication in weather information, the Japan Meteorological Agency (JMA) is legally and socially the only agent that is allowed to publish weather information, and there is little space for users to become involved the construction process for the JMA's information. This situation may be creating information dependency in users and preventing them from understanding the relationship between themselves and the disaster risks that the weather information is trying to convey.

On the participatory approach of various stakeholders, some similar practices were found especially in the fields of flood risk management (FRM). Maskrey et al. (2016) used Bayesian network model (BNM) for the collaborative flood risk management of Hedden Bridge in UK. As web-based approach, Alopradie et al. (2015) tried to construct the system where various stakeholders can join to make flood risk management plan. Moreover, on the Multi-Criteria Decision Making (MCDM) system in Li et al. (2014), community-based information of multi-stakeholders was shared and used efficiently by each stakeholder. As the collaborative action research through the community information as same as this manuscript, Gautam et al. (2013) showed the cooperation among various stakeholders including local communities for establishment of flood early warning system led participants to share water level information and take some structured actions. Macherera et al. (2016) reviewed various examples of such community-based early warning systems for reference of that on malaria and checked their definitions and the differences between global and national systems and community-based ones. In addition, the characteristics of some documented community-based early warning systems were summarized.

Others than these studies researched on inhabitants' participation in water-related disaster management too, but most of them tried the improvement of cooperation or share of each information. Few studies construct community-sized weather information collaboratively including local residents for various meteorological disasters and use them as real-time information by residents in association with various high-advanced and professional weather information.

3. COLLABORATIVE CONSTRUCTION OF COMMUNITY WEATHER INFORMATION

Collaborative Community Weather Information (CCWI) is an important concept for the collaborative construction of weather information. This information is constructed by transforming a large amount of highly specialized weather information into a format that uses local expressions. CCWI is constructed to facilitate assessment of the situation and heighten the awareness of risks, in turn leading to quick disaster response. Important features about CCWI are that it is familiar and easily used in a given locality (local information), that users themselves compose the information and have opportunities to use it (local ownership), and that it is shared throughout the area to heighten the awareness of disaster's dangers (local share) (Takenouchi et al. 2013). In considering mutual risk communication for the collaborative construction of weather information, CCWI can facilitate the understanding of it as information that reflects the knowledges and experiences of its local users. Simon (1957) argued that "People make rational judgments based on their limited cognitive ability in a limited period of time", and then the heuristic way of thinking

based on this limited rationality that deals with people's cognition and judgment under uncertainty is compatible with cognition of disaster risks. From this perspective, some improvements in response measures in disasters can be expected by using CCWI involved with the context of residents. (Takenouchi et al. 2013).

In the collaborative construction of CCWI, various agents become involved in the construction of information itself on equal footing representing their own contexts, and collaboratively produce the social product using scientific technology. This process is similar to stakeholder dialogue, but the participants' positions are similar to those in a scenario workshop. The reason for this equal relationship in the model is because, disaster prevention requires tight collaboration among those who are involved on equal footing, in additional to individual judgments. In such a situation, involved parties must take responsible actions from their positions. Therefore, this collaborative construction model can be considered as a citizen-participation model on weather information. However, unlike consensus meetings and citizen jury system in STS such as Kobayashi et al. (2002), Fujigaki et al. (2008), where citizens participate in discussion of issues and make the final decisions on various issues in technology. As Takenouchi et al. (2014) have suggested, collaborative construction of weather information takes six steps; (1) advance preparation, (2) deciding the contents of CCWI, (3) start of information usage, (4) normal period, (5) occurrence of the weather phenomena relevant to the CCWI, and (6) update of the information. These steps are divided into three phases: the advance phase, where discussion of the contents of the information is conducted (Steps 1 and 2); the information usage phase, where disaster prevention drills using the CCWI are conducted and actual responses using the information are taken (Steps 3, 4, and 5), and the reconfirmation and succession phase, where the information is updated, local meteorological disaster risks are reconfirmed, and the disaster-preparedness culture is passed on (Step 6). This study will mainly consider the first phase (i.e., advance phase), namely, the discussion of information as part of the collaborative construction of CCWI, and examine the attitudes of the involved parties toward the collaborative construction. The evaluation of the relationship between CCWI and various existing weather information will be discussed elsewhere. This research analyzes this collaborative construction of weather information through the case study from the view of risk communication.

4. A CASE STUDY OF NAKAJIMA SCHOOL DISTRICT, ISE

4.1 Previous cooperation toward the trial

We have been engaged in practical disaster prevention research in Nakajima school district, whose population is about 6 thousands, which is located along the Miyagawa River in Ise, Mie Prefecture. We have been involved in some efforts for disaster prevention in this area since in 2012, leading up to the present study of collaborative construction of CCWI. These cooperation has strengthened the trust between the researchers and the residents, and led the implementation of this study.

Among the efforts, an all-household questionnaire survey on willingness to participate in collaborative construction of weather information was conducted in December 2013. The results of the questionnaire survey are shown in Figure 1, which shows that over half of the respondents (60%) were willing to participate in the effort of this study. We conducted a workshop to collaboratively construct weather information for Nakajima school district on June 29, 2014.

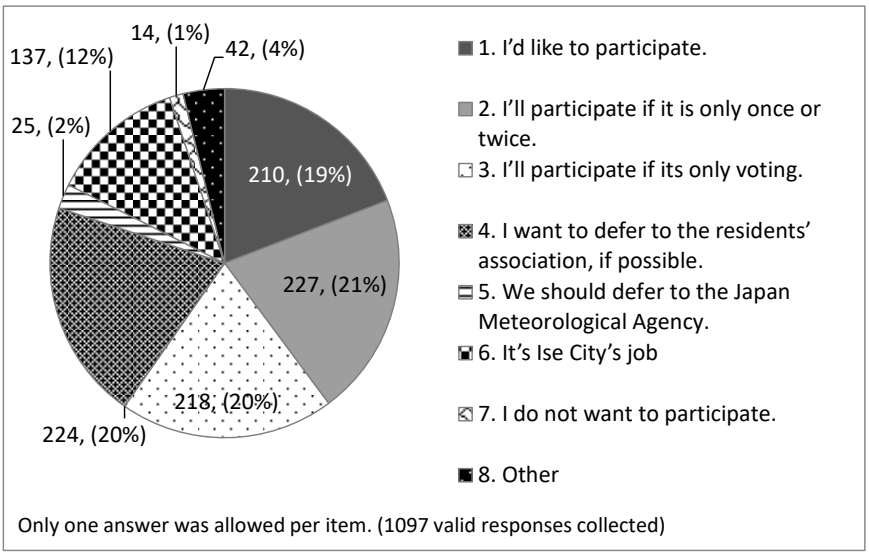

Figure 1. Willingness to participate in the collaborative construction of weather information

4.2 Framing the workshop to collaboratively construct weather information

As Takenouchi et al. (2014) showed, there are several methods to consider the contents of information in the collaborative construction of CCWI. Citizens can participate through a workshop, voting system, or discussion with representatives of voluntary disaster prevention groups. Moreover, related parties can discuss the contents of information through a mutual consultation, opinion inquiries, or a scenario workshop. So then, the method for the workshop of the collaborative construction was considered. Given that it was the first trial, and the collaborative construction of CCCWI was not fully understood by the residents, we took two steps to increase resident participation. First, residents took initiative in discussing the contents of the information (Information Construction Process) and then representatives from related parties considered the utility and importance of the information (Information Discussion Process). This method, as long as the residents are informed of the results of the deliberation and methods for utilization of the CCWI, can serve as a citizen-participation model, since it fulfills the conditions necessary for social rationality (Fujigaki et al. 2008). These conditions are the guarantee of diverseness of subjects in decision making, disclosure of necessary information for decision making and guarantee of diverseness of options, guarantee of transparency and fairness of decision and consensus making processes, and clarification of procedures. The parties involved in this workshop were the residents and the Council (community building council at Nakajima school district), the local government (Ise City), and the meteorological observatory (local meteorological observatory at Tsu of Japan Meteorological Agency). These three parties took distinct roles: experts of local knowledge (the residents), public officials responsible for local disaster prevention (the local government), and experts on weather information (the meteorological observatory).

The details of the procedure are as follows. The Information Construction Process composes Step 1 and Step 2, and about the Information Discussion Process Step 3 and Step 4 are components of it.

Step 1: Confirmation of the local disaster information held by individuals

The residents are divided into groups of several people and share information that they know about local disaster possibilities. A card (Shown as Figure 2) is used to describe where (for example, the street under M clinic), when (in heavy rain), how much (about 15 cm), and what happens (became submerged in water) in the disaster (Figure 3, left).

Step 2: Selection of information through group work

The residents select important information from the total of all information presented in Step 1. The residents then rank the information by the degree of risk and selected the top three (Figure 3, center).

Step 3: Discussion by representatives of the related parties

Representatives of the related parties then discuss the utility and importance of the information presented by each resident group. Some items of information are chosen as targets of discussion by a majority vote. The representatives reflect the interests of their respective groups, and they vote on the feasibility of the practical usage of the information (select one from "Highly feasible", "Not very feasible" and "Not feasible at all") (Figure 3, right).

Step 4: Discussion on the future practical usages of the information

The representatives summarize the issues for the future investigation.

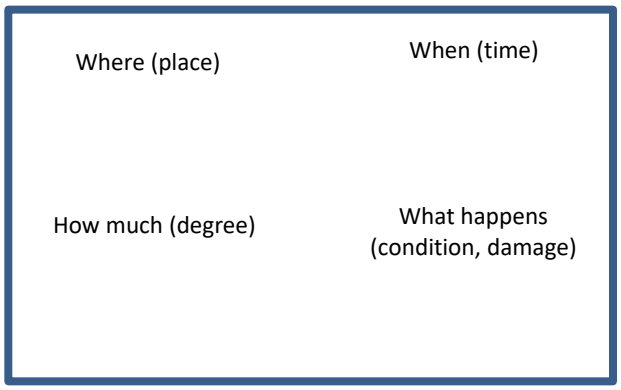

Figure 2. Individual disaster information card

Figure 3. Workshop Left, Step 1 (Confirmation of local disaster information owned by individuals); Center, Step 2 (Selection of information through group work), Right, Step 3 (Discussion by representatives of the related parties)

5. RESULTS OF THE RESIDENTS' INFORMATION CONSTRUCTION PROCESS

5.1 Measuring well-being in the information construction process

First, we would like to discuss the results of Steps 1 and 2 discussed in the previous chapter. In this workshop, 85 items of information were obtained from 12 groups. Each group selected three items of information they believed to be important for the district, and a total of 36 items of information were extracted. The information included items that only those who experienced and witnessed a situation in the past were able to cite, and ones that many of the residents of the district were aware of. An example of the former was, "In heavy rain, the low-lying street in the back of K noodle shop in K town was flooded, the nearby empty lot got submerged into water (waist-deep). In the past, the space under floors was flooded in July 7th Flood in 1974 and Isewan Typhoon." and an example of the latter was, "In front of Y station, during daytime, about 10 cm, streets are submerged in water." Representatives of the related parties selected from these items of information and discussed them in more detail (next chapter).

Here, we will show the results of a questionnaire survey of 95 residents who participated in the information construction process (n=88 respondents).

Figure 4 shows the distribution of the respondents' age. Since the district percentage of those aged 65 or older was 32.6% in the district (National census of 2010), most of the participants were over the age of 60, and indeed, they comprised 70% of the participants. The percentage of the young was low.

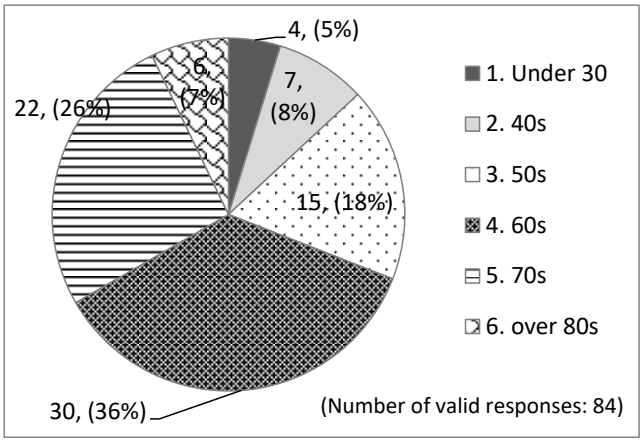

Figure 4. Distribution of the age of participants who took part in the information construction

One of the questionnaire items checked what challenge the current weather information was facing based on the thoughts to weather information of the respondents. Four possible challenges were listed for the respondents: target area (The target area is too large to be used as local disaster information); local effect (Local conditions cannot be predicted from the weather information), information overload (Too many kinds of information are included, and it is difficult to comprehend the degree of risk), and false alarm effect (People take the weather information for

granted and do not feel threatened). For each item, the respondents were asked to choose from "Agree," "Disagree," and "I don't know." Figure 5 shows the results for this item. Over 60% of respondents believed that the weather information was not effectively utilized for all items except for the false alarm effect.

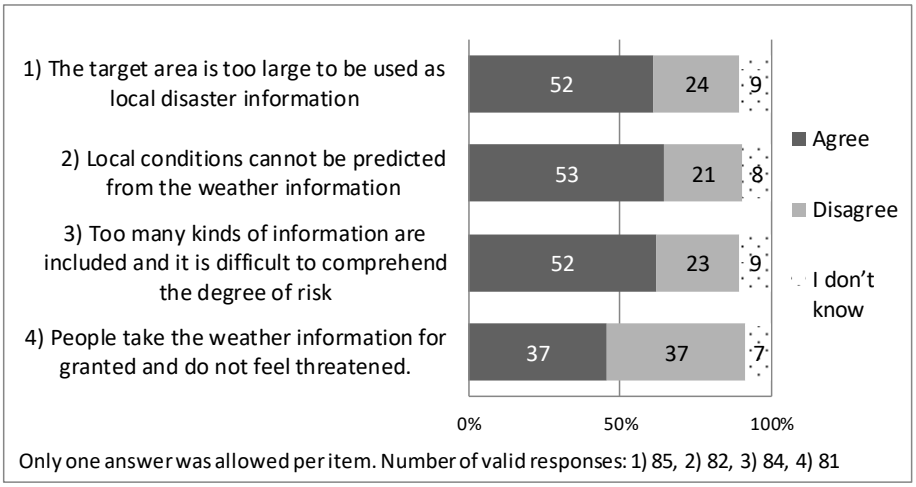

Figure 5. Challenges facing the current weather information

Another question item was prepared to examine the effect of collaborative construction of CCWI on each perceived challenges. These results are shown in Figure 6.

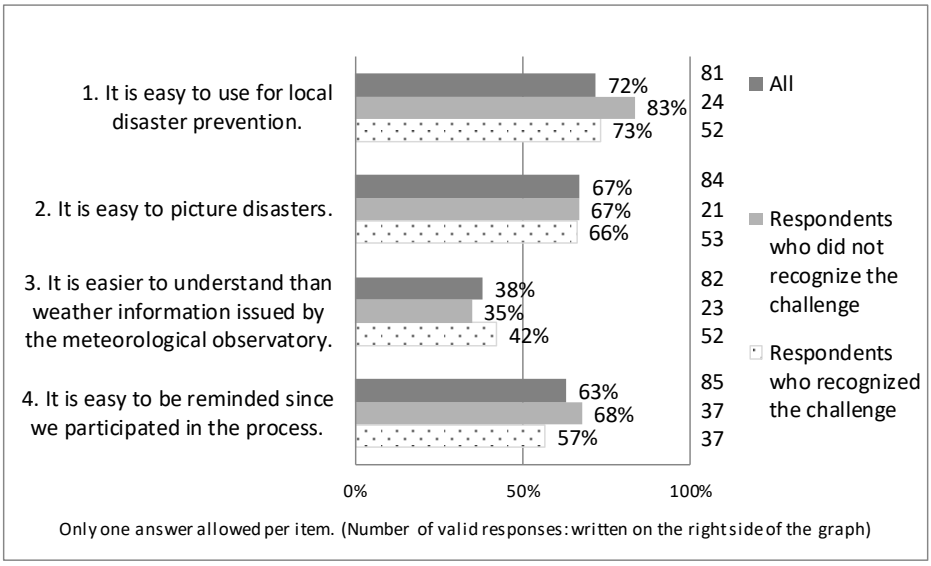

Figure 6. Effects of the collaborative construction of weather information on the identified challenges.

* For each effect, the bottom two bars show the percentage of those who recognized the effect out of those who had not seen the challenge, and out of those who had.

About the information respondents constructed, 72% of them said, "It is easy to use for local disaster prevention," (target area) and 67% of them said, "It is easy to picture disasters" (local effect). This was probably because the information described the areas that the respondents live in. In addition, 63% of them said "Construction by ourselves makes us give attention to the information.". This effect was probably based on the ownership awareness produced by the collaborative construction.

From these results, the collaborative construction of CCWI not only enhanced the users' understanding of disaster risk, but also increased their awareness that they should actively pay attention to the information instead of passively receiving it. However, only 38% of respondents said, "It is easier to understand than the information issued by the meteorological observatory." This was probably because this was the first collaborative construction of weather information. The present weather information is not simply facts, but it is a part of important tools for disaster prevention, that has been developed and used in the society over time. To varying degrees, it occupies a certain position in the residents' social life, and is familiar to them due to frequent media reports such as on TV. So then, the method of understanding is established to some extent. While some participants believed that the CCWI constructed in this workshop was easy to understand and pay attention to, the information content was still new to them, and this shows that some time is required for the information to be accepted as a part of local tool for disaster prevention through drills and opportunities for use. The bottom two bars in Figure 6 show the percentage of those who recognized the effect of collaborative construction out of those who had not or had seen the challenges described in Figure 5. There was no significant difference between these two groups. This suggests that the effects perceived by participants were not due to their having recognized challenges in the current system; instead, they reflected the participants' impression of the collaborative construction of CCWI itself.

Apart from the effect on the remediation of the recognized issues, Figure 7 shows the percentage of the participants who felt that there was some significance of the collaborative construction itself.

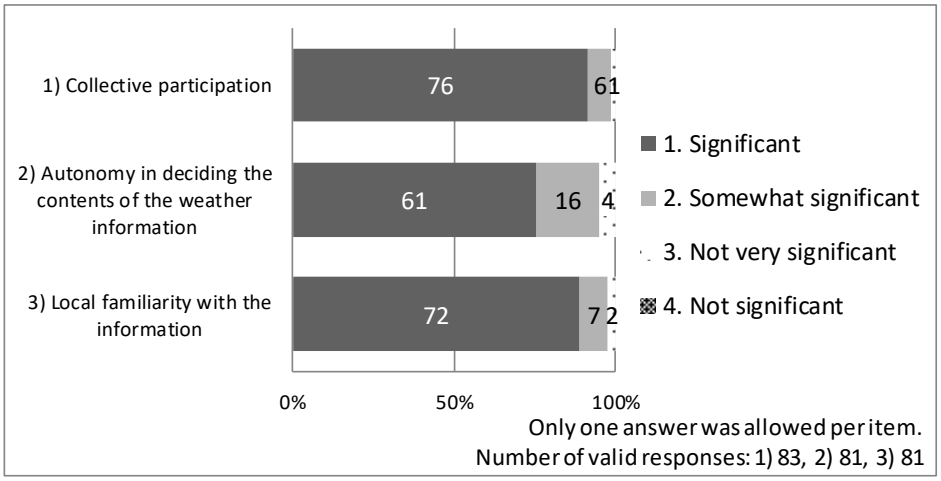

Figure 7. Significance of the collaborative construction of the weather information

The respondents were asked about their perceived significance of collective participation,

autonomy in deciding the contents of the weather information, and local familiarity with the information; 92%, 75%, and 89% of respondents found each aspect, respectively, to be significant. These three aspects were fairly fundamental, but the results show the positive evaluation of inhabitants' having relationship to weather information. How important the relationship among the related parties of the weather information can be for the information users.

Finally, Figure 8 shows the changes in the impressions on the weather information of participants to information construction process.

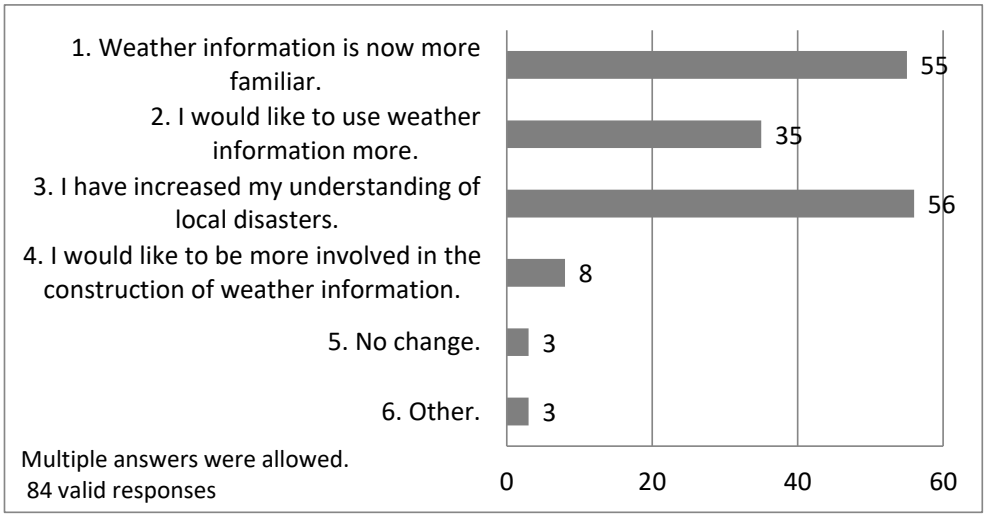

Figure 8. Changes in participants' impression of weather information after the information construction process

As Figure 8 shows, 55 participants (65%) stated, "Weather information is now more familiar," and 35 (42%) said, "I would like to use weather information more." Although the meaning of the workshop itself was not fully understood by the participants, close to half of them answered in this sort of positive manner. These numbers are significant for the advancement of understanding weather information with risk communication between weather information composers and residents. Moreover, 56 participants (67%) said, "I have increased my understanding of local disasters," indicating a byproduct of sharing the local disaster information among the residents. Through the workshop, the participants not only collaboratively constructed weather information, but also shared their awareness about local disasters. This also shows the collaborative construction of CCWI can play the role for the purpose of facilitating the succession of the local disaster memory. However, only 8 participants (10%) said, "I would like to be more involved in the construction of weather information." This suggests that while the significance of the collaborative construction of CCWI was understood, more discussion on methods will be necessary to encourage willingness to participate.

As these results show, the residents who participated in information construction process considered their weather information for themselves and regarded the collaborative construction of CCWI as significant. Moreover, this new collaborative construction can be expected to improve disaster prevention action of residents compared to the conventional weather information.

6. RESULTS OF THE INFORMATION DISCUSSION PROCESS BY THE REPRESENTATIVES

6.1 Findings on risk communication in the information discussion process

This section will discuss the results of the deliberation by the representatives of the related parties conducted after the information construction process discussed in the previous chapter.

A brief overview of the deliberation method was presented in Step 3 of Chapter 4, and this information discussion process is the place for the representatives to check the possibilities of local effects and the importance about the information constructed in information construction process. Through this responsible check, the considered CCWI can be adjusted as available information in practice and in their lives. The conditions of the information deliberation are presented here in full in Table 1. This section shows how the representatives discussed and what risk communication they had based on the analysis of the deliberation and in the next section how they thought of this collaborative construction from the results of the questionnaire survey. The deliberation participants selected five items of information by a majority vote from the 36 items of information that residents suggested through Steps 1 and 2 in the information construction process. Table 2 shows the items of information that were considered[3]. Through the deliberation on five selected items, 3 characteristic risk communication were found; (1) New risk communication about weather information, (2) Risk communication that enhances mutual understanding and (3) Improvements in the current risk communication. We will look at a part of the deliberation over each information and find the characteristic features.

The first item is No. 7. Hereafter, the community building council of Nakajima school district, Crisis Management Section in Crisis Management Division of Ise City, the local meteorological observatory of Tsu, and the researchers will be referred as the council, local government, meteorological observatory, and moderator, respectively and "(Feature number)" in the deliberation means characteristic point.

Table 1. Conditions of the deliberation in the collaborative construction of weather information

Element	Contents
Participant	Community building council of Nakajima school district (4 people) Crisis Management Section of Crisis Management Division, Ise city (3 people) Local meteorological observatory at Tsu, Mie prefecture (4 people)
Information to be considered	Out of the 36 items of information suggested by residents, 5 were tentatively selected after considering their degree of risk and importance.
Method of deliberation	Participants freely presented their opinions reflecting the interests of their representing parties.
Focus of the deliberation	Feasibility of each item of weather information (including points to be improved and the importance of the information)
Method of	For each item of information, the representatives voted using 3cards

judgment	("Highly feasible", "Not very feasible" and "Not feasible at all"). They were allowed to present their opinions with some reservations.
Responses after the judgment	Discuss how to use the information as collaborative community weather information in a specific manner[2].

Table 2. Items of information that were discussed in the collaborative construction of weather information

Number*	Contents of the information**
No. 7	It's scary during the daytime in the area between Miyagawacho and Watarai Bridge, the water reaches the orange line on the pier. (Watarai Bridge is located near Miyagawacho and has piers with colored lines. The orange line indicates that the water has reached a water level where consideration of evacuation is necessary. This suggests that residents feel threatened when this occurs.)
No. 12	When a large amount of water gushes off the cliff near S grocery store in a heavy rain. (There is a 10-m cliff by S grocery store in the district. Water often runs powerfully off the cliff when it rains heavily. This suggests that the residents are worried about this.)
No. 16	The water level exceeds the flood level or some sections are flooded at part of the Miyagawa levee (in the morning). (This suggests that water level of the Miyagawa River is above the flood level, and some parts along the levee are flooded.)
No. 26	The small river by A dental clinic is currently flooded up to the street. (By A dental clinic, there is a small river that is a tributary of the Miyagawa River. This river overflowed several times in the past due to inland flooding.)
No. 34	A bathtub full of earth, sand, and rocks has fallen behind the Tsujikuru housing complex. (The area has a small mountain called Mt. Sangou, at the bottom of which lies the developed Tsujikuru housing complex. In the past, the phenomenon of muddy water flowing from the mountain was observed around here. Residents had witnessed muddy water running off the mountain in a heavy rain.)

* Numbers were given to the items of information extracted by residents, for ease of reference.
** Information inside each parentheses is supplementary.

Item No. 7 It's scary when, during daytime, the water reaches the orange line on the pier in the area between Miyagawacho and Watarai Bridge.

(Local government) Water reaches the new orange line after an evacuation order is issued.[4]

(Council) That means the orange line is meaningless, since we can just use an evacuation order instead. In order for the prior information, the height of the line should be lowered, maybe to a water level where the flood watch is necessary. (Feature 1)

(Council) To make it appear more threatening, wouldn't it better to give a warning after it gets more dangerous? (Feature 2)

(Meteorological observatory) Is this information supposed to ask the residents to evacuate, or

is it just preliminary information to begin with?

(Moderator) Basically, it is supposed to be preliminary information. If it is the information given after the degree of risk gets higher, it needs to be based on the existing weather and evacuation information. We can also replace it with something local.

(Meteorological observatory) What criteria are the evacuation information based on? (Feature 3)

(Local government) The area along the Miyagawa River is divided into six sections, and the evacuation information is set up based on the water level. The establishment of a new levee will not change the criteria.

(Moderator) When will the orange line be redrawn?

(Meteorological observatory) According to the Mie Office of Rivers and National Highways, it is expected to be done soon.

(Meteorological observatory) We need to see if the residents are paying attention simply to the orange line, or to the water level. If they are paying attention to the water level, we should use the previous water level, not the new orange line level.

These are an excerpt of the exchanges of opinions that arose during the deliberation. As seen in these exchanges, three distinct types of risk communication were observed during the deliberation as a whole: new risk communication about the weather information; risk communication that enhances mutual understanding; and improvements in the current risk communication.

(1) New risk communication about weather information

A new type of risk communication among the related parties that can emerge through the collaborative construction of CCWI was observed.

First, in Features 1 and 2, the residents themselves expressed their opinions about the degree of risk the information was supposed to convey. Previously, they had been only receivers of the current weather and evacuation information. However, in this workshop, they were given a chance to think of what should be included in the information by participating in the construction of information. Moreover, the residents discussed if information that conveys higher degree of risk should be used. By doing so, they considered how they would use the information.

In addition, as seen in the part of the deliberation over Item No. 26, the residents and the local government attempted to improve the contents of the information. A perception gap between the residents and the government was recognized, and they deliberated on the content of the information in light of this gap.

Item No. 26 The small river by A dental clinic is currently flooded up to the street

(Local government) In the sentence describing this phenomenon, instead of talking about A dental clinic, wouldn't it better to mention the closure of K floodgate?

(Council) Actually, this is our first time hearing about K floodgate. It is possible that, with the exception of the area around here, this word is not familiar even in Nakajima school district. The residents are probably more familiar with A dental clinic or M bridge.

(Council) When are the floodgates closed?

(Local government) Each has different standard, and it is closed and opened according to it.

Similarly, the participants discussed the expression used in Item No. 26. In the following exchange, the participants pointed out the need to change the way that the information is expressed, and the participants agreed to change it.

Item No. 26 The small river by A dental clinic is currently flooded up to the street

(Local government) It seems like we have many items of information about specific spots. I think it is better to expand the area to consider the degree of risk in a wider area, instead of that of just spots.

(Moderator) Some think that spot information is also alright, because we can understand the local conditions from the spot information. However, maybe we should double check if residents are able to imagine from the information what is going on around that spot.

(Council) In that sense, right now, information that describes not only a spot, but also the surrounding area is appropriate.

(Local government) Since spot information is not really appropriate, it is better to reconsider it. Information sentences should include the larger surrounding areas, not just a spot.

(Council) Since we can see a similar trend in the information extracted from the residents, we should reconsider that as well.

(2) Risk communication that enhances mutual understanding

The participants checked each party's response in a disaster. Risk communication where they checked their relationship with the target information was observed. Feature 3 during the deliberation over Item No. 7 was one example. Even between the administrative bodies that cooperate on a daily basis, it is not realistic to recognize all disaster responses of all other parties. In the example deliberation, the administrative bodies checked each party's disaster response.

(3) Improvements in the current risk communication

The participants checked the existing weather information and attempted to improve the methods for utilization, and then apply it to the information to be discussed. As shown below in an excerpt of the deliberation over Item No. 12, the participants deliberated on the weather information extracted from the residents voluntarily.

Item No. 12 When a large amount of water gushes off the cliff near S grocery store in a heavy rain

(Local government) Although we have heard that water often collects around that area, we are not sure how dangerous it is.

(Meteorological observatory) If we can know when that happens from past experiences, we will be able to predict somewhat beforehand. When does this happen?

(Council) It probably occurs during torrential rain. In that case, what kind of information can be used?

(Meteorological observatory) Radar information with 1 km resolution can be used. As for prior information, thunder information and heavy rain warnings can also be used.

As seen here, during the deliberation, the participants discussed the contents of the CCWI based on their intentions and the information they each had. In addition, they checked each other's disaster response and the method of using the present weather information.

Figure 9 shows the number of communication among related parties

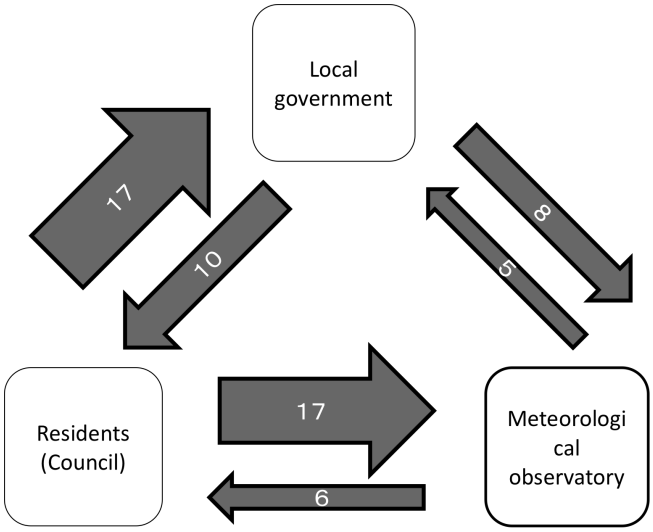

Figure 9. Amount of communication among related parties

* When an utterance was directed to the entire group, it was counted as communication from the sender of the information toward both of the other parties.

** We counted a set of utterances as 1, instead of counting each detailed component about a subject as a discrete utterance.

Since the information dealt with was highly localized and since extra consideration was given to the use of the information by the residents, the council (the residents) had the most number of utterances. However, as Takenouchi et al. (2014) have shown, unlike the current weather information system where the information is disseminated from the meteorological observatory to the residents via the local government, the communication here is not one-way. From the perspective of risk communication, this is a big change.

Next, the results of feasibility discussion and subjects of future investigation are shown in Table 3 (Step 4). Except for Items No. 12 and No. 16, which were omitted during the deliberation, positive feedback was given. However, some conditions were attached to each item of information. For Item No. 7, the deliberation took place right after the river level criteria had been changed, and the parties therefore discussed whether the old or new criteria should be used. For Item No. 12, since even the representatives of the council were unaware of the gushing water phenomenon, the degree of risk remained to be examined for the future. As a result, more representatives gave "Not very feasible" votes on the information's feasibility than for any other

item. The participants decided to change the expressions used in Item No. 26 so that it would describe not just a spot, to consider a more extended surrounding area. For Item No. 34, the contents were unclear, as was the case with Item No. 12. Therefore, the participants decided to examine if the phenomenon was regular muddy water from the surface of the mountain, or a precursor to a sediment disaster.

It is significant for the development of risk communication that various subjects of future investigation were raised here, since this means that related parties themselves deliberated on concrete corrective strategies and points to be checked in order to make the CCWI more effective. Historically, this type of deliberation on the contents of weather information among related parties, including residents of the area, has been rare. In many cases in Japan, various educational activities on weather information issued by the Japan Meteorological Agency have been carried out before a disaster. Examination of administrative responses and the weather information used during the disaster have also been conducted after the disaster, with an aim toward improving the weather information. However, it is undeniable that the same responses and problems repeat for each disaster. Currently, there is not enough discussion on how residents who are the potential victims of a disaster should be made aware of the information and use it. From this point of view, the collective construction of CCWI helps deepen the understanding of the related parties about the relationship between a disaster and the weather information, and can facilitate better risk communication in preparation for a disaster.

Table 3. Results before and after feasibility discussion, and subjects of future investigation

	Highly feasible	Not very feasible	Not feasible at all	Subjects of future investigation
No. 7 before	11	0	0	Examine the utility of the new and old orange lines and decide upon judgmental criteria for the information
No. 7 after	9	2	0	
No. 12 before	2	7	2	Decide whether to include this information on the agenda after examining if the residents in the area feel threatened by the phenomenon, and how often it occurs
No. 12 after	4	7	0	
No. 16 before	-	-	-	The degree of risk described in No. 16 was higher than that in No. 7. So, No.7 can be dealt with as prior information to No. 16. This No.16 was omitted from the agenda.
No. 16 after	-	-	-	
No. 26 before	9	2	0	Include A dental clinic and M bridge in the information, and change the information so that it describes not just a spot, but the wider surrounding area.
No. 26 after	7	4	0	

No. 34 before	5	6	0	Examine if the described phenomenon is a precursor to a sediment disaster. If it is, consider the use of the information.
No. 34 after	11	0	0	

As discussed below, some points for improvement in the methods of deliberation and the role of information were found in this workshop.

Issue 1 Shortcomings derived from the deliberation among only the representatives

When deliberating on the information extracted from the residents, there were some items of information that some of the representatives found hard to understand. To solve this issue, participation of representatives of each resident's association, and interviews with those who provided the information, are necessary. In this workshop, the deliberation was conducted immediately after information was extracted from the residents in a discussion. However, a more effective deliberation is likely possible if the deliberation is conducted after sorting and checking the information given by the residents.

Issue 2 Choice between spot and broader information

The utility of spot and broader information can vary depending on the content of the information. However, during the deliberation in this workshop, it was discussed that information from various spots, not just one, should be included. Therefore, the information omitted from the deliberation in the workshop can probably be used to create effective broader information (For the use of broader local information, please see the study by Arai (2011) on the disaster response by Oyamacho in Shizuoka Prefecture using an observational network).

Issue 3 Degree of risk and frequency of information

During the deliberation, there was a time when the participants had to figure out whether the information discussed was about a phenomenon that occurred on a daily basis or was something that would indicate a disaster. This demands necessity of setting how the risk degree of the information is. If they use high risky information as the CCWI, they need to try not to treat the present weather information or evacuation information as safe information.

6.2 Opinions of participants in the information discussion process

Next, the results of the questionnaire survey on the information discussion process on CCWI are shown.

At first, the participants of the deliberation were asked about the significance of the collaborative construction of CCWI. As the results, all 11 participants said, "it was very significant."

In addition, the 4 items were checked as follows; 1 Usefulness of the current weather information for the local residents in a disaster, 2 Usefulness of the CCWI for the local residents in a disaster, 3 Participation in the construction of the weather information, 4 Awareness of local disasters before checking the information given by the residents. The results are shown in Figure

10. As the results for Questions 1 and 2 in Figure 10 show, while many of the deliberation participants recognized the usefulness of the current weather information, they also believed that the CCWI was useful. After participating in the process, 9 participants said, "We need to participate more," and 2 said, "We need to participate somewhat" (Figure 10, Question 3). It is important to note that both those who had constructed weather information and the information users came to view the participation of various related parties in a positive way. This suggests that risk communication among the participants that occurs during the collaborative construction of CCWI facilitates the sharing of disaster risk information among the related parties, and can lead to cooperation among related parties in a disaster.

Moreover, as Figure 10, Question 4, shows, only two participants said that they had been fully aware of the local disaster risk, suggesting that the collaborative construction of weather information was useful in sharing the local disaster information.

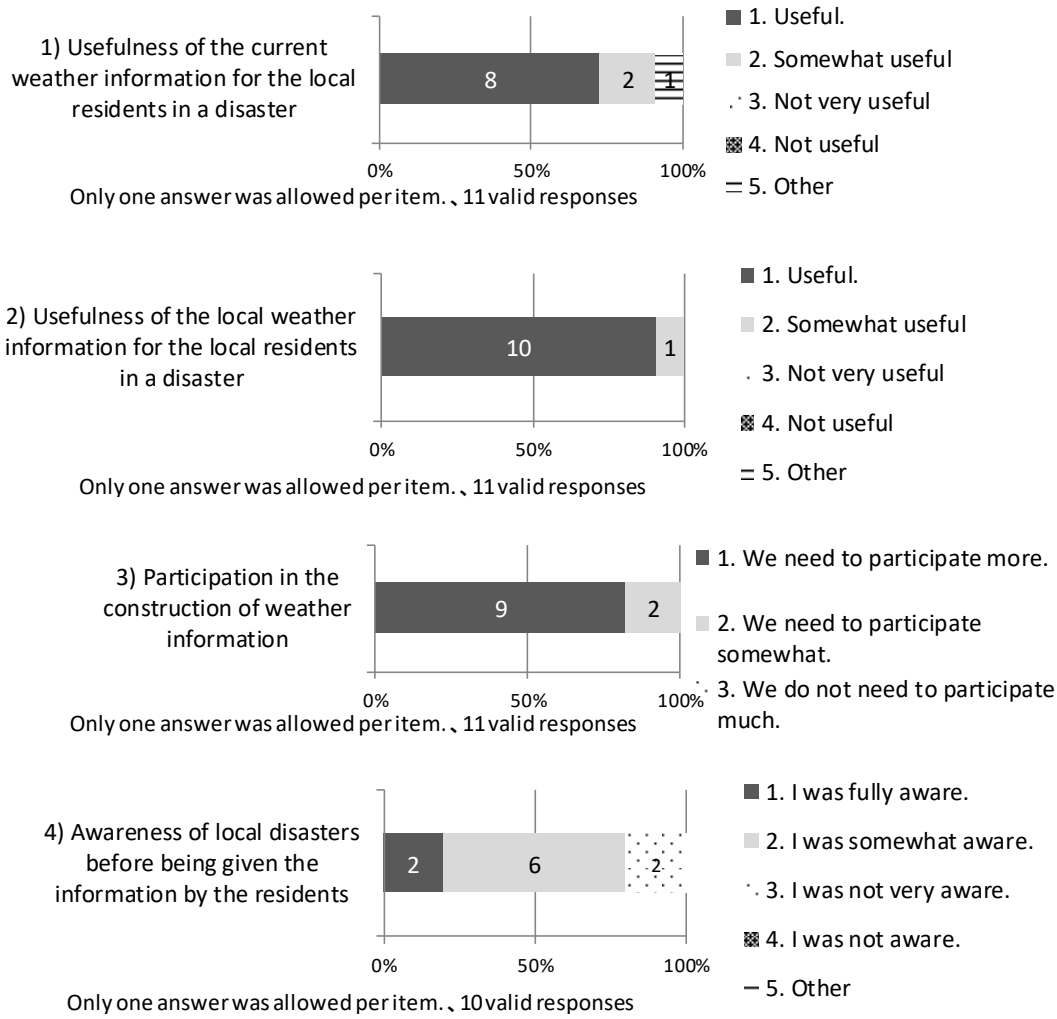

Figure 10. Opinions on the collaborative construction of the weather information of the participants in the information discussion process

7. THE SUBSEQUENT CONTINIOUS PRACTICE

After the workshop, the community building council of Nakajima school district had discussed the use of their CCWI henceforth. In the result, they have operated their original CCWI related to Item No.7, No.26 and No.34 since July 1, 2014. The local meteorological office consulted the conditions of these CCWI in reference to past meteorological disaster situations and set them as the residents could judge from present various weather information easily by themselves.

Since then, the members of the council including representatives of local residents have checked whether the meteorological situation meets the conditions of their CCWI and, in such cases, the residents share the announcement of the CCWI by e-mail or telephone and communicate in their community. The CCWI activated twice before, but fortunately this district was not damaged in either cases. The case to be discussed was the following. On September 9 in 2015, the 18th typhoon of the season approached this region, but Nakajima district was hardly affected. However, Kusube district, which is located at a distance of only about 5 km away, was hugely damaged by the local heavy rainfall. We verified that the conditions in Kusube district could have applied in Nakajima district and checked the effects of the CCWI precautions. We confirmed that the CCWI could work effectively for the residents to prepare for the disaster. The community responses in this case are described briefly below.

At noon on September 8, information about the meteorological situation for the next few days was issued by the local meteorological office. The members in the councils discussed their preparedness based on this information. The information indicated that the situation wasn't severe: rainfall of 250 mm/day somewhere in the southern area of the prefecture and a pressure of 985 hPa with the arrival of the typhoon in this region. During the case of the 21st typhoon of the 2004 season, which caused heavy inundation in this district, the amount of rainfall was about 700 mm/day. As a result of the discussion, they decided one continuous monitoring of the weather situation until the typhoon arrived in the next day.

The next day, there had been strong rainfall around Ise since the early morning. At 07:40, the danger of a real-time landslide risk in this district reached the "Caution Level". After receiving this information, the members in the council discussed and decided to share the CCWI on sediment disaster as warning to prepare for evacuation. The members shared the situation to the residents by e-mail or telephone and the community made their preparation to respond to the disaster. However, after 8 o'clock, the rainfall became weak, so the evacuation instruction from local government was not issued. In the damaged area of Kusube district, an evacuation advisory was issued at 08:17 and the evacuation order was given at 08:41.

We verified that if the rainfall situation that occurs in Kusube district has also happened in Nakajima school district, an evacuation advisory would have been issued at 09:07 with a subsequent evacuation order at 09:31. So, the CCWI could have prepared this community prior to the more severe disaster risk situation.

As shown in the above case, the residents could use the important weather information for themselves by themselves and deal with the local disaster risk. There was, therefore, effective and active use of weather information that was formed in the community through the CCWI.

8. CONCLUSIONS

The current study calls for the reconsideration of weather information from the perspective of risk communication. This communication is not one-way "the meteorological observatory announces weather information and residents just accept the announcement", but mutual bi-directional "Various relevant members collaborate to construct weather information".

In this study, those who had been involved in the construction of weather information participated in the collaborative construction of CCWI in Nakajima school district, Ise City. The participants were the residents and the council (The community building council of Nakajima school district), the local government (Ise City), and a meteorological observatory (local meteorological observatory at Tsu City). In this workshop, a good number of residents participated in the construction of the contents of the information, and representatives from related parties took part in deliberating the information.

In the information construction process, 85 information which were local and familiar for the residents were constructed. Among the residents who participated in this process, 92% of them agreed that deliberating together was significant, and 75% and 89% said that it was important for them to decide the contents of weather information themselves and that it was important that the contents of the information was familiar to them, respectively. In addition, as many as 72% said that the information they constructed was easy to use for local disaster prevention, and 67% said that it was easy to picture a disaster. However, only 38% said that the information they constructed was easier to understand than that issued by the meteorological observatory. This suggests that it is important to instill the information to local community in future.

A reciprocal style of communication emerged during the discussion, wherein new risk communication about the weather information, risk communication that enhances mutual understanding, and improvements in the current risk communication were observed. These kinds of communication have never existed in present one-way weather information system and are very significant changes in risk communication.

9. RECOMMENDATION

The participants deliberated on the CCWI, and raised some specific issues, such as on the methods and roles of the information. Specifically, they brought up shortcomings derived from the deliberation among only the representatives, the choice between spot and broad information, and the degree of risk and frequency of the information. This suggests that the participants' understanding of the information can be enhanced through deliberation, and that the information can be improved through this process. This is a significant point in risk communication. In this workshop, residents, local government, and meteorological observatory had roles respectively as experts on local information, responsible officials and experts on weather information, and provided the assurance of validity and possibility of using of the CCWI. However, many items of information related to floods and sediment disasters were raised, so in addition to the participants in this workshop, river administrators and representatives from the public works sector should be included in the process.

At present, various kinds of weather information are used in each country. The weather information is developed based on the geographical situations and social demands in each country. However, local context of residents based on daily life is likely to be different from that of weather information. In Japan, as the meteorological forecast model and observatory system are sophisticated and high-resolution, weather information has been improved mainly from the view point of natural sciences. Various contexts of local communities may have gradually disappeared on the way to its improvement. The efforts, such as the collaborative construction of weather information in this study, showed the need to increase the connection of the contexts between weather information and residents. So then, weather information will be used efficiently for local disaster prevention.

In Nakajima school district, they have operated their CCWI by themselves. As the future prospects, we will continue to check risk communication in the community and discuss some practical issues with the residents through this continuous operation.

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FOOTNOTES

(1) River information such as observed water level is usually not considered as weather information. However, users often consider it as a part of heavy rain information, and information related to floods is also part of weather information. Therefore, in this study, weather information includes not only disaster prevention weather information issued by the meteorological observatory, but also other information such as observed river water levels.

(2) Another possible method is to provide the discussed information from the meteorological observatory to the local government and the representatives of the district. However, when the system of disaster prevention weather information and the structure of the meteorological observatory were considered, it was not feasible. Therefore, the CCWI constructed in the current study is considered to be advanced reference information to be used when considering how to use the current weather information more effectively at the local level (Takenouchi et al. 2014)

(3) During the deliberation process, the majority vote and closed questions were used to construct and deliberate the information on the same day. However, selection of information and revisions to the information should be done through risk communication among the related parties. Therefore, if the construction and the deliberation on the information can take place on different days, the information can be sorted and checked before deliberation. This point has been listed in Chapter 6 as a limitation of the deliberation among only the representatives.

(4) The orange line on the bridge pier is planned to be newly redrawn, as the evacuation water

level of Miyagawa River was changed in 2014.

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