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Analysis of Regional Response and Development of Disaster Prevention Teaching Materials for "Nankai Trough Earthquake Extra Information"

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Abstract Nankai Trough Earthquake Extra Information is a bulletin issued when the likelihood of a Nankai Trough earthquake is assessed to be relatively higher than normal, and it is expected to contribute to the mitigation of tsunami and earthquake damage. However, there has not been sufficient discussion on the social response to Nankai Trough Earthquake Extra Information. Therefore, this study examined the social response to Nankai Trough Earthquake Extra Information in Hamamachi Ward of Kuroshio, Kochi Prefecture, where response to Nankai Trough Earthquake Extra Information is discussed in the local disaster prevention plan using action research methodology. In addition, issues that were discussed in a workshop for local residents were compiled to create disaster prevention teaching materials. The materials were then used in disaster prevention education at a local junior high school. Through these activities, it became clear that it is important to consider evacuation measures for people who require assistance during disasters when Nankai Trough Earthquake Extra Information is issued, and that it is necessary to consider the continuity of daily life and disaster response in parallel.

Keywords: Nankai Trough Earthquake Extra Information, action research, disaster prevention plan, Crossroad, two-pronged approach

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1. INTRODUCTION

1.1 Nankai Trough Earthquake Extra Information

This study investigated issues related to regional response to Nankai Trough Earthquake Extra Information (hereinafter referred to as NTEEI)[2]. This NTEEI (rinji joho in Japanese) is issued in the following three cases. The first case is when an "unusual phenomenon" is observed along the Nankai Trough and an investigation has been launched to determine whether the phenomenon is related to an impending Nankai Trough earthquake. The second case is when the investigation started in the first case has determined that the likelihood of a Nankai Trough earthquake is relatively higher than normal[3]. The third case is when the investigation started in the first case has determined that the likelihood of a Nankai Trough earthquake is not relatively higher than normal. In the first case, preliminary information is issued before any conclusions have been made, whereas in the third case, the warning status is rescinded. Therefore, this study examined mainly the second case because it is the most important when considering the social response to NTEEI.

The abovementioned unusual phenomena are classified into three cases, each of which hold different implications for social response (Working Group on Disaster Management Response to Unusual Phenomena along the Nankai Trough, Central Disaster Management Council 2018; Aoki 2018; Cabinet Office 2019a). The first is a "half-crack case," in which there is a major earthquake of M8.0 or greater with severe damage. The Nankai Trough is a roughly 4,000-meter-deep trench that runs about 700 km along the ocean floor 100–150 km south of the Japanese archipelago from the Tokai region to the Kii Peninsula, Shikoku, and Kyushu. In a half-crack case, for example, a large-scale earthquake might occur off the Tokai coast but is assumed to remain cracked off the coast of Shikoku and other areas. This case corresponds to the Ansei Nankai Trough Earthquake of 1854, in which huge earthquakes occurred in succession on the eastern and western sides of the Nankai Trough with a time difference of about 32 h after the first earthquake. The second case is the "partially broken case" in which there is an earthquake of M7.0–8.0. For example, this case would correspond to the status right after the M7.3 earthquake that occurred off the Sanriku coast on March 9, 2011, two days before the M9.0 Great East Japan Earthquake on March 11, 2011. The third case is the "slow-

[2] Nankai Trough Earthquake Extra Information (NTEEI) is translated by Cabinet Office (2019a) from the Japanese word "*rinji-joho*," but the word "extra" is a literal translation that may make it difficult to understand the characteristics of this disaster information. Given the role of "*rinji-joho*" as a warning that the likelihood of a Nankai Trough earthquake is higher than usual, "*rinji-joho*" might be better translated into English as "Special Early Warning Information," for instance. It is important to further discuss the appropriate English translation of "*rinji-joho*" so that it can be used by people who do not understand Japanese language.

[3] Since the Mw 6.3 earthquake in L'Aquila, Italy, on April 6, 2009, much attention has been paid to the scientific prediction of earthquakes in advance. A report entitled "Operational Earthquake Forecasting - State of Knowledge and Guidelines for Utilization" was subsequently compiled by 10 seismology experts from 9 countries (International Commission on Earthquake Forecasting for Civil Protection, 2011). The report clearly distinguishes between prediction and forecasting, defining prediction as a deterministic assignment of 0 or 1, and forecasting as a probabilistic reference, not necessarily divided only between 0 and 1. Based on this definition, NTEEI is disaster information based on the concept of forecasting, not prediction.

slip case," in which significant changes are detected by strain gauges; however, this differs greatly from the above two cases in that there is no damage to society at that time.

The Cabinet Office (Cabinet Office 2019b) published guidelines in March 2019, outlining its policy on how to respond to each of the three unusual phenomenon cases. The guidelines cover a wide range of topics, but one of the most significant topics is related to the half-break case described above. The guidelines call for early evacuation in areas that are expected to be inundated by tsunami, as part of a "massive earthquake alert response" for about a week, when the likelihood of another large-scale earthquake is considered particularly high. Specifically, the guidelines target those who would need assistance to evacuate after the earthquake as well as residents of areas where evacuation is difficult. There are also guidelines for various organizations such as educational institutions and hospitals.

Because the NTEEI is released before the occurrence of a Nankai Trough earthquake, it should be extremely effective at reducing the number of victims, which is estimated to exceed 320,000 in the worst-case scenario (Tanaka 2018). In particular, if the recommended pre-evacuation is properly implemented in areas expected to be inundated by tsunami, the number of tsunami victims, who are estimated to account for about 70% of all victims, can be expected to be substantially reduced.

There are some points that should be noted about NTEEI. First of all, the hit rate is unfortunately not very high. Even in the case of a half-cracked earthquake, the probability of a subsequent earthquake occurring within a week or so, which is the criterion for pre-evacuation, is about 1 in 10. The hit rate is even lower in the case of a partially cracked or slow-slip earthquake.

In addition, because pre-evacuation requires residents to take extraordinary actions to evacuate their homes before major damage occurs, following the guidelines may conflict with the continuity of daily life and bring about social disruption. Specifically, there are concerns about the stagnation of social and economic activities, especially in the areas where the information is issued, as well as speculation about the impact of the disaster on the tourism industry. In addition, there is concern that the effectiveness of issuing such information may be adversely affected if the earthquake in question does not occur within a period of about one week after the NTEEI is released, especially if it is regarded as a "swing and miss" *(i.e.,* a pointless evacuation).

Therefore, despite the great potential for NTEEI to mitigate loss of life in a disaster, unless methods and mechanisms for its effective use are carefully considered and implemented by society, it may end up causing unnecessary confusion. The issues that need to be considered regarding NTEEI are enormous and cover a very wide range of areas. Moreover, it has only been about four years since the NTEEI system became operational (November 2017), so it is difficult to fully examine the social response to date. Therefore, in this study, we attempted a basic analysis focusing on the above-mentioned pre-evacuation scenarios.

1.2 Awareness rate of NTEEI

Focusing on the aspect of pre-evacuation, the simplest and biggest problem with the NTEEI is that, at least as of this writing (November 2021), the information is not being sufficiently disseminated to the residents of areas that would need to be evacuated in advance. In many cases, they are not even aware that they are subject to pre-evacuation. The following are survey results that illustrate this point.

First, we introduce data from Hamamachi Ward, Kuroshio, Kochi Prefecture. Hamamachi is one of the areas that the Cabinet Office has used as a model for developing the aforementioned guidelines. However, in April 2018, when a questionnaire survey was conducted of 54 of Hamamachi's nearly 350 residents, 46.2% of the respondents answered that they had "no idea" about the NTEEI. Even the name of the information system was not known by many people, and fewer people still understood the distinction between the three cases.

Next, a survey conducted in May and June 2018 by a planning committee established by Tokushima Prefecture to deal with NTEEI found that of 1,141 residents of the town of Kaiyo (Department of Emergency Management, Tokushima Prefecture 2018) 30.8% knew what NTEEI was, 40.0% had heard about it, and 29.2% had not heard about it. If we consider the fact that there is a certain bias related to social desirability (in this case, we can assume that respondents would consider it more desirable to answer "I know"), the figures should be understood as indicating that about 70% of the residents have at most heard about the situation.

In addition, in a survey conducted by NHK in collaboration with the University of Tokushima during fiscal year 2018 (NHK and Tokushima University 2018) of 293 elder-care facilities located in tsunami inundation areas in the four prefectures of Shikoku, only 5% of respondents were "well aware," whereas 51% were "somewhat aware," 37% were "not well aware," and 6% were "not at all aware." It can thus be concluded that awareness of the NTEEI system is still low and that an insufficient number of people understand it.

1.3 Problems in planning for NTEEI

In addition to the low awareness of the information, there is another important point to consider when thinking about pre-evacuation based on NTEEI, that is, the need for individualized and specific planning. The guidelines discuss pre-evacuation at a general level but do not clearly consider how individual municipalities, which have different susceptibilities to earthquakes and tsunami as well as a wide variety of geographical and social conditions, will make use of NTEEI. There is also no clear consideration of how individual groups and organizations such as schools, commercial facilities, welfare facilities, and voluntary disaster prevention organizations should respond.

However, this does not mean that the government has abandoned its responsibility. The problem lies in the nature of the information itself. As mentioned in the previous section,

although NTEEI is expected to have a tremendous disaster mitigation effect, it also comes with a very high degree of uncertainty. For this reason, the government has no choice but to issue a policy stressing the importance of each individual taking safe disaster prevention actions in response to disaster risks while weighing the likelihood of an earthquake against the impact of disaster preparedness on daily life and business activities. Although some municipalities have already formulated disaster reduction plans for NTEEI (Kochi Prefecture 2021; Kagawa Prefecture 2021; Shimanto Town 2021; Tokai City 2021; Hamamatsu City 2021; Sakai City 2020), these plans are prepared by the government and described in a top-down manner, and do not consider the detailed social response according to the characteristics of each community.

We consider that there are three key points to the policy presented here. The first is "bottom-up," the second is "individuality and diversity," and the third is a "two-pronged approach." The published guidelines admit that "the occurrence of an earthquake cannot be clearly predicted" and suggest that there will be no strong top-down regulation of social activities, as in the case of the Tokai earthquake. Indeed, it uses the term "self-help" and calls for the parties concerned to "choose" their own disaster prevention actions. In this sense, it is actually a bottom-up approach. Next, the guidelines state that "risks in the event of an earthquake vary depending on the situation," and call for responses that are tailored to individual and regional circumstances, rather than a uniform nationwide response. Accordingly, individuality and diversity are emphasized. Finally, the guidelines recommend that "while conducting daily life, take action with caution in the event of an earthquake," and call for a balance between the daily life and disaster modes. In this sense, a two-pronged approach to both daily life and disasters is emphasized.

In short, in responding to NTEEI, including guidance for pre-evacuation, each organization, group, community, and household is required to think and act independently in a bottom-up manner rather than being regulated or instructed by the government. This is also what is required by the District Disaster Prevention Plan System that was launched in April 2014 after the Basic Act on Disaster Control Measures was revised (Cabinet Office 2014). Of course, it is not so easy to promote such bottom-up efforts. In the future, it will be necessary for residents, disaster prevention organizations, and the government to work together in various parts of the country, especially in areas subject to pre-evacuation.

As a first step toward this goal, this study reports on the efforts implemented in Hamamachi Ward. With a focus on the abovementioned three key points, this case study examines the nation-leading effort to create a specific plan for pre-evacuation based on NTEEI.

2. RESEARCH OBJECTIVES AND CASE REPORTS

2.1 Research Object and Research Method

Hamamachi Ward has a population of around 350 people and an aging rate of 52% (as of April 2019). Because most of the residents are engaged in fishing and operate bonito fishing vessels in the distant seas, there are relatively fewer male residents between February and November each year, so the female residents are primarily responsible for the management of the ward. As a result, fire prevention and disaster prevention activities by women are thriving in Hamamachi. With the slogan "Kakarigamashii" (meaning "caring" or "meddling" in the local dialect), they are diligently considering evacuation measures for the elderly, disabled, and other people who need assistance during disasters.

According to the Nankai Trough earthquake and tsunami forecast issued by the Cabinet Office in 2012, the first wave of tsunami is expected to reach the area about 15 min after the earthquake, with a maximum inundation depth of about 20 m. Moreover, because there is no high ground in the area, it had been designated a "difficult tsunami evacuation zone" for many years. However, in April 2017, one of the tallest tsunami evacuation towers in Japan was built in the Hamamachi, improving the environment for evacuation has improved to a certain extent (Kuroshio Town 2017).

Furthermore, Hamamachi was selected as a model ward in March 2018 by the Cabinet Office's study group examining NTEEI measures. Study sessions for residents on NTEEI were held four times during FY2018. In parallel with the study group organized by the Cabinet Office, discussions on NTEEI were also held independently at the board of directors meeting of a voluntary disaster prevention organization as part of the activities of the local disaster prevention plan in the Hamamachi ward.

The authors have been involved in the Hamamachi ward since 2015 as advisors for the district disaster management plan, and have also played an advisory role in NTEEI workshops and study groups held in the Hamamachi ward to organize residents' discussions. The authors collected and recorded data through questionnaires and participant observation, and analyzed the debate on NTEEI in Hamamachi ward using the research method of action research (Lewin 1946; Rossman and Rallis 2003; Herr and Anderson 2005; Yamori 2006)[4]. In addition, the authors explained orally to the subjects of the records how the survey results would be used and that privacy protection would be taken into consideration, and obtained their consent.

2.2 Awareness rate of NTEEI in study area

The authors administered a questionnaire on NTEEI to 54 residents (average age 65 years; 52 valid responses for analysis) living in the Hamamachi ward in April 2018. A total of 24

[4] Action research is a concept proposed by K. Lewin, the founder of group dynamics. Levin defined action research as a research activity that leads to the next social activity by conducting an analysis of the situation and impact of social practice activities (Lewin, 1946). Since then, action research has been dealt with in areas related to various social issues, such as medical practice, education, and corporate activities, and action research methods have been refined in academic fields such as psychology, social work, and education (Herr *et al.*, 2005). The advantages of action research include the fact that the research methodology itself has a broad social impact, is expected to empower both researchers and practitioners involved in action research activities (Rossman *et al*., 2003).

(46.2%) respondents answered that they had "no idea" about the NTEEI. However, when asked about the effectiveness of the information, 43 respondents (82.7%) answered that the information was "very useful" (34 respondents) or "somewhat useful" (9 respondents). When asked about specific actions to be taken after the issuance of NTEEI in an open-ended question, 33 respondents (63.5%) did not provide specific answers. These results suggest that local residents accepted the NTEEI system in a vague way as "something that might be useful," but did not have a full understanding of its contents.

2.3 Planning for NTEEI in the study area

As revealed by our survey, the NTEEI was not well understood by the residents of Hamamachi, but through study sessions and discussions at the board of directors meeting of the voluntary disaster prevention organization, their understanding gradually increased and a countermeasure plan to act on NTEEI was gradually formulated (Fig. 1). Various aspects were discussed, but in the end, the focus of the discussions converged on the method of pre-evacuation for those who require assistance when evacuating. This direction is in line with the focus of the guidelines compiled by the Cabinet Office (Cabinet Office 2019c).

Figure 1. The board of directors meeting of the voluntary disaster prevention organization in Hamamachi ward

We summarized many of the opinions expressed by residents regarding the pre-evacuation of people in need of care into four main measures. Then, in a study session on NTEEI, residents discussed the pros and cons of these four measures.

The first measure is pre-evacuation in groups to a distant location on higher ground (non-inundated area). The advantage of this method is that there is no risk of tsunami at the evacuation site, and because the evacuation is carried out at the ward level, the daily relationships with one's neighbors can be maintained at the evacuation site. For example, one man in his 70s said, "If we run to the elementary school in Iyoki (a non-inundated area located about 4.5 km from Hamamachi), we will be safe, but the elderly cannot live in a shelter for a long time" (March 17, 2018). However, it was pointed out that one of the disadvantages of this method is that the evacuation site is outside the usual living area, making it difficult for many caregivers of people with special needs to take care of them while they are at the evacuation site. In addition, Hamamachi is located in a coastal area, whereas Iyoki is in a mountainous area, and so they differ in terms of lifestyle and culture, making it difficult for residents of Hamamachi to ask the residents of Iyoki to support them when they evacuate. A woman in her

60s said, “We don't have any friends or acquaintances in the Iyoki area, and even if we were to live in an evacuation shelter there, we don’t know who would take care of the elderly evacuees” (February 15, 2019).

The second measure is pre-evacuation in groups to a public facility close to the primary evacuation site in the ward. It is important to note that the facilities to be evacuated are in the tsunami inundation zone, so they will need to be evacuated in the event of an earthquake. Even though the tsunami risk is not completely eliminated, the advantage of this strategy is that the facilities to be evacuated are within the residential part of the Hamamachi, so it is easy to secure caretakers for the people who need them from within the ward. This point was emphasized by a woman in her 60s who said, “We have no choice but to evacuate to a junior high school because we know it well and can take care of my mother there” (February 15, 2019). It was also pointed out that although further evacuation may be necessary, the public facilities to be evacuated in advance are closer to the primary evacuation site than to their homes, and thus have the advantage of enabling quicker tsunami evacuation than fleeing from home. However, there is an emergency evacuation site near the junior high school, but there are not enough facilities to shelter everyone from the rain and wind. For example, a man in his 60s said, “I cannot live in a shelter without worrying because the tsunami is expected to hit the junior high school in Saga. Even if I go up to higher ground, there is no place to shelter from the rain and wind, so old people may die in the rain” (December 16, 2018).

The third measure is to evacuate individually to a distant place in advance. In this method, each household evacuates in advance to a relative’s home in a distant elevated area (non-inundated area), rather than to a shelter. The advantage of this method is that it is easy to secure caretakers for those who need them because they can rely on their relatives and there is no risk of tsunami at the evacuation site. A woman in her 60s said, “My niece lives on high ground in Kochi City, so if I leave my mother there for a while, my niece can take care of her for a few days, but not for months" (July 24, 2018). However, the problem with this method is that because the evacuation is not carried out at the ward level, daily neighborhood relationships will be disrupted, and not all residents have relatives living in non-inundated areas nearby, which limits the number of people who can adopt this method. As one man in his 60s put it, “What about those who have no relatives outside of Kuroshio? There is nothing we can do” (December 16, 2018). In addition, it has been pointed out that if voluntary disaster prevention organizations are unable to determine the evacuation status of individual residents, they may waste valuable time attempting to rescue people who evacuated in advance. For example, one man in his 60s said, “If you evacuate to a relative’s home in advance without notifying the voluntary disaster prevention organization, they will not know who is at home when an earthquake occurs, and you might inadvertently put their lives in danger” (December 16, 2018).

The fourth measure is to continue life as usual at home without pre-evacuating. The advantages of this method are that there is no need to secure a caretaker for the pre-evacuation, the daily relationships with one’s neighbors can be maintained, and there will be no added burden on human relationships during the evacuation. As one woman in her 50s noted, “Even

the elderly have problems with human relationships. It is difficult to live together in an evacuation shelter, no matter how close you are" (July 24, 2018). However, the need for tsunami evacuation immediately after an earthquake, the distance from one's home to the primary evacuation site, and the risk of being trapped in an indoor space and not being able to evacuate quickly, were pointed out as disadvantages. One man in his 60s said, "We don't know what will happen in an emergency. We have no choice but to prepare and spend our time as usual" (February 15, 2019).

Of the four measures summarized above, the board of directors of the voluntary disaster prevention organization in Hamamachi finally decided to recommend pre-evacuation in groups to nearby areas (the second measure) and pre-evacuation individually to distant areas (the third measure). During this period, the government did not provide any guidance to the residents of the Hamamachi. Rather it was the residents themselves who chose these measures for pre-evacuation. In this respect, the measures were decided in a bottom-up way and were based on the individuality and diversity of the Hamamachi ward (*e.g.*, the high aging rate, rich neighborhood relations, and the fact that the physical distance to the nearest non-inundated area is far and there are few deep ties). In addition, the two measures adopted in the Hamamachi ward are based on a two-pronged approach that balances the two modes of daily life and disaster. Although fully aware of the risk of tsunami, the Hamamachi district has also placed importance on the continuity of daily life, especially in terms of securing caretakers for those who need care.

2.4 Development of disaster prevention teaching materials based on the results of the workshop on NTEEI

In the workshop held in the Hamamachi ward, there were several issues that divided the discussion. Although the participants reached a certain consensus after discussing controversial issues, they decided to continue the discussion. These issues were compiled to create disaster prevention materials, which we called "Crossroad" so that others could easily discuss them too.

Crossroad examines the dilemmas experienced in various phases of a disaster (Yamori 2008; Aziro *et al*. 2011). Crossroad has been studied as a teaching material for various areas such as earthquake disaster prevention, tsunami disaster prevention (Lee *et al*. 2019; Sogawa 2020), evacuation shelter management, and disaster reporting, but there have been no examples of Crossroad teaching materials on the theme of NTEEI. Therefore, developing a crossroad on the theme of NTEEI was highly novel from both academic and practical perspectives.

Using these materials, workshop participants consider the issues as they relate to their own circumstances, answer "yes" or "no" to the questions, and then share the reasons for their answers with the members of their group. Thanks to its simple format, Crossroad can be used to create a variety of questions.

In cooperation with residents of the Hamamachi ward, we developed the following two discussion questions and used them to provide disaster prevention education to junior high school students and their parents at Saga Junior High School in Kuroshio on February 7, 2020 (Fig. 2) [5]. Saga Junior High School is also part of the Hamamachi ward, and in order to consider countermeasures against NTEEI in the Hamamachi ward, the junior high school also jointly participated in the Hamamachi ward study group and held a study group on NTEEI using "Crossroad" at Saga Junior High School. The questions are as follows: “Question 1: You are a resident. The Japan Meteorological Agency has issued NTEEI (Major Earthquake Warning). However, the primary tsunami evacuation sites near the coastal areas do not have buildings to shelter you from the rain and wind, and you will have to move to the distant mountainous areas to get to shelters where you can live. Would you evacuate in advance to a residential facility in a coastal area where it would be easier to evacuate to the primary tsunami evacuation site, even though the facility is in the tsunami inundation zone?” and “Question 2: You are a resident. The Japan Meteorological Agency has issued NTEEI (Major Earthquake Advisory). Would you like the elementary and junior high schools in your area to be closed for the next week?”

Figure 2. A class on disaster prevention education at Saga Junior High School

In the disaster prevention class, a variety of affirmative and negative opinions were expressed by the students and parents. For Question 1, 78% of the students and 75% of the parents responded that they would not evacuate. Reasons for this response included “The elderly who have been living in coastal areas for a long time are not accustomed to living in distant evacuation centers in mountainous areas, and it would be difficult for them to get around. Therefore, I think it is more practical to evacuate in advance to a residential facility in the coastal area where it would be easier to evacuate to the primary tsunami evacuation site, even though it is in the tsunami inundation zone” and “I prefer to evacuate in advance at night since it is hard to see the earthquake damage and evacuate at night. However, it is difficult to move every night from the coastal area where I live to the mountainous area, so I would like to pre-evacuate to a building in the coastal area near the primary tsunami evacuation site, even though it is in the tsunami inundation zone.” Reasons given for not evacuating included “I'm young, so I don't need to evacuate in advance, but I can evacuate from my home in the coastal area to the primary evacuation site when the earthquake happens” and “If I know in advance that an earthquake is going to happen, I would like to evacuate to a shelter in a mountainous area where

[5] Saga Junior High School, established in 1947, is one of two junior high schools in Kuroshio. Since the junior high school is located in the tsunami inundation zone, the school focuses on disaster prevention education. One of the tallest tsunami evacuation towers in Japan was built near the junior high school, and the school has long been involved in disaster prevention activities in collaboration with local residents and school staff and students.

tsunami evacuation is not necessary, even if it is a little inconvenient to leave my home in the coastal area." This issue is related to the second pre-evacuation measure (group evacuation to a shelter close to the evacuation site) in the Hamamachi ward workshop discussed in the previous section. After the participants finished discussing this question, we introduced the pros and cons by the participants at the Hamamachi ward workshop.

There was also a lively discussion about Question 2. Specifically, 46% of the 49 students responded that they would like the school to be closed, while 54% responded that they would not. In contrast, 83% of the 12 parents answered that they would like the school to be closed, whereas only 17% answered that they would not. The reason that parents gave for wanting schools to be closed was the desire for their children to be as far away as possible from places that are at risk of tsunami inundation. However, some of students said, "We have had tsunami drills at school, so we can evacuate safely in the event of a tsunami, so it is not a problem, but we are worried that if the school is closed, we will not be able to evacuate together." In addition, some parents said, "If the school is closed, the children will have to evacuate from their own homes, and if an earthquake hits when the children are at home alone, we are worried that they will not be able to evacuate." This issue was also raised at the Hamamachi workshop. After the participants finished discussing this question, we introduced the opinions shared by the workshop participants.

As of February 7, 2020, Kochi City and Nankoku in Kochi Prefecture were considering a plan to uniformly close schools when NTEEI on a Nankai Trough earthquake was announced. However, based on the results of the Crossroad activities, it became clear that response plans should consider the pros and cons of school closure. We shared our results with the staff of the Kuroshio Board of Education, who considered the points raised by the students and parents in response to Question 2, and they ultimately decided not to uniformly close schools in Kuroshio even when NTEEI is issued. Therefore, we consider that Crossroad was effective at influencing the disaster prevention policies of Kuroshio.

As described above, using Crossroad to provide disaster prevention education was effective at eliciting a wide range of opinions. Further discussions are needed to promote consensus-building among students, parents, local residents, and the government on how best to respond to NTEEI.

3. CONCLUSIONS

3.1 Bottom-up, individuality, diversity, and a two-pronged approach

The disaster prevention and mitigation system in Japan is based on the premise of separating the "routine" from the "unexpected." Expressions such as "switching to disaster mode" and "establishing and dissolving a disaster task force" symbolize this separation. However, there is

a lack of experience and know-how necessary for managing and responding to a situation that is a mixture of both routine and unexpected.

As we have discussed so far, to respond to NTEEI, we need to take a two-pronged approach. Although NTEEI is extremely uncertain, it indicates that the probability of a disaster occurring is several hundred to several thousand times higher than usual, and if it is used to decide appropriate responses, it can have a substantial effect on disaster mitigation. Therefore, to make the most of this information, it is important to not fall into the trap of arguing for certainty without being prepared. It is necessary for each entity to consider and prepare for a two-pronged response (a "gray solution" that is neither pure white nor pure black) that is flexible enough to accommodate uncertain information while reducing various trade-offs. It is also important to build new disaster prevention systems and frameworks that will support this over time.

Specifically, it is necessary to make a list of the advantages and disadvantages of both the continuity and convenience of daily life compared with the effectiveness of responses in the event of an earthquake, and to take measures to maximize the advantages and minimize the disadvantages. To prepare for these measures, there is no choice but to formulate bottom-up plans that are individualized and diverse, based on the characteristics of the local community. In this sense, as mentioned earlier, responding to NTEEI has a high affinity with the concept of district disaster prevention plans.

However, there are some points to consider. In the case of Hamamachi, the concrete development of the discussion on NTEEI was made possible by actions that Kuroshio has taken to create a district disaster prevention plan since FY2015. Not only are all the town office staff involved in this initiative under the Kuroshio's unique Regional Staff System, but through this initiative, unique disaster prevention measures such as indoor evacuation drills (evacuation drills to the entrance and to the second floor) and the installation of individual storage boxes at evacuation sites have already been created in a bottom-up manner. The bottom-up approach has already produced some very unique disaster prevention measures (Sugiyama and Yamori 2020; Yamori and Sugiyama 2020). It would likely have been difficult to start a constructive discussion on what measures to take in response to NTEEI from the bottom up, without such preparation.

3.2 Connection between pre-evacuation activities and emergency disaster response

There is always the possibility that a Nankai Trough earthquake and tsunami will occur suddenly before any NTEEI can be issued. For this reason, it is necessary to not only pay transitory attention to NTEEI, but also to integrate it with conventional preparations for sudden disaster scenarios. In fact, countermeasures and preparedness for such scenarios will also enhance countermeasures and preparedness for NTEEI. For example, earthquake-proofing and improving the environment of schools that will serve as evacuation centers will increase the number of options available for temporary evacuation in response to NTEEI. However,

promoting measures for NTEEI might also promote preparedness for unexpected scenarios. For example, even if nothing happens during an evacuation in response NTEEI, if we view it as an opportunity for hyper-realistic disaster drills (*i.e*., "practice swing" (Yamori 2019) rather than considering it a "swing and a miss, we can prepare for sudden-onset scenarios.

Therefore, it is essential to use NTEEI as a reminder to prepare for a Nankai Trough Earthquake and to use it as an opportunity to refine local disaster prevention plans. In fact, since the Cabinet Office announced a heightened alert for a Nankai Trough earthquake and tsunami in 2012, the Hamamachi ward has been conducting disaster prevention activities with the mindset that a disaster could occur at any time, and it could be said that NTEEI has already been issued, at least in the minds of local residents. For this reason, the designation of the area as a model for responding to NTEEI and the recent regional discussion did not result in any qualitative changes in earthquake/tsunami countermeasures or disaster prevention activities. This fact is reflected, for example, in the words of man in his 70s who said, "Even if NTEEI is rescinded after a week, we'll still act as if it were still in effect" (December 16, 2018). Although it is extremely important to incorporate responses to NTEEI as part of the district disaster prevention plans, it is also important not to overestimate or rely on NTEEI, but rather promote responses in conjunction with those to sudden-onset scenarios.

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