CHANGES IN PEOPLE'S CONSCIOUSNESS REGARDING THE EARTHQUAKE EARLY WARNING BEFORE AND AFTER THE GREAT EAST JAPAN EARTHQUAKE

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ABSTRACT: In Japan, earthquake early warnings (EEWs), also known as alerts, have been broadcast to the general public since October 1, 2007. Issuance times of EEW increased drastically after the Great East Japan Earthquake, and citizens had much more frequent experience with EEWs. This study analyzes secular changes in rates of recognition and reception experiences of EEW. It also analyzes awareness regarding EEW accuracy by comparing study results with EEW issuance history nationwide. Secular changes in the expectations of the general public regarding EEWs are also clarified.

Key Words: Earthquake early warning, Great East Japan Earthquake, questionnaiere survey

INTRODUCTION

Earthquake early warnings (EEWs), also known as alerts, have been issued to the general public since October 1, 2007, especially in regions with predicted intensity of 4 or more when predicted intensity of 5 lower or more is anticipated. According to records from the Japan Meteorological Agency (JMA) website, EEWs were issued 18 times before the March 11, 2011, Great East Japan Earthquake and 114 times from that date until the end of December 2012. Issuance times increased drastically after the March 2011 quake, and citizens had much more frequent experience with EEWs. Frequent missing and overlooking of EEWs occurred after the Great Japan East Earthquake, possibly adversely affecting the trustworthiness of EEWs.

The University of Tokyo's Center for Integrated Disaster Information Research (CIDIR) has annually conducted "regular survey on the degree of disaster information recognition and trends in disaster awareness" (hereafter, regular disaster information survey) since fiscal 2009. This paper analyzes secular changes in rates of recognition and reception experience related to EEWs by comparing results of 2012 with those since 2009. Issuance times and hit, missing, overlook rates of EEWs nationwide thus far are also calculated and calculation results are compared with those of regular disaster information survey to analyze regional differences among awareness of the general public concerning EEW accuracy. Expectations of EEWs are also analyzed.

EEWs include two types of warning; the one is the alerts for the general public receiving by TV or radio etc., the other is the alerts for advanced users receiving by special receiving devices. EEWs for advanced users are issued, as a rule, when "the amplitude of the P wave or S wave is 100 gal or more" and "the calculated magnitude is 3.5 or more or the maximum predicted intensity is 3 or more". The EEW in this paper means the former one, the alerts for the general public.

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ANALYSIS OF RATES OF RECOGNITION AND RECEPTION EXPERIENCE WITH EEWS

Issuance Times of EEWs Nationwide

The JMA website gives detailed data on the EEWs issued, such as issuance date, location, and estimated magnitude. Based on this, Fig. 1 shows EEW issuance times by month from October 2007 to December 2012. The highest numbers were 46 in March 2011, when the Great East Japan Earthquake occurred, and 26 in April 2011. Since then, issuance times have increased drastically due to aftershocks and induced earthquakes, although they decreased to 1-3 times a month after October 2011 and remained at that level thereafter. All issuances in March 2011 were after the great earthquake.

EEWs are issued to approximately 200 prediction regions nationwide. Miyagi Prefecture, for example, is divided into north, central, and south regions. Figure 2 shows total issuance times before and after the March 2011 quake to all regions from Tohoku to Kanto and Koshinetsu. Northern Ibaraki Prefecture was issued the most 64 EEWs following the March 2011 quake, followed by 58 to the Hamadori area in Fukushima Prefecture and 56 to the Nakadori area of the same prefecture. Average issuance by prefecture was calculated based on issuance for individual prediction regions as shown in Fig. 3. The highest after the Great East Japan Earthquake was 56 times for Ibaraki Prefecture, 51 for Fukushima Prefecture, 33 for Tochigi Prefecture, 31 for Chiba Prefecture, and 28 for Miyagi Prefecture. Fukushima and Ibaraki Prefectures thus received more warnings than Iwate or Miyagi Prefectures where the damage from the concomitant tsunami was significant. For comparison, no warnings were issued until December 2012 to the prefectures of Kyoto, Osaka, Hyogo, Nara, Tottori Okayama, Yamaguchi, Tokushima, Kagawa, Ehime, Kochi, Fukuoka, Saga, Nagasaki, Kumamoto, Oita or Miyazaki Prefectures. No regions in the Shikoku district received warnings, either.

The first EEW was issued on April 13, 2013, to the 10 prefectures of Kyoto, Osaka, Hyogo, Nara, Kagawa, Tokushima, Ehime, Kochi, Tottori, and Okayama when an earthquake hit Awaji Island in Hyogo Prefecture. (Please note, however, that the scope of this paper does not include this in Figs. 2 and 3.)

Overview of Regular Disaster Information Survey

The CIDIR, The University of Tokyo has annually conducted regular survey on recognition degree of disaster information and disaster awareness since fiscal 2009. The surveys were performed as follows.

- Survey region: Entire Japan
- Survey agency: Survey Research Center, CO., LTD.
- Survey period: December of 2012, 2011, 2010, and 2009
- Survey method: Internet questionnaire
- Survey target: Males and females aged 20 to 69. Two-thousand people for 2009 and 2010 and 3000 people for 2011 and 2012. The sample number for each prefecture was distributed proportionally to the population composition ratios. The number of respondents per sex and per district for each research year is shown in Tables 1 and 2, respectively.

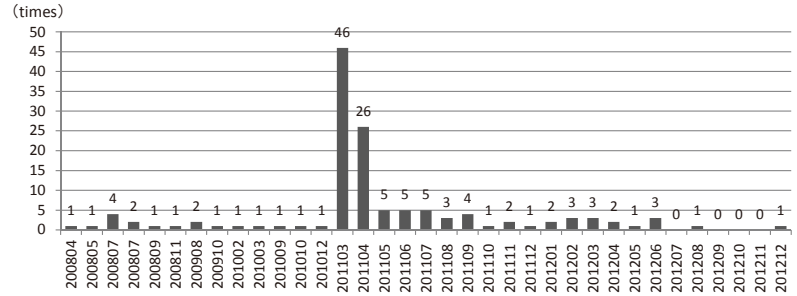


Figure 1.Issuances of EEWs from 2007 to 2012

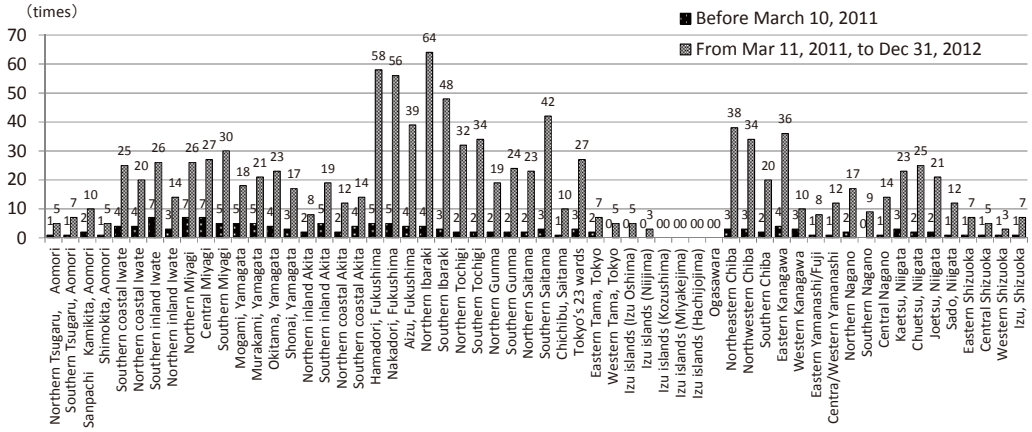


Figure 2.Issuance times of EEWs by prediction region

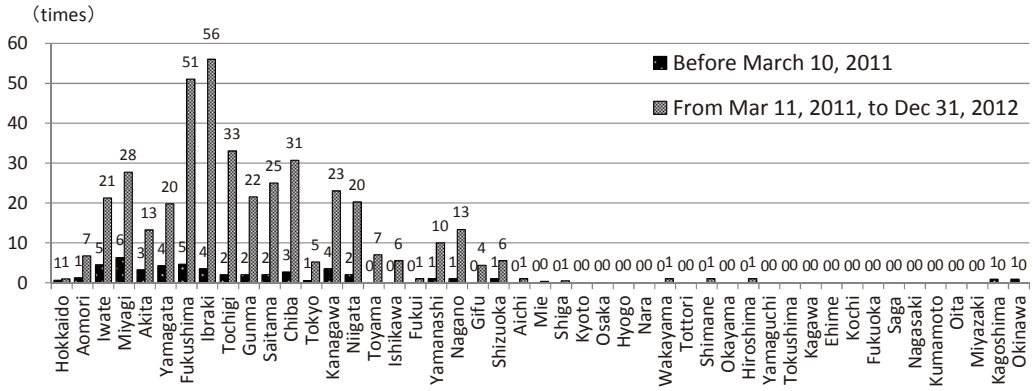


Figure 3.Average issuance of EEWs by prefecture

Table 1.Number of respondents by age

Sex/Age		2009 2010	2011 2012
Male	20's	189	233
	30's	218	358
	40's	188	329
	50's	223	291
	60's	182	300
Female	20's	182	222
	30's	214	343
	40's	186	321
	50's	223	286
	60's	195	317
	Total	2,000	3,000

Table 2. Number of respondents by district

Region	Prefectures	2009 2010	2011 2012
Hokkaido	Hokkaido	89	133
Tohoku	Aomori, Iwate, Miyagi Akita, Yamagata, Fukushima	146	196
Kanto	Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa	681	1,032
Chubu	Niigata, Yamanashi, Nagano, Toyama, Ishikawa, Fukui, Gifu, Shizuoka, Aichi, Mie	363	541
Kinki	Shiga, Nara, Wakayama, Kyoto, Osaka, Hyogo	325	491
Chugoku	Tottori, Shimane, Okayama, Hiroshima, Yamaguchi	117	176
Shikoku	Tokushima, Kagawa, Ehime, Kochi	59	92
Kyusyu, Okinawa	Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, Okinawa	220	339
Total		2,000	3,000

Secular Changes in Rates of Recognition and Reception Experience with EEWs

This section analyzes the secular changes in rates of recognition and reception experience of EEWs by comparing the results of the regular disaster information survey conducted in 2009-2012. The "recognition rate" is defined as a "rate of people who have heard of information." EEWs for the general public can be received by TV, radio, cell phones, and radio communications for disaster prevention and administration. Here, the "reception experience rate" is defined as a rate of people who have received EEWs by themselves by those means.

The "recognition rate" is 56.1% in 2009 and 61.3% in 2010 before the March 2011 quake. The rate significantly increased to 79.3% as of December 2011 after the Great East Japan Earthquake, approximately 1.29 times compared to the figure in the previous fiscal year. This can be considered due to the effect of numerous EEWs issued after the March 2011 quake.

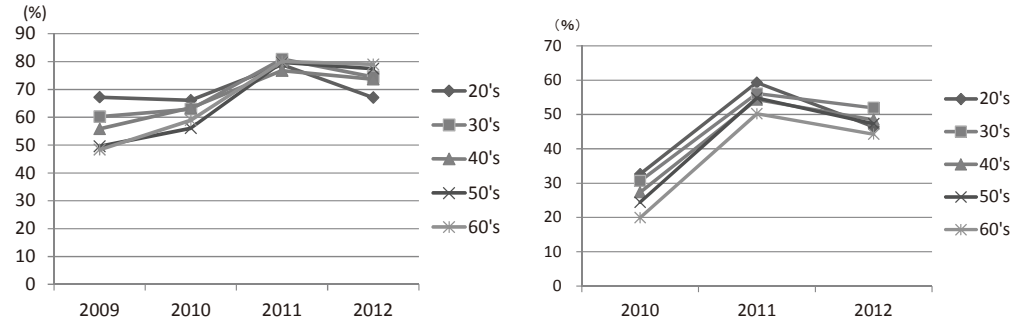
Figure 4 shows the age-based secular changes in rates of recognition and reception experience of the EEW. Here, the reception experience rate is shown only after 2010 because this item was not included in the survey in 2009. The recognition rate in 2009 and 2010 are highest for those who are in their 20's, while it increased from December 2011 after the Great East Japan Earthquake for all generations. The increase rate from 2010 to 2011 is highest for those in their 50's, 1.42 times, and lowest for those in their 20's, 1.19 times. The recognition rate is lower in 2012 for all the generations than that in 2011, showing considerable decrease for those in their 20's by approximately 12%. The decrease rate from the previous fiscal year is smaller with the age is higher. Diminished consciousness of younger generations about EEWs is a concern.

The reception experience rate is 27% on average for all generations in 2010 and 54.9% in December 2011 after the March 2011 quake, increasing approximately twofold. It decreased to 47.7% in December 2012. The age-based results indicate that the reception experience rate is higher with the age is younger in 2010 and 2011. In 2010, the rate in their 20's is 32.6% while that in their 60's is 19.9%, which is a difference of 1.64 times. Meanwhile, in 2011, the rate in their 20's is 59.3% while that in their 60's is 50.2% with reduced difference between the two generations of approximately 1.18 times. The reception experience rate decreased for all the generations in 2012. It is worrying that the memory of receiving numerous EEWs will fade and the consciousness about EEWs will diminish after the next fiscal year as time passes from the Great East Japan Earthquake.

Figure 5 shows the district-based secular changes in rates of recognition and reception experience of the EEW. The recognition rate exceeded 50 % in all the districts as of 2009. In 2009, the highest

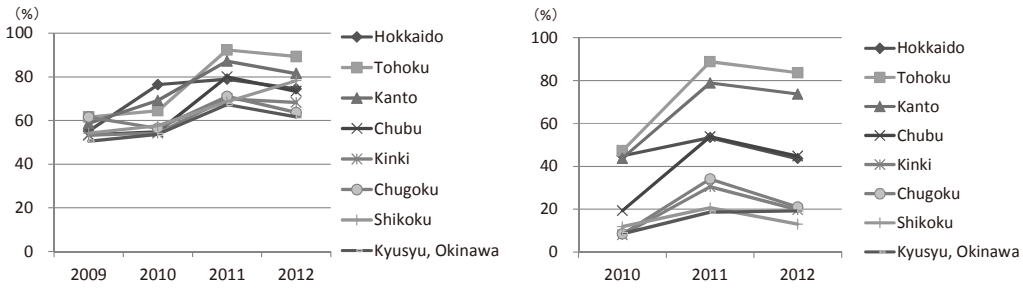
value of 61.9% is for Tohoku district, whereas the lowest of 50.5% is for Kyushu Okinawa district. In 2011 after the March 2011 quake, the highest value increased to 92.3% for Tohoku district and the lowest to 67.3% for Kyushu Okinawa district. 89.3% for the Tohoku district in 2012 is still higher than those for other districts. The recognition rate of the entire country tends to decrease compared to previous fiscal years with the exception of Shikoku district of 78.3%.

The results of district-based reception experience rate show a larger regional difference than those of recognition rate. The reception experience rate for Tohoku district is the highest in every year, increasing approximately 1.88 times from 47.3% in 2010 to 88.8% in 2011. The rate slightly decreased to 83.7% in 2012. In 2011 and 2012, not only Tohoku district, Kanto district also displays higher rate of 78.9% and 73.7%. In contrast, the rates for Hokkaido and Chubu district in 2012 are as low as approximately 40% and those for western Japan, Kinki, Chugoku, Kyushu, Okinawa districts are all approximately 20%. 13.0% for Shikoku district in 2012 is the lowest. As mentioned above, the recognition rate for Shikoku district increased significantly, which is not based on their own reception experience.



(a) Recognition rate (b) Reception experience rate

Figure 4.Age-based secular change in rates of recognition and reception experience of EEWs



(a) Recognition rate (b) Reception experience rate

Figure 5. District-based secular change in rates of recognition and reception experience of EEWs

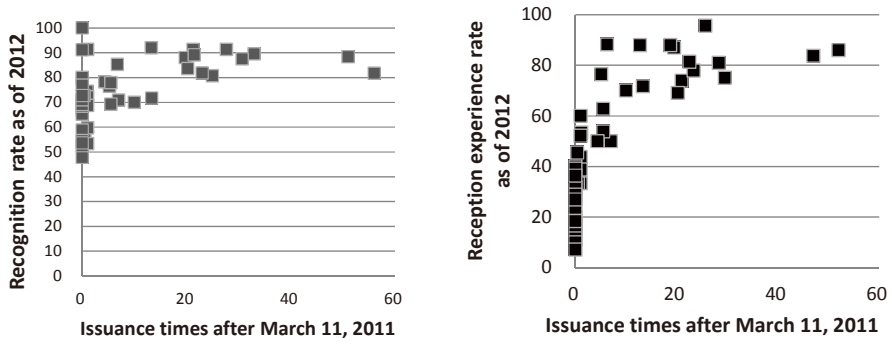


Figure 6. Relationship between issuance times and rate of recognition or reception experience of EEWs

Analysis of Relationship between Issuance Times per Region and Recognition Rate/ Reception Experience Rate of EEWs

Based on the results above, this section analyzes the relationship between average issuance times per prefecture and recognition rate/ reception experience rate of EEWs. Figure 6 plots the average issuance times of each prefecture from March 11, 2011 to the end of December, 2012 (Fig. 3) against the recognition rate and the reception experience rate as of 2012. Each plot in the figure indicates individual values for each prefecture.

When the average issuance times exceed 20, the recognition rate is approximately 80-90% and the reception experience rate is approximately 70% or more. In addition, when the average issuance times exceed 10, the rates of recognition and reception experience exceed approximately 70%. It is confirmed that the rates of recognition and reception experience exponentially increase when the issuance times increase to a certain level. However, the rates of recognition and reception experience are not the highest for Ibaraki and Fukushima Prefectures, for which average issuance times are as considerably high as more than 50. The rates of recognition and reception experience per region are likely to differ depending on issuance time of a day, daytime or night.

In the prefectures with the average issuance times of 0 or 1, the recognition rate ranges widely from 50 to 100%, while the reception recognition rate 10 to 60%. The recognition rate exceeds 50% for prefectures that have not received the warning. The issuance times are 0 and the reception experience rates are as low as slightly over 10% in Tokushima, Kochi, Ehime Prefectures in Shikoku district, and Fukuoka, Saga, Nagasaki, Oita, Kumamoto Prefectures in Kyushu district. Meanwhile, in Chugoku and Kinki districts, the issuance times are 0 or 1, but the reception experience rate dispersed from about 20% to 60%. If some TV program is being broadcasted nationwide when an EEW is issued, its warning message can be seen in regions that are not the target. This is thought to increase the reception experience rate for Kinki and Chugoku districts to which warnings were quite rarely issued.

ANALYSIS OF AWARENESS OF GENERAL PUBLIC CONCERNING ACCURACY OF EEWS

Next, the awareness of the general public concerning the accuracy of EEWs is analyzed. The accuracy of EEWs for aftershocks and induced earthquakes after March 11, 2011 decreased due to the facts such that concurrent multiple earthquakes cannot be separated and the number of available seismometers decreased because of blackouts and disruption of communication lines. According to the press release of the JMA (2011), 70 warnings issued from 11 March to 28 April included many missing cases. At 17 earthquakes (24%), an EEW was issued to the regions whose observed seismic

intensity was 2 or less by mistakes. In addition, among 46 earthquakes with the observed maximum intensity of 5 lower or more, 20 cases (43%) were overlooked with no warnings although EEWs were issued to 26 cases (57%). They say these issues were partly resolved by the upgrade of software as of August 10, 2011. However, missing and overlook of EEWs may have affected motivation for use and recognition of usefulness regarding the warning.

Regional Trends in Accuracy Based on EEW Issuance History

This section discusses the regional trends in accuracy based on issuance history thus far.

EEWs is issued to regions with predicted intensity of 4 or more when predicted intensity of 5 lower or more is anticipated in some regions. Figure 7 compares the maximum intensity observed when EEWs was issued before and after the great earthquake: from October 2007, when EEWs launched, to March 10, 2011 and from March 11, 2011 to the end of December, 2012. The rate of cases with the maximum intensity of 5 lower or more observed when EEWs was issued was 58.8% before the great earthquake and 44.7% after it, showing a decrease in accuracy of predicted maximum intensity. In 5% of cases before and after the great earthquake, felt earthquakes were not measured.

Note that EEWs issued successively at 8:43:55.2 and 8:44:13.1 at the Iwate and Miyagi inland earthquake on June 14, 2008 are dealt with as a single event. Therefore, 18 EEWs were issued before the great earthquake, while Fig. 7 contains data for 17 earthquakes.

The discussion so far is a nationwide analysis, and accuracy is analyzed hereafter from the perspective of regions to which EEWs is issued. Here, trustworthiness of information offered by the JMA is focused on. The regional trends in accuracy of EEWs is analyzed by comparing EEWs issued to all or part of each prefecture with actually observed intensity, which is obtained in the intensity database of the JMA website. Ohara [3] analyzed issuance history until the end of March, 2012 using a similar method. This paper includes comparison using the latest data, expanding the target period to the end of December, 2012.

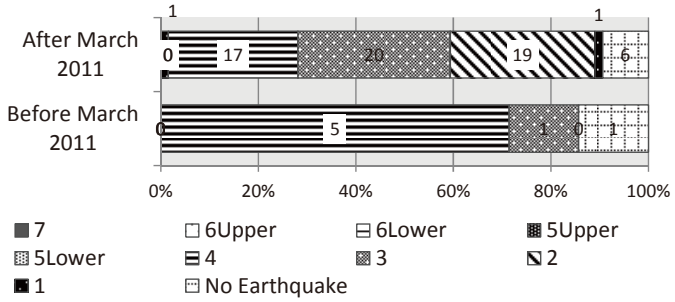


Figure 7. Maximum intensity observed for EEWs issued before and after the Great East Japan Earthquake

Figure 8 aggregates hit, missing, overlook times of EEWs per prefecture before and after the great earthquake. EEWs is issued to regions with predicted intensity of 4 or more when predicted intensity of 5 lower or more is anticipated in some regions. "Hit" warnings are therefore defined as those issued to all or part of a prefecture concerning an earthquake with observed intensity of 4 or more in the same prefecture when intensity of 5 lower or more is observed in any region in the country. "Missing A" warnings are defined as those issued to all or part of a prefecture when no earthquakes occur in the country. "Missing B" is the case in which a warning is issued to all or part of a prefecture when intensity of 4 or more is not measured in the same prefecture, but measured in other prefecture. The case of missing A is inferior to the case of missing B. "Overlook" warnings for a prefecture means the case in which EEWs is not issued when an earthquake with intensity of 5 lower or more is measured in any region in the country and intensity of 4 or more is also measured in the same prefecture. Table 3 lists hit, missing, overlook times of each prefecture before and after the

great earthquake.
Figure 8 excludes prefectures to which EEWs was issued only once before and after the great earthquake. The Izu islands and Sado island are shown separately because they display a different tendency than that of other regions. The average hit rate is 39.4% before the great earthquake but decreased to 21.6% after it. The hit rate after the great earthquake significantly decreased especially in Hokkaido and Tohoku districts by more than 50% in Hokkaido, Aomori, Iwate, and Niigata Prefecture except Sado. The hit rate increased after the great earthquake in Ibaraki Prefecture, Tochigi Prefecture, Izu islands, and Nagano Prefecture. The average overlook rate increased from 20.7% to 28.8% after the great earthquake. It increased significantly especially in Hokkaido, Iwate, Miyagi, and Akita Prefecture. The increase in the overlook rate in Iwate and Miyagi Prefectures is considered to be largely affected by the decrease in the number of seismometers available in the coastal area. Meanwhile, the overlook rate decreased in Ibaraki and Tochigi Prefectures after the great earthquake. The average missing A rate increased from 6.3% to 23.4%, while the average missing B rate slightly increased from 20.7% to 26.9%. The missing A rate considerably increased after the great earthquake in Niigata Prefecture except Sado, Fukushima Prefecture, and Nagano Prefecture. The missing B rate considerably increased in Shizuoka Prefecture and Izu islands in Tokyo. The missing B rate is as high as approximately 60% before and after the great earthquake in Tokyo 23 wards and Tama area.
From the above, the rough tendency is that the hit rate decreased and overlook and missing A rate increased with no major difference in missing B rate in Hokkaido and Tohoku districts. In Ibaraki and Tochigi Prefectures, where EEWs were relatively frequently issued, the hit rate increased and overlook rate decreased after the great earthquake, indicating higher accuracy. The accuracy of Tokyo 23 wards and Tama area and Saitama Prefecture decreased with lower hit rate and higher overlook rate although they are far away from Tohoku district. The both prefectures show peculiar trends in higher missing B rate before and after the great earthquake. In the regions with decreased accuracy after the Great East Earthquake, motivation for use and consciousness of usefulness regarding EEWs might presumably be decreased.

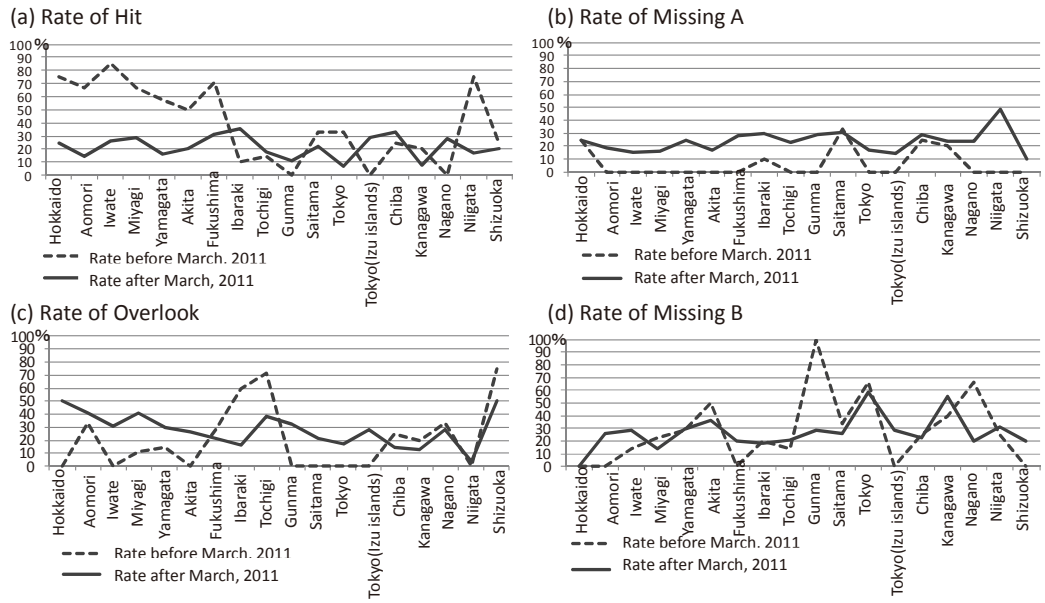


Figure 8. Rates of hit, missing, overlook by prefecture before and after the Main March 2011 quake

Table 2. Times of hit, missing, overlook by prefecture

Prefecture	Before March, 2011				After March, 2011			
	Hit	Missing A	Missing B	Overlook	Hit	Missing A	Missing B	Overlook
Hokkaido	3	1	0	0	3	3	0	6
Aomori	2	0	0	1	4	5	7	11
Iwate	6	0	1	0	12	7	13	14
Miyagi	6	0	2	1	16	9	8	23
Yamagata	4	0	2	1	6	9	11	11
Akita	3	0	3	0	6	5	11	8
Fukushima	5	0	0	2	28	25	18	19
Ibaraki	1	1	2	6	32	27	16	15
Tochigi	1	0	1	5	10	13	12	22
Gunma	0	0	3	0	3	8	8	9
Saitama	1	1	1	0	10	14	12	10
Tokyo	1	0	2	0	2	5	17	5
Tokyo(Izu islands)	0	0	0	0	2	1	2	2
Chiba	1	1	1	1	16	14	11	7
Kanagawa	1	1	2	1	3	9	21	5
Nagano	0	0	2	1	7	6	5	7
Niigata	3	0	1	0	5	14	9	1
Shizuoka	1	0	0	3	2	1	2	5

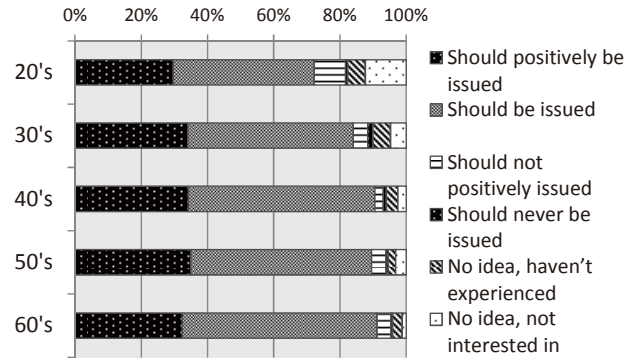


Figure 9. Age-based motivation for use considering missing warnings.

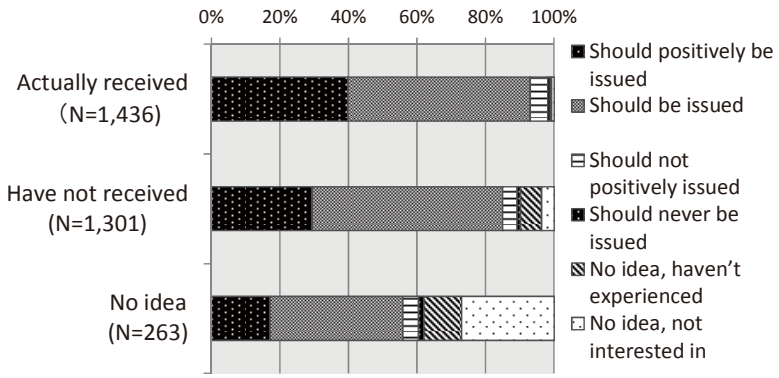


Figure 10. The reception experience and motivation for use considering missing warnings.

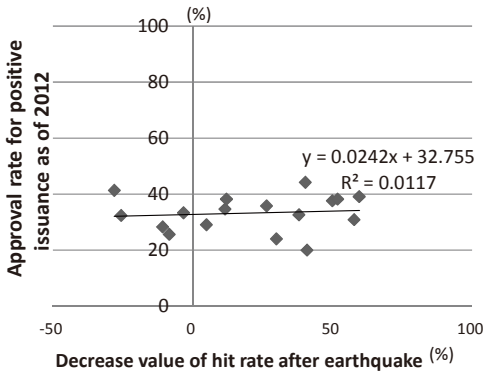


Figure 11. Relationship between decrease value of hit rate after the great earthquake and approval rate for positive issuance.

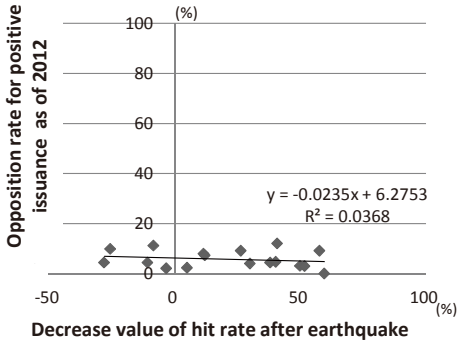


Figure 12. Relationship between decrease value of hit rate after the great earthquake and opposition rate for positive issuance.

Motivation for EEW Use

Considering the results in the previous section, the regular disaster information survey in December 2012 asked comments on whether EEWs should positively be issued in spite of possibility of missing warnings. 33.1% of the total responded "warnings should positively be issued in spite of possibility of missing warnings," 52.5% responded "warnings should be issued in spite of possibility of missing warnings," 5.0% responded "warnings should not positively be issued because of possibility of missing warnings," and 0.9% responded "warnings should never be issued because of possibility of missing warnings," resulting in 85.6% of respondents accepting missing warnings. Figure 9 shows the results of answers per age. The rate of approving missing warnings is relatively low in the generations of 20's and 30's, whereas 40's to 60's shows a similar tendency. Figure 10 shows the cross-aggregation results between the reception experience rate and motivation for use considering missing warnings. As a result of chi-square test, a statistically-significant difference was confirmed when $p < 0.001$. 40% of those who have received EEWs responded "warnings should positively be issued in spite of possibility of missing warnings." The reception experience is assumed to lead to positive motivation for use.

In order to study the effect of the decrease in accuracy of EEWs on motivation for use, Fig. 11 plots the decrease value of the hit rate after the great earthquake per prefecture against the rate of answering "warnings should positively be issued in spite of possibility of missing warnings" in the same prefecture. This figure indicates that the decrease in the hit rate do not directly cause motivation for

the use of EEWs to decline because there is no correlation between the two.
Figure 12 shows the relationship between the decrease value of the hit rate after the great earthquake per prefecture and the rate of answering "warnings should not positively be issued because of possibility of missing warnings" and "warnings should never be issued" in the same prefecture. This figure also shows there is no correlation between the decrease in the hit rate and opposition for the issuance of EEWs.

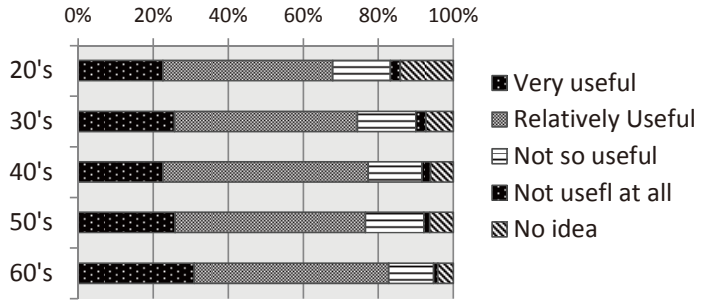


Figure 13. Recognition of usefulness of EEWs per age.

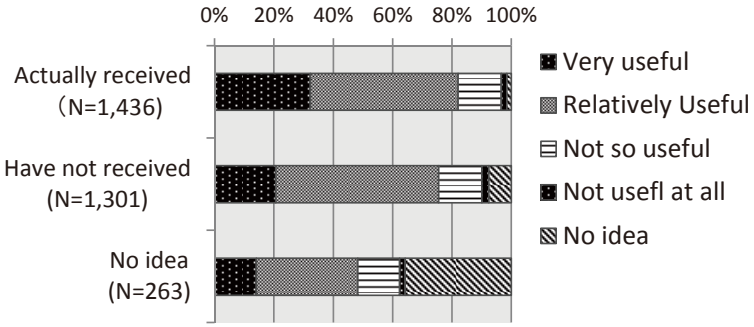


Figure 13. Reception experience and recognition of usefulness of Earthquake Early Warning.

Recognition of EEW Usefulness
Next, the regular disaster information survey in December 2012 asked "do you think EEW is useful for ensuring personal safety?". "Very useful" is 25.5% of the total, "relatively useful" 50.3%, "not so useful" 14.6%, and "not useful at all" 2.1%. Figure 13 shows the answers per age. The percentage of "very useful" and "relatively useful" increases with age. Figure 14 shows the cross-aggregation results between the reception experience rate and recognition of usefulness. As a result of chi-square test, a statistically-significant difference was confirmed when $p < 0.001$. 32% of those who have received EEWs responded "very useful." This is a higher value than that of those who have not received the warning. The reception experience is assumed to lead to recognition of usefulness. Figure 15 shows the relationship between the number of the hit warnings after the great earthquake per prefecture and the rate of answering "very useful" in the same prefecture. There is no correlation between the number of hit warnings and recognition of usefulness. Figure 16 shows the relationship between the decrease value of hit rate after the great earthquake per prefecture and the rate of answering "very useful." The decreased accuracy does not lead to the decrease in the recognition of usefulness, because the rate of answering "very useful" is relatively higher in regions with a hit rate decreased after the great earthquake.

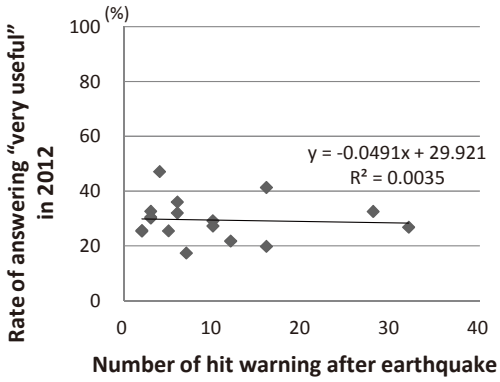


Figure 15. Relationship between the number of hit warning after the great earthquake and recognition of usefulness.

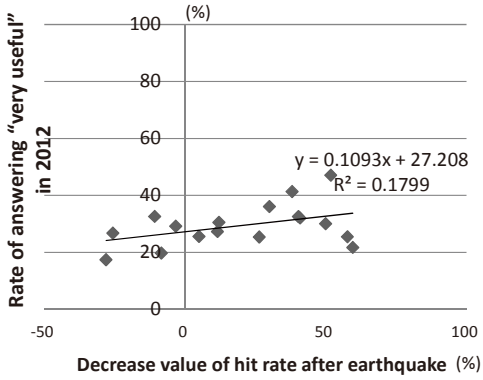


Figure 16. Relationship between the decrease rate of hit rate after the great earthquake and recognition of usefulness.

ANALYSIS OF EXPECTATIONS FOR EEWS

Finally, this chapter analyzes the secular changes in expectation for EEWs based on the results of the regular disaster information survey from 2010 to fiscal 2012. Figure 17 shows the answer rate of choices to the question "what should be done in order to make EEWs more easy to use?" The most popular answer in 2010 is "automatically turn on deactivated TV or radio to receive warnings" at 56.0%. However, the rate of this answer decreases together with "make warnings receivable by every kind of cell phones." This seems to be the effect of the recent increased rate of receiving the warnings using cell phones. The rates of "tell earthquake intensity" and "tell after how many seconds the shock will occur" increased from 2011 to 2012 after the Great East Japan Earthquake. The rate of "tell earthquake intensity" is the highest among all choices in 2012 at 55.6%. The motivation for more positively using EEWs enhanced after the March 2011 quake, resulting in desire to know predicted intensity and time until ground motion arrives. Currently, EEW for the general public don't tell predicted intensity or time until ground motion arrives, whereas EEW for advanced users inform of these information. It means interests in the information only for advanced users are increasing recently.

Meanwhile, the rate of "want to know what to do specifically when receiving EEWs" decreased significantly from 41.8% in 2009 to 26.8% in 2012. Figure 18 shows this rate for those who have

heard of EEWs (those who recognizes warnings) and those who have not. Regardless of the recognition of EEWs, this rate decreased from 2010 to 2012. It is possible that situations during earthquake disasters are more clearly imaged after the Great East Japan Earthquake but interest in proper behaviors is waning due to easy understanding. Figure 19 shows the rate of "want to know what to do" for those who have received EEWs by themselves and those who have not. The reason for the decrease in this rate from 2010 to 2012 appeared to be that those who have received the warnings by themselves developed behavior images when receiving warnings. However, this rate for those who have not received the warnings also decreased considerably in 2012. The interest in proper behavior might be waning because those who have not received the warnings also created behavior images when receiving warnings. Nevertheless, this image is likely to include incorrect understanding for proper behaviors, so awareness for proper behaviors should continuously be raised. Interest in behaviors when receiving EEWs need be enhanced by means of training and materials of EEWs in regions to which EEW have rarely been issued so far and where the reception experience rate will fluctuate at a low level in the future, such as western Japan.

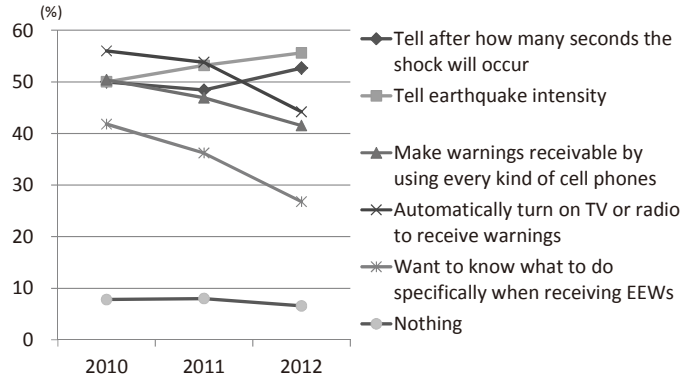


Figure 17. Expectation for EEWs.

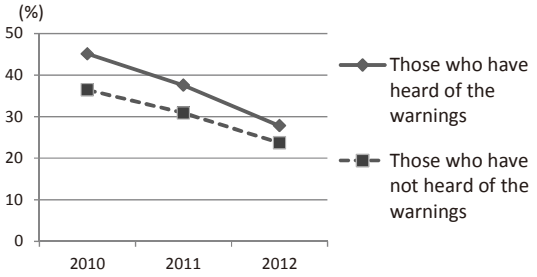


Figure 18. Rate of those who want to know what to do when receiving EEWs (per recognition rate)

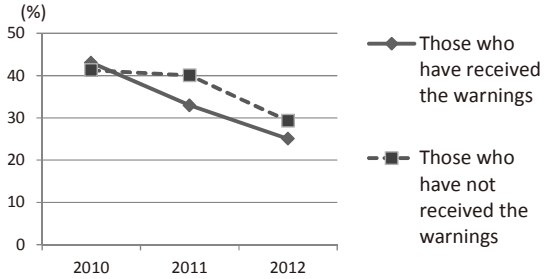


Figure 19. Rate of those who want to know what to do when receiving EEWs (per reception experience)

CONCLUSIONS

In this paper, the secular changes in the rates of recognition and reception experience of EEWs were analyzed by comparing the result of the regular disaster information survey from fiscal 2009 to 2012. In addition, the regional differences of the awareness of the general public regarding the accuracy of EEWs were analyzed by comparing issuance history of EEWs nationwide thus far with the results of the regular disaster information survey. Finally, the secular changes in expectations of citizens for EEWs were clarified. Major findings obtained are as follows.

- •The rates of recognition and reception experience of EEWs increased significantly after the Great East Japan Earthquake.
- •The recognition rate exceeded 50% as of 2009 in all districts, while the reception experience rate showed larger regional differences than the recognition rate. The reception experience rate in western Japan is as low as approximately 20%.
- •It was confirmed that the rates of recognition and reception experience tend to rapidly increase when issuance times of EEWs increases. The both rates exceeded approximately 70% when the average issuance times exceeded roughly 10.
- •The rate of responding "warnings should positively be issued in spite of the possibility of missing warnings" was as high as 85.6%
- •The decrease in the accuracy of EEWs did not clearly affect motivation for use and recognition of usefulness of EEWs. Meanwhile, reception experience leaded to positive motivation for use and recognition of usefulness.
- •Needs for information about predicted intensity and time until ground motion arrives are increasing for the future EEW. Needs for information about "what to do specifically after EEW" is decreasing, suggesting a possibility of insufficient understanding for proper behaviors. Interest in behaviors when receiving EEWs should be enhanced in the regions where EEWs rarely issued.

Note that the analysis focuses on whether EEWs is issued or not to each prefecture. However, the relationship between whether or not EEWs was issued before the arrival of the main shock and the awareness of the general public cannot be analyzed due to the constraints of data. In addition, the relationship between the observed intensity in each prefecture and the awareness of the general public is not analyzed. Further analyses considering these points are required as future issues.

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