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PROPOSAL OF SEISMIC HAZARD MAPS BASED ON CONDITIONAL PROBABILITY IN CONSIDERATION WITH SPATIAL CORRELATION OF GROUND MOTION INTENSITY

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Abstract

When developing a regional disaster prevention plan, an earthquake risk assessment is conducted based on a deterministic approach. In this assessment, multiple large earthquake scenarios that cause significant damage to the region are selected, and seismic hazard, various damage such as building damage, casualty, and economic damage are evaluated for each earthquake. On the other hand, the 2011 Great Tohoku Earthquake was not anticipated in the earthquake risk assessments. Therefore, the Japanese government has stipulated in the master plan for disaster prevention to set the Possible Maximum Earthquake (PME) that occurs in or near the region, which is assumed based on scientific knowledge, for the regional risk assessment. Local governments have estimated the PME scenario which has maximum magnitude, but there are cases in which seismic hazards by such PME are extremely high. In addition, the probability of occurrence of such an earthquake hazard is not assumed. The authors assume that it is necessary to select multiple earthquake scenarios that should be considered for the regional disaster prevention plan, considering the occurrence probability of earthquakes and earthquake hazards from the viewpoint of various damages that occur over a wide area.

The authors proposed a spatial probabilistic seismic hazard analysis (SPSHA) to grasp the earthquake risk of wide-area disaster in the region. This method calculates the area of the strong ground motion in the region and the occurrence probability, considering the spatial correlation of ground motion intensity and correction of the ground motion prediction equation, based on the earthquake observation records in the target region. However, since the results are expressed in the seismic area hazard curve, there was a problem that the region where strong ground motion occurred could not be specified. In this study, as a solution to this problem, we present a method to select the target earthquake based on SPSHA and create a Conditional Probabilistic seismic Hazard Map (CPHM).

In creating the CPHM, the target risk level R and hazard level H is defined by the ground motion intensity y, area of strong ground motion a, the exceedance probability P, based on seismic area hazard curve. For the seismic area hazard corresponding to R and H, the hazard deaggregation method for calculating the contribution of each seismic source is shown. CPHM is expressed as a seismic intensity distribution that satisfies the hazard level H when a target earthquake scenario selecting from a source area with high contribution occurs. In SPSHA proposed by the authors, the ground motion distribution in the target area is calculated by Monte Carlo simulation and spatial interpolation by simple kriging, considering the spatial correlation of ground motion intensity, and the seismic area hazard is calculated. CPHM is selected from these samples.

In the application of this method, SPSHA is carried out to Kanagawa Prefecture. In addition, hazard deaggregation is performed to identify the target earthquake for the region, and then CPHMs corresponding to the occurrence probability is created. Based on these studies, we discuss the PME and probability level that should be considered in the earthquake risk assessment and show how this method can be used for earthquake disaster reduction in the region.

Keywords: Spatial probabilistic seismic hazard analysis, Seismic hazard map, Probabilistic approach, Spatial correlation, Earthquake risk assessment

1. Introduction

When developing a regional disaster prevention plan, an earthquake risk assessment is conducted based on a deterministic approach. In this assessment, multiple large earthquake scenarios that cause significant damage to the region are selected, and seismic hazard, various damage such as building damage, casualty, and economic damage are evaluated for each earthquake. On the other hand, the 2011 Great Tohoku Earthquake was not anticipated in the earthquake risk assessments. Therefore, the Japanese government has stipulated in the master plan for disaster prevention [1] to set the Possible Maximum Earthquake (PME) that occurs in or near the region, which is assumed based on scientific knowledge, for the regional risk assessment. Local governments have estimated the PME scenario which has maximum magnitude, but there are cases in which seismic hazards by such PME are extremely high. In addition, the probability of occurrence of such an earthquake hazard is not assumed. The authors assume that it is necessary to select multiple earthquake scenarios that should be considered for the regional disaster prevention plan, considering the occurrence probability of earthquakes and earthquake hazards from the viewpoint of various damages that occur over a wide area.

Several studies have been conducted on the selection of target earthquakes in regional earthquake damage assessment. Okada et al. [2] explained that the uncertainty of target earthquake scenario setting affects the estimation of damages. Tomatsu et al. [3] proposed a method to select target earthquakes using analytic hierarchy process (AHP) based on estimated damages. These are based on a deterministic approach, and the earthquake scenario represented by the epicenter location and magnitude is easy to understand. Since there are few scenarios, there is a concern that an unexpected earthquake may occur. In addition, the probability of occurrence of earthquakes and ground motion distributions required to discuss the priority of measures and the implementation period is insufficient.

The authors proposed a spatial probabilistic seismic hazard analysis (SPSHA) to grasp the earthquake risk of wide-area disaster in the region [4]. This method calculates the area of the strong ground motion in the region and the occurrence probability, considering the spatial correlation of ground motion intensity and correction of the ground motion prediction equation, based on the earthquake observation records in the target region. However, since the results are expressed in the seismic area hazard curve, there was a problem that the region where strong ground motion occurred could not be specified.

In this study, as a solution to this problem, we present a method to select the target earthquake based on SPSHA and to create a Conditional Probabilistic seismic Hazard Map (CPHM). In the application, SPSHA is carried out for Kanagawa Prefecture in Japan. And the target earthquakes are selected based on probabilistic approach, and CPHMs are created to utilize for regional disaster reduction.

2. Outline of SPSHA

In Spatial Probabilistic Seismic Hazard Analysis (SPSHA) proposed in [4], the probability $P(A > a; t, y)$ that area A (or area ratio) of the area exceeding the strong ground motion intensity y exceeds a in t years owing to earthquakes in a certain area is calculated by

$$(A > a; t, y) = 1 - \prod_k \{1 - P_k(A > a; t, y)\} \tag{1}$$

where, $P_k(A > a; t, y)$ denotes the probability that area A (or area ratio) of the area exceeding the strong ground motion intensity y exceeds a in next t years owing to the k-th earthquake. $P_k(A > a; t, y)$ is given by Eq. (2) if the updating process is adopted for the k-th earthquake occurrence probability, and Eq. (3) if the Poisson process is adopted.

$$P_k(A > a; t, y) = P\left(E_k\ ; t\right)P\left(A > a; y|E_k\ \right) \tag{2}$$

$$P_k(A > a; t, y) = 1 - exp\{-\nu(E_k)P(A > a: y|E_k) \cdot t\} \quad (3)$$

where, $P(E_k\ ;t)$ is the occurrence probability of the k-th earthquake in next t years, $\nu(E_k)$ is the annual frequency of occurrene of the k-th earthquake and $P(A > a; y|E_k)$ is a conditional probability that the area A (or area ratio) of the area where the strong ground motion that exceeds the ground motion intensity y occurs exceeds a, if the k-th earthquake occurs.

We calculate the seismic ground motion distribution samples for the target area by Monte- Carlo simulation (MCS) using the Ground Motion Prediction Equation (GMPE) corrected by the earthquake observation records obtained in the target area and the spatial correlation model regressed from these data. We employed peak ground velocity (PGV) as ground motion intensity measures. PGV at each site is treated probabilistically by the following equation considering the spatial correlation of the seismic intensity between sites.

$$\log(x_{ij}) = \hat{x}_j + \beta_i + \varepsilon_{ej}(0, \sigma_e) + \varepsilon_{cj}(0, \sigma_c) \quad (4)$$

The subscripts i and j represents a site and a sample number respectively. x is a PGV sample, $\hat{x}$ is a log median value of PGV calculated by the GMPE, and β_i is a site correction coefficient of the GMPE obtained from data analysis of earthquake observation records. $\varepsilon_{ej}(0, \sigma_e)$ and $\varepsilon_{cj}(0, \sigma_c)$ are random variables with an average 0 and a standard deviation of σ_e and σ_c, respectively. σ_c represents inter-event variation and assumes common and perfect correlation at all sites. σ_c indicates intra-event variation and gives spatial correlation by the equation

$$\rho = exp(-\gamma \cdot z^{\delta}) \quad : \gamma = 0.044, \delta = 1.043 \quad (5)$$

z is a separation distance (km) between two sites, ρ is a correlation coefficient, and γ and δ are regression constants obtained from data analysis of earthquake observation records [4].

β_i in Eq. (4) is calculated only at earthquake observation sites. Therefore, after sampling PGV at the sites by Eq. (4), the PGV at the center points of the meshes obtained by spatially discretizing the target area are calculated by spatial interpolation using the simple kriging method.

The relationship between the area and the exceedance probability exceeding the given ground motion intensity y calculated from the above is hereinafter referred to as a seismic area hazard curve (Fig.1).

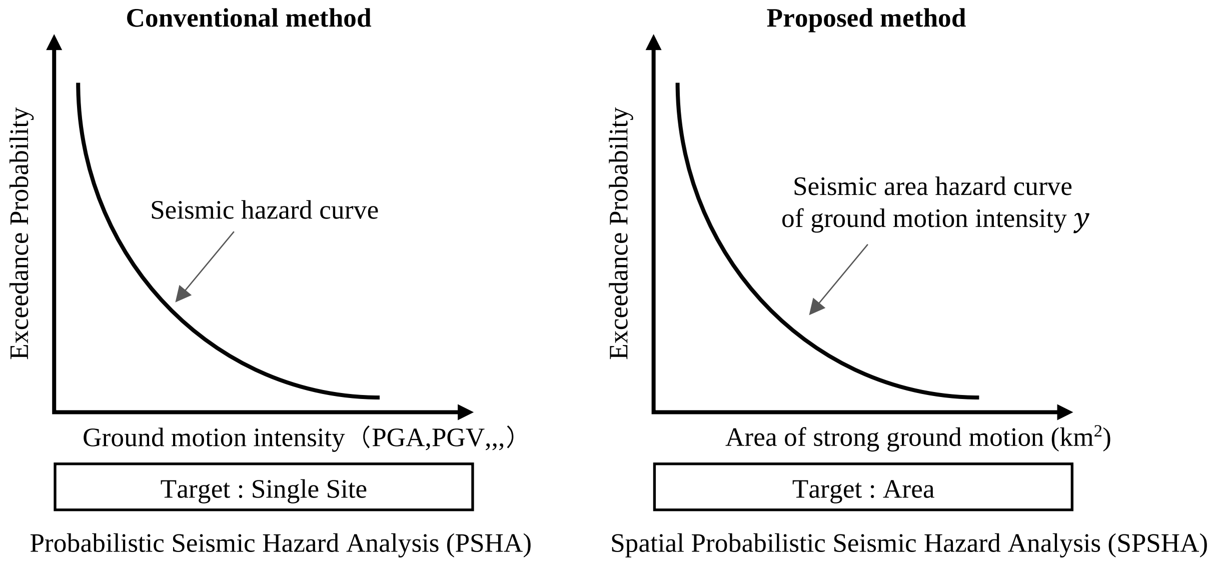

Fig. 1 – Outline of SPSHA

3. Earthquake Scenario selection by seismic hazard deaggregation

3.1 Numbering of subsections

Seismic hazard deaggregation in PSHA is a method to measure the contribution of each seismic source on the seismic hazard for a given exceedance probability. The deaggregation of seismic hazard at a specific site is shown by Kameda et al. [5] and McGuire [6]. The magnitude of the influence of each seismic source on the seismic hazard with a certain exceedance probability is expressed as the contribution index. Expected values of magnitude and source distance are derived from the results of hazard deaggregation to get the image of seismic source corresponding to the probabilistic seismic hazard. This is the expected target scenario for various damage assessment based on PSHA. In SPSHA, the target is the area, thus the source distance cannot be determined identically. Therefore, the degree of contribution is calculated as follows, and the earthquakes that affect the earthquake hazard are identified from the source model of PSHA.

STEP1: SPSHA for the target region

Conduct SPSHA for the target region to be evaluated and calculate the seismic area hazard curve. The area a of the region exceeding the earthquake ground motion intensity y corresponding to the risk level defined by the exceedance probability $P_{o:t}$ for t years is obtained from the seismic area hazard curve. This event is defined as hazard level $H_{a:y}$.

STEP2: Contribution index for each seismic source

At the hazard level $H_{a:y}$, the contribution index of each earthquake in the source model is calculated. The contribution index c_k of earthquake k to $H_{a:y}$ is defined by Eq. (6). c_k denotes the conditional probability that the event is earthquake k if the area of the region exceeding the seismic intensity y in the area exceeds a.

$$c_k\left(H_{a:y}\right) = P_k(A > a; t, y)/\sum_k P_k(A > a; t, y) \tag{6}$$

3.2 Earthquake scenario selection by seismic area hazard deaggregation

Earthquakes in a source model used in SPSHA are partitioned into several groups relative to activity, area, and type. The contribution to the hazard level $H(a; yt)$ is determined up by groups. From the group with the highest contribution value, the earthquake with the highest contribution rate is the representative scenario of the risk level $P_o(t)$ and the hazard level $H_{a:y}$. If contribution indexes are similar among multiple groups, it is necessary to adopt representative scenarios from multiple groups. Thus, earthquakes that affect a region in a view point of wide-area damage is quantitatively selected by a probabilistic approach. As a result, it is possible to objectively select earthquake scenarios to be targeted for regional disaster risk reduction for each risk level.

4. Creating the conditional probabilistic seismic hazard map

We create a CPHM that matches $H_{a:y}$ for the target earthquake scenario. The outline is shown in Fig.2. In calculating $P\left(A > a; y|E_k\right)$ in Eqs. (2) and (3), We had generated the ground motion intensity samples at the earthquake observation points in consideration of the site correction for the ground motion prediction equation[4]. After that, we proposed a method to create a ground motion distribution sample by repeating spatial interpolation of the ground motion distribution in the target area using the Simple Kriging method. This method is also used in this study. First, the seismic intensity samples at the earthquake observation points in and around the target area are calculated by Eq. (4). Next, the ground motion distribution samples in the target area are generated using spatial interpolation by the Simple Kriging method based on the ground motion intensity samples at the earthquake observation points. For the N samples of generated seismic ground motion distribution, the areas S_j (j = 1 to N) of the area of the seismic ground motion y or more are calculated and sorted in descending order, and n ground motion distributions where S_j is equal to or more than a are extracted.

Then, the n-th ground motion distribution sample in which S_j is equal to or more than a and becomes the minimum is defined as CPHM. In addition, n/N represents the conditional probability under which the target earthquake scenario occurred. Hereinafter, this conditional probability is referred to as CP.

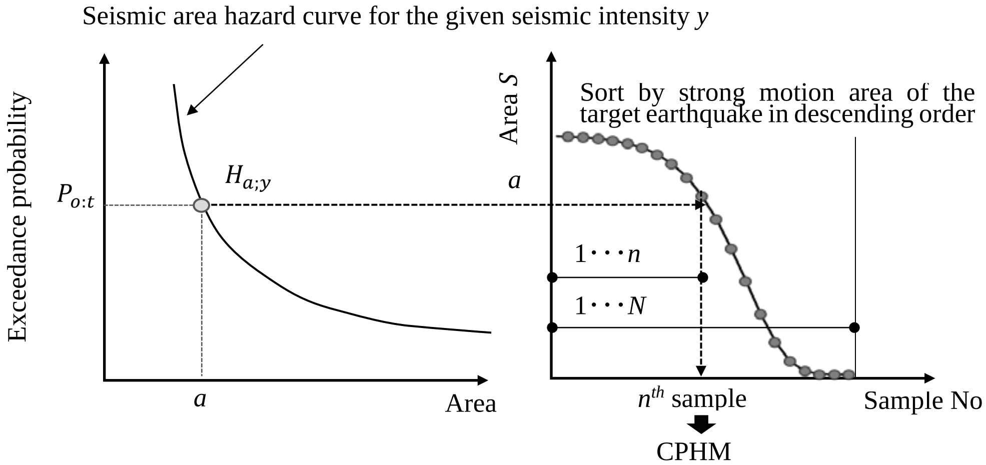

Fig. 2 – Outline of creating CPHM

5. Application

5.1 Conducting SPSHA

SPSHA was conducted for Kanagawa Prefecture shown in Fig. 3. From the proposed method, correction term of GMPE and spatial correlation model of ground motion intensity are set based on the earthquake observation records of K-NET/KiK-net [7] in Kanagawa Prefecture and ground motion intensity is sampled at observation station sites. We perform surface interpolation of the ground motion intensity distribution of the target area by Simple Kriging method based on ground motion intensity samples at observation sites. The target area is discretized into a mesh of about 1 km^2 and PGV on engineering bedrock at the center point of the mesh is estimated. Ground motion intensity distribution is calculated on a mesh of about 250m^2 on the surface ground consideration with amplification by shallow soil. PGV on the surface is converted to JMA seismic intensity. The earthquake source model for probabilistic seismic hazard analysis, earthquake ground motion prediction equation on engineering bedrock, shallow soil amplification factor, and relationship between PGV and JMA seismic intensity are obtained from Japanese National Seismic Hazard Map by HERP [8, 9]. The probabilistic characteristics of ground motion are given by MCS, with perfect correlation for inter-event error and spatial correlation for intra-event error for GMPE based on [4]. Standard deviation of inter-event variation and intra-event variation are 0.192, and 0.160, respectively. The number of earthquake ground motion distribution samples of each earthquake by MCS is 1,000 times. The area of a given ground motion intensity is summed up as seismic area hazard curve.

The seismic area hazard curves for Kanagawa Prefecture with JMA seismic intensities of 6 lower (6-), 6 upper (6+), and 7 were calculated for each exceedance probability with in the next 30 years (hereinafter referred to as EP30). In addition, this result was defined as the ratio of the area where strong ground motion occurred to the area of the region from the viewpoint of grasping the wide area of strong ground motion. Fig. 4 shows the seismic area hazard curves. The larger the seismic area hazard curve, the greater the probability that the strong ground motion will occur more widely in that area. The EP30 on the vertical axis can be measured from the area of strong ground motion on the horizontal axis via the seismic area hazard curve (Table 1). Conversely, the area of strong ground motion can be measured from the EP30 (Table 2). With a probability equivalent to a frequency of about once every 200 years (EP30:14%), seismic intensity 6- or more in more than half of the area of the prefecture, and there is a concern that serious damage may occur. From this result, it is not clear where in the area the strong ground motion is occurring. Therefore, it is necessary to understand the representative ground motion distribution by CPHM.

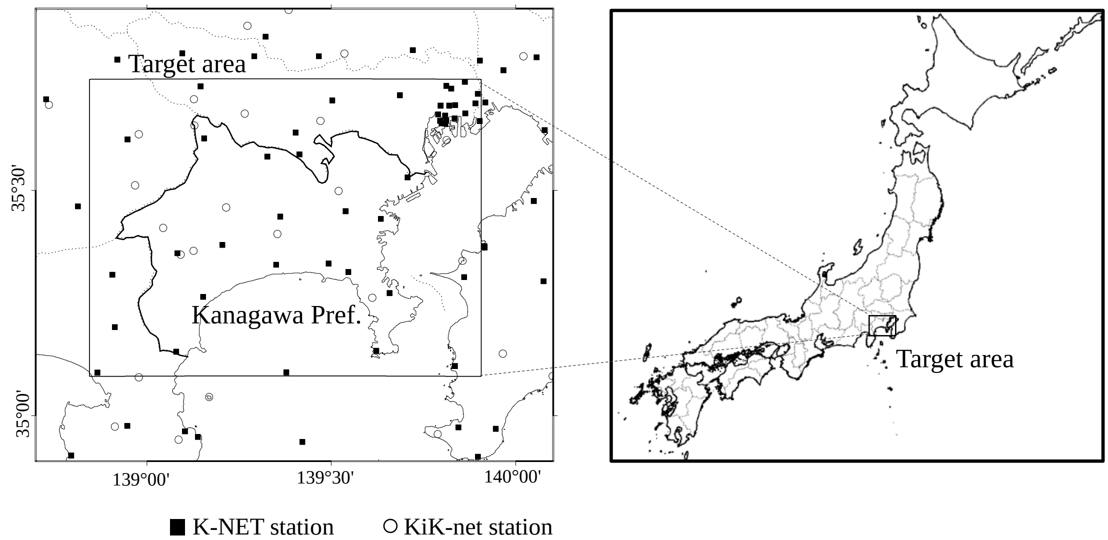

Fig. 3 – Target area for this study

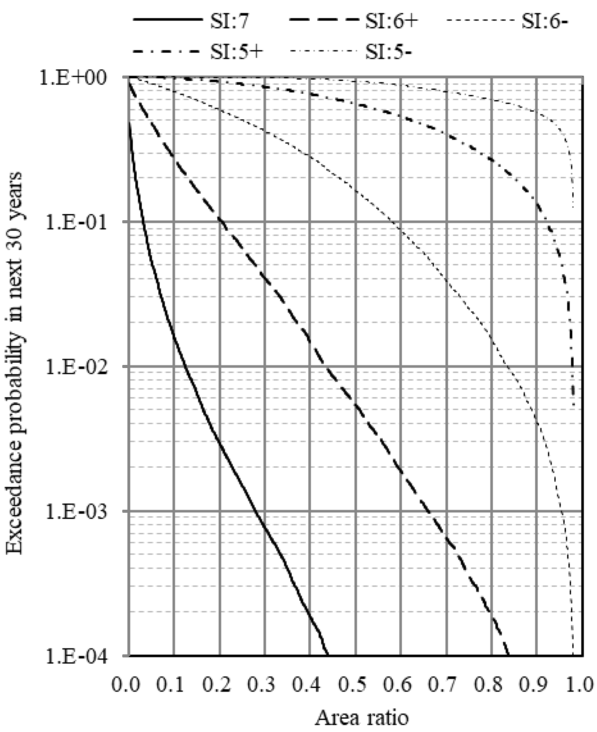

Fig. 4 – Seismic area hazard curve

Table 1 – the area ratio corresponding to EP30

SI	EP30					
	0.1%	1%	3%	6%	14%	26%
5-	0.98	0.98	0.98	0.98	0.98	0.97
5+	0.98	0.98	0.97	0.95	0.90	0.81
6-	0.95	0.83	0.73	0.65	0.53	0.42
6+	0.66	0.43	0.33	0.26	0.17	0.10
7	0.28	0.12	0.07	0.05	0.02	0.01

SI:JMA seismic intensity
Area of Kanagawa Pref.: 2,416 km^2

Table 2 – EP30 corresponding to the area ratio

SI	Area ratio greater than the specified seismic intensity					
	0.05	0.1	0.2	0.5	0.7	0.9
5-	100.0%	100.0%	99.8%	93.6%	79.4%	56.8%
5+	99.7%	98.1%	92.8%	65.4%	40.4%	13.4%
6-	90.2%	79.2%	59.3%	16.3%	3.9%	0.4%
6+	47.8%	27.0%	10.4%	0.5%	0.1%	0.0%
7	5.3%	1.6%	0.3%	0.0%	0.0%	0.0%

SI:JMA seismic intensity
Area of Kanagawa Pref.: 2,416 km^2

5.2 Conducting hazard deaggregation of SPSHA

Seismic hazard deaggregation for the results of SPSHA in the previous section were conducted to record quantitatively the contribution of each seismic source for the seismic area hazard. When we deaggregate the seismic area hazard, it is necessary to set earthquake groups referring to the seismic source data of SPSHA. Earthquakes are first classified into two categories: the identified earthquakes and the unidentified earthquakes. The former is called the characteristic earthquakes and the latter is called the background earthquakes in PSHA. Next, they are classified into earthquakes associated with the plate subduction earthquake of Pacific plate, Philippine sea plate and inland crustal earthquakes. Characteristic earthquakes of the Philippine sea plate are further classified into M8 class earthquake around Sagami Trough (hereinafter called “Sagami Trough earthquake”) and M8 class Nankai Trough earthquakes (hereinafter called “Nankai Trough earthquake”). Characteristic earthquakes of the crustal inland faults are classified into major active faults and other active faults. Subclassification of background earthquakes includes inter-plate earthquakes, intra-plate earthquakes around the Pacific and Philippine sea plate, and crustal faults. However, from the long-term evaluation for the earthquakes around Sagami Trough [10] by HERP, the M7 class earthquakes owing to Philippine sea plate subduction (hereinafter called “Tokyo inland earthquake”) have about 70% chance for next 30 years. It has a huge impact on the target region, thus classified as an independent group. Tokyo inland earthquake is modeled as a background earthquake (area No.6/7) of the Philippine Sea plate in the Japanese National Seismic Hazard Maps. Magnitude of these earthquake is M6.7 or higher. Earthquake groups are shown in Fig.5.

Table 3 shows the results of hazard deaggregation for seismic area hazard of JMA seismic intensity 7 and 6- or more. Figure 6 shows quantitatively the earthquake groups with greatest effect on the extent of strong ground motion. The vertical and the horizontal axes represent the contribution of each earthquake group and the area ratio of strong ground motion, respectively. The lower part of the thick solid line indicates the contribution of the characteristic earthquakes and the upper part indicates the that of the background area earthquakes. At seismic intensity 6- or more, the Nankai Trough earthquake (C11) is dominant in all area ratios, but the effect becomes smaller when the seismic intensity is strong, or the area is large. At strong seismic intensity, the effect of the Sagami Trough earthquake (C10) becomes greater. Source area of the Sagami Trough Earthquake is on the plate boundary just below Kanagawa Prefecture, and is indispensable for studying disasters where strong ground motions occur over a wide area in the prefecture. On the other hand, M7-class earthquakes around the Sagami Trough (B25,26) have a significant effect on all area ratios of seismic intensity 6-, 6+, and 7. Overall, the contribution of the characteristic earthquakes is larger than that of the background earthquakes, as the strong ground motion becomes wider. Therefore, when selecting earthquake for earthquake risk assessment, an earthquake scenario with strong ground motion occurring in a narrow area is set as a hypothetical seismic source, and earthquakes scenario that generate strong ground motion in a wide area is selected from characteristic earthquakes.

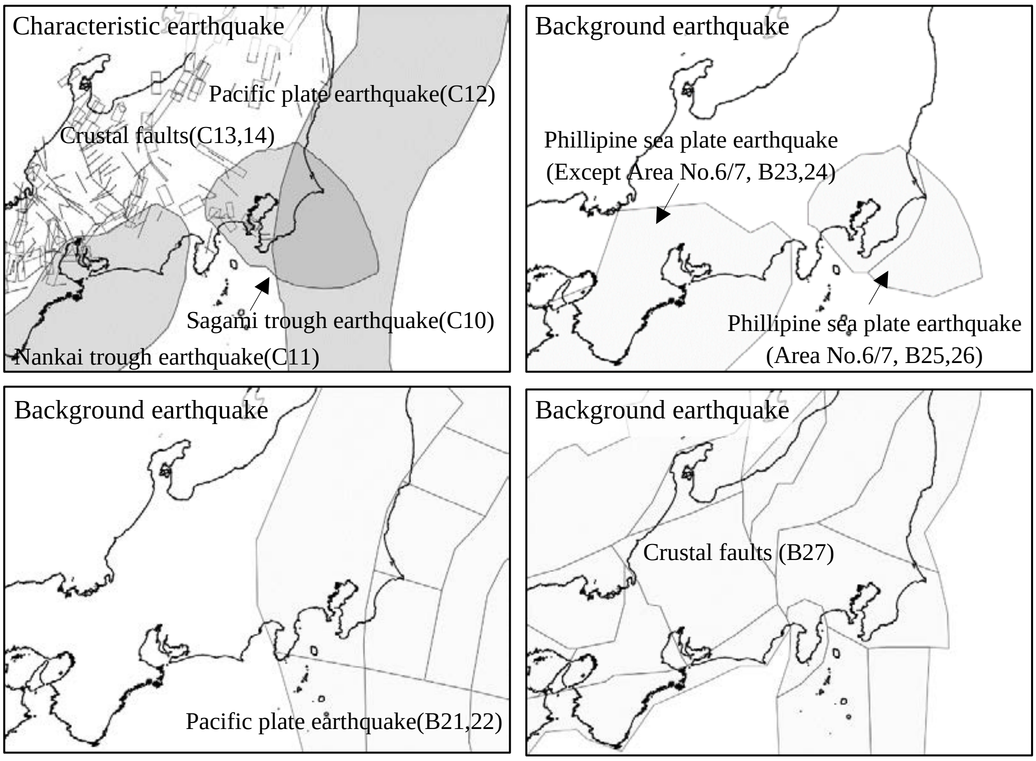

Fig. 5 – Earthquake groups for deaggregation of the seismic area hazard curve

Table 3 – Contribution for each earthquake group corresponding to EP30

Category	Class	Earthquake group	Group ID	Seismic intensity 7						Seismic intensity 6- or more					
				EP30						EP30					
				0.1%	1%	3%	6%	14%	26%	0.1%	1%	3%	6%	14%	26%
Characteristic earthquakes	Philippine sea plate	Sagami Trough Earthquakes	C10	0.53	0.20	0.11	0.08	0.03	0.02	0.66	0.24	0.12	0.08	0.04	0.02
		Nankai Trough Earthquakes	C11	0.00	0.10	0.16	0.19	0.31	0.36	0.06	0.43	0.55	0.61	0.61	0.60
	Pacific plate	Specified Earthquakes	C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Crustal faults	Major faults	C13	0.00	0.01	0.02	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00
	Crustal faults	Other faults	C14	0.00	0.00	0.01	0.01	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Background earthquakes	Pacific plate	Inter-plate earthquakes	B21	0.00	0.00	0.01	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.01
	Pacific plate	Intra-plate earthquakes	B22	0.01	0.05	0.07	0.07	0.08	0.07	0.00	0.00	0.01	0.01	0.02	0.03
	Philippine sea plate (Except area No.6/7)	Inter-plate earthquakes	B23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Intra-plate earthquakes	B24	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
	Philippine sea plate (Area No.6/7)	Inter-plate earthquakes	B25	0.22	0.22	0.19	0.17	0.13	0.11	0.17	0.14	0.13	0.11	0.10	0.09
		Intra-plate earthquakes	B26	0.23	0.41	0.44	0.43	0.35	0.30	0.11	0.18	0.18	0.19	0.21	0.23
	Crustal faults	Unknown faults	B27	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00

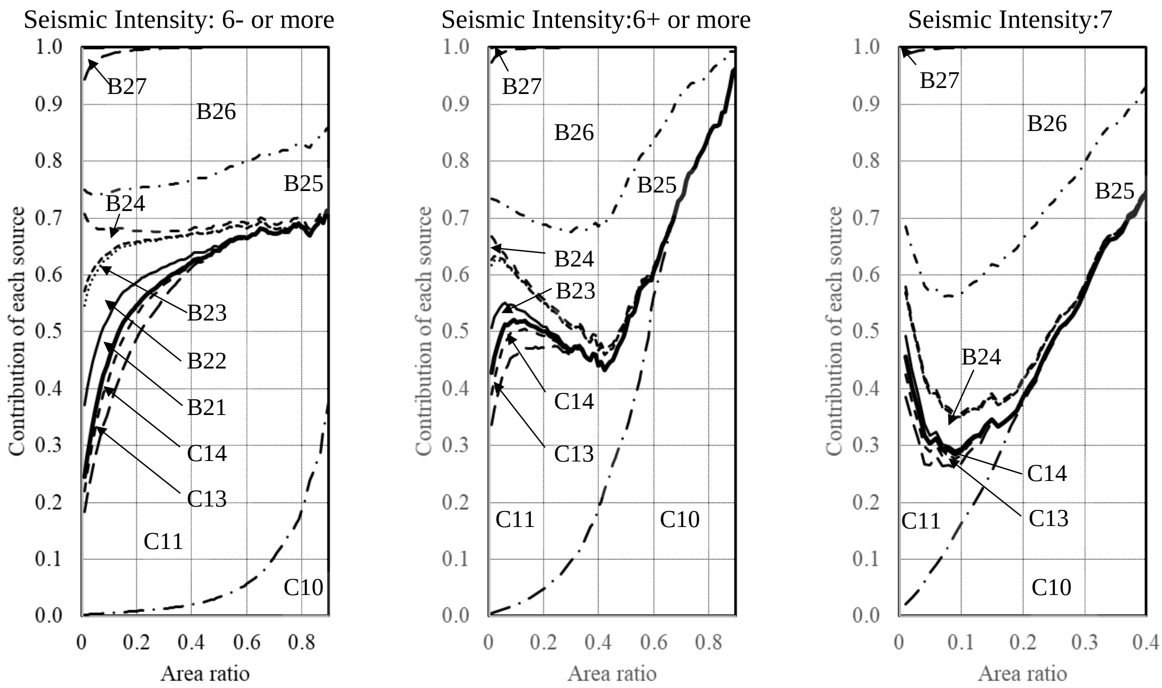

Fig. 6 – Results of hazard deaggregation of SPSHA curve

5.3 Creating Conditional Probabilistic seismic Hazard Maps

A target earthquake scenarios are selected based on the results of hazard deaggregation of SPSHA, and some CPHMs are created. The seimic intensity of seismic area hazard curve for the CPHM is 6- or more, and the risk level $P_{o:t}$ are EP30 with 1, 3, 6, 14, and 26% of 5 cases. CPHM employs two target earthquakes in each probability case. From the result of seismic intensity 6- or more of Table 3, the largest contribution was C11 in all 5 cases, so the primary target earthquake scenario was the Nankai Trough earthquake. Next, C10 and

B26 are selected with reference to the second contribution group. Figure 7 shows the created CPHMs and the source area of these target earthquake scenarios. CP value that shows the likelihood of CPHM when the target earthquake scenario occurs is also shown in the figure. For the Nankai Trough earthquake of seismic source model which are employed in this study, there are 15 patterns of earthquakes with different magnitudes. The occurrence probabilities of these 15 patterns are branched by weight under condtion which the earthquake occuers. Among them, the occurrence pattern in which four or more source areas cascade simultaneously has a small contribution because the weight is small. For other earthquakes, there are three earthquakes (Mw8.7, Mw8.9, Mw8.3) which the source area reaches the eastern end of the Suruga Trough. They are closest to the target area in all patterns. In preparing the CPHM, two target earthquake scenarios, M8.3 and M8.9, were selected. It can be seen that the area of seismic intensity 6- or more increases as EP30 decreases. In all cases, the seismic intensity was large in the soft soil area around the Sagami River. In the case of the secondary target earthquake, the Sagami Trough earthquake was selected for the CPHM with EP30 of 1%, and the Sagami Trough M7 earthquake (intra-plate) was selected for the case of EP30 of 3% or more. In the case of the secondary target earthquake, since it is the group with the second highest contribution, the occurrence probability is lower and the CP is larger than the CPHM of the primary target earthquake.

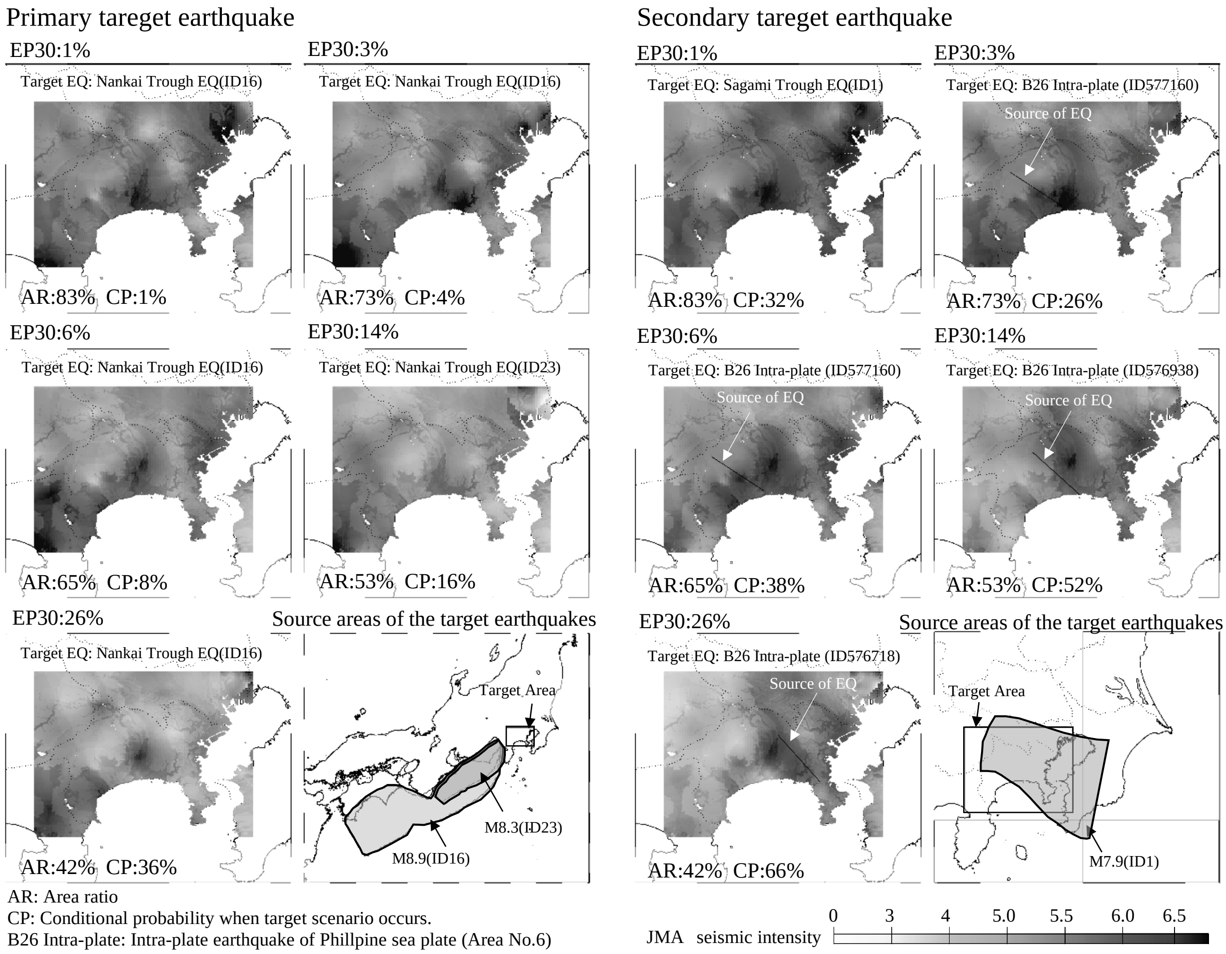

Fig. 7 – Conditional Probabilistic seismic Hazard Maps for Kanagawa pref.

5.4 Utilization of Conditional Probabilistic seismic Hazard Maps

The CPHM corresponding to the risk level $P_{o:t}$ indicates a typical earthquake scenario that is expected as an event of $H_{a:y}$. CPHM is superior to the Japanese National Seismic Hazard Maps in that the earthquake scenario and the regional ground motion distribution are clear. Earthquake risk assessment requires earthquake damage scenarios that involve not only buildings and casualty but also various damages such as lifelines and economic losses in a complex manner. In such a case, if some earthquake scnarios are selected based on a deterministic approach and the ground motion distributions are evaluated, information on the occurrence probability is insufficient. By setting CPHM of various risk levels using our proposed method, it becomes possible to consider short-term countermeasures for high-probability events and long-term countermeasures for low-probability events.

When examining the probable maximum earthquake (PME) deterministically, after identifying the maximum source around the area, the source parameters are determined and the ground motion is evaluated. In other words, selection of the PME and evaluation of the ground motion are performed separately. On the other hand, by prposed method, the selection of the target earthquake and the estimation of the ground motion are integrally examined from the viewpoint of the wide-area of the ground motion hazard, and the uncertainty of the ground motion evaluation can be considered with the probability. In this study, we examined CPHM, which has a very low probability of 1% (approximately once every 2980) and a relatively high probability of 26% (approximately once every 100 years). Thus, it is important to clarify the selected earthquakes and ground motion distributions for various probabilities and to understand the differences. Then, a certain low probability ground motion distribution can be determined as the PME for the target region. For example, in this study, a CPHM with a seismic intensity of 6- or more occurring in a wide-area at a risk level of EP30:1% can be selected as the ground motion distribution due to the PME. At this time, for Kanagawa Prefecture, it is appropriate to use the CPHM of the Sagami Trough earthquake selected as the secondary target earthquake when confirming the contribution by the hazard deaggregation of seismic intensity 7 as well as seismic intensity 6-.

6. Conclusions

In this study, the method of hazard deaggreagation of SPSHA was shown, and the method of selecting the earthquake scenario in the regional seismic risk assessment employed the probabilistic approach was shown. In addition, we proposed a method to set the Conditional Probabilistic seismic Hazard Map (CPHM) as a representative ground motion distribution from the SPSHA results, considering the probability of the occurrence of the earthquake and the distribution of the ground motion.

7. Acknowledgements

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