(Attachment)

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Headquarters for Earthquake Research Promotion
Earthquake Research Committee
Subcommittees for Long-term Evaluations and
for Evaluations of Strong Ground Motion

Preliminary Version of Probabilistic Seismic Hazard Map (Specific Area)

Contents

Introduction

In April 1999, Headquarters for Earthquake Research Promotion fixed 'On Promotion of Earthquake Research - Comprehensive Basic Policies for the Promotion of Seismic Research through the Observation, Measurement, and Survey of Earthquakes -' ('Comprehensive Basic Policy', hereafter). Carried as a subject to promote today in this article has been preparation of a nationwide general view of seismic hazard map integrating survey of active faults, long-term evaluation for possible breakout of earthquakes, prediction of strong ground motion and the like ('Seismic Hazard Map in General View of the Whole Japan', hereafter).

Also described in the Comprehensive Basic Policy (Headquarters for Earthquake Research Promotion, 1999) regarding the Seismic Hazard Map in General View of the Whole Japan are the followings:

> An example of seismic hazard maps has shown information predicting possibility that a certain area is attacked by a strong seismic ground motion in a certain term by means of probability in the nationwide general view. In general, it is what has exhibited, by fixing two parameters among term, seismic ground motion level (seismic intensity and maximum acceleration for example) and probability, distribution of the remaining one on the map as an isoline contour.

This corresponds to what has been called probabilistic seismic hazard map in the fields of earthquake engineering and seismology, profits to compare seismic risk (possibility of suffering strong ground motion) at every place or to study the level of earthquake-resistant design, and may be called as the **seismic risk map** (map that shows possibilities of suffering strong ground motion). Here we consider those illustrated in the Comprehensive Basic Policy as the nationwide general view of seismic hazard map, and turned to call this as '**Probabilistic Seismic Hazard Map**'.

On the other hand, when estimating damage for national or regional plan of disaster management, prediction of seismic ground motion for a specified seismic source fault[1] has been conducted. A map prepared by this is sometimes called

[1] Here, 'for a specified seismic source fault' means to have included the state that the range of seismic source faults was roughly specified. For instance, in the long-term evaluation of fault zone on the Itoigawa Shizuoka-kozosen (Earthquake Research Committee, 1996), the evaluated result says 'The segment that includes Gofukuji fault is highly possible to cause an earthquake. However, the limit where the fault segment (location) causing earthquake extends can not be judged,' and this is also included in the utterance 'Specified seismic source faults'.

scenario[2] **earthquake map**, but we concluded to call this '**Seismic Shaking Map for Specified Seismic Source Fault (Scenario earthquake map)**' hereafter. This time, we prepared a preliminary version by limiting the area for the probabilistic seismic hazard map.

As for the probabilistic seismic hazard map, examples utilized in disaster management plan prepared by the nation or local authorities are seldom observed. Because of this, it is necessary to widely discuss among those related to disaster prevention and scientists on the way of preparation by keeping its utilization in mind when preparing the probabilistic seismic hazard map by aiming at the end of fiscal 2004 (Heisei 16th), and this preliminary version was prepared as the start line.

By taking ease of such discussion into consideration, the preliminary preparation was made for the region centering Yamanashi Prefecture where the way to prepare the map is easily understood (**Fig.1a**: (called 'Region for Preliminary Version', hereafter). In this region, a plurality of anxious earthquakes are hypothesized. 'Amplification factor of the ground surface to the engineering bedrock[3]' premised on the preliminary preparation was also set as shown in **Fig.1b**. It can be read from **Fig.1b** that the Kofu Basin has thick sedimentary layers, with which seismic wave incident into the Kofu Basin is amplified at a rate higher than other places.

In the followings, explanations are given in **1st Section** for what are related to the region for preliminary version with respect to 'Seismic shaking map for specified seismic source fault' generally prepared for disaster management plan, and then in **2nd Section** for contents and outlined constitution of the 'Probabilistic Seismic Hazard Map', followed by **3rd Section** for contents of the preliminary version in view of profiting comprehension of various possibilities for utilization of the probabilistic seismic hazard map, and in **4th Section** for expected application methods of the probabilistic seismic hazard map.

1 Seismic shaking map for specified seismic source fault

'Seismic shaking map for specified seismic source fault' has been prepared and utilized when estimating damages for disaster management plan, and it is a general custom that distribution of seismic intensity (when the specified earthquake occurred) has been shown on the map. Earthquakes for specified seismic source faults include the followings:

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[2] Because the seismic source fault has been specified and scenario stating what kind of earthquake will happen can be described, the term 'scenario' has been used in seismology.

[3] 'Engineering bedrock' stands for a quality ground to be founded as the base when building relatively large-scale architecture or engineering fabrics, being in the velocity range of 300 to 700 m/s in S wave though depending on the kind of buildings or state of the ground, and we took the upper boundary of the layer corresponding to 400 m/s at this time.

- Characteristic earthquakes[4] that occur in major 98 active fault zones[5] (called 'characteristic earthquakes of the major 98 active fault zones', hereafter.),
- Earthquakes that occur in active faults except the major 98 active fault zones,
- Earthquakes occurring at the major 98 active fault zones except characteristic earthquakes, and
- Large earthquakes that occur at the oceanic plate boundary of sea area (called 'subduction earthquakes', hereafter).

Earthquake Research Committee individually evaluates possibility of long-term occurrence in succession (called 'long-term evaluation', hereafter) as well as the level of seismic ground motion (called 'evaluation of strong ground motion', hereafter) regarding characteristic earthquakes of the major 98 active fault zones and subduction earthquakes among these (evaluation of strong ground motion is carried out for major earthquakes with a high precision by using hybrid simulation procedure[6], and also for other earthquakes by using attenuation relation[7] added with effect of site amplification).

Earthquakes that are supposed to give a large influence on the region for preliminary version (centering Yamanashi Prefecture) include characteristic ones in the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu), the same (Nambu), the Fujikawa-kako fault zone and the Kannawa/Kouzu-Matsuda fault zone, respectively, as 'characteristic earthquakes of the major 98 active fault zones'. Besides, Assumption of the Tokai Earthquake[8], Kanto Earthquake[9] and Tonankai Earthquake[10] are also influential and known as the subduction earthquakes (**Fig.2**).

Shown here as examples with respect to Assumption of the Tokai Earthquake, Kanto Earthquake, 'characteristic earthquakes of the Itoigawa Shizuoka-kozosen fault

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[4] 'Characteristic earthquakes that in active fault zones' is the term used, while large earthquakes with nearly equal size and mechanism are taking place repetitively at the said active fault zone as the seismic source fault, when dealing with such repetitive breakout of earthquakes by modeling, and stands for large earthquakes repetitively breaking out. In this modeling, by considering an active fault zone causing similar earthquakes that break out repetitively from whole of the fault as the range of seismic sources with relatively uniform occurrence intervals, and those take charge of the most strain energy released from the said active fault, they do call those as the characteristic earthquakes.

[5] Based on Subcommittee for Survey and Observation Plans, Policy Committee, Headquarters for Earthquake Research Promotion (1997).

[6] 'Hybrid simulation procedure' is also called 'hybrid synthetic method', and it estimates a seismic waveform that covers all of frequencies deeply taking part in causing disaster (Refer to Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2001, p.11).

[7] 'Attenuation relation' stands for an empirical formula on attenuation of seismic ground motion level in dependence on distance from the seismic source fault.

[8] Earthquake shown in the Special Survey Committee for the Tokai Earthquake of Central Disaster Management Council (2001).

[9] A large-scale earthquake that breaks out along the Sagami Trough shown by Expert Committee for Designating Areas to Strengthen Earthquake Disaster Management Measures, Central Disaster Management Council (1992), (Example: The 1923 Kanto Earthquake M7.9).

[10] The Tonankai Earthquake described here is that in Earthquake Research Committee (2001b).

zones (Hokubu and Chubu), and the same (Nambu)' are seismic hazard maps with specified seismic source faults (**Figs. 3, 4, 5a and 5b**). Employed for the Assumption of the Tokai Earthquake among these are those by the Special Survey Committee for the Tokai Earthquake of the Central Disaster Management Council (2001). Also with respect to Kanto Earthquake and the Itoigawa Shizuoka-kozosen fault zone (Nambu), maps were prepared by means of the attenuation relation by preliminary setting the seismic source fault and magnitude. Further prepared for the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu) were by means of the attenuation relation based on the seismic source fault and magnitude shown by Subcommittee for Long-Term Evaluations (1996) and Subcommittee for Evaluations of Strong Ground Motion (2001a), both of Earthquake Research Committee.

In consequence of these preliminary calculations or the like, region for preliminary version turn to have orange or ocher regions where seismic intensity is 6 Lower and greater for any earthquakes. By stepping on these facts, these figures turn to be utilized for grasping influences when an earthquake occur in national or regional measures of disaster prevention.

(Note: Employed in **Fig.3**, Assumption of the Tokai Earthquake, has been means of superposing the both results of waveform calculation method[11] and use of the attenuation relation[12] depending on the regional characteristic (Special Survey Committee for the Tokai Earthquake, Central Disaster Management Council, 2001). With respect to Kanto Earthquake, the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu) and the same (Nambu), on the other hand, Earthquake Research Committee has not yet finished evaluation of strong ground motion and used an attenuation relation averaged over the whole Japan (**Figs.4**, **5a** and **5b** used values of preliminary calculation).

2 Probabilistic seismic hazard map and evaluation for its preparation

In the probabilistic seismic hazard map, the long-term probability of occurrence and level of seismic ground motion with respect to 'earthquakes for specified seismic source faults' are evaluated together[13], 'those for non-specified seismic source faults in

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[11] Utilized as 'waveform calculation method' in the Assumption of the Tokai Earthquake has been statistic Green function method (*Cf.* Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2001a, p.1 of explanation: Calculating method for short-period portions), a partial method composing above-mentioned 'Hybrid simulation procedure'.

[12] As 'attenuation relation' in the Assumption of the Tokai Earthquake, it has taken direction of breakage and regional characteristic, too, into consideration.

[13] Evaluation for preparing the probabilistic seismic hazard map with respect to 'earthquakes for specified seismic source faults' comprises, for every earthquake, 3 steps of evaluation of magnitude and its long-term occurrence probability, evaluation of probability exceeding a certain level of seismic ground motion for every spot within a fixed period of time, and combination of these evaluations.

advance' are evaluated[14] in a statistic way, and prepared after that by integrating[15] all of these (called 'integration', hereafter). Namely, this map has been featured with 'use of occurrence probability of each earthquake' and 'consideration of every earthquake'.

In the preliminary version of the probabilistic seismic hazard map, we concluded to fix two parameters out of 'term', 'seismic ground motion level' and 'probability', and indicate distribution of the remaining one on the map in a similar manner shown in the Comprehensive Basic Policy as an example.

Explained in this section are concrete procedures of evaluation and 'integration' for preparing the probabilistic seismic hazard map with respect to each of 'earthquakes for specified seismic source faults' and 'those for non-specified seismic source faults in advance'.

(1) Evaluation of earthquakes for specified seismic source faults

In the probabilistic seismic hazard map, long-term occurrence probability and seismic ground motion level are evaluated together and then 'integrated' for 'earthquakes for specified seismic source faults', as mentioned before. Regarding 'characteristic earthquakes of the major 98 active fault zones' and 'subduction earthquakes' in particular, Earthquake Research Committee has individually advanced 'long-term evaluation' such as long-term possibility of occurrence and magnitude, and 'evaluation of strong ground motion' but it is currently in the state only partially evaluated, and many have not yet. With respect to those not yet evaluated in preliminary version today, those used as numerical values necessary for 'integration' were preliminary ones.

'Earthquakes for specified seismic source faults' in relation to regions for preliminary version (centering Yamanashi Prefecture), are shown in **Tables 1**, **2**, **3** and **4**. Evaluated results for long-term occurrence probability and seismic ground motion level shown in these tables were used in the way of consideration shown in these tables. As for active fault zones, those in the range of 1° (approximately 90 km) from east and west ends and of 1° (approximately 110 km) from north and south ends of the region for preliminary version were 'integrated'. With respect to subduction earthquakes, those in a wider range than this were 'integrated'.

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[14] Evaluation for preparing the probabilistic seismic hazard map with respect to 'earthquakes for non-specified faults in advance' comprises, for every earthquake classification 3 steps of evaluation of occurrence property for every magnitude, evaluation of probability exceeding a certain level of seismic ground motion within a fixed period of time for every spot, and combination of these evaluations.

[15] Here, 'integration' stands for integration of probabilities exceeding a certain seismic ground motion level within a fixed term with respect to a specified spot from assessed result for preparation of the probabilistic seismic hazard map for every 'earthquakes for specified seismic source faults' and that for every classification of 'earthquakes for non-specified seismic source faults in advance'.

(2) Evaluation of earthquakes for non-specified seismic source faults in advance

As for 'earthquakes for non-specified seismic source faults in advance', 'integration' is carried after statistic evaluation as mentioned earlier. They can be classified as follows:

- Earthquakes at the oceanic plate boundary excluding 'subduction earthquakes',
- Earthquakes in the subducting plate, and
- Earthquakes for non-specified active faults among inland shallow earthquakes (in the crust)

All of these relate to the region for preliminary version (centering Yamanashi Prefecture). Regarding these, while aiming at the range of 1° (approximately 90 km) from east and west ends and of 1° (approximately 110 km) from north and south ends of the region for preliminary version, those in a more or less wider range were 'integrated'[16]. Also, its influence was evaluated only for earthquakes with magnitude 5.0 and greater.

Statistic evaluation procedure for earthquakes for non-specified seismic source faults in advance has not yet established at present. Accordingly, applied in the preliminary version was procedure judged as applicable at this time point (Subcommittee for Long-term Evaluations, Earthquake Research Committee, 2002).

3 Preliminary version of probabilistic seismic hazard map (specific area)

A method how to make the preliminary version and its contents are explained in this section.

(1) Procedure how to make the probabilistic seismic hazard map and its contents

The probabilistic seismic hazard map was considered all earthquakes as mentioned before, and similarly to the example in the Comprehensive Basic Policy. We concluded to indicate distribution of the remaining one of three parameters such as 'term', 'seismic ground motion level' and 'probability' on the map, while fixing the two of them. In the preliminary version, the specific region including Yamanashi Prefecture was given as mentioned above.

'Time-term' indicates the length of time from 2002, and 30 and 50 years were shown as examples in accordance with the following aspect of Subcommittee for

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16 Earthquakes in the Pacific plate were not evaluated with the preliminary version because their seismic sources are deep and supposedly give little influence. Also, evaluation was conducted by using data from which aftershocks were removed by a fixed method in order not to excessively evaluate influences of aftershocks induced by a large earthquake.

Instituting Results in Society, Policy Committee of Headquarters for Earthquake Research Promotion(2001).:

- By considering the objective length of time that the general public will take when thinking of life design, probability evaluation during 30 years is appropriate as a standard.
- Because structures with lifetime of 50 years and even longer have been built, it is necessary to evaluate also probability for the term of 50 year or the like.

Shown as examples for the 'seismic ground motion level' were 'seismic intensity equal to and greater than (>=) 6 Lower' regarded as criterion of reinforcing measures for disaster prevention, and 'seismic intensity >= 5 Lower', criterion of possible occurrence of damages (Explanation Tables Associated with Seismic Intensity Scale of Japan Meteorological Agency; Japan Meteorological Agency, 1996, p.76).

Shown as examples for the 'probability' were '3% in 30-year term' and '0.1% in 30-year term' regarded as large and small criteria of long-term occurrence probability for the major 98 active fault zones (Ex.: Earthquake Research Committee, 2001a; p.28), and '5% in 50-year term' and '10% in 50-year term' as criteria of structure design. Incidentally, '5% in 50-year term' and '3% in 30-year term' give nearly equal results[17] while '10% in 50-year term' and '6% in 30-year term' give nearly equal results[18], though depending on feature of the earthquake concerned.

Figs.6a and **6b** show 'probability' under fixed 'term' and 'seismic ground motion level'. Regions caused by earthquakes with seismic intensity >= 6 Lower (**Fig.6a**) or >= 5 Lower (**Fig.6b**) at probability (preliminary calculation) >= 6% within 30 years from now have been shown in orange color, while those >= 3% and less than(<) 6% in ocher color. It is found from **Fig.6b** that probability (preliminary calculation) at which the region is caused by a seismic ground motion with intensity >= 5 Lower within 30 years hereafter is >= 6% for the whole area. And it is found from **Fig.6a** that, regarding the region for preliminary version, regions caused by a seismic ground motion with intensity >= 6 Lower within 30 years hereafter at a probability >= 3% have not only been limited to central and southern areas of Yamanashi Prefecture but also spread to northwestern part of the prefecture. However, it is to be noted that the above results were derived from preliminary calculation with values under a number of preliminary settings (and so forth).

Fig.7b shows 'seismic ground motion level' under fixed 'term' and 'probability'.

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[17] When assuming random breakout of earthquakes independent from time, this corresponds to once per 1000 years in average.

[18] When assuming random breakout of earthquakes independent from time, this corresponds to earthquake occurrence once per 500 years in average.

Regions caused by a seismic ground motion with intensity >= 6 Lower within 30 years hereafter at a probability >=3% are shown in ocher, and further, those caused by a seismic ground motion with intensity >= 6 Upper are shown in orange color[19].

Fig.6a (cited again in **Fig.7a**) shows probabilities exceeded at a certain seismic ground motion level in a fixed term as mentioned above, while **Fig.7b** shows seismic ground motion level exceeded at a certain probability in a fixed period. Comparison of these allows us to have the following aspect: Namely, the spot marked with X in the yellow region of **Fig.7a** is visited, for instance, by a seismic ground motion with intensity >= 6 Lower in 30 years from now at a probability >= 0.1% and < 3%, and we can learn seismic intensity if the probability is >=3% by looking at the spot marked with X in **Fig.7b**. It is found from **Fig.7b** that this spot is caused by a seismic ground motion with intensity >= 5 Upper at a probability >= 3%.

Figs.8a, **8b** and **8c** were prepared similarly to **Fig.7b**, after setting 'term' to 50 years, by fixing probability at 5, 10 and 40%, respectively.

Besides, figure prepared through calculation at 3% probability in 30-year term and that at 5% probability in 50-year term are nearly equal (Refer to **Figs.7b** and **8a**).

On the other hand, a number of figures shown at this time are nothing but examples. Many other variations are possible depending on needs in the user side. Shown in **Table 5** were possibilities of preparing various figures.

(2) Probabilistic seismic hazard map for deaggregated earthquake groups

The probabilistic seismic hazard map shows diversified features by variously changing 'term', 'seismic ground motion level' and 'probability' to be set. Another method to practically use this map is to divide relating earthquakes into every classification above mentioned. In this consequence, it becomes possible to compare necessities of countermeasures in dependence on classification of earthquakes.

Figs.9 and **10** were prepared based on **Fig.7** excluding Assumption of the Tokai Earthquake with extreme influence. Further these figures were divided into the following three groups of the earthquake: Namely, they were 'characteristic earthquakes of the major 98 active fault zones', 'subduction earthquakes excluding Assumption of the Tokai Earthquake' and 'earthquakes other than "characteristic ones of the major 98 active fault zones" and "subduction earthquakes" ' (**Figs.11~16**).

These figures were shown in couples with two kinds. Namely, by fixing the term to 30 years for the both, one showed distribution of probability while fixing the seismic intensity to '>= 6 Lower', and the other showed distribution of seismic intensity while

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[19] It is common in engineering fields to express a figure like **Fig.7b** by using terms 'probability of exceedance' as 'seismic intensity distribution with 3% probability of exceedance in 30 years'. By the way, the seismic ground motion level turns to have a width here caused by drawing figures by means of seismic intensity. (measured intensity was sorted by the rank). Therefore, probability became to have width '>= 3%'.

fixing the probability to '>= 3%'.

(In the case of excluding Assumption of the Tokai Earthquake)

By excluding Assumption of the Tokai Earthquake, influence shaken by earthquakes in the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu) becomes distinct among other earthquakes. Also, places where site amplification factor is high, shown in **Fig1b**, stand out.

(In the case of characteristic earthquakes in the major 98 active fault zones)

What give large influences on the region for preliminary version as the major 98 active fault zones are the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu), the same (Nambu), the Fujikawa-kako fault zone, and the Kannawa/Kouzu-Matsuda fault zone.

(In the case of subduction earthquakes except Assumption of the Tokai Earthquake)

Subduction earthquakes excluding Assumption of the Tokai Earthquake[20] include Kanto Earthquake[21], Tonankai Earthquake and Nankai Earthquake[22]. Orange or ocher color looks from vicinity marked Spot A in **Figs.13** and **14** toward southwest. Site amplification factor is high at these places in **Fig.1b**. Also, the earthquake causing this is found to be Tonankai Earthquake from **Fig.17** mentioned later.

(In the case of earthquakes excluding ' "characteristic earthquakes of the major 98 active fault zones" and "subduction earthquakes" ')

To such earthquakes, those in **Tables 2** and **3** shown in **Section 2-(1)** and 'earthquakes for non-specified seismic source faults in advance' shown in **Section 2-(2)** correspond, and influence of individual earthquakes is small. It is found from **Figs.15** and **16**, however, that seismic ground motion level >= 6 Lower can be brought by participation of many earthquakes of this kind. Earthquakes mainly causing this are those occurring in the Philippine Sea plate that is subducting north from Sagami Bay. It is understood from this that, countermeasures are needed against earthquakes other than the major ones anxious, too, next to them.

(3) Evaluation of contribution factor at sites in probabilistic seismic hazard map

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[20] The earthquake shown at the Special Survey Committee for the Tokai Earthquake, Central Disaster Management Council (2001).

[21] The large-scale earthquake occurring along the Sagami trough shown by the Expert Committee for Designating Areas to Strengthen Earthquake Disaster Management Measures, Central Disaster Management Council (1992). (Ex.:1923 Kanto Earthquake M7.9)

[22] The Tonankai and Nankai Earthquakes cited here are those shown at Earthquake Research Committee (2001b).

The probabilistic seismic hazard map enables to quantitatively analyze which earthquake gives larger influence on a particular site.

In the preliminary version, it is possible, with respect to a spot around the central portion (called 'Spot A'[23], hereafter) and a spot in the north (called 'Spot B', hereafter) of the region for preliminary version, to distinguish individual earthquakes and their kinds that are highly possible to cause seismic intensity >= 6 Lower (seismic ground motion level) within 50 years (term) hereafter (from 2002) and to analyze their relative weight (called 'contribution factor', hereafter,)(**Fig.17**). Here, the seismic ground motion levels are derived using an average site characteristic in a range of approximately 1km x 1km including Spots A or B, respectively. These are called 'region including Spot A' and 'region including Spot B', respectively, hereafter.

(For Spot A)

In the region including Spot A, probability of suffering a shock with seismic intensity >= 6 Lower within 50 years hereafter is >= 40% as found in **Fig.8c**, and major earthquakes causing this and evaluated result of their weight (contribution factor) are shown in **Fig.17**. According to this, it is found that one of earthquakes highly possible to bring seismic intensity >= 6 Lower within 50 years hereafter is Assumption of the Tokai Earthquake, but in addition, there are also those of the Itoigawa Shizuoka-kozosen fault zones (Hokubu and Chubu), Tonankai Earthquake, those of the Fujikawa-kako fault zone and those of the Itoigawa Shizuoka-kozosen fault zone (Nambu), (*cf.* **Fig.2** for positions of active fault zones and earthquakes). Regarding 'earthquakes other than the major ones', they are found to have a weight similar to Tonankai Earthquake when taking them as a single set.

(For Spot B)

In the region including Spot B, probability at which a seismic ground motion with intensity >= 6 Lower within 50 years hereafter is >= 10% as found in **Fig.8b**, and major earthquakes causing this and evaluated result of their weight (contribution factor) are given in **Fig.17**. In accordance with this, there are earthquakes of the Itoigawa Shizuoka-kozosen fault zones (Nambu and Chubu) as those highly possible to bring seismic intensity >= 6 Lower within 50 years hereafter, but in addition, there are also those of the Itoigawa Shizuoka-kozosen fault zone (Nambu), (*cf.* **Fig.2** for positions of active fault zones).

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[23] The preliminary version is that strictly shows a sample of a seismic hazard map in such a manner as preliminary set regarding long-term probability of occurrence or the like, and seismic intensity and probability of individual spots on each figure (in **Figs. 6~16**) of the preliminary version are not strict but show images. Accordingly, such names were used because it is not appropriate to treat 'Spot A' as a proper noun of innate name of municipalities. Similarity applies to 'Spot B', too.

4 For understanding probabilistic seismic hazard map

As mentioned in the beginning, the probabilistic seismic hazard map makes it possible to compare seismic risk (possibility to be caused by a strong ground motion) of various places and study seismic ground motion level in earthquake-resistant design of structures at specified regions. Conceivable application is described here.

Fig.6a shows distribution of 'probability' under fixed 'term' and 'seismic ground motion level', that is probability at which spots are caused by a seismic ground motion with intensity >= 6 Lower within 30 years hereafter, and orange and ocher colors show probability >= 3%. Whereas **Fig.6b** shows probabilities at which spots are caused by a seismic ground motion with intensity >= 5 Lower within 30 years hereafter, and the region for preliminary version is fully in orange color, showing a probability >= 6%.

Fig.7b shows distribution of 'seismic ground motion level' under fixed 'term' and 'probability', regions caused by seismic intensity >= 6 Upper at a probability >= 3% within 30 years is shown in orange color, while seismic intensity >=6 Lower in ocher color. **Figs.8a**, **8b** and **8c** similarly show those for 'a probability >= 5% within 50 years', 'a probability >= 10% within 50 years' and 'a probability >= 40% within 50 years'.

By comparing seismic risks standing on these evaluations, the probabilistic seismic hazard map is expected for the following applications in the future, taking better accuracy of prediction and regionally finer map into consideration:

- Related to survey and observation of earthquakes
  - Investigation of priority regarding the survey and observation of earthquakes
- Related to earthquake disaster counter measures
  - Investigation of priority regarding reinforcement of earthquake disaster counter measures
  - Investigation of object earthquakes for planning disaster prevention program
- Related to land planning
  - Investigation of siting location for various facilities included important ones
  - Evaluation of risk for industry siting
  - Investigation of guiding land planning
- Related to earthquake-resistant design
  - Study of seismic loading in standards for earthquake-resistant design at every region of facilities and structures
  - Data for making decision target of earthquake resisting capacity of individual facilities and structures
- Related to citizen residents
  - Advance of consciousness for seismic disaster prevention of citizen

5 How to advance the seismic hazard map hereafter

With respect to the probabilistic seismic hazard map, study of the following technical subjects has to be continued.

- Study on modeling procedure of 'earthquakes for non-specified seismic source faults in advance'.
- Study on superimposition procedure of 'earthquakes for specified seismic source faults' into the probabilistic seismic hazard map.
- Study on weighting method in constructing logic tree (Earthquake Research Committee, 2001a) when taking various considerations on the range of probable seismic source region.
- Study on handling procedure (setting of finish) of fluctuation in the 'attenuation relation'.
- Study on handling procedure of 'the other characteristic earthquakes in the major 98 active fault zones'.

It is also necessary to continue individually long-term evaluation and evaluation of strong ground motion with respect to characteristic earthquakes in the major 98 active fault zones and subduction earthquakes with a mind to prepare the Seismic Hazard Map in General View of the Whole Japan by aiming at the end of fiscal 2004 (Heisei 16th).

Further, Policy Committee (Subcommittee for Instituting Results in Society) has concluded to study on the ideal way of the 'Seismic Hazard Map in General View of the Whole Japan' that can be easily understood by the general public and practically applied to advance consciousness and countermeasures of earthquake disaster prevention from the standpoint of users since June 2002 based on this preliminary version (Subcommittee for Instituting Result in Society, Policy Committee, Headquarters for Earthquake Research Promotion, 2001). Earthquake Research Committee does prepare the maps based on these studied results.

As the next step hereafter, another preliminary version with enlarged region has been to prepared based on results above-mentioned. The next version is planned to be prepared with respect to a region centering the North Japan in 2002 (Heisei 14th).

References (In alphabetical order)

Earthquake Research Committee (1996): Survey and evaluation of Itoigawa-Shizuoka Tectonic Line Fault Zone, Publications of Earthquake Research Committee - July 1995 - December 1996 - ,pp.501-510 (in Japanese).

Earthquake Research Committee (1999): Seismic activity in Japan -regional perspectives on the characteristics of destructive earthquakes,395pp(in Japanese).

Earthquake Research Committee(2001a): Regarding methods for evaluating long-term probability of earthquake occurrence, 46pp (in Japanese).

Earthquake Research Committee(2001b): On the long-term evaluation of earthquakes in the Nankai trough, 52pp (in Japanese).

Expert Committee for Designating Areas to Strengthen Earthquake Disaster Management Measures, Central Disaster Management Measures(1992): Report on Expert Committee for Designating Areas to Strengthen Earthquake Disaster Management Measures, Central Disaster Management Measures (August 21, 1992) (in Japanese).

Headquarters for Earthquake Research Promotion(1999): The Promotion of earthquake research - Comprehensive basic policies for the promotion of seismic research through the observation, measurement, and survey of earthquakes -, 20pp (in Japanese).

Japan Meteorological Agency(1996): Seismic intensity - fundamental knowledge and practical use -, Gyosei, 238pp (in Japanese).

Special Survey Committee for the Tokai Earthquake, Central Disaster Management Measures(2001): Report on the Special Survey Committee for the Tokai Earthquakes, Central Disaster Management Council (December 18, 2001) (in Japanese).

Subcommittee for Evaluations of Strong Ground Motion(2001a): On strong ground motion evaluation methods of the Itoigawa-Shizuoka Tectonic Line Fault Zone(Northern,Central areas) as a putative earthquake generating fault(interval announcement) , 43pp (in Japanese).

Subcommittee for Evaluations of Strong Ground Motion(2001b): On strong ground motion evaluation methods for projected earthquakes in the Nankai trough(interval announcement) (December 7 2001)(in Japanese).

Subcommittee for Instituting Results in Society, Policy Committee, Headquarters for Earthquake Research Promotion(2001): Departmental announcements to apply results achieved by the Policy Committee to the public - To apply the results of long-term evaluations by the Headquarters for Earthquake Research Promotion - (in Japanese).

Subcommittee for Long-term Evaluations, Earthquake Research Committee(2002): Evaluation methods for earthquakes of which hypocenters are not specified (interim reports) (in Japanese).

Subcommittee for Survey and Observation plans, Policy Committee, Headquarters for Earthquake Research Promotion(1997): Fundamental seismic survey and observation plan, 38pp(in Japanese).

Matsuda, T.(1990): Seismic zoning map of Japanese islands, with maximum magnitudes derived from active fault data, Bulletin of the Earthquake Research Institute, University of Tokyo,Vol.165,pp.289-319 (in Japanese).

Table 1 'Characteristic earthquakes of the major 98 active fault zones' regarding regions for preliminary versions

Name of fault*	Long-term occurrence probability (30-year occurrence probability)**	Concept of adoption	Seismic ground motion level
Itoigawa Shizuoka-kozosen fault zone (Hokubu and Chubu; a segment including Gofukuji fault)***	14%	According to Earthquake Research Committee (2001a).	Evaluated in accordance with an empirical rule by standing on the magnitude value of about M8.
Itoigawa Shizuoka-kozosen fault zone (Nambu)	2.5% (preliminary setting)	For mean interval of activities tentatively set by standing on results of existing surveys and studies, Poisson process was applied for preliminary calculation.	Evaluated in accordance with an empirical rule by standing on magnitude value (M7.3) tentatively set based on the fault length.
Fujikawa-kako fault zone	0.20~11%	Probability (5.2%) was applied for preliminary calculation, which was obtained by using mean fluctuation widths of mean interval of activities and the latest active terms, according to Earthquake Research Committee (2001a).	Evaluated in accordance with an empirical rule by standing on the magnitude value of about M8.0.
Kannawa/Kouzu-Matsuda fault zone	3.6%	According to Earthquake Research Committee (2001a).	Evaluated in accordance with an empirical rule by standing on the magnitude value of about M8.
Other19 fault zones	(Individual influence on map region for preliminary version is small.)		

Note 1*: Names of faults taken from Earthquake Research Committee (1999).
Note 2**: Earthquake occurrence probabilities are values since 2002.
Note 3***: Names as 'the major 98 active fault zones' are Itoigawa Shizuoka-kozosen fault zone (Hokubu) and the same (Chubu)

Table 2 'Earthquakes occurring at active faults except the major 98 active fault zones' regarding regions for preliminary versions

Name of fault*	Long-term occurrence probability (30-year occurrence probability)**	Concept of adoption	Seismic ground motion level
Sone-kyuryo fault zone	0.6% (preliminary setting)	For mean interval of activities tentatively set by standing on results of existing surveys and studies, Poisson procedure was applied for preliminary calculation.	Evaluated in accordance with an empirical rule by standing on magnitude value (around M 7.0) tentatively set based on the fault length.
Ogiyama fault	0.4% (preliminary setting)		
Daibosatsu-rei Nishi-gawa fault zone	0.1% (preliminary setting)		
Tsurukawa fault	0.1% (preliminary setting)		
Other 23 faults	(Individual influence on regions for preliminary versions is small.)		

Note 1*: Names of faults are taken from Matsuda (1990). Listed faults are those located in Yamanashi Prefecture.
Note 2**: Earthquake occurrence probabilities are values since 2002.

Table 3 'Earthquakes occurring at the major 98 active fault zones except characteristic ones ' regarding regions for preliminary versions

Name of earthquake	Long-term occurrence probability	Concept of adoption	Seismic ground motion level
Earthquakes other than the largest ones at 24 fault zone* such as Itoigawa Shizuoka-kozosen fault zone (Hokubu and Chubu).	(Evaluation as 'earthquakes for non-specified seismic source faults in advance')		

Note 1*: Itoigawa Shizuoka-kozosen fault zone (Hokubu and Chubu) is counted as two active fault zones.

Table 4 Subduction earthquakes regarding regions for preliminary versions

Name of earthquake	Long-term occurrence probability (30-year occurrence probability)**	Concept of adoption	Seismic ground motion level
Assumption of the Tokai Earthquake	More than or equal to the occurrence probability of the neighboring Tonankai Earthquake.(preliminary setting)		Adopted assumed seismic ground motion of Special Survey Committee for the Tokai Earthquake, Central Disaster Management Council (2001).
Kanto Earthquake***	approximately 0.2% (preliminary setting)	Calculating on the basis of interval up to the following earthquake, shown by Expert Committee for Designating Areas to Strengthen Earthquake Disaster Management Measures, Central Disaster Management Council (1992).	Evaluated in accordance with an empirical rule by standing on the magnitude value of M7.9.
Tonankai Earthquake*	50% or so	According to Earthquake Research Committee (2001b).	Evaluated in accordance with an empirical rule by standing on the magnitude value of M8.1 or so.
Nankai Earthquake*	40% or so	According to Earthquake Research Committee (2001b).	Evaluated in accordance with an empirical rule by standing on the magnitude value of M8.4 or so.

Note 1*: Names of earthquakes are taken from Earthquake Research Committee (2001b).
Note 2**: Earthquake occurrence probabilities are values since 2002.
Note 3***: Large-scale earthquakes along the Sagami Trough (Ex: Kanto Earthquake in 1923, M7.9).

Table 5 Variation of preliminary version of probabilistic seismic hazard map (specific area)
(Possibility of preparing various figures)

1 Probabilistic seismic hazard map showing distribution of 'probability' under fixed 'term' and 'level of seismic ground motion'

Figs.6a and 7a
Probability of suffering a ground motion with seismic intensity >=6 Lower* within 30 years hereafter.

→

Fig.6b
Probability of suffering a ground motion with seismic intensity >= 5 Lower** within 30 years hereafter.
(Change of intensity)

→

Various terms (ex: 50, 100 and 300 years) or various seismic intensity (ex: >=6 Upper or >= 7) can be set. And as an index of seismic intensity, maximum acceleration, maximum velocity or response spectrum can also be utilized.

2 Probabilistic seismic hazard map showing distribution of 'ground motion level (intensity) under fixed 'term' and 'probability'.

Fig.7b
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 3% within 30 years hereafter.

→

Fig.8a
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 5% within 50 years hereafter
(Term & prob. change)

→

Fig.8b
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability>=10% within 50 years hereafter.
(Probability change)

→

Fig.8c
Map of regions suffering a ground motion>=a fixed seismic intensity with a probability >= 40% within 50 years hereafter.
(Probability change)

→

Various terms and probabilities (ex: 30 years 6% or 30 years 40%) settable.

↓ (from Fig.7b)

Decomposition 1
(Except earthquakes having eminent influence)

→

Fig.10
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 3% within 30 years hereafter (Excluding Assumption of the Tokai Earthquake)

↓

Decomposition 2
(Further decompose earthquakes depending on the group of earthquakes.)

Fig.12
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 3% within 30 years hereafter. (For only characteristic earthquakes of the major 98 active fault zones)

Fig.14
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 3% within 30 years hereafter. (For only subduction earthquakes excluding Assumption of the Tokai Earthquake.)

Fig.16
Map of regions suffering a ground motion >= a fixed seismic intensity with a probability >= 3% within 30 years hereafter. (Except 'characteristic earthquakes of the major 98 active fault zones' and 'subduction earthquakes***)

Note 1*: Here, expresses 'over measured intensity 5.5 (lower limit of 6 Lower)'.
Note 2**: Here, expresses 'over measured intensity 4.5 (lower limit of 5 Lower)'.
Note 3***: This applies to 'earthquakes of active faults other than the major 98 active fault zones' and 'those for non-specified seismic source faults in advance.