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A Comprehensive and Effective Earthquake Information System: Contributions to Earthquake Hazard Mitigation for a Local Government (4)

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Synopsis

So-called “Tottori project” has been carried out for these 3.5 years. As for this cooperative project, the earthquake researchers provide the detailed earthquake information to the administrative organs of Tottori local government. The outcomes obtained by utilizing actually are then fed back to researchers. The purpose of this project is to improve earthquake information to be more useful for actual society. Through the experience for 3.5 years, it was recognized that there were some discrepancies between the researcher side and the administration one. As the 21COE project was finished, we started to distribute a home-page of earthquake information experimentally.

Keywords: earthquake information, local government, earthquake disaster prevention

1. Introduction

As a research project of 21st century COE program, Research Center for Earthquake Prediction, D.P.R.I. of Kyoto University put so-called " Tottori project " into effect with Tottori prefecture. The origin of this project was the M5.3 earthquake occurred in the central part of Tottori prefecture in September 2002.

When a remarkable earthquake occurred, a local government was able to get seismic intensity information quickly at that time. So, the disaster prevention measures were supposed to be accomplished based on this information. But, it was difficult for a usual local government to get more detailed information about the successive seismic activity after that. Therefore, it was necessary to execute the effective measure in the so-called grope state after the occurrence of a remarkable earthquake.

The author and the director of the disaster protection service of Tottori prefecture discussed and made the following plan. First, the researcher side of the university offers detailed seismic activity information to the local government. The local government utilizes this information in earthquake disaster prevention program. By using those results of utilization, the university and the local government execute the joint research which improve earthquake information and communication technique to be more effective. This is so-called " Tottori project ".

This paper is a generalization of " Tottori project ".

2. Seismic activity in the western Japan and the earthquake of the central Tottori prefecture in 2002

At first, we look back to the historical major seismic activity in the western Japan (Fig.1). M7 class large

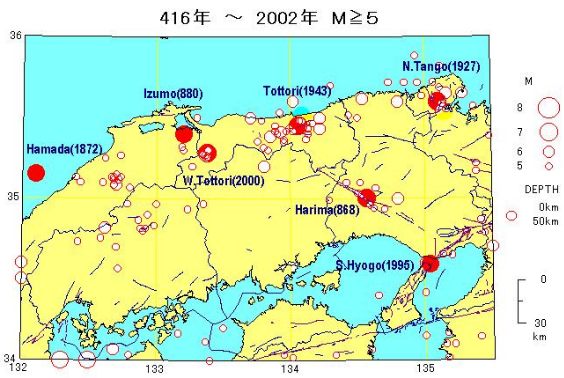

Fig.1　The earthquake distribution of more than M5 in western Japan from historical days to recent (by JMA data). Red circles show M7 class earthquakes.

earthquakes which appeared first in the area of Fig.1 were Harima earthquake (in 868 (Jogan 10), M>=7) and Izumo earthquake (in 880 (Gankei 4), M7), both after the chronological table of science. After them, for about 1000 years, any M7 class large earthquake had not occurred in the area of the figure until Hamada earthquake in 1872 (M7.1).

Following the occurrence of Hamada earthquake, the seismic activity started to be active again in the San-in coastal region. Tajima earthquake (1925, M6.8), northern Tango earthquake (1927, M7.3) and Tottori earthquake (1943, M7.2) successively occurred, and after them, Tonankai earthquake (1944, M7.9) and Nankai earthquake (1946, M8.0) which were the interplate major earthquakes occurred in the Pacific Ocean coastal area. These activity seemed to be the "Seismic activation in the southwestern Japan preceding the Nankai interplate major earthquake". After those two large interplate earthquakes, any M7 class large earthquake has not occurred in the western Japan for about 50 years.

Finally in 1995, southern Hyogo prefecture earthquake (M7.3) occurred, and in 2000, 5 years and 9 months later, western Tottori prefecture earthquake (M7.3) followed. Repetition of these M7 inland earthquakes makes us imagine the activation of inland earthquakes preceding the next Nankai major earthquake considered to occur in 21 mid-century.

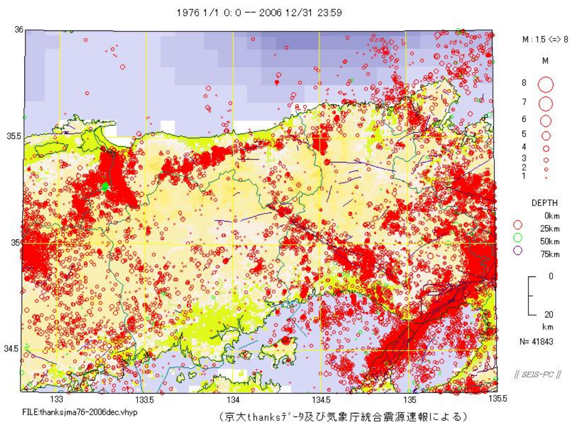

Fig.2 The earthquake distribution of the southwestern Japan for these 30 years (after THANKS data of Kyoto University and the JMA integration seismic catalogue)

In Fig.2, the seismic activity for these 30 years of the region is shown. Considering the historical seismic activity, the San-in coastal region is seismically active in recent 150 years.

Southern Hyogo prefecture earthquake in 1995 was an extreme catastrophe. The system and the direction of Japanese earthquake investigation have changed greatly taking advantage of this earthquake. On the other hand, each local government settled a disaster prevention plan for its own area and started to promote the administration for disaster prevention based on this plan. Under such conditions, a M5.3 earthquake occurred in the central part of Tottori prefecture on September 16th in 2002. Seismic intensity 4 was recorded in several points in the prefecture, and the local government of Tottori prefecture took the measures which appeared in the disaster prevention plan. The largest aftershock of M3.9 occurred on 19th, 3 days later from the main shock. But the head quarter of the prefecture could not get enough information about the aftershock activity, so the alert of Tottori prefecture had been continued about one month consequently. The author exchanged views with the director of the Disaster prevention Department of Tottori prefecture about the situation that it was difficult for a local government to get detailed seismic information. This was the beginning of this joint research project. Through such passage, the cooperative project described in the Introduction paragraph has started.

3. Execution of 21COE plan, "Tottori project"

A project plan " Center of Excellence for Natural Disaster Science and Disaster Reduction" was adopted as a 21st century COE program for D.P.R.I., Kyoto University. The Research Center for Earthquake Prediction carried out the project titled "Study of the comprehensive and effective earthquake information and its transfer to contribute the countermeasure of the local governments to earthquake hazard" (deputy: Prof. Yasuhiro Umeda, Director of R.C.E.P.) since fiscal year 2002. This plan was proposed based on the consultation with the author and the director of the Disaster prevention Department of Tottori prefecture about an earthquake occurred at the central part of Tottori prefecture in 2002. After we conferred with Tottori-prefecture on embodiment of this plan, "The written agreement about cooperation and coordination which affects earthquake disaster prevention" is concluded between the director of D.P.R.I. of Kyoto University and the director of the disaster protection service of Tottori prefecture on March 10th in 2003, and this plan has begun to move for implementation.

There are three reasons that Tottori prefecture was suitable as the counterpart of the above investigation plan. Those will be described simply. First, the inland seismic activity in San'in district has been active for these 150 years, including several M7 order big earthquakes. In particular, the Tottori earthquake occurred in 1943 brought great damage to this area. And the memory of the earthquake is still fresh among the people of this district. Tottori prefecture and the residence in this district are much interested about earthquakes. We thought that this interest was important and effective in execution of the plan. Next reason is as follows. Since the establishment of the Tottori microearthquake observatory in 1964, D.P.R.I. of Kyoto University has carried out the routine observation of seismic activity in the area from Kinki to Eastern Chugoku for these 40 years. So, we have a great knowledge about the seismic activity through this district. Finally, Tottori prefecture is always aggressive about earthquake disaster prevention and information disclosure.

We thought these factors were important and indispensable as the co-investigator of our study. Joint research project with Tottori prefecture was proposed by means of these reasons. We do not think that any other local government is suitable to promote this research. Because of the conditions described in the previous and this sections, an earthquake information system was installed in Tottori prefectural office and the project study started.

4. Earthquake information system

Seismic intensity information just after the occurrence of a big earthquake triggers the disaster prevention plan execution at that area. Therefore, this information should not include any indeterminacy nor investigational element. The main purpose of the earthquake information system established in Tottori prefectural office by this project is to indicate information which explain the usual seismic activity of the area, not to tell the urgent alarm in real time.
The block diagram of the system is shown in Fig.3. The information system consists of the following compositions. A satellite receiving antenna is installed on the roof of Tottori prefectural office and receives

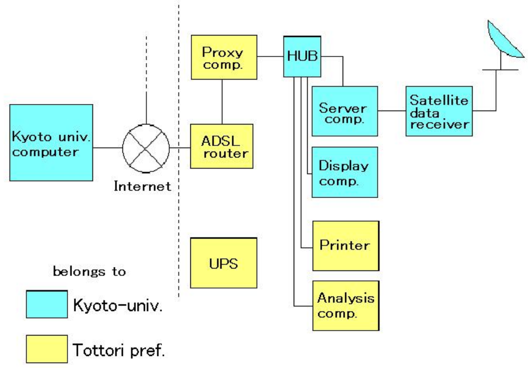

Fig.3 Block diagram of the information system. The equipments shown in the right part beyond the dotted line were established in the Tottori prefectural office.

the data of high-sensitivity seismic network delivered by E.R.I. of University of Tokyo. The results obtained by synthesizing both data received by the satellite and seismic information from D.P.R.I. of Kyoto University received via internet can be seen on the display at the Tottori prefectural office (Umeda et al.,2004,).

Displayed contents of the system are as follows.
1. Seismic activity (by designating area and period by selecting on the menu). Hypocentral distribution (An example is indicated in Fig.4.), space-time distribution, frequency distribution of earthquakes, accumulated number of earthquakes and M-T distribution can be seen.

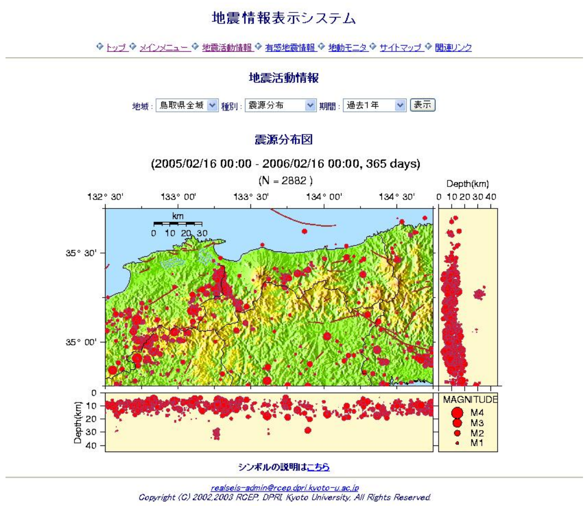

Fig.4 An example of hypocentral distribution

2. Information of felt earthquakes. The information from J.M.A. is indicated.
3. Monitor of ground motion (by designating the observation point and the time). Continuous record of high sensitivity seismometer at any seismic station can

be indicated by an LTR (long-term recorder) image (an example is indicated in Fig.5). Each line indicates the ground motion of 1 minute. 60 lines (i.e. one hour record) are shown in one page.

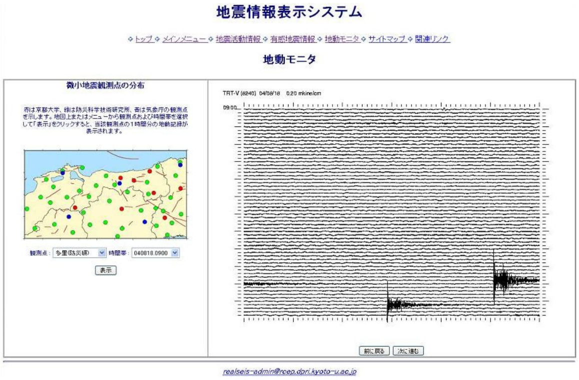

Fig.5 : An example of continuous ground motion

4. Link

Among the contents above-mentioned, monitor of ground motion is a significant information. By this displaying page, we can see a continuous ground motion of any observation point in semi-real time. In usual earthquake data processing, hypocenter determination is carried out only about the triggered events based on some standards. Therefore, those events which deviated from triggering judgment, for example, very small local earthquakes or peculiar events or tremors, are not compiled usually. But the monitor of ground motion is the whole continuous record, so this includes all kinds of ground motion information. By watching this record in detail, we can know a slight change of aftershock activity and a characteristics of seismic activity of the region and others. But in order to comprehend these seismic activity totally, seismological knowledge and experience of some level are needed. So, to use this information effectively, much appropriate explanation is needed. On the contrary, there is also an anxiety that such explanation gives some kinds of prediction. About this problem, we will describe later at the part of user questionnaire.

5. Situation of the practical use

Test practical use of the system started on March 18th in 2004 at Tottori prefectural office. As the system was in test use, the access right was permitted only for the staffs of Tottori prefecture, Kyoto University, Tottori University and several persons concerned (Turner,S.,2004).

For about 2 years and half period from the start of the system on March 18th in 2004 to the end on November 20th in 2006, any big earthquake did not occur around Tottori prefecture fortunately. This means, in other words, that there was no chance to utilize this system effectively nor to get much request from the administrative side about the contents of this information system. After J.M.A., the number of felt events at anywhere in Tottori prefecture during the above-mentioned period are shown for every intensity.

Intensity 1 : 40 times
Intensity 2 : 15 times
Intensity 3 : 5 times
Intensity 4 : once,
any more seismic intensity was not recorded.

Seismic intensity 4 was recorded by the earthquake at southeastern off Mie prefecture occurred at 23h57m September 5th in 2004 with M7.4, whose hypocentral depth was 44 km. This was a so-called distant big earthquake from Tottori prefecture. In other cases, there was not any influence to Tottori prefecture. Therefore, there were few chances for this earthquake information system to be utilized effectively.

We made a survey through questionnaire about this system on the staffs of Disaster Prevention & Crisis Management Division of Tottori prefecture in the period from December 2004 to January 2005, about 9 months after the system began its operation. The questionnaire was composed of 6 items and 1 additional question (Watanabe,K., 2005; Watanabe, K., 2006). An addition one was about the propriety of publication of earthquake prediction information. The questions are as follows.

Q.1 : Have you ever seen the earthquake displaying system installed at Tottori Office?
Q.2 : In what kind of situation do you see the system?
Q.3 : Do you have an interest in the contents of the system?
Q.4 : Are the displayed contents easy to understand?
Q.5 : Is the information useful for anything?
Q.6 : What kinds of additional information and improvement are needed for earthquake disaster prevention of a local government?
Additional Question : Earthquake prediction is practically difficult today. In this circumstances, if the reseachers get some kinds of irregular but indefinite phenomena, should they publish those

phenomena?

The number of answer was a few with about ten names, so there was no statistical meaning. Therefore, those answers are digested overall and the compiled result is enumerated in the following.

○About simplicity of the displayed contents:

*It's concise. Contents are classified into some items, so the required information can be picked out easily.

*Hypocentral distribution is easy to understand. The graphs shown in three dimensions are convenient.

*There is a lot of English indications. So an additional explanation page in Japanese may be useful.

*Comprehension of the ground motion monitoring is difficult. Explanation is needed.

○About the utility of information:

*It can be used for communication of the outline of seismicity with related organizations.

*As the seismically active area can be grasped, we can provide the useful information. The occurrence tendency, the seismically active area and the area where attension is needed can be known.

*Temporal activity change can be understood.

*It is difficult how the information should be utilized.

○About the point that should be improved:

*The explaining site of general knowledge about earthquakes is desirable. Interpretation of the past earthquakes is also preferable.

*The information about the tendency of earthquake occurrence in the area and the probability of aftershock occurrence are useful.

*The plain explanation by Japanese is expected.

*A local government often requires the information expressed numerically and in written form. The information contents illustrated both in tabular and graphical forms are desirable.

*It is preferable to list up the installed points of seismometers and intensity meters.

*It is useful to indicate the results of long-term prediction, the future's activity and suggestions for each active fault.

*The estimated information about the aftershock magnitude and place, as much as possible, is also preferable.

*After dividing the damaged area into small meshes, it is also useful to send detailed information (directions or recommendation of refuge etc) to each meshed area.

○Additional question : If some kind of information about earthquake prediction is recognized but not completely sure, should this information be released or not?

*There are no reasons to be undisclosed. By mentioning the specialist's opinion and also adding the explanation how the judgement has been got, disclosure of the information may be able to get general understanding.

*Fact should not be hidden intentionally, but should be published rather aggressively. It's a problem of personal consciousness how to catch that.

*If an information is called after an earthquake occurrence, it isn't useful any more.

*It would be significant to publish the consideration and explanation about the past earthquakes and about those expected from now on

*A local government is not a research institute, so it should not release those research problems under the name of the local government. If there is a question, the administration side can not reply any more.

The replied answers were those described above.

Generally speaking, the utility of the earthquake information system might be admitted. But, some items to be improved were proposed. Those were improvement of explanation, clear expression, digitization, tabular and written form etc.

It was shown clearly that the indeterminacy or discretion should not be matched with the administration side. There is consciousness among the researchers (the data supplier side) that it is important to offer the data resource without any prediction, in which all kinds of information are involved. On the other hand, when there is no suitable interpretation and specification about the information by a specialist, the administration side can not allow to use nor account that.

There is also another problem. On the institution side, one specific researcher is usually engaged over a long term. On the contrary, transfer of staffs is frequent in the administrative agency. Therefore, a local government requires a information which can be utilized without any specialist nor specific technology and knowledge. The difference between these two organizations will be a big factor in considering the utilization and donation of information.

6. End of the project and the information service in future

The 21st century COE project of a five-year plan, as scheduled, has been ended in fiscal year 2006. The satellite system that the researcher side had been used for storing and transmitting of high-magnification seismic data also ended its utilization at November, 2006. Therefore, this joint research project with Tottori prefecture also had no choice but to end with finishing of the satellite utilization. Looking back for these three years experience, it is obvious that detailed earthquake information is useful for the earthquake disaster prevention program of a local government. Both sides, administration side and researcher one, also expressed the expectation for effective utilization of the detailed earthquake information in future through the discussion held after being finished of the project. As a result of the argument, the researcher side has begun to produce a homepage with much contents beyond the former system. But there may be another problem in publishing the data circulated between researchers for investigation to polities and general public. Moreover, practical use of a home page is not accepted as a investigation at the university side, so there is also a problem who takes charge of managing a system like this. There are many factors still left in joint research between variety organizations that can not be settled by the personal effort.

Fig.6 Cover of the earthquake information home page

Level up of the social recognition about earthquake is important to distribute earthquake information widely. This is also the shortcut for information to be utilized effectively.

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自治体における地震防災に貢献する正確かつ役に立つ地震情報およびその提供手法に関する研究(4)

渡辺邦彦・橋本　学

要　旨

いわゆる「鳥取プロジェクト」は３年半にわたって実施された。この計画では、地震研究者が詳細な地震情報を鳥取県の行政側に提供し、行政による実際の使用の結果を研究者側にフィードバックする。こうして実際に役立つ地震情報を構築することが目的である。３年半の実験研究の結果、研究者側と行政側の視点にはいくつかの相違が点あることがわかった。２１世紀 COE 計画が終了したので、われわれは地震情報をホームページで公開する試みを開始した。

キーワード：地震情報、地方自治体、地震防災