

## Operational forecast of large event after major earthquake

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1. none

In a large-scale earthquake disaster, a large number of people stay in shelters, and some of them may lose their physical condition or may die away. Among the 6434 deaths of the Kobe Earthquake (1995), 919 persons are "earthquake related deaths" certified by local governments. In the Kumamoto earthquake (2016), more than half of the victims were "earthquake related death". The Japan Meteorological Agency has forecasted the probabilities for large aftershocks related to 15 major main shocks since 1998. The Earthquake Research Committee of Japan published the report "Information on the prospect of earthquake activity after a major earthquake" last year. In the information immediately after a major earthquake the message is "Please be careful about the same degree of earthquake for about a week in the strong ground motion area", in which they call warning higher than before.

Announcing the magnitude and intensity of earthquake underestimated may increase the human injury during the earthquake. On the other hand, excessive forecast may result excessive evacuation behavior and increasing the possibility of deteriorating health or death. In the forecasting information, it is required to minimize human injury, considering both of these aspects.

I will discuss here the operational forecast of events after a major earthquake. Some points are as follows.

Maximum event following the major earthquake

Fig. 1 shows the magnitude difference between the maximum event within the next 7 days and the preceding major shallow inland earthquake of M6.5 or larger listed in report. Only the Kumamoto earthquake case (black) the subsequent event was bigger than preceding one, and only 2 cases (gray) were of the same level (magnitude difference is 0.3 or less). It is reasonable that the response after the inland earthquake of M6.5 or higher is a conventional policy that calls attention to aftershocks one size smaller than the preceding major earthquake, and new policy has a large tendency of excessive attention and warning.

Probabilistic forecast

In the report it is written that low probability of the event is received as safe information, thus they quitted issuing the probabilistic forecast. It should be more desirable to explain frequently the people on media that a large event will occur at a reasonable rate, even if the probability is small. While aftershock activity is very active, it is questionable to repeat qualitative message without the probability of large event. Note that statistical testing is not able to applied for such qualitative information.

Representation of the risk

Probabilistic forecast is familiar to some people and very useful information, but for many citizens, it is unfamiliar and they do not know how to use it. The proposed forecast draft is concise and clear, but concrete is inferior to the conventional probability prediction. As another expression form, it is conceivable to display the maximum earthquake magnitude during the forecast period as a probability distribution. By looking at the result figure, it is easy to ascertain "How much is the maximum magnitude?" and "What is the forecast accuracy of magnitude?". In the weather forecast, the ordinary forecasts, precipitation probability forecast and high resolution precipitation now cast etc. are executed in parallel. As people who use earthquake forecast also have various purposes and methods, it is hopeful that the attention in sentence expression, the probability of large events, and the magnitude distribution of the

largest earthquake etc are presented in parallel.

#### Verification of forecast and improvement of model

It is necessary to verify and evaluate the results of forecast. The international commission examined the prediction of the L'Aquila earthquake (2009, Mw 6.3, more than 300 people dead) recommended about the method of earthquake forecasting for civil protection as follow;

Recommendation F1: Forecasting methods intended for operational use should be scientifically tested against the available data for reliability and skill, both retrospectively and prospectively. All operational models should be under continuous prospective testing.

Therefore it had better to test and to evaluate the earthquake forecasting results by the Japan Meteorological Agency.

Fig. 1. Magnitude difference between the maximum event in the next 7 days and the preceding major shallow inland earthquake of M6.5 or larger in Japan.

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