Number of earthquakes from seismic activity model of the national seismic hazard maps for Japan

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In this paper, as a part of the verification of the probabilistic national seismic hazard maps for Japan, we compare the earthquake occurrence ratio from seismic activity model in the national seismic hazard maps for Japan and that from earthquake catalog data.
As the number of earthquakes from seismic activity model of the national seismic hazard maps for Japan 2018 version, the expected value in 30 years is calculated for each magnitude and expressed by the cumulative number of earthquakes. The procedure is as follows.
1. For earthquakes with nonstationary seismic activity model adopted, set the probability of occurrence of earthquake in 30 years from January 2018 as the expected value of the number of earthquakes.
2. Earthquakes in Nankai Trough (M8-9 class), in Sagami Trough (M8-class), Mega-earthquake along the Kuril trench, and large plate-boundary earthquakes in Tokachi-oki and Nemruo-oki, the whole 30 years of the earthquake occurrence probability by the weight of each occurrence pattern as the expected value of the earthquake number in 30 years, respectively.
3. For the earthquakes in which the Poisson process is adopted, use the 30 year earthquake number based on the occurrence frequency of earthquakes.
Here, we prepare three datasets of cumulative earthquake number. The first is based on the “average case”, the second is based on the “maximum case”, and the third is based on the “averaged hazard” models.
For the earthquake catalog to be compared, we combine earthquakes with M 6.0 or more from 1885 to 1925 by Utsu (1982) and Japan Meteorological Agency earthquake data of M 5.0 or more from 1926 to 2010. At this time, aftershocks are removed according to the same rules as the national seismic hazard maps for Japan.
For shallow crustal earthquakes, the number of earthquakes from the model and the catalog are consistent at less than M 7.0 for the “average case”, and are consistent at less than M 7.7 for the “maximum case”. However, on a larger magnitude, there is a tendency for the model to have a smaller number of earthquakes. For earthquakes in Philippine Sea Plate, the number of earthquakes from the model and the catalog are consistent at M 8.0 and below. However, on a larger magnitude, the number of earthquakes in the model is extremely large. This is caused by the modeling of the large occurrence probability based on the time predictable model for the Nankai Trough earthquake. The number of earthquakes from the “average hazard” model decreases at M 8.0 or more. For earthquakes in the Pacific plate, the number of earthquakes from the model and the catalog are consistent at less than M 7.0. However, on a larger magnitude, the number of earthquakes from the model is somewhat larger. For M 7.8 and more, the model has changed based on the new long-term evaluation of earthquakes along the Kuril Trench by Headquarters for Earthquake Research Promotion of Japan, and the increase in number of earthquakes is also affecting.
On the other hand, when the period of the earthquake catalog is expanded until 2015, after the 2011 great Tohoku earthquake, the number of earthquakes from the model becomes smaller than that from the catalog for earthquakes in the Pacific and Philippine Sea plates. This is due to a large number of aftershocks and induced earthquakes of the 2011 Tohoku earthquake. How to incorporate the earthquake catalog after the great Tohoku earthquake into the seismic activity model in the seismic hazard assessment is a very important task.

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