Is it valid to apply time predictable model to the evaluation of Nankai Trough earthquake?

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A 30-year probability of earthquake occurrence along the Nankai Trough is evaluated as 70 ˜ 80 % in 2019 by the Earthquake Research Council on the basis of the time-predictable model by Shimazaki and Nakata (1980) (hereafter SN80). However, this is an overestimate. I list up several issues to be resolved.

There must be large observation errors in measurements of uplift during past events that are the basis of calculation of probability, but they are not considered. This led to erroneous evaluation of recurrence interval. SN80 used 1.8 m, 1.2 m, and 1.15 m for 1707 Hoei, 1854 Ansei and 1946 Nankai earthquakes, respectively, which is the basis of the estimate of recurrence interval. For the 1707 and 1854 events, they relied on the documents by Imamura (1930), who introduced an old document on measurements of tide in the Murotsu port before and after the events. However, there are no descriptions of the way of measurements, condition of weather and ocean, time and day which is essential to calculate solar and lunar tides, etc. There is another drawback that measurement was made 50 years after the 1707 event. Therefore, I suspect that there is large measurement error. For the 1946 earthquake, SN80 referred to Sawamura's (1953) results, which also suffered from similar errors. I simulate time series of uplift at Murotsu, with random errors of 10 cm for 1946 and 30 cm for 1854 and 1707, respectively. Expected time of occurrence of the next earthquake range from 2020's to 2050's. If we take these measurement error into account, the resultant probability must be reduced.

It is worth noting the inconsistency between average subsidence rate obtained by geodetic surveys and average uplift rate used in the time-predictable model. It is implicitly assumed that the uplift rate is proportional to the stress accumulation rate on the plate interface in the time predictable model. This is ˜13 mm/year according to SN80. In the framework of seismic cycle of interplate earthquake, stress accumulation rate can be estimated from the rate of vertical movement of overlying plate. In case of Murotsu, this is the subsidence rate of nearby benchmark, which is ˜ 7 mm/year with relative to that in Aki city. Data at the Muroto tide station also shows subsidence of ˜ 7 mm/year after 1970's. This large discrepancy between coseismic uplift and interseismic subsidence rates implies a significant residual uplift. If this subsidence rate has been unchanged during hundreds of years, we must have significant residual uplift, but we do not see such data according to Maemoku (2001). Furthermore, residual uplift may be plastic deformation and we cannot treat the data along the line of linear elasticity. Therefore, physical basis of the time-predictable model is problematic.

In the report of ERC (2013), there is a critisism that it is a contradiction to apply the time-predictable model to the entire Nankai Trough and the recognition of a wide variety of rupture patterns along the Nankai Trough. Other critisism such as Scholz (1990) was also mentioned in the report. Based on these critisisms, most scientists in the working group were against the adoption of time predictable model and recommended a renewal model using average recurrence interval. However, the discussion of scientists and practionists decided to adopt time predictable model.

Though it is regrettable that scientific discussion was not adopted, we cannot help accept the conclusion. Because we do not have scientific knowledges and there is a fact that shortest interval is 90 years, it may

be reasonable that countermeasures may be prioritized. However, the final report of ERC did not mention anything about this process and caused misunderstanding that the report was based purely on scientific discussions. It is strongly criticized that the process of adoption of final values, which is based on not only scientific discussions and but political ones, is not revealed in the report.

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