Probabilistic tsunami hazard analysis based on logic-tree approach

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Probabilistic hazard analysis is commonly used for seismic hazard, but rarely used for tsunami hazard. We propose a logic-tree approach to estimate tsunami hazard curves (relationships between tsunami height and probability of exceedance) and present some examples for Japan. The results will be used for quantitative assessments of the tsunami risk for important facilities located on coastal area.

In the logic-tree approach two kinds of uncertainty, aleatory and epistemic, are distinguished. Aleatory uncertainty is due to the random nature of earthquake occurrence and its effects. Epistemic uncertainty is due to incomplete knowledge and data about the earthquake process. A hazard curve is obtained by integration over the aleatory uncertainties. A large number of hazard curves are obtained for different branches of logic-tree representing epistemic uncertainty.

A probabilistic tsunami hazard estimate consists of tsunami source model and coastal tsunami height estimation. We developed the logic-tree models for local tsunami sources around Japan and for distant tsunami sources along the South American subduction zones. Logic-trees were made for tsunami source zones, size and frequency of tsunamigenic earthquakes, fault models, and standard error of estimated tsunami heights. Numerical simulation rather than empirical relation is used for estimating the median tsunami height. Some examples of branches in the logic-tree are illustrated in Figure 1.

Weights of discrete branches that represent alternative hypotheses and interpretations were determined by the questionnaire survey for tsunami and earthquake experts, whereas those representing the error of estimated value were determined on the basis of historical data. Examples of tsunami hazard curves were evaluated for the coastal sites, and uncertainty in the tsunami hazard was displayed by 5-, 16-, 50-, 84- and 95-percentile and mean hazard curves. The long-term stationary fractile and mean hazard curves obtained from local and distant tsunami sources for Yamada are shown in Figure 2.

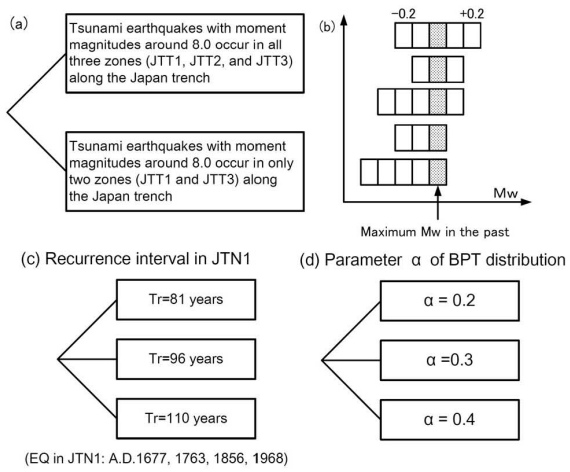

Figure 1. Examples of nodes in the logic tree

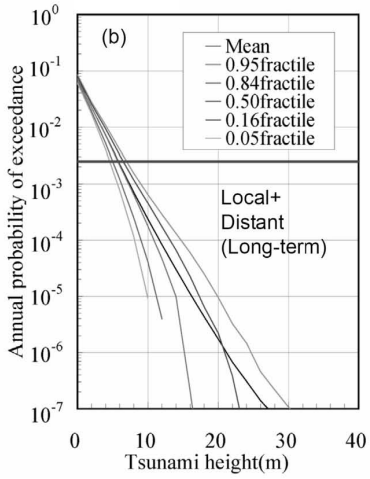

Figure 2. Example of tsunami hazard curves