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Sumatra Earthquake Disaster – Verification of the Method of Parameterization of the Character of Distribution of the Rare Major Events

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Routine statistical procedures are hardly efficient in the case of rare strong events because of a very limited number of observations. A few years ago a new approach to parameterisation of the distribution law of rare strong events was presented. This approach is based on a few assumptions that can be clearly displayed for the case of the seismic disasters. It is known that the distributions of the seismic moment, seismic energy and losses from earthquakes can be well approximated by the Pareto law with the density $f(M) \sim M^{-1-\beta}$, where $\beta<1$. But in the range of values, corresponding to rare strong events, the real distribution should differ from the Pareto law, since the latter leads to infinite mean value. As we had shown earlier, at the time intervals when the probability of occurrence of rare strong events is small, the typical values of cumulative sums S(t) of seismic moments, energy, and loss values increase with time in a non-linear manner, as t^{α} (where $\alpha \cong 1/\beta > 1$). The time moment Tc, when the non-linear regime of growth of S(t) changes to the linear one, corresponds to the cross-over point Mc separating moderate and strong events. The distribution of events with M<Mc obey the (truncated) power law with $\beta<1$, while the stronger events with M>Mc obey the unknown distribution law with a finite mean value. As a variant of this unknown law the Pareto law with $\beta>1$ can be suggested. The recurrence time of events of size Mc can be evaluated as Tc. Procedure of the robust estimation of parameters α, Tc and Mc was suggested. To characterize the slope of distribution law of the strong events with M>Mc the so-called Generalized Pareto Distribution (GPD) and the Gnedenko-Pickands-Balkema-de Haan theorem were used. Using the seismic moment Harvard catalogue data for 1977-2000 years this method of parameterisation was applied to a number of seismic regions. Using the data on losses the method was applied to the developed and the developing countries for the first and the second half of the XX-th century. Parameters obtained by this way were compared with tectonic characteristics and with the social and economical situation in the studied regions and a few new relations were revealed.

The data on major disasters after 2000 such as the great tsunami earthquake 26/12/04 allows to verify the plausibility of the method. Similar verification using the data on the strong events occurring before 1977 was carried out also, and a good agreement with the results presented earlier for interval 1977-2000 were obtained. Thus, the suggested method can be recommended as a general method for the evaluation of probability of rare strong events occurring in similar situations.