



The magnitude and frequency of energy released by geological hazards and the fatalities eventuated

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The magnitude-frequency relationships in all geological disasters, earthquakes, tsunamis, landslides and volcanic activities are summarized. A unified scale for comparison of geological hazards based on the source energy of the events is introduced. Furthermore, database of geological hazards that caused more than 1,000 fatalities during 1600-2012 was gathered based on various available datasets and literature. Among the four geological disasters, the greatest total energy-release has been for the volcanic disasters. Furthermore, the highest energy-efficiency of geological hazards to cause more than 1,000 fatalities, based on our database, has been for tsunamis.

Comparing the risk of geological hazard to human life, using FN-curves, we found that earthquake disasters are dominant disasters among the four disasters analyzed. Furthermore, the slope of FN-curves for all geological disasters is less than 1.0, which suggests that they are mainly controlled by large events. We also introduced a new risk factor (RF) which is conducted based on the parameters of the power-law characteristics of FN-curves. RF of earthquake disasters is the highest; the next most risky geological disasters are tsunamis, volcanic activities and landslides, in descending order.

Moreover, we showed that frequency of events with more than 1000 fatalities has increased significantly by factor of 0.004 since 1600, while there is no significant evidence of increase or decrease in the total energy-release by geological disasters and the energy-efficiency of the geological disasters.