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Geological and statistical aspects of seismically triggered landslide investigation for the sake of paleoseismicity study and estimating earthquake induced topography changes

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Earthquake triggered landslides are widespread phenomena in tectonically active mountain terrains. Each earthquake source creates a signature on the geology and the geomorphology of an area that is unequivocally related with the order of magnitude of its earthquake potential. A single earthquake event can induce up to thousands of landslides in a wide range of sizes. The most informative are the largest ones that can be preserved in arid climate for thousands years and can provide allusions to the Holocene paleoseismisity.

One of the major challenges of paleoseismogeological research is to build empirical relations between various categories of coseismic effects in the natural environment and earthquake magnitude. In our study due to broadening the data set up to 17-th earthquake we specify the coefficients of linear regression which describe the correlation between the earthquake magnitude and the total volume of triggered landslides. Using data on 14 strong modern earthquakes worldwide we have also calculated the correlation between earthquake magnitude and the volume of the largest triggered landslide. Contribution of moderate earthquakes to the topography changes was analyzed by the example of the 1995 Tunka earthquake (M=5.9) which show the negligible impact of such earthquakes on denudation. The contribution of aftershock triggered landslides to erosion becomes considerable for mountain provinces where aftershock activity doesn't fir Bath and Omori Lows. Thus statistical approaches form the basis for estimating the paleoseismicity and earthquake induced topography changes in case of failing seismological data and lack of historic accounts for the time period of about 104 years. In this work by three independent ways we have calculated the Holocene erosion rate due to seismically triggered landslides for the most active south-eastern part of Russian Altai.

These numerical estimations were verified by calculation of the volumes of the Holocene earthquake triggered landslides using method of detailed profiling. The topographical interpretation on the basis of air photos and detailed topographical maps certified by intensive field investigations were used for detection prehistoric seismogravitational dislocations. Accumulative bodies are cut by profiles to antiprisms. The base of landslide body is determined from morphology of unbroken slope and antiprism sectional areas are calculated from topographical or geodetic data. Studying of more then 70 seismically triggered landslides mapped within Kurai-Chuia active zone (Russian Altai) argues that the ratio of landslide volume to area suggested by Hovius et al. (1997) give the best fit for seismotectonic and climatic conditions of Russian Altai. This ratio is right almost for all types of earthquake triggered landsides except of spreads and flows that are extremely rare here and giant multievent and deep sited rotational landslides.

Obtained results as well as data from other active regions argue that main factors which control erosion due to seismically triggered landslides are earthquake magnitude and climate.