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Probabilistic mapping of co-seismic landslide hazard in Uttarakhand state (India)

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Probabilistic mapping methods are receiving more attention in the field of landslide susceptibility assessment due to their ability to incorporate the spatial and temporal uncertainties linked to the variability of hydrological, seismological, geological, geotechnical, and geomorphological parameters. Studies on the probabilistic seismic landslide hazard are necessary for Uttarakhand state (India) due to its high seismic activity. Therefore, the present research presents a probabilistic methodology to model the uncertainties associated with modified Newmark's model, which considers the shear strength parameters of rock joints for the static factor of safety computations. By using statistical distributions to describe these values, the uncertainties pertaining to the input parameters were taken into consideration. The Monte Carlo approach was used to simulate several probability density functions pixel-by-pixel, and the simulation results were carried over into the computation. As a result, when converting the obtained numbers into probabilistic hazard maps, there were no restrictions on the mathematical symmetry or complexity of the underlying distributions. The likelihood of seismically induced slope deformation surpassing a threshold of 5 cm was computed for each pixel and presented in terms of the hazard map. The Greater and Middle Himalayas had high probability values, highlighting the potential of earthquake-induced landslides in this area. Finally, the landslide inventory from the 1999 Chamoli earthquake was used to validate the results. The produced seismic landslide hazard map will provide local governments and infrastructure planners with a tool for assessing the danger of a seismic landslide for land use planning and applying suitable mitigation measures to limit the losses.