Mapping Rockfall Susceptibility across New Mexico at 1:750,000 scale

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We present two 1:750,000 maps that provide a first-order approximation of rockfall susceptibility for the state of New Mexico. The maps are intended for regional planning purposes and determining where detailed studies may be warranted. 'Susceptibility' describes the natural propensity (likelihood) of the landscape to produce rockfall given adequate driving forces. An essential input for these maps was a preexisting, statewide map of rockfalls produced by Cardinali et al. (1990) using aerial photography. This map has a bias towards larger rockfalls and captures only a fraction of the total rock falls in the state, but nonetheless it is assumed to be a statistically valid subsample of the total. The first susceptibility map shows the point densities of the mapped rockfalls of Cardinali et al. (1990), which are contoured using the kernel function. It may serve as a proxy for where large rockfall events may occur in the future.

The second rockfall susceptibility map relates mapped rock falls to nearby slope values. Using a 28 m DEM in ARC GIS, a slope map is created. We capture the maximum slope around a mapped rock fall point using a 300 m-radius window, which corresponds to the median of the error range in the mapped rockfall points. The average and maximum value of the slope within this window was obtained, but the frequency distribution curve for the average value is heavily skewed to low values, probably because most of New Mexico is relatively flat and spatial errors would result in a rockfall being on low-sloping ground. However, the maximum value within the window gave a quasi-normal distribution centered on a mean value of 29° and having a standard deviation of 12°. We chose to use these maximum values within the 300 m-radius window, with the assumption that most rock falls tend to accumulate on relatively steep talus slopes.

Using the mean and standard deviations calculated from the distribution of these maximum slopes, we categorize the aforementioned slope map into three susceptibility classes. "Likely susceptible" zones correspond to slopes lying at or above the mean-less-one standard-deviation (17°). Locally in this zone are rockfall-generating ledges and steep slopes allowing rockfall transport. "Potentially susceptible" zones correspond to slopes in the range of 8-17°, bracketed by the mean-less-one standard-deviation and the 5th percentile of the aforementioned maximum slope frequency distribution. This zone may have small rockfall-producing ledges; it also includes a 470 m-wide buffer extending downslope (on 5-17° slopes) of Likely susceptibility areas, designed to capture rockfalls having sufficient momentum to travel notably downhill of ≥17° slopes. The 470 m value corresponds to the 90th percentile (excluding outliers) of mapped rockfall distances from the Likely susceptible zone. "Unlikely susceptible" zones include very low slopes (<8°) lying outside of the aforementioned buffer. Final processing steps involved down-sampling to 500 m grid-size consistent with a 1:750,000 final map scale.

References:


Keywords:

rockfall, susceptibility, New Mexico, slope