



Modelling increased landslide susceptibility near highways in the Andes of southern Ecuador

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Mountain roads are affected by and also affect themselves landslide susceptibility. Especially in developing countries, inadequate drainage systems and mechanical destabilization of hillslopes by undercutting and overloading are known processes through which road construction and maintenance can enhance landslide activity within the immediate surroundings of road infrastructure. In the Andes of southern Ecuador, strong precipitation gradients as well as lithological differences provide an excellent study site in which the relationship between highways and landslide susceptibility and its regional differentiation can be studied.

This study uses Generalized Additive Models (GAM) to investigate patterns of landslide susceptibility along two paved interurban highways in the tropical Andes of southern Ecuador. The relationship of landslides to distance from road is modeled while accounting for topographic, climatic and lithological predictors as possible confounders and modifiers, focusing on the odds ratio of landslide occurrence at 25 m versus 200 m distance from the highway. Spatial attention is given to uncertainties in estimated odds ratios of landslide occurrence using spatial block bootstrap techniques. The GAM is able to represent nonlinear additive terms as well as bivariate smooth interaction terms, providing a good tradeoff between model complexity and interpretability.

The estimated odds of landslide occurrence were 18-21 times higher near the highway than at 200 m distance, based on different analyses, with lower 95% confidence limits always >13. (Semi-) parametric estimates confirmed this general range of values but suggests slightly higher odds ratios (95% confidence interval: 15.5-25.3). Highway-related effects were observed to fade at about 150 m distance from the highway. The results suggest that there may be local modifications of landslide susceptibility based on geological conditions, with increased occurrences in Holocene gravels and Laramide andesite/basalt.

Overall, landslide susceptibility near paved interurban highways was more than one order of magnitude higher than in areas distant from the highways.