

## Spatial landslide risk assessment in Guantánamo province, Cuba

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**ABSTRACT:** Within the Cuban national system for multi-hazard risk assessment, landslide hazard and risk have not been addressed thus far. This paper focuses on a method for landslide susceptibility assessment, its conversion into hazard, and the combination with elements at risk data for vulnerability and risk assessment. The method is tested in Guantánamo province, one of the areas with the highest incidence of landslides in Cuba. The GIS-based assessment was carried out with input maps at 1:100,000 scale or larger resulting in digital maps with 50 m pixel resolution. For the susceptibility analysis 12 factors maps were considered: geomorphology, geology, soil, landuse, slope, aspect, internal relief, drainage density, road distance, fault distance, maximum daily rainfall and peak ground acceleration. The relationship between these factor maps and the landslide inventory was analyzed using a combination of heuristic and statistical methods (Artificial Neural Network analysis and Weights of Evidence method). Five different landslide types were analyzed separately (small slides, debrisflows, rockfalls, large rockslides and topples), resulting in five susceptibility maps. Success rate curves were generated and analyzed to evaluate the predictability and to classify the maps. The susceptibility maps were converted into hazard maps, using the event probability, spatial probability and temporal probability. Return periods for different landslide types were estimated based on the main triggering events and geomorphological reasoning. The vulnerability analysis started with the generation of a provincial database with five elements at risk maps: number of inhabitants per house, essential facilities and non-residential buildings, roads, agricultural landuse and natural protected areas. The spatial landslide risk assessment was conducted by analyzing the 5 hazard maps and the 5 vulnerability maps. A qualitative risk assessment was carried out using Spatial Multi-Criteria Evaluation. Semi-quantitative risk assessment was done by applying the risk equation in which the hazard probability is multiplied with the number of exposed elements at risk and their vulnerabilities. In this paper only the results of the semi-quantitative assessment of population risk are presented and briefly discussed. The study was able to identify high risk areas and the main causes derived either from high landslide hazard or from high spatial concentration of element at risk in Guantánamo province. In order to derive a quantitative estimation of risk more information should be available on temporal probability and vulnerability. Both of these require an extensive landslide database which should be implemented and maintained at the national level.