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Spatial representation and volumetric mapping of block falls using GIS-based decision-tree models

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Among the various natural hazards, mass movements (MM) are probably the most damaging to the natural and human environment in the Mediterranean countries, including Lebanon which represents a good case study of mountainous landscape. Although affecting vast areas in the country, the phenomenon was not studied at regional scale, and related maps are still lacking. This study focuses on building decision-tree models for mapping the volume of block falls in a study site (762 km^2,8% of the Lebanese territory) within Lebanon using remote sensing and GIS. Satellite imageries (IKONOS 1m) helped in discriminating existing block falls, while GIS was used to extract ordinal (elevation, slope angle, slope aspect, slope curvature, proximity to fault line, distance to the drainage line, proximity to roads) and nominal (lithology, karst type, soil type, land cover/use) variable terrain parameters. Decision-tree models were constructed based on different input terrain parameters; (1) all terrain parameters, (2) topographic parameters only, (3) geologic parameters only, and adopting various processing techniques (pruned and unpruned trees). The most powerful model proved to be the regression unpruned (exploratory) tree-model based on all considered parameters explaining correctly 86% of the variance in the trained data. Once pruned, this model classifies 50% in block falls volumes by selecting just four parameters (lithology, slope gradient, soil and land cover/use). The unpruned model built using only 4 geological parameters (lithology, soil type, proximity to fault line, and karst type) seems interesting, since it is created using similarly 4 parameters, but it has a higher

predictive accuracy (68%). The highest predictive decision-tree model was converted to quantitative 1:50,000 block falls' map with six classes; nil (class 1) indicating the absence of block falls, very low volume (class 2 – volume being less than 1000 m^3), low volume (class 3 – volume ranging between 1000 and 2000 m^3), medium volume (class 4 – 2000 m^3 $<$ volume $<$ 3000 m^3), high volume (class 5 – 3000 m^3 $<$ volume $<$ 4000 m^3), and very high volume (class 6 – volume $>$ 4000 m^3). This map can be used to prioritize the choice of specific zones for further measurement and modelling. It is extremely useful fitting management needs and helping in the adoption of measures to reduce the occurrence of harmful block falls, specifically in 18% of the studied area with block falls' volumes exceeding 2000 m^3.