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2D and 3D rockfall simulations of a real-size experiment on weathered volcanic hillslopes in Tahiti, French Polynesia

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The Land Planning Authority of French Polynesia contracted BRGM to run a real-size rockfall experiment, called OFAI, in September 2009. The purposes of the experiments are two fold : first observe real-size rock trajectories in a context of variably weathered volcanic rock slopes; and second, use observed rockfall trajectories to calibrate block propagation models. 90 basalt blocks were dropped down a 150-m-long slope made of hard basalt veins, lenses of colluvium and erosion channels covered in blocks of various sizes. Parameters of the experiment concerned the shape (from nearly perfect sphere to elongated cubes) and mass of the blocks (from 300 kg to >5000 kg), and the launching point, in order to bounce the blocks both off stiff basalt veins and colluvium lenses.

The data obtained from this real-size experiment were analyzed using two rockfall simulation models: a 2D model developed by the University of British Columbia, the Geological Survey of Canada and BRGM, and a 3D model which was developed from the 2D model, with the purpose of integrating the lateral dispersion of rockfalls. Both models are characterized by a “hybrid approach” with a lumped mass assumption, taking indirectly the shape and rotational momentum of the block into account. Bouncing is simulated using soil restitution coefficients and plastic impact model (Falcetta, 1985). The input data are defined by probability density functions, thus allowing for both deterministic and probabilistic analysis. Usually calibrated with rare and punctual rockfall events, this recent experiment gave us a complete inventory of real 3D trajectories, associated with precise descriptions of the blocks (mass, shape) and accurate geomorphological characteristics of the impact points, so as to assess the performance of both models. The aims of the simulations were (i) comparing real trajectories to the simulated ones and evaluating their reliabilities (ii) calibrating material parameters for weathered volcanic tropical soils (iii) measuring the benefit from the 3D approach compared to 2D analysis. Limits and further improvements on the models are discussed; especially, the major influence of the spatial resolution of the Digital terrain model (DTM) was clearly highlighted.