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# Application of Random Walks Model and Derministic Debris Flow Routing in the Assessment of Sediment Yield in a Catchment Scale.

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## 1. Introduction

Beyond the potentiality of shaping landscapes and changing rivers morphodynamics, the interplay of landslides and debris embody devastating features. The eroded and transported materials sometimes reach impressive volume during heavy rainfall, enhancing in such circumstance the vulnerability of downstream settlements.

More often than not, the incipient motions of sediment during these extreme events is triggered by slope failures. The capability to reliably assess the erosion and deposition processes and the overall sediment yield in the catchment depends on our capacity to estimate the volume of sediments stemming from landslides.

Since several decades, questions regarding the location, timing and size of the landslides have been largely investigated. Despite the progress made so far, most of developed models focus more on landslides susceptibility mapping rather than the process of sediment transport after slope failures have occurred. It is in this framework that this preliminary study has been conducted. An infinite slope model coupled with hydrological process has been used to map zones of sediment volume initiation. Afterwards the sediment routing has been carried out with a random walks model.

## 2. Methodology

The infinite slope has been modified to account for the effect of group failure. In the real field, the failure of one hillslope may compromise the stability of its surroundings. The approach proposed by Van den Bout et al. has been modified according to a 1D stream flow topology, mapping relation between each cell with its corresponding upstream cells (Figure 1).

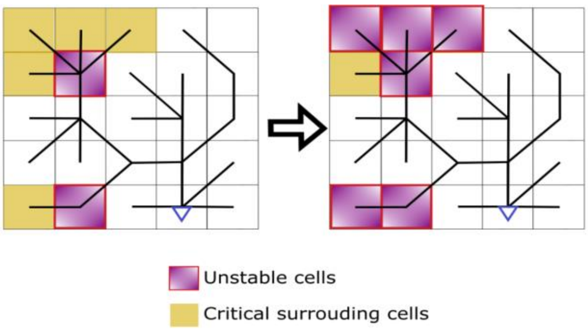


Figure1: Treatment of failure of group of cells.

The random walks have thus been applied to route sediments from their initiation location. The calculation process is similar to the one described by Gamma(2000). Possible pathways for each cell are given by:

$$N = \left\{ n_i \left| \begin{cases} \gamma_i \geq (\gamma_{max}^{a}) & \text{if } 0 < \gamma_{max} \leq 1 \\ \gamma_i = \gamma_{max} & \text{if } \quad \gamma_{max} > 1 \end{cases} \right. \right\}$$

$$\mathrm{i} \in \{1,2,4,8,16,32,64,128\}; \qquad a \geq 1$$

$$\gamma_i = \frac{\tan \beta_i}{\tan \beta_{thres}}$$

## 3. Results and Discussion

The output of the above model (Fig.2) has been applied to a catchment located in Kyushu and rainfall conditions correspond to the heaviest downpours that occurred in July 2017 in that area. The number of slope failures are less compared to observed data. This is particularly due to constant soil parameters allocated throughout the catchment, especially the soil depth, taken equals to 1m, and which largely affect the calculation of the safety factor.

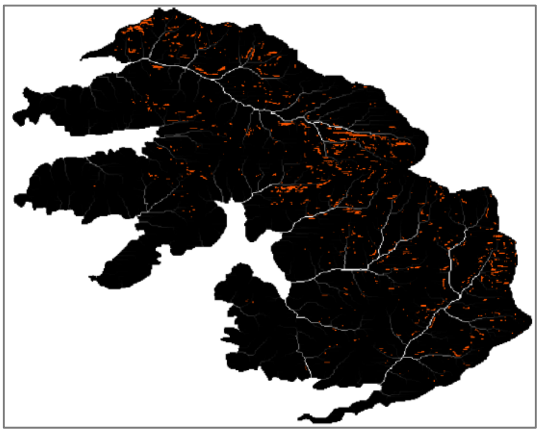

Figure2. Location of Slope failures in red.

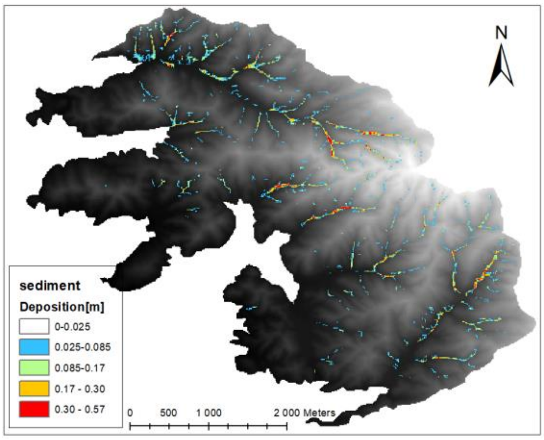


Figure 3. Spatial distribution of sedimentation

For each cell, a walk distance was set to 1.5km. The slope threshold denoting the talus angle is 20° while the factor of inertia is taken equals to 1.3. Other parameters are described in Gamma(2000).

The sedimentation occurs once the displaced mass attains a velocity less than 8 m/sec.

These results will be compared with a physically based debris flow model considering the same initial

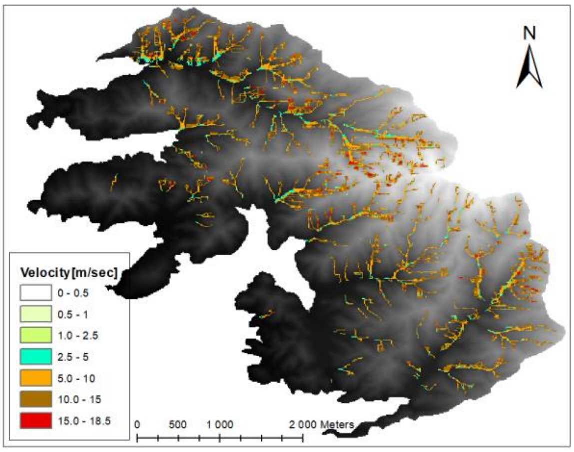


Figure 4. Velocity distribution

conditions. This will allow to calibrate the random model and assess its effectiveness in the determination of sediment yield during extreme precipitations.

**4. Reference**

1) van den Bout, B., Lombardo, L., van Westen, C. J., & Jetten, V. G. (2018). Integration of two-phase solid fluid equations in a catchment model for flashfloods, debris flows and shallow slope failures. *Environmental modelling & software*, *105*, 1-16.

2) Gamma, P. (2000): Dfwalk — Ein Murgang-Simulationsprogramm zur Gefahrenzonierung. Geographica Bernensia, G66, 144 (in German).