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Reply on CC1

Natalie Brožová et al.

Author comment on "Multiscale analysis of surface roughness for the improvement of natural hazard modelling" by Natalie Brožová et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-85-AC3, 2021

Dear Sebastiano Trevisani,

Thank you for your comments to our paper. Regarding the points you highlighted we addressed and discussed them below.

1. Directional roughness lines 103-104 and 108-109

Thanks to your comment and after a literature review involving the directional roughness we will rephrase the following sentence

Lines 103-104 “Some attempts to calculate the roughness along a given direction have been made, but they have not yet been applied to large-scale hazard mapping (Michelini, 2016; Trevisani and Cavalli, 2016).”

“However, the investigated natural hazards have a predominant diffusion direction identified as the combination of terrain slope and curvature. Some studies implemented the surface roughness along a predefined direction (Michelini, 2016; Trevisani and Rocca, 2015). The direction for which roughness has been computed, usually derived through GIS algorithm (D8 or D-infinity), applied to the original or smoothed elevation models. However, the direction derived through neighbourhood cells analysis is not always equal to the direction of the mass flow propagation. Such behaviours are sometimes observed when the routing volumes are extreme and therefore in some particular situations the propagation direction may be defined by its inertia rather than the topography (Guo et al., 2020). In other cases, the particular mountain topography may force mass flows to affect the opposite hillside of the valley through a runup mechanism (Iverson et al., 2016). Furthermore, the flow direction of banks and channel sides features computed with GIS algorithms do not usually correspond to the mass flow direction. In this situation bank direction can be improved through a smoothing process of the DTM in order to remove gullies and channel from the basal topography. This technique can be easily applicable in case of regular channels but it could become more complex when the channel morphology is irregular, since it could oversimplify the basal topography. For such reasons in this study, we propose a novel approach to calculate surface roughness along user defined lines.”

As reported in the method section (lines 264-274) we developed a new directional roughness algorithm where the flow direction is established by the user through geospatial polylines. We then calculated the roughness as the standard deviation of the residual topography for the cells identified by the flow direction in the 3x3 moving window. As reported in the sentences above the manually identified flow directions can be more reliable with respect to the direction derived from a neighbourhood cell analysis, in case of particular routing mass flow behaviours. However, the flow direction can also be computed through a GIS algorithm and then used in the directional roughness algorithm reported in our study. Furthermore, we increased the number of directional roughness computation to 16 in comparison to the commonly used eight directions (D8 algorithm). For the technical implementation of the algorithm, we refer to the script available at the following link: https://github.com/TommBagg/terrain_roughness_GRASS.

2. Selection of the roughness indices

In our study, we considered the most commonly used roughness indices for hazard modelling. We selected the roughness derived through standard deviation and vector dispersion approaches applied in a certain moving window. In this way, the roughness algorithms we analysed can be directly applied to available elevation models.

We further integrate the paragraph involving the roughness algorithm selection. We therefore modified lines 177-180.

"In order to describe the roughness, which consists of both geomorphological features and vegetation, we selected and tested seven algorithms using high-resolution DSMs. We selected widely used roughness algorithms already applied in the context of natural hazard modelling (Bühler et al., 2013; Crosta and Agliardi, 2004; Pfeiffer and Bowen, 1989; Veitinger and Sovilla, 2016; Wang and Lee, 2010). They are based on standard deviation and vector dispersion approaches calculated in a certain moving window. We then tested them with different spatial resolutions (0.1 m, 0.5 m and 1 m) and moving window areas (9 m^{-2}, 25 m^{-2} and 49 m^{-2}) on both study areas. The selected algorithms are summarized in Table 1."

3. Reference of the standard deviation of residual topography

Thanks for this observation. We will change the reference in line 204 from "Trevisani and Cavalli, 2016" to "Cavalli and Marchi, 2008" as you suggested.

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