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Comment on nhess-2021-85

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Community 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-CC1, 2021

Dear authors,

the paper is interesting and addresses important topics related to earth surface processes. However, some sentences in the paper, in my view, should be rephrased to furnish a wider perspective to the readers, especially concerning roughness and its evaluation.

A first point is related to flow directional roughness, as expressed in these two sentences:

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).”

Lines 108-109: ” (3) Is it possible to improve the roughness calculation by introducing a directional roughness along the predominant mass flow direction?”

Being one of the authors of the cited paper (i.e., Trevisani and Cavalli, 2016) and having worked directly to the implementation of the surface roughness algorithms, as for example the indices based on the median of absolute directional differences (MAD, Trevisani and Rocca, 2015), I feel useful to furnish some more information to the readers.

The algorithm of flow-directional roughness presented in Trevisani and Cavalli 2016 (https://esurf.copernicus.org/articles/4/343/2016/) is fully working, even if a prototype, and can be applied at any scale, any resolution and for any given task, including natural hazards. In the cited study, for example, the algorithm has been applied to an area of 500 km2 with a LiDAR derived DTM (2 m pixel size); in general, there are no limitations for the size of DEM (i.e., it depends on available computational resources and to the given implementation). In that paper, we applied it as a coefficient in the sediment connectivity evaluation (Cavalli et al., 2013) and as a geomorphic tool for distinguishing morphologies using differences between isotropic and flow-directional roughness (e.g., for individuating gullies, landslide scarps, etc.). Consequently, to your question “Is it possible to improve the roughness calculation by introducing a directional roughness along the predominant mass flow direction?” the reply is “yes”, as demonstrated in the cited paper. Clearly, that one is not the only possible approach and could be improved, but it seems to work well and put the basis for further developments.

The algorithm used in the paper is based on the MAD algorithm implemented as ArcMap tool and available in Github (see Trevisani and Rocca, 2015). The implementation is straightforward and can be implemented in other environments working with kernel based approaches for image analysis (e.g., Envi, raster package in R, Surfer, google earth engine, etc.).

The second point is related to the calculation of roughness indices e.g. line 107:

"(1) How well can different surface roughness categories be distinguished with the selected algorithms? "

I think that in the paper it could be important to highlight further that you tested standard approaches for roughness calculation and others have not been considered. For example, the MAD algorithm (applicable both for roughness calculation as well as for image analysis) has been developed with 3 main ideas in mind. The first, as a development from variogram based approaches (and with analogies to Local binary pattern and gray-level co-occurrence matrices), is to accept the fact that the surface roughness (or the synonym: surface texture) is a complex entity and that there are multiple aspects of surface roughness/texture that can be computed at multiple scales (e.g. anisotropy, short-range roughness, relative roughness, etc.). The second was to overcome some of the issues inherent to roughness measures such as the variogram and the standard elevation of DEM derivatives (residual topography, slope, etc..) that are affected by nonstationarity in data and by the presence of outliers. The third, was to create indices easy to interpret according to studied processes. Accordingly, as reported in Trevisani and Rocca 2015, even the short-range isotropic roughness calculated with MAD works much better than the standard deviation of residual relief or the one estimated with a variogram-based approach. Finally, the basic idea of that algorithm could move on further with the development of more complex approaches such as the capability to adapt locally to the "wavelengths" of morphologies (with similar approaches to Lindsay et al., 2019) or detecting curvilinear structures via multipoint statistical indices (e.g., Mariethoz, G. & Lefebvre 2014).

In the paragraph "This approach is widely used because it can be applied to different data types, such as point clouds (Vetter et al., 2012), satellite imagery (Gille et al., 2000; Schumann et al., 2007) and DEMs (Glenn et al., 2006; Trevisani and Cavalli, 2016)." I suggest changing "Trevisani and Cavalli, 2016" with "Cavalli and Marchi, 2008", because it is one of the first applications of standard deviation of residual DTM to LiDAR-based DTMs.

Sincerely,

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