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Hydrology and Earth System Sciences Discussions

Interactive comment on "A new method for determination of Most Likely Initiation Points and the evaluation of Digital Terrain Model scale in terrain stability mapping" *by* P. Tarolli and D. G. Tarboton

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The paper concerns the prediction of most likely initiation points of shallow landslides by using SINMAP and its stability index. The authors aim to validate their approach by applying it on a specific area and to evaluate the effectiveness of the method also with respect to the resolution of the topographic data (LIDAR) Following the development of the manuscript the first observation that can be done is relative to the partial review of the literature concerning this specific subject. Very few references are cited and mostly relative to the same type of approach proposed by the authors. No mention is made to other papers presented in the literature concerning the same type of problems but

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analysed with a different approach (e.g. Iverson, 2000). In the introduction the authors rise a major point concerning the cell size of the used DTM and observe that small pixels are generally associated with larger slope angles which control the groundwater flow. This is true but it can be considered also in a different way. Smaller cell sizes are associated to larger slope angles and these controls the inclination of the failure surface. In the infinite slope approach the slope angle is assumed equal to the inclination of the failure surface and so it strongly controls the results in terms of factor of safety. This assumption is not correct at very large scales (i.e. small cell size) when local morphological features are independent by the failure surface or soil/bedrock contact surface. Furthermore, it is not theoretically correct because the method (Skempton and DeLory, 1957) explicitly assumes an infinite slope, so a continuous slope with constant topographic gradient. The study area is the 10 km2 Miozza catchment (Italian Alps) where the authors mapped some recent landslides. The landslides are mapped without a subdivision between source and transport or deposition sectors and the DTM is relative to the post failure condition (see figs. 2 and 3). This is a major point that need to be discussed together with the fact that no distinction among different landslide types (rotational, translational, etc.) is done, and that both erosion and landslide areas are grouped together, and that no description of their size is given. The analysis is performed on a DTM which allows the computation of post failure slope inclination values. The slope will be quite different from the original pre failure value and the highest inclinations will be observed in coincidence of major scarps or close to the toe of the slope where torrent erosion can act directly on the landslide accumulation. As a consequence we expect that most of the unstable areas will be located close to these features. The vegetation cover varies within the area, according to what is stated in the setting paragraph, and probably also the soil physical mechanical characteristics as well as the soil thickness are not constant in the area. These properties controls directly the slope stability results and so the assumption of a random value within a certain range is not the best approach if not supported by at least some field observations. This point and its influence should be discussed in the paper and especially in the dis-

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cussion also describing if rock outcrops or similar areas have been eliminated from the analysis. Coming to the analyses, the authors use the Stability Index computed by SINMAP to individuate the MLIPs. Four values are suggested as SI thresholds: 0.2, 0.5, 1 and 10. The highest threshold value correspond to a safety factor of 10. Considering the uncertainties involved in the approach and in the data collection a much lower value higher that one could have been chosen. In engineering practice a value ranging between 1.3 and 3 could have been considered more significant and representative of the uncertainties. The results are presented in terms of distribution of the MLIPs within the mapped landslides and as percentages of area with SI less than the specified threshold value. If we look at the map in figure 10, showing both landslide polygons and MLIPs, we observe that the most unstable zones are sometime in coincidence of the landslide scarps and sometime at the slide toe or in coincidence of small drainage lines within the landslide polygon. This suggests that the model is performing well in recognizing steeper areas, often coincident with post failure morphologies, and a comparison with a simple slope gradient map could be useful to understand what are the controlling factors. So the relatively good performance of the model is influenced directly by the instabilities that have been mapped both from aerial photos and LIDAR survey. Finally, the use of MLIP seems appropriate for some type of landslides (shallow slide/debris flows) and for some kind of slope morphology (e.g., relatively short slopes), but cannot be generalized. In fact, some problems do exist: the possibility that shallow landslides initiate, during one or multiple events, at different positions along a unique flow line; the uncertainty introduced in the parameters is not consistent with the idea of identifying single MLIPs (i.e. the real initiation point could be in a different cell from that simulated as the most unstable); the MLIP approach can give contradictory results because it promotes as initiation points cells with a SI higher than other cells, not considered as critical, because they are not the minimum along a specific flow line.

Concerning the tables, I personally think that Table 1 (and fig. 4) with LIDAR specifications is not so relevant. Table 2 and 3 seem to suggest that, excepted for some cell sizes, the model is unable to discriminate or improve its performance being the output

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values equal for any threshold value. Furthermore, this does not tell us if the pixels considered as critical are located always in the same positions. Figures 7 and 8 are already presented together in figure 9 so they can be eliminated. Figure 11 and 12 are quite peculiar cases where the MLIPs correspond exactly to the landslide scarp. This seems to demonstrate the capability of the model but at the same time suggests tha the model is only recognizing steeper slope sectors.

References: could be completed see for example Iverson (2000), Barling et al (1994) and other references could be found easily in the literature

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 395, 2006.