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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

Anonymous Referee #3

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Review of "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

General comments

This manuscript describes a terrain analysis technique that can be used to further refine the results of regional slope-stability modeling and facilitate the comparison of results with landslide inventories. The rationale for developing the technique is that landslide inventories often do not adequately define the spatial distribution of "landslide initiation locations" because those who map landslide inventories typically do not dis-

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tinguish between source areas, travel paths, and deposits. Results of several SINMAP analyses applied over a LiDAR-derived digital elevation model (DEM) with varying grid-cell resolution are presented for a small catchment in the northeastern Italian Alps. The authors conclude that the technique increases the accuracy of the SINMAP analyses when compared to mapped landslide inventories and that DEMs with a grid spacing of less than 10 m provide little improvement in SINMAP results.

The Most Likely Initiation Point (MLIP) technique identifies the cell with the lowest SINMAP stability index along a flow path. This cell is then interpreted to be the point where the landslide was initiated. The authors assume that steady solutions for the hydrologic response to rainfall infiltration coupled with an infinite-slope stability calculation applied over a grid-based digital terrain are adequate to identify shallow landslide source areas. Iverson (2000) has shown that the assumptions of steady, slope-parallel flow are a suitable approximation for assessing slope stability only if several, quite restrictive, conditions are met (e.g. rainfall of low intensity and very long duration, shallow depths, and strongly anisotropic hydraulic conductivity of hillslope materials). The authors make no attempt to address these restrictions nor do they mention Iverson's (2000) criticism of this approach.

Because the first-order control on shallow landslide location is topographic slope, topographic index models such as SINMAP may capture significant portions of shallow landslide inventories. It seems that in this application, the MLIP technique is simply SINMAP squared and provides little additional insight into the spatial distribution of shallow landslide occurrence. The MLIP technique may be useful for refining the results of other regional slope stability models; however we are unable to evaluate its utility because we are only given SINMAP results.

Results from the comparison of elevation model grid spacing are potentially interesting and useful. The DEMs of the study area were apparently created from LiDAR point data with significant gaps (5 to 7 m) between some points. Given that the data were collected using a helicopter traveling at 80kts 1000 m above the ground surface, it is not surprising that the DEMs with less than 10-m grid spacing provided little improvement in the SINMAP results. Ten-meter cells essentially capture all the point data. Again, because of the reliance on SINMAP I am left to wonder how increasing grid-cell resolution affects regional slope-stability modeling. The authors demonstrate that 10 m cells are optimal for SINMAP simulations, but given the physical shortcomings of the model and the relatively coarse LiDAR point data we gain little insight into the spatial distribution of shallow landslides.

In summary, the approach seems useful for comparing regional slope stability models with landslide inventories, but some discussion of the physical meaning of the MLIP technique should be added. As it is written now, the main conclusion that DEM grid-spacing less than 10 m provides little increase in the predictive accuracy of SINMAP results does not appear supportable given the relatively low resolution of the LiDAR data.

References

Iverson, R.M., 2000. Landslide triggering by rain infiltration. Water Resources Research, v. 36, p.1897-1910.

Specific comments

Title. I suggest adding "landslides" after "Likely" in the title to give readers a better sense of the paper content.

Throughout the paper. The authors introduce several new acronyms. The paper would be much more readable if they were simply spelled out.

Page 400 - lines 21-22. Is the annual rainfall between 1300 and 2500 mm or the annual precipitation between 1300 and 2500? I assume that much of this falls as snow given the elevation.

Page 401 - lines 10 -12. Some basic details about the landslides should be provided (how thick, do they fail at the bedrock soil interface, what type of soils, what rainfall triggered the slides, etc.).

Page 402 - lines 6 - 8. Why is the “spline” algorithm good? What are “proper” topographic characteristics? Explain.

Page 404 - lines 18 - 24. The dense jargon of this paragraph makes it barely readable.

Page 407 - lines 2 - 5. It is not clear from Table 2 that “as the threshold is reduced the percentage of terrain less than the SI threshold that falls within the mapped landslide scars increases”. Looking at Fig. 1a, all the terrain in the landscape has a SI $<$ 10, thus all the terrain in a landslide scar should have an SI $<$ 10? Something appears to be wrong with the SI columns in Table 2.

Page 408. - lines 12 - 14. It is not evident from Fig. 10 that the MLIPs “cluster at the upslope end of the landslide scars”. In fact, just looking at the figure it is reasonable to say just the opposite. Many of the MLIPs are outside the mapped slides and of many of those within the polygons seem to be at the downslope parts of the mapped slides. This is particularly evident in the large landslide complex at the upper left of the figure. This shouldn’t be surprising since the least stable cells in a SINMAP analysis assuming uniform soil thickness and material properties will be the steepest slopes below the largest contributing areas. Fig 11. Looks more convincing, but where is it with respect to Fig. 10? Why aren’t the mapped landslide polygons shown?

Interactive comment on Hydrology and Earth System Sciences Discussions, 3, 395, 2006.