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Interactive Comment

Interactive comment on "Evaluation of shallow landslide triggering scenarios through a physically-based approach: an example of application in the southern Messina area (north-eastern Sicily, Italy)" *by* L. Schilirò et al.

Anonymous Referee #1

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Synopsis: The paper presents a case study of assessing landslide potential using the TRIGRS model calibrated to a recent event, and considering rainfall events of varying return intervals.

General comments: The paper is well organized, mostly well written, and presents an interesting case study and application of assessing landslide potential for different rainfall scenarios. The overall approach is fairly sound and should be readily transferable to other locations. Clarity of the paper would benefit from additional explanation of a few points, and minor revisions to the text. The paper would also benefit from some additional analysis to learn how much model calibration could be improved. Improvements to model calibration are likely to result in some changes to the results. Also, the authors need to do a bit more analysis of the model output to understand some of the results in greater depth. Questions for the authors to address and suggestions for improvement are keyed to specific parts of the manuscript in the following paragraphs. The paper would also benefit from minor editing to improve the English in a few places.

p. 2976, lines 16-17. The observation that the same rainfall amount predicts greater instability for a longer duration seems odd, but might result from delayed rise of pressure head in the deeper grid cells. Total rainfall over a longer duration would result in a lower infiltration rate and seemingly fewer or equal unstable cells, unless it is taking a long time for water to reach the base. This might indicate a problem with the hydraulic parameters of the model. See additional comments later.

p. 2980, line 6. The 10-minute peak rainfall, 18.5 mm is equivalent to an intensity of 111 mm/hour or about 2.5 X greater than Ks (1.22 m/s). The first landslide event occurred shortly after this peak. Unless total rainfall between 17:00 UTC and 18:00 UTC approaches 44 mm (so that Iz/Ks approaches 1), the model might not predict shallow, rapid initiation. This type of response might actually be predicted better by the saturated infiltration models in TRIGRS.

p. 2980, lines 21-29. This information on landslide timing is very important and should be plotted on Figure 2a. Vertical lines or shading indicating the times reported for the landslides would help the reader relate landslide occurrence to the rainfall.

p. 2981, line 16. Change “most of whom during” to “most of which were during”

p. 2982, line 21, change “rainfall cumulated” to “cumulative rainfall”

p. 2984, line 24. In this section you have described the various infiltration options in the TRIGRS model. Based on information appearing elsewhere, it appears that you are

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basing your model runs on the assumption of initially unsaturated conditions and finite depth to the impermeable boundary. Stating your assumptions about these boundary and initial conditions would be helpful at the end of section 4.2.

p. 2986, lines16-17. This is a good starting place for estimating the hydrodynamic parameters. However, you note on page 2987, line 20, that the regolith mantling the slopes of the study area has "extremely variable texture." Variation in Ks across an order of magnitude or more would not be unusual in different samples of similar material. Did you perform any testing with HYDRUS or TRIGRS to confirm that observed responses were consistent with those values. How sensitive are your model results to variation in Ks and alpha? Can this sensitivity explain any of the discrepancies between model results and observations described later in the manuscript?

Table 5. Reconsider your attributed values of the strength parameters. Although the values of cohesion and friction angle in Table 5 are consistent with lab test results and values used by others, your model results indicate a high number of unstable cells (11,163 or about 2% of all grid cells in the study area) at the beginning of the simulated rain storm (14:00 UTC, Table 6). Assuming your initial condition of water table at the base of the soil coincides with 14:00 UTC, the number of unstable cells at that time is theoretically zero. One of the first steps in the calibrating a factor of safety model of this type is adjusting the strength parameters so that few cells («1%) in the slope range where landslides have occurred have an initial factor of safety less than 1.

p. 2991, lines 24-28. What do you know about the study area that might explain why the model misses about half the source areas and over predicts particularly in the northwest part of the area (p. 2992, line 1)? What factors characterize cells with false positive values and false negative values? Could any of this information be used to improve your model calibration?

p. 2992, section 5.3. The approach used here, to test the model for rainfall scenarios having different return periods, is reasonable, but the model results need to be

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tested more rigorously against historical records summarized earlier. I would suggest reevaluating the landslide potential after improving model calibration as suggested in previous comments. Also, I would suggest that the results from the modeling be evaluated against recent landslide events and the corresponding rainfall return periods. In other words, do relationships between landslides and rainfall return periods identified by your modeling efforts agree with what the historical records show?

p. 2993, lines 1-8. See my comment below regarding what is happening with the 1-h rainfall. Have you studied the pressure head output to understand why this is happening for the longer storms? It might be necessary to run these scenarios for single, representative grid cells in stable and unstable areas and saving/plotting the time history to understand in more detail why the number of unstable grid cells is changing as duration increases. Perhaps the water is reaching greater depths as duration increases and resulting in more of the deeper and flatter grid cells becoming unstable. If these results (and the corresponding time histories of pressure head and factor of safety) are contrary to what your historical landslide and rainfall data indicate, it might indicate some problems with model calibration, or may indicate some process that is poorly represented by the TRIGRS model or limitations of your soil depth model.

p. 2993, lines 24-27. In relation to this rainfall threshold, note that the value of Ks specified in Table 5, 1.22e-05 m/s is equivalent to ∼44 mm/hour. Regardless of what might happen in the field, with regard to runoff, the TRIGRS model does not allow infiltration rates higher than Ks, because maximum infiltration rates decrease rapidly to Ks. Thus, your threshold is about 44 mm/hour in this case and the model gave identical results for 1 hour return periods greater than 2 years, all of which exceed 44 mm/hour (table 8).

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 2975, 2015.