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Discussions

Interactive comment on "A theoretical model for the initiation of debris flow in unconsolidated soil under hydrodynamic conditions" *by* C.-X. Guo et al.

Anonymous Referee #1

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The object of this paper is the proposal of a theoretical model for debris flow initiation supported by one laboratory experiment. The writer identified the following main deficiencies:

1. Author mix different types of debris flow triggering both in the introduction and model development. 2. Authors use material with 90 % of gravel (> 2 mm), that is a cohesionless material: how can they measure cohesion in dry conditions? 3. Presentation of the laboratory experiment is very poor. 4. Findings of both theory and laboratory are not consistent.

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The writer suggests the authors the complete rework of the paper. The detailed explanations and suggestions regarding these points are as follows:

1) The debris flows are divided in two categories: landslide failure debris flows and runoff generated debris flows. Landslide failure debris flows are usually ruled by viscous or Coulombian rheology and runoff generated debris flows are usually ruled by grain-inertial rheology. As a consequence landslide failure debris flows are composed by slurries or gravel within a slurry matrix. Runoff generated debris flows are mainly composed by gravel. Experimental results of Gregoretti (2000a,b) and Tognacca (2000) shows that in case of granular material debris flow is triggered by runoff that entrain the solid material. As size material of the authors is 90% larger than 2 mm, that is 90% is gravel, the material is assumed granular and debris flow triggering is due to runoff. Then authors should concentrate only on runoff generated debris flows. Authors that studied runoff generated debris flows in the field are:

Berti and Simoni, 2005; Cannon et al., 2008; Coe et al. 2008; Gregoretti and Dalla Fontana, 2008; McCoy et al., 2012; Theule et al., 2012; Kean et al., 2013.

According to Kean et al. (2013), models of Armanini and Gregoretti (2005), Lamb et al. (2008), Gregoretti et al. (2008) and Recking (2009), provide a framework for determining exactly the critical discharge for the starting of sediment entrainment in a water flow. Friendlier approach is the empirical one of Tognacca et al. (2000) and Gregoretti and Dalla Fontana (2008) based on flume data. The writer does not understand the introduction of the hydrologic model of Berti and Simoni (2005) because it models the kinematic routing of a water flow in a channel and not the formation of runoff due to rainfall in the upstream contributing basin.

2) Material used in the experiment being is granular because 90% of it has size larger than 2 mm, that is, it is mainly composed by gravel. So it is very curious that cohesion due to only to the clay (not to sand or lime) appears. In some cases it is due to a dilatancy effect when there is a decrease of shear after a peak value but this is not visible

in figure 5. Authors should justify their findings. It is also curios that cohesion disappears in saturated conditions and that internal frictional angle changes about 15%. Data of Tubino and Lanzoni (1993) show that difference in friction angle between dry and saturated condition is less than 5%.

3) Experiments: measures of the flume size (length, width...) are missing. A detailed description of the experiment is missing: where the inflow of runoff? The figure 1 does not explain it and a sketch of the experimental facility is missing. Experiments with rainfall have very few sense. Assuming, from figure 1, 3 m flume length and 0.3 m width the supplied discharge is 140 x 0.001 x (3 x 0.3) / 3600 = 0.00035 m3/s that is very low. The triggering of debris flow in a location is due to the stream flow given by the excess rainfall in the upstream basin. The rainfall fallen in channel reach of some meter is not able to form runoff. The fact that inflow is not specified, forbids the writer from understanding the entrainment mechanism of granular material. The writer, as the large runoff seen in figures 4, suspect both an overtopping (figure 4a) and headcutting due to emerging seepage (figure 4b). In both the cases granular material is entrained by runoff and not by a landslide failure mechanism. About that see the experiments of Liao and Chou (2003), Huang et al. (2007) and Gregoretti et al. (2010). Moreover, the meaning of the three layers that compose the slope and their influence on debris flow triggering is not introduced.

4) The model does not seem consistent with the experiment because entrainment of material seems due to surface erosion of particles caused by overtopping flow or the emerging of seepage flow and not to the slide of a layer of particle. Moreover, model sketch of figure 7 (bottom parallel to the slope) is not consistent with the experiment (bottom horizontal). Another issue is that flow depth and velocity are not parameters of model but real physical quantities otherwise is not possible apply the model for different slope angles. They should be the quantities measured during the experiment. Finally model should be tested with several experiments carried on varying the slope angle in a range of possible values.

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