

## ***Interactive comment on “Discharge of landslide-induced debris flows: case studies of Typhoon Morakot in southern Taiwan” by J.-C. Chen and M.-R. Chuang***

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Received and published: 27 May 2014

Thank you for the reviewer comments from NHESD. I greatly appreciate the helpful comments and suggestions for our manuscript. Our manuscript has been revised following reviewers' suggestions. The related discussion and descriptions added in the revised manuscript (the supplement) are shown in a blue color for ease of reading.

Reviewer #1:

General comments: 1. I still miss explanation or elaboration about Landslide ratio RL. I haven't heard about this ration before and I think it should be explained in more details.

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More about that in Specific comments. Response: Thank you for your comment. In response, we have further explained and elaborated on the landslide ratio in the revised manuscript (please see p. 6, lines 6–16).

2. Jakob 2005: Classes of debris flows should be determined using table 17.3 in Jakob 2005 for better comparison with other worldwide events. Ratio between debris flow volume and deposition area is mentioned in introduction of the reviewed manuscript. I suggest that author tests the equation 17.24 in Jakob 2005 and see what the correlation between these values and calibrated ones is. And also  $Q_{wp}/V$  relation suggested in Jakob 2005 (table 17.5) - how do these values correlate with calibrated ones in the manuscript. Response: (1) Classification of the debris-flow magnitude (Jakob, 2005) has been determined and is shown in Table 1. (p. 6, lines 18–22) (2) The calibrated results for debris-flow volume, deposition area, and debris-flow discharge in this study were used to compare with other empirical equations suggested by Jakob (2005), and a related discussion is presented in section 4.4 (p. 19–21).

3. Melton number could be determined for tested watersheds, because Melton number is widely used in European Alpine space for classifying torrential basins / watersheds and one could make a comparison between local and tested watersheds. Response: The Melton ruggedness number RM for the tested watersheds has now been determined and is listed in Table 1.

Specific comments: 1. Chapter 2.1: RL ratio must be explained. Is it AL/A ration before or after the event? Do you need a landslide cadastre to determine RL, or maybe landslide susceptibility map? Is field survey necessary? I would include Melton number in this Chapter to enable comparison with other watersheds in other regions. Response: The definition and meaning relating to RL, the method in the determination of RL, and the value of the Melton number have now been added and are presented in section 2.2 (p. 6, lines 6–19)

2. Chapter 3.2.1: Has been Brookfield viscometer, used in this study, used for debris

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flow rheology research before? In my experience it is hard to determine correct values testing only soil samples with a particle diameter of less than 1mm when it is known that major effect on shear stress is related to more coarse particles (boulders etc). Just a question. . . Response: (1) The Brookfield rotational viscometer and capillary viscometer are devices used to determine the rheological properties of debris-flow slurries, and have been commonly used in Taiwan (Jan et al., 1997; Wang, 2007). The rheological parameters obtained from these viscometers have now been applied to simulate debris flow and to classify the risk degree of hazardous debris-flow areas in Taiwan using the FLO-2D model (Lin et al. 2011, Lin et al. 2013). This description is presented on p. 8, lines 6–10. (2) Debris flow generally contains a wide range of grain sizes, from clay to boulders. The rheological property of coarser particles contained in debris flow is usually difficult to measure in laboratory experiments. Thus, in some of these applications, Bingham model parameters were inferred from the measured rheology of fine material slurry samples. Bingham model parameters majorly reflect the effect of fine particles on the rheological properties of debris flow (Jan and Shen 1992), and the collision effect from coarser particles of debris flow may be reflected on the values of  $n$  (Rickenmann et al. 2006). A description of the above is presented on p. 8, lines 7–15, and selected  $n$  is also discussed on p. 9 (lines 2–30).

3. Chapter 3.2.3: Usefulness/ value of the empirical equations for ratio  $Q_{dp}/V$  proposed in Jakob 2005 could be presented. Just to see what are the  $Q_{dp}/V$  values determined in this study and what are the  $Q_{dp}/V$  values determined using equations in Jakob 2005. Response: The  $Q_{dp}/V$  values determined in this study and the  $Q_{dp}/V$  values determined using equations in Jakob 2005 are shown in Fig. 9 and presented on p. 19–20.

4. Chapter 4.1. Is it possible to get same modeling results using two different combinations of  $C_b$  and  $C_V$  ? Response: In the three case studies, it is not possible to obtain identical modeling results using two different combinations of  $C_b$  and  $C_V$  because  $C_b$  and  $C_V$  need to satisfy the field conditions below. Such conditions include the ranges of

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$C_b$ , which are based on the possible ranges of debris-flow volume (p. 10, lines 27–28) and a set of values for  $C_V$  (p. 10, lines 20–21), and the inclusion of certain information related to the travel time of the debris flow (p. 12, lines 14–19).

5. Chapters 4.1.1 + 4.1.2: MD is much more useful for calibrating Flo2D model than FD. As mentioned in my first report comment n7. Response: (1) FD data in the original manuscript (Figs 5, 7, and 8) has been deleted, and MDs in the field have been re-checked and used. (2) Fig. 6 in the revised manuscript has been added instead of the original Figs 5, 7, and 8, in order to clearly present the results between simulations and field investigations. A related discussion pertaining to Fig. 6 is presented on p. 14 (lines 5–12).

6. Chapter 4.3: If author can get strong correlation between  $RL$  and  $C_b$  it could be used for direct determination of  $Q_{wp}/Q_{dp}$  ratio. Response: A correlation between  $RL$  and  $C_b$  has been added (in Eq. (8) and on p. 16, lines 15–20), and is shown in Fig. 8.

Please also note the supplement to this comment:

<http://www.nat-hazards-earth-syst-sci-discuss.net/2/C886/2014/nhessd-2-C886-2014-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 315, 2014.