Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2017-241
Invited perspectives. A hydrological look to precipitation intensity duration thresholds for landslide initiation: proposing hydro-meteorological thresholds
Reply to Referee # 3 Francesco Marra

We thank Francesco Marra for the insightful comment. Below we address and reply to the comments and questions. In Italic typesetting the original review is given, and in roman typesetting our replies.

Thom Bogaard and Roberto Greco

The authors analyze the concept of precipitation intensity-duration (ID) thresholds for shallow landslides and debris flows from a hydro-meteorological perspective to propose a new approach to the problem. The contribution is largely welcome since it suggests new approaches and perspectives to overcome important, but sometimes neglected, limitations of the commonly used methods.

Within the interesting analysis of the relationship between ID thresholds and IDF curves, the discussion so far neglects the impact of rainfall estimation uncertainty and its possible dependence on rainfall duration and return period (e.g., Krajewski et al., 2003, www.dx.doi.org/10.1623/hysj.48.2.151.44694; Ciach and Krajewski, 2006, www.dx.doi.org/10.1016/j.advwatres.2005.11.003). Recently, rainfall estimation uncertainty caused by the use of rain gauge measurements (still the most common source of rainfall estimates in this field) was shown to significantly affect the derived ID thresholds causing systematic bias (Nikolopoulos et al., 2014, www.dx.doi.org/10.1016/j.geomorph.2014.06.015). This systematic bias is caused by (i) systematic rainfall patterns observed around the triggering locations and (ii) the use of log-transformations within the derivation of the ID (Marra et al., 2016, www.dx.doi.org/10.1016/j.jhydrol.2015.10.010). At least for durations 2 days, these rainfall patterns were observed to be related to the return period of the triggering rainfall (Destro et al., 2017, www.dx.doi.org/10.1016/j.geomorph.2016.11.019). Consequently, the 'slope' of the ID threshold is affected by rain gauge sampling, and this potentially undermines the comparison between the slope of ID thresholds and IDF curves reported in the manuscript. In particular, I think this aspect should be discussed when the authors say [line 157 and following]: "On the other hand, for longer precipitation durations, ID thresholds have smaller slopes than IDF curves.This means that landslide initiation on the right side of the graph (lower precipitation intensity with longer duration) would occur with rapidly increasing return periods of precipitation events". In fact, the observed pattern could be caused/emphasized by the sampling issues discussed by Marra et al., (2016) and Destro et al. (2017).

To conclude, IDF curves are expected to vary within the examined region (generally a regional, if not global, scale); it is thus unclear to me how the idealized IDF curves in Fig. 3 have been drawn. The 'slope' of the curves (i.e. the dependence of I with D) at the regional scale may change so that the curves should be better represented as a shaded area – such as done for the ID thresholds.

This was a technical comment on an introductory aspect of the study; this being said, I repeat my compliments to the authors for the manuscript and the new proposed perspective.

With kind regards, Francesco Marra

Dear Francesco Marra

Thank you very much for you excellent comment. We strongly focus on the hydrology whereas you bring up the point of the effect rain patterns and rain measurements (rain gauge based precipitation observation, spatial organisation of rain and associated uncertainty) that so far we on purpose have left out of the article. We tried to keep the article brief as is requested for an “invited commentary”. Our focus is that only using precipitation data for landslide hazard assessment is neglecting the importance of hydrological processes in landslide initiation. Hereto, we make a quite extensive ‘problem’ analysis showing the currently used ID thresholds have limited physical meaning, at the best they are statistically interesting to use. However, you are of course fully right that precipitation estimates and uncertainty can also be responsible for (part of) the observed low slopes of the ID thresholds. So, in hindsight we agree this is a too important aspect not to address, so we will add a short discussion on the effect of precipitation measurement uncertainty as depicted in your comment.

Your second point is about the (slope of the) IDF curve that we published in Figure 3. Yes, this is a somewhat arbitrary but representative, set of IDF curves (that is, the chosen slope is not far from those of the examples of IDF curves of Fig. 1, which refer to very different locations around the world). Like we write in the caption “Schematic” and in our opinion useful for the argumentation. It is however a good suggestion to show, also graphically, in Figure 3, that the IDF are schematic, so we will adapt the figure and explain it in the text as well.