

Interactive comment on “Rainfall events with shallow landslides in the Entella catchment (Liguria, Northern Italy)” by Anna Roccati et al.

Anna Roccati et al.

fabio.luino@irpi.cnr.it

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GENERAL COMMENTS

The manuscript is about a case study where three main rainfall events are thoroughly described; after, already published and well established methods are applied. Therefore, the only value of the manuscript is presenting the new case study, while no relevant scientific findings are presented.

@ We maintain that the manuscript is well within the aims of NHESS. Undoubtedly, several papers on rainfall thresholds and landslides induced by intense rainfall events in the Mediterranean area, including Italy and Liguria region, are published. As it is, we applied an already published and established method: however, we consider that

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implementation of the method in a region as the Entella River basin, most frequently affected by intense and severe meteorological events, can consolidate and increase the scientific value of the method itself. At bottom, we would not have all this great scientific heritage on the rainfall thresholds if we had not considered individual studies on thresholds on specific areas!

The introduction is poor. It fails to present the existing state of the art and to introduce the advances presented with this manuscript. Moreover, the introduction is centered only on the case of study. The scientific literature is not properly addressed, thus it is not clear the novelty and the improvements conveyed by the work.

@ In the revised final version of the paper, we shall include a brief description of the state-of-art in order to clarify the improvements of our work.

References should be completely revised. They are very numerous but they are very biased: almost only Italian authors are present. Some of them with a unnecessary high number of works. Moreover, some of the references are unnecessary or not relevant (e.g. conference proceedings). I suggest to reduce the references and address the recent international literature.

@ We can improve references, reducing as required. Many Italian papers will be erased and enlarged the international section.

The discussion is not a discussion. It starts with a recap, then it introduces some elaborations (rainfall threshold analysis) that in my opinion should be described in the methodology and in the result section.

@ We developed discussions according to a consistent thread: starting from the aim of the paper, we applied a method and described the outcome of our study, therefore we discussed and interpreted results, with reference to the knowledge of the territory investigated and the existing state of the art about the topics treated. We can clarify and refine this section, if necessary.

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The comparison with some literature thresholds is trivial. It is obvious that different sites are represented by different thresholds. I suggest to either cut this descriptive part, or to deeply discuss the reasons of the similarities/differences.

@ Comparison with similar threshold curves proposed in the literature for mountain catchments, local areas or single regions, with analogous physiographic, climatic and meteorological features, in Italy comparable with the Entella River basin is required to discuss and interpret the outcomes of the study. Many preceding studies have developed this kind of approach (Guzzetti in particular). We can improve this section, deeply discussing the reasons of the similarities and the differences between the threshold obtained for the Entella River Basin and the curves proposed in the literature, if necessary.

Some of the conclusions are not supported by data and are just speculations: -How can the study be useful for "land planning" and "risk reduction"? You didn't provide a susceptibility map or a hazard assessment. - the "method to define..." is not original work of this manuscript. It is a published and quite well established procedure.

@ We can better investigate the topic about the practice and the usefulness of our study for land-planning and landslides risk mitigation in terms of early warning system, similarity to the flood risk. Although, we adopted an already published and established procedure to define rainfall thresholds, our work represents a suitable employment and case-study in a Mediterranean area characterized frequently by severe and damaging rainfall events, with important implication in terms of landslide hazard assessment and civil protection.

SPECIFIC COMMENTS

#1L21: a reason for the low threshold should be provided

We attribute the result to the peculiar orographic and meteorological conditions that characterize the Entella catchment, with a high MAP and the frequent occurrence of convective thunderstorms (born on the Ligurian Sea) whose formation is favored by the

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local orographic setting (L273-274 in section 5). Furthermore, the low thresholds can be referable to the fact that several shallow landslides triggered on the slopes on the flanks of the road networks, thus they are favoured also by human activity.

#2 Study area: typical landslides should be characterized (at least typology and size)

The Entella River basin presents a composite geomorphological setting, and features several processes, landforms and deposits due to gravity: different types of landslide can be identified, from DSDDG (particularly at the head of the valleys) to falls, slides, flows and complex movements, with different states of activity, from active to stabilized. The events analyzed in the present paper, characterized by intense rainfall and short duration, trigger mainly shallow landslides, such as debris flows or soil slips: in terms of damage produced and volume involved, they are characterized by a moderate destructive capacity and a low magnitude, but they are widely spatial distributed in the catchment area.

#3L71: why inundations are included in a work about landslides?

The rainfall events that we considered to define the rainfall conditions for the possible initiation of shallow landslides in the Entella River basin induced severe ground effects both on slopes and along the watercourses, including local inundations and flash floods that affected the valley floor of the three main tributaries and the coastal alluvial plain. We reported this detail to highlight the damaging feature of the rainfall events and for completeness of information. Like in other parts of the world, shallow landslides and flash floods along small catchment are strictly connected.

#4L69-81: two sections cannot have the same title.

This is our mistake. The title of section 3 is "Landslides and rainfall data", whereas the correct title of section 4 is "Rainfall events with landslides".

#5L89: please, avoid generic terms like "most". How many of them?

For each rainfall event, the number of shallow landslides that really occurred cannot

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be determined exactly. Information available from various sources is not always accurate and reliable about the type and the number of the triggered landslides. In many cases, the sources reported indefinite or approximate descriptions e.g., “a number of landslides” or “multiple slope failures”, or simply “landslides”. As shown in Table 1, we classified the abundance of the landslide as “single” or “multiple”. In order to define the thresholds, we used the intensity and duration information related to the first landslide triggered for each rainfall event. In many cases we do not know the exact number of slope failures occurred.

#6 L113-177: I don't understand the reason of including detailed event reports in a research paper. This part could be consistently shortened or cut.

The three events illustrated in the paper (24 November 2002, 21–22 October 2013, and 10 November 2014) represent the most severe events occurred in the considered period 2002-2015, in terms of abundance of landslides and damage. For the authors it's important to highlight the frequency and recurrence of harmful effects.

#7 L194-198: these are just generic statements. They are not supported by data. It would be interesting to see statistics and numbers. E.g. what's the difference between an abandoned and a maintained terrace? From your text it seems that in both cases they increase landslide susceptibility. This is a very strange statement: can terraces be abandoned harmlessly?

The aim of our paper is to define an event rainfall intensity – event duration, ID empirical rainfall threshold for the possible initiation of shallow landslides in the Entella River basin. As explained in section 3, we used specific landslide information, including (i) the location and number of the event landslides, (ii) the time of occurrence of the slope failures, and (iii) the consequences of the landslides (i.e., type of damage, casualties). It has been a difficult work of homogenization: in fact, we obtained the landslide information from different sources, including scientific papers, technical and event reports, damage reports, and catalogues compiled by regional and local authorities, archives

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of local municipalities, newspaper articles, and interviews to local inhabitants. For this reason, the available information are not homogenous and have been drawn up by people with different scientific rank, belonging to diverse professions/bodies: therefore, information about type and number of landslides triggered by each rainfall event are not homogenous. In another paper (currently in progress) we are investigating features of landslides occurred in the catchment area and their correlation with different controlling factors i.e., slope acclivity and aspect, land-use, anthropic disturbances etc.

#8 L275-281: As I understand, rainfalls have been normalized by the MAP registered by three rain gauges. This is not correct: each rainfall should be normalized by the MAP registered by its own rain gauge.

Each rainfall record was normalized to the MAP of the same raingauge, to investigate the possible role of the antecedent rainfall conditions in the initiation of the rainfall-induced landslides in the Entella catchment (L275-278). Next, we reported the results of the analysis obtained for the three rain gauges of Panesi, Borzone and Pian dei Ratti because they represent the rain gauges nearest to the central portion of the Entella catchment, where the considered rainfall events induced more abundant, widespread and damaging landslides.

#9 L296: I think in the text you provided different numbers.

In the 2002-2016 period, we have identified 29 rainfall events with landslides. The events are listed in Table 1 (see also section 3, L70). Among these 29 rainfall events, we have information about time and location of landslides with sufficient temporal and geographical accuracy only for 16 events (not 17 as indicated in L296, events were wrongly numbered):

1) 24/11/2002 2) 20/2/2006 3) 12/11/2008 4) 1/12/2008 5) 8/12/2009 6) 22-25/12/2009 7) 7-9/5/2010 8) 2/11/2010 9) 21-22/10/2013 10) 30/10/2013 11) 26-27/12/2013 12) 4/1/2014 13) 16-20/1/2014 14) 10-11/10/2014 15) 10-11/11/2014 16) 14-9-2015

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The 34 rainfall intensity-duration conditions listed in Table 3 (see section 4, L82-86 and section 5, L199-208) are related to the landslides induced by the 16 rainfall events mentioned above.

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