

Interactive comment on “Landslides, floods and sinkholes in a karst environment: the 1–6 September 2014 Gargano event, southern Italy” by Maria Elena Martinotti et al.

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We thank the Reviewer for considering the manuscript interesting, well-written and well-structured. We are particularly thankful for her/his opinion about the fact that the manuscript addresses relevant scientific and technical questions.

1 - The time resolution of rainfall data and the temporal accuracy of the landslides are independent. We attribute the poor accuracy in the occurrence time of the majority of the failures to the difficulty to reach some of the places where the landslides occurred, and to the fact that many landslides occurred in the evening or during the night, and were reported only several hours after the event. Nevertheless, we want to stress that even if the temporal uncertainty is large, plots in Figure 10 show that the temporal

ranges defined for the possible occurrence of the landslides do not significantly affect the prediction capabilities of the E-NEP algorithm.

2 - We did not take into consideration the hypothesis of considering different intervals for the analysis of the cumulative rainfalls. However, the outcome of such analysis would have resulted in less detailed plots (e.g. cfr. Fig. 10) with histograms having larger bins and lines showing abrupt steps. We think that we would not have obtained relevant information from the observations of those plots.

3 - Unfortunately, we only have rainfall data for a 7-years period for the selected rain gauges. For this reason, we cannot add nothing more than what we have reported in the manuscript (Figure 4): except for the Monte Sant'Angelo rain gauge, the 1–6 September rainfall period exhibited the highest cumulated rainfall in the observation period.

4 - There was an error in preparing the first version of the manuscript, and the soil slips are actually earth flows. We amended the text accordingly.

5 - We thank the Reviewer for the suggestion that improves the readability of the paper and of the figure. Figure 5 now includes the location of the clusters.

6 - This is a good point and we are thankful to the Reviewer for the question. As stated in section 5 (Discussion), the analysis of the rainfall records (Fig. 10) highlights that neither the rainfall intensity nor the cumulative rainfall could be considered diagnostic for the detection of the rainfall conditions responsible for landslides. We also observe that the evolution of the precipitation, before and during the landslide occurrence time, was different among the four clusters. In the different clusters, the specific characteristics of the rainfall events are different. Surprisingly, the E-NEP metric, in the period of the landslide occurrence, is not affected by this variability. Landslides have occurred, in all the cases, as soon as (i) the NEPmax metric reached the maximum value and (ii) all the NEP percentiles increase abruptly. We conclude that, at least for this study, the results obtained using the E-NEP metrics are not controlled by the specific character-

istics of the rainfall events.

7 - Thank you for the remark. We used the term nearly-dry for classifying that period in the manuscript.

Minor adjustments

Page 4 line 23 “record available” instead of “record available to us”. Done.

Page 4 line 25 Include a reference to figure 5 (e.g. after sinkholes). It is desirable that figure 5 s referred in text prior to figure 6. We thank the Reviewer for her/his advice, we added a citation of Figure 5 before that of Figure 6.

Page 5 line 7 “the towns of Cagnano Varano and Carpino (Fig. 5)”. Done.

Page 8 line 14 Reference to figure 2 is inadequate. Done. Reference deleted.

Page 8 line 17 Reference to figure 3 is inadequate. Done. Reference deleted.

Page 10 line 25 The reviewer would not include rock falls in the group of landslides authors are dealing with. It is true that rock falls are the landslides types that are less related to rainfall. We removed them from the text.

Page 11 line 14 “High infiltration to shallow depth in the rock mass facilitates the formation of flash floods”. This is not clear. In order to better explain the meaning of the previous sentence, the paragraph has been modified and rewritten as follows. “In the karst environment of the Promontory, rainfall infiltration is efficient even for high intensity rainfall rates. This limits the occurrence of landslides, except for very intense (i.e., “extreme”) rainfall events. On the other hand, arrival of great amount of rainfall in a setting typically characterized by water infiltrating within the rock mass through the network of conduits and joints, highly facilitates the formation of flash floods, particularly in small catchments, as has been frequently registered also in other parts of Puglia (Parise, 2003; Mossa, 2007). Further, karst aquifers have very poor retention capacity. These, and other characteristics as well, allow to identify the flash floods as one of the

main hazards in karst terrains (Fleury et al., 2013; Gutierrez et al., 2014; Parise et al., 2015).”

Figure 2 Reconsider the caption of figure 2. The area covered by images is much larger than the Gargano Promontory. I suggest using “over the central and southern Italy” instead of “in the Gargano Promontory”. Done.

Figure 6 The caption of photo F is missing. 1-6 September instead of 11-6 September. Photo F is considered together with photo C in the figure caption. We corrected the dates.

Figure 7 Landslide inventory map instead of Inventory map. Done.

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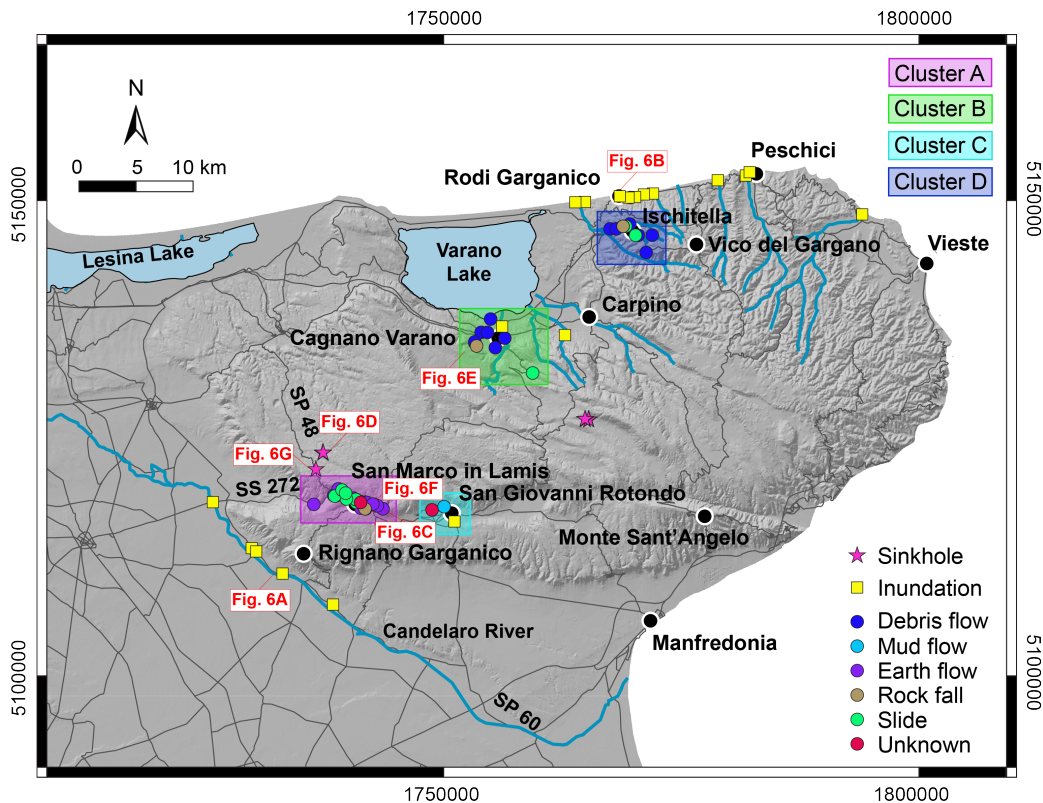


Fig. 1. Figure 5: Map showing location of event landslides, floods, and sinkholes triggered by the 1-6 September 2014, intense rainfall event in the Gargano Promontory. WGS84/Pseudo Mercator (EPSG:3857).

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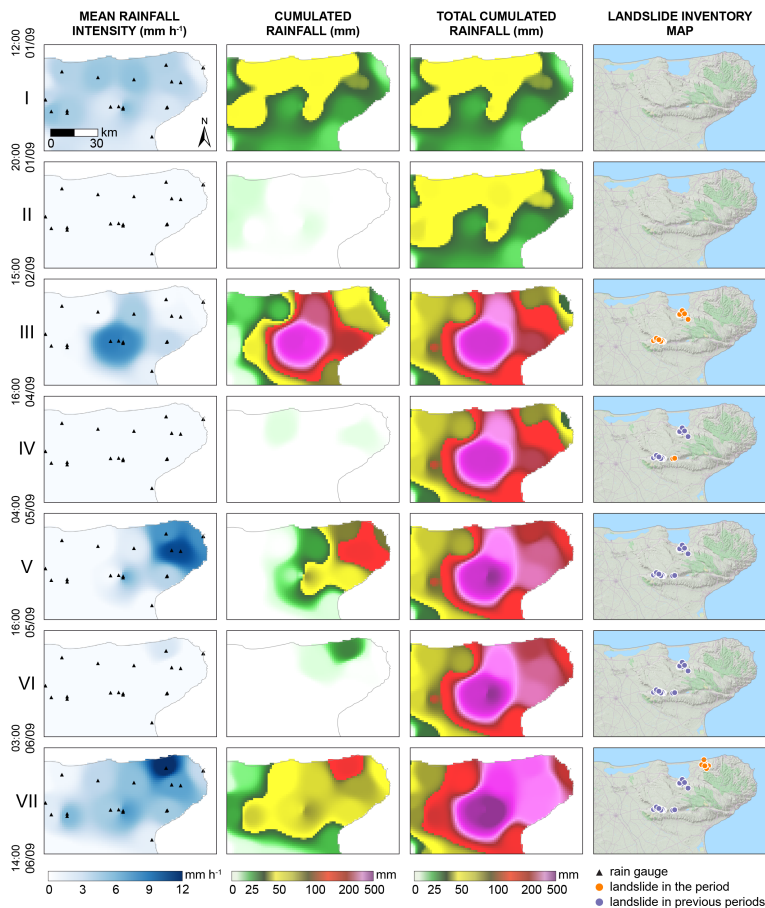



Fig. 2. Figure 7: Analysis of the spatial and temporal distribution of the event rainfall, and of the triggered event landslides. See text for explanation.