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Response to ‘comment on “The influence of geological–morphological and land use settings on shallow landslides in the Pogliaschina T. basin (northern Apennines, Italy)” by Bartelletti et al. (2017)’

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This is a reply to the comment by Marchi on our recently published work (Bartelletti, Giannecchini, D’Amato Avanzi, Galanti, & Mazzali, 2017). First of all, the authors of ‘The influence of geological–morphological and land use settings on shallow landslides in the Pogliaschina T. basin (northern Apennines, Italy)’ greatly appreciate the suggestions and observations made by Marchi. Although we agree with almost of all his observations, there are some points that we would like to focus on here. The comment of the discussor (i.e. Marchi) concerns the assessment of the 25 October 2011 rainfall event in the Pogliaschina Torrent basin (eastern Liguria, Italy) and its implications to explain the landslide spatial distribution.

The discussor analysed the 24-hour isohyet map of the 25 October 2011 rainfall event proposed by ‘Bartelletti et al. (2017)’ for the Pogliaschina T. basin (Vara Valley, eastern Liguria, Italy). No information about the implementation of this rainfall map was actually provided by Bartelletti et al. (2017). The map was carried out by interpolating the rain gauges data using the Radial Basis Functions (BRFs) as the interpolation technique. As the discussor rightly noticed, this map is affected by the strong conditioning of the rain gauges spatial distribution, which is very clear from observing the pronounced ‘islands’ of low and high rainfall amounts. Moreover, these ‘islands’ also result from the low rain gauges density in the Vara Valley (one rain gauge per 28 km²; Galanti, Giannecchini, D’Amato Avanzi, Barsanti, & Benvenuto, 2016).

The discussor also compared the rainfall map in Figure 2 of Bartelletti et al. (2017) with the one shown in Figure 1 of the discussor’s comment, which was obtained by integrating the rain gauge data with the weather radar observation. As the discussor observed, the spatial distribution of rainfall is quite different. At Vara Valley basin scale, the general rainfall trend is more visible and clearer than the second map, which

also highlights the elongated SW–NE rainfall bands better than in the first. The landslide and flood distribution does actually seem to follow this predominant direction.

The discussor focused on the difference between these two maps in the southernmost sector of the basin, comparing Figure 1 of the discussor’s comment with Figure 3 of Bartelletti et al. (2017). As can be seen in Figure 3, the highest value of rainfall was recorded by the rain gauge located close to the closing point of the basin, so the eastern sector of the basin received a large amount of rainfall. On the contrary, no detailed rainfall data on the southernmost sector of the basin were available, as no rain gauges were present. Therefore, as expected, the rain gauge spatial distribution influenced the final results, ascribing a minor amount of rainfall in the southernmost sector of the basin.

The discussor also dealt with the cross validation technique of rainfall amounts and peak discharge data described in Amponsah et al. (2016) at a sub-basin scale. The results obtained by the comparison of the peak discharge from post flood field surveys with the model resulting from the application of the rainfall-runoff calibrated at the Vara River basin were consistent. Once again, neither of these methods seem to confirm the lowest rainfall amount in the southernmost sector of the basin.

Finally, the discussor focused on the relationship between the rainfall event and the landslide distribution in the Pogliaschina Torrent basin. The Author did not agree with the ascription of the low ratio of landslide area to the Macigno Fm as a consequence of the minor rainfall amount as written in Bartelletti et al. (2017). The final question that the discussor argued was the explanation of the limited landslide occurrence in the southern-western sectors of the basin, mostly underlain by the Macigno Fm., not as a consequence of the low rainfall amounts.

Taking into consideration all the suggestions and results, we agree with the discussor on the importance of the integration of the rain gauge data with the weather radar observation to overcome the limitation of measurement points and improve the rainfall map. Although the rainfall map in Figure 3 does not provide a completely satisfactory representation of the rainfall distribution, it anyway showed that the north-western sector of the basin received a minor amount of rainfall, coherently with the rainfall map presented in Amponsah et al. (2016). The significant difference between these two maps is found mainly on the southernmost sector of the basin.

In our opinion the reason for the lesser landslide occurrence in the southern-western sectors of the basin is not only attributable to the different rainfall distribution, but it could also be related to other landslide predisposing factors, such as the land use. Bartelletti et al. (2017) highlighted that the eastern part of the basin is mainly covered by terraced agricultural areas and pine woodlands, which showed a high landslide index for land use (LI_{LU} ; 3.8 and ranging between 13.7 and 16.2, respectively). On the contrary, the western sector of the basin is mainly covered by chestnuts (LI_{LU} of 2.1). Bartelletti et al. (2017) demonstrated that the agricultural areas were more prone to landsliding than woodlands. Furthermore, the pine and chestnut woodlands were affected by different parasite infestations. In particular, landslide density was greater in areas of heavily infested pine woodlands than in less infested areas. The important role of the land use parameter on the shallow landslide occurrence is also highlighted by the susceptibility map obtained by Persichillo et al. (2016a), 2016b for the Pogliaschina T. basin.

However, the issue regarding a very different landslide distribution in the Pogliaschina T. basin is still open. Further geomorphological–geotechnical studies on this topic are necessary to improve the knowledge achieved so far.

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