

Dear Martin Mergili

Thank you for your most valuable comments, that will surely help us provide a better revised paper

To address your comments we proceeded point by point.

*General comments*

**1 - “Fig. 2 and the associated text are not clear to me. Why do you need a special tool for the change detection (6457, 25f) – as it is described, you could just do it with the ArcMap Raster Calculator, r.mapcalc in GRASS or whatever. Please explain better what it is that makes this issue more difficult. Further, I do not understand why the maximum of erosion or deposition is 95.24 m in Fig. 2, but only 27.9 m in Fig. 4. Please explain the difference in a clearer way. Note also the specific comments concerning the figures.”**

R: For the preliminary analysis of geomorphic change detection, we did not use any special tool: we just used a tool implemented in Whitebox GIS that, as explained in the text, calculates the magnitude and the direction of variation (erosion or deposit) by simply subtracting the two topographic surfaces (pre- and post-DTM). We agree with the reviewer that there is nothing “special” in this simple operation and that it could have been made using other tools of different GIS software (e.g., ArcMap Raster Calculator and r.mapcalc in GRASS). We mentioned Whitebox Change Vector Analyses (CVA) tool just because we used it. Anyway, in the revised manuscript, we avoid specifying the tool used for this simple computation and we simply describe the performed operation. Maximum values of DoD in Figs 2 and 4 are different because in Fig. 2 the DoD map was computed for the entire catchment area whereas in Fig. 4, it was calculated only within the boundary that was drawn on the basis of the preliminary analysis (DoD map in Fig 2). In particular, the value of 95.24 m in Fig. 2 is due to a pixel affected by border effect.

**2 – “Be consistent with the tense used in the Methods chapter. E.g., in 6459, 21 you use past tense, in the following line you use present tense for two aspects which should be in the same tense.”**

R: Thank you for pointing this incongruence; the paper will be amended according to the valuable Reviewer's advice.

**3 – “In the Discussion and conclusions you should mention that a further step from backcalculation to prediction is necessary, requiring certain assumptions/scenarios.”**

R: We will expand the paragraph and we will explain better how we would like to proceed to define hazard scenarios

*Specific comments*

**6455, 18f: The sentence starting with “Dynamic computer models ...” is formulated in a quite optimistic way – all of us know about the connected problems and uncertainties. I suggest to add a sentence emphasizing the limitations such as the parameter uncertainties (incl. the need to backcalculate parameters based on observations) and the need to appropriately assess the uncertainties and sensitivities of the parameters.**

R: We agree on the fact that it may look as over-confidence in the potential of numerical models, we will underline the downsides of computational methods

**6456, 6f: "... from 1930 m down to 590 m a.s.l. where ..."**

R: Paper will be amended accordingly.

**6456, 12f: I do not think that the term "alluvial" is used in a correct way here. My suggestion: "Thick layers of residual rock and rock fall material cover the upper part ..."**

R: Paper will be amended accordingly: we will avoid to use alluvial and leave just deposits as some material is quite fine deriving from the alteration of the marls.

**6456, 20: "... evolve into debris flows ..."**

R: Paper will be amended accordingly.

**6456, 23: "... located farther downstream ..."**

R: Paper will be amended accordingly.

**6457, 1: "... In the last event, which occurred on 4 November 2010, ..."**

R: Paper will be amended accordingly.

**6457, 8: The term "model" is ambiguous here, there are many types of models. Please specify in a clearer way which type of model you mean.**

R: we will correct it with "reliable numerical reconstruction"

**6457, 14: "... was carried out on 21 October 2010 ..."**

R: it will be corrected, thank you

**6458, Eq. 1: Check formatting of equation and define q**

R: Parameter  $\delta$  (q) is the uncertainty. Further, equation contains a typo that will be corrected.

**6458, 26: You state that the error in both DTMs was set to 0.2 m. Before (6457, 18) you have specified the RMSEs associated with both of the surveys. Please explain in a clearer way why you finally chose to work with 0.20 m.**

R: RMSE values are relative to the LiDAR point clouds and not to the interpolated surfaces. They have been calculated by the commercial company in charge of performing the survey. The operator from that company compared GPS control points acquired in flat surfaces with the respective LiDAR points to calculate RMSE. A larger value of 0.20 m has been used as a rough estimation of the error, instead of the calculated RMSEs, because it is a sort of worst case scenario: by this both the increase of error with the interpolation into a regular grid (2 m resolution) and the effect of catchment morphology on DTM uncertainties are somehow considered (please note that error increases with increasing slope).

**6459, 2: "... was performed with the DAN3D software ..."**

R: Paper will be amended accordingly.

**6459, 4: “... discretized into numerous ...”**

R: Paper will be amended accordingly.

**6459, 8: “... curvature on the erosion/deposition pattern ...”**

R: Paper will be amended accordingly.

**6459, 28: “... the cells were resampled to a 5 m x 5 m grid.”**

R: Paper will be amended accordingly.

**6460, 3: I am not sure if the reference to Fig. 3 is correct here. In my opinion, the reference should rather point to Fig. 4. As far as I see, Fig. 4 is not referenced at all whilst Fig. 3 is not really described in the text.**

R: we agree with the reviewer, fig.3 and fig. 4 were erroneously inverted. Further, the following phrase will be added: “The resulting differential DTM (Fig. 3 – the DoD map) was analyzed in order to identify erosion and depositional areas related to the event and to quantify them in terms of volume (Fig. 4 – the histogram).

**6460, 10: As far as I can see from Table 1, the discrepancy of 15,000 m<sup>3</sup> could also just be a result of data uncertainty, as the error in volume may be 50,000 m<sup>3</sup> - therefore, the difference could also point in the other direction.**

R: we agree with the reviewer. In the revised manuscript, we underline the high error associated to the Total Net Volume Difference.

**6460, 21: “Agno di inlet” or “Agno inlet”? Further, show this place in Fig. 1.**

R: “Agno di” is wrong and it is probably a misprinting we will correct it. The stream is indicated in fig.1 but thanks to your pointing it out: it is obviously not readable, we will highlight it

**6460, 26: “... due to the increase”**

R: Paper will be amended accordingly.

**6461, 5ff: Please check the grammar of this sentence.**

R: Paper will be amended and the sentence will be re-phrased as follow: “The coupling of frictional and turbulent behavior allows to describe better the complex dynamic of the landslide and its long travel distance coupled with more than 10 % of entrainment

**6461, 22: “... while in the lower tract it was ...”**

R: Paper will be amended accordingly.

**6461, 23: I suggest to give the errors not only in absolute values, but also as percentages (also in Table 2).**

R: we will do that, thank you

**6461, 23: Again, “Agnò di inlet” or “Agnò inlet”?**

R: Paper will be amended accordingly.

**6461, 23ff: “... downstream. This is an acceptable ...”**

R: thank you for your suggestion, it makes the sentence clearer

**6461, 24: Maybe better: “... for a large debris flow.”**

R: We thank the Reviewer; our preference for the term landslide refer to Cruden and Varnes (1996) classification as the whole phenomenon could be defined as complex landslide.

**6462, 1f: “... transversal dynamics of deposition in the external part of the curve and erosion in the internal part, ...” Further, are you sure that deposition occurred in the external and erosion in the internal part and that it was not the reverse?**

R: We agree that typically in channels the opposite of what is stated occurs due to transverse bed-load transport. However, in this example we believe that the combined effect of the secondary currents and the direction of the flux coming from the Agno inlet had a more significant effect. In fact from the upper track a flow with a fairly high angle of friction arrives; then two things simultaneously happens at the bend: the channel slope changes significantly from 15° to 7° and the water discharge from the Agno enters in the main channel. The water flow from the Agno is directed to the internal part of the bend therefore fluidifying the internal flow allowing it to maintain momentum, to carry more sediments and also to erode. On the other hand, the material flowing on the external part of the bend would have undergone a less significant change in the rheology therefore depositing more quickly due to the change of channel slope and also to the lesser velocities. We will surely explicit this in the revised paper.

**6462, 5: “... downstream from the Agno inlet ...”**

R: Paper will be amended accordingly.

**6462, 6: “... upstream from the Agno inlet ...”**

R: Paper will be amended accordingly.

**6463, 1: “a spatially distributed ...”**

R: Paper will be amended accordingly.

**6463, 2: “... of fast moving does ...”: it seems that a word is missing here.**

R: Thank you, flows is missing

**6463, 4: Strictly speaking, the DoD does not compensate for the lack of velocity data – these are two different things which provide reference data for different output parameters of the model.**

R: We agree that strictly speaking it does not and we do underline that is something that is missing in our analysis. What we wanted to highlight is that the amount of data that the DoD provides could allow to delineate the dynamic of the event even though velocities are missing.

**6463, 5: “...it is advisable for future studies ...”**

R: Paper will be amended accordingly

**6463, 6: What do you mean with geotechnical instrumentation here?**

R: the sentence will be re-phrased as follow: “...also the set up of instruments like ultrasonic, radar, laser sensors or geophones”

**6463, 13f: “... cost has dramatically decreased ...”**

R: Paper will be amended accordingly

**Table 1: Remove the colon after “Estimate”**

R: it will be done, thank you

**Table 2: In my opinion, it would be fine if you could give the differences also in per cent.**

R: it will be done, thank you

**Fig. 1: Some of the labels are not readable, further you should use larger fonts in general.**

R: Those labels will be amended accordingly.

**Fig. 2 (see also general comment): 0 should be no colour, fonts should be larger**

R: Fonts of Fig.2 will be enlarged and the legend modified.

**Fig. 3, caption: “(a)” after “distribution” should probably be removed.**

R: Yes it should, thank you

**Fig. 4: (see also general comment): Larger fonts would be better.**

R: Fonts will be enlarged, thank you