

March 2017

A review of “A multi-centennial record of past floods and earthquakes in Valle d’Aosta, Mediterranean Italian Alps” by Bruno Wilhelm et al.

Manuscript number: nhess-2016-364

This paper presents a lake sediment-based reconstruction of historical earthquakes and flood events in the Italian Alps over the last ~270 years. It builds on the burgeoning literature investigating palaeofloods and palaeoseismicity and its research objectives fit within the scope of NHES. It is well-written, the data are generally analysed rigorously, the figures are largely clear and effective and I enjoyed reading the paper.

I have a number of interpretational queries and requests for clarification on certain aspects of the paper prior to recommending it for publication. In addition, I have a broader concern around the scope and impact of the paper. The authors and their collaborators have published a series of papers on this theme from various lakes in the European Alps over the last few years. If the authors are pitching it as a further case study, that’s OK, and it meets the criteria of NHES by presenting new data. On the other hand, the authors state on line 316 that Lago Inferiore has the “highest Earthquake Sensitivity Threshold Index of any studied Alpine lake”. This is a much stronger statement than is made in the abstract. I urge the authors to consider re-framing the paper so they sell its novel aspects

Important interpretational queries

- (i)** The sediment accumulation rate is surprisingly high if the majority of the catchment is inactive, owing to the high-elevation lakes, and it is frozen for half the year. This will leave an active catchment in the order of 1-2 km². I suggest you elaborate further on the sources of sediment, especially how much may be glacially-derived material. Will this not have a very different sedimentological signal to the floods and mass movements?
- (ii)** It is unclear how you associate the lamination thickness with the grain size measurements sampled continuously at 5-mm intervals. In the Passega-type diagrams, what did you do if a maximum D50 or D80 value was derived from a 5-mm slice that overlapped into another distinguishable lamination?
- (iii)** The suggestion that the ¹³⁷Cs spike associated with AD 1963 weapons testing has been diluted by the Chernobyl signal seems unlikely, considering the rate of sediment accumulation. AD 1963 should occur within a band at 12-18 cm (1σ), which corresponds with GB-IIIa. Is it more likely that this mass movement may have redeposited older material and diluted the atmospheric ¹³⁷Cs signal?
- (iv)** The extrapolation of the age-depth model is a concern, although I appreciate this cannot be easily resolved without substantial effort e.g. acquiring radiocarbon ages. I presume the authors looked for earlier metal signals reflecting earlier industrial emissions and/or mining/smelting? Further, sediment density is higher below 20-cm. Could this point to greater input of clastic material? I suggest the authors make a convincing case that sediment accumulation rates are likely to have remained constant through this time window. In particular, would the SAR have remained constant as the glacier(s) in the catchment retreated after the mid-19th century maximum (assuming it followed the regional pattern)?
- (v)** The sedimentological evidence of mass movements is convincing but can anything be inferred from the different depositional characteristics of the four mass movement layers? Is the likelihood

for one depositional mechanism to occur sensitive to earthquake intensity or distance from epicentre, for example? Or does the lake and/or catchment evolution influence which type of mass movement deposit occurs in response to an earthquake? I've seen little on this in the literature and it would be an interesting point to try and make.

(vi) The role of glacial input and/or snow avalanches has not been considered fully. The former could make a significant contribution to the basal sediments because the active catchment from the eastern stream is so small. There is potential for snow avalanches to deliver a characteristic deposit – see some of the work by Eivind Støren and colleagues. This could be a factor in the discussion on lines 332-334. Are there any records of avalanches in those years or local meteorological data that suggest particularly warm springs, which could have triggered widespread snowmelt? This notion of snowmelt applies more broadly, as the lake is frozen for 6 months of the year. Do the historical data (as referred to on line 372, presumably derived from Mercalli et al. 2003) suggest any regional floods triggered by snowmelt?

(vii) On Figure 8 there appears to be two earthquakes that plot above the sensitivity threshold. In terms of fully understanding the process sedimentology, I suggest the authors offer some explanation as to why those earthquakes did not leave a preservable imprint.

(viii) I am unconvinced by the argument that grazing facilitated thicker recent event deposits. Did grazing in the catchment really only begin in the 1990s? It would be helpful for the authors to provide evidence.

Figure 1: (i) The colour scheme associated with the DEM ought to be incorporated; (ii) The purpose of panel C is unclear. The lake appears disconnected from the major regional tributaries

Figure 3: (i) Could the horizontal layer stripes be shaded to reflect the different processes? (ii) Explain in the caption what the layer codes represent, or at least point the reader to the relevant section; (iii) The matrix-supported layer is very difficult to distinguish. Could you use a different colour scheme or patterning?

Figure 4: (i) Change 'sedimentary' to 'sediment' on the y-axis

Figure 7: Spell out what "l_o" and "d" are in the caption

Figure 9: (i) Spell out "INF" and "LED" or else include these codes in the caption; (ii) What does the horizontal red line represent?

Minor comments

Lines 34-35: the phrase on 'robust risk assessments' is rather vague

Line 36: Should include a reference

Line 38: "have been" instead of "were"

Line 46: "In **the** case of earthquakes..."

Line 49: "centuries"

Line 61: remove "it"

Line 120: replace “during” with “from”

Line 140: remove “the”

Line 150: “...deposits, representing...”

Line 150: come up with a better technical word than “interrupted”

Line 197: add “down-core” or similar at the end of the sentence

Line 207: “cannot **be** as clear defined.”

Global change: the word “decennial” is odd. I suggest a global change to “decadal”

Line 379 and section 5.2.3: I suggest the authors insert additional references to Mediterranean climate in this section (some of which are listed in the bibliography and referenced elsewhere)