New flood frequency estimates for the largest river in Norway based on the combination of short and long time series

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This paper presents a very interesting case study for flood frequency analysis in the Glomma river in Norway, based on the combination of systematic, historical and paleoflood data. It benefits from a specific configuration of the Glomma river during large floods, when the flow level is exceeding a threshold. Flood deposits can be found within a small lake located 7 km from the main river.

It provides a valuable analysis of the variability of flood regime over the last 10 000 years. A flood rich period during the Little Ice Age does correspond to lower than average summer temperatures. As the future climate will be warmer, the design flood might decrease.

I have some recommendations that may improve the quality of the paper, which is already good.

Length of the paleoflood record

It is not clear how the authors state the value of 10 300 years from the sediment core. Is it the first dating of a sediment? If yes, according to the dating uncertainty (see a discussion in Dezileau et al., 2014, Geomorphology, 10.1016/j.geomorph.2014.03.017), it may be better to round it to 10 000 years. Another option is to refer to the huge glacial lake outburst flood (reported in section 5.1). It may be the beginning of the paleoflood record. Hogaas and Longva (2016) postulated a date of 10 000 – 10 400 years. So again, a rounded value of 10 000 years may be preferable.

Section 1

Page 2, line 3: the main reason for the increasing of flood damages is the increase of economic values within the flood plain. Impact of climate change is of concern, but do not forget that flood risk has two components: flood hazard and flood exposure.

Section 2

Figure 2 left: put one curve with dash lines (easier to follow)

Page 5, line 5: is the beginning of the Holocene period in Norway exactly 11 700 years ? Give a reference.

Section 3

Page 3, lines 8-11: it is not clear within section 3.1 which systematic period is considered. It is written 1871-1937, but in fact, floods larger than x0 = 2533 m3/s have been used (table 1: years 1966, 1967, 1995). If the flood regime was affected by river regulation after 1937, we expect to introduce a correction on the three largest floods after 1937. If not, you can consider the whole period 1871-2019. Please provide the p-value of a statistical test (e.g. Mann Kendall test) with the two periods: 1871-1937 and 1938-2018.

Page 10, lines 10-21: Stability of the geometry of the Glomma river is discussed in section 5.1. May be here in section 3.2.1 or in section 5.1, you could add information on the gaugings. Is the rating curve stable or do we need to use a set of different rating curves according to the gaugings?

Section 4.3

It is not easy to follow the different options of computation for flood frequency analysis:

- Systematic period: is it 1871-1937 (section 3.1) or 1872-1936 (section 5.3)?
- Historical period: 1653-1872. It may end in 1870 or 1871
- Paleoflood period: 1320-1850. Explain the starting date 1320. If paleoflood and historical floods are in agreement during the overlapping period, we expect to have 1320-1652

Plotting positions for figures 14 and 15 are not explained. According to Hirsch and Stedinger (1987), you should consider ALL the floods larger than the threshold x0 over the historical + systematic period, and then the systematic floods lower than x0. We expect to find a set of 14 peak flows (11 from historical period + 3 from the systematic period), and the remaining annual maximum values lower than x0 for the systematic period.

Plotting position of the 1789 flood should be different, according to option 1 or 2 (largest flood since 1653 or since 10 000 years).

On figure 5, it is not easy to understand which curves relate to cases (i), (ii) and (iii) vs systematic floods included, all floods included, paleoflood included.

Section 5.2

On figure 17, it is very interesting to see the flood rich period during the LIA with low temperature (and the contrary before 500 cal. yr BP). The authors could add a comment on the fact that we have two peaks during LIA but the temperature did not significantly change.

Section 5.3

Page 26, line 6: it remains unclear how the 600 year period is chosen. Additionally, according to section 4.3, it a rather a 530 year period (1320-1850) or a 332 year period (1320-1652)

Small typos

Page 2, line 18: they require that buildings

Page 2, line 22: up to 1000-year floods… (see Lovdata, 2010, and TEK17, 2018 for regulations

Page 3, lines 24-25: (Hanssen-Bauer et al., 2017

Page 5, line 16: the flow direction reverses

Page 5, line 24: in Fig. 5

Page 6, line 6: (after Hegge, 1968)

Page 10, line 4: reference of Ostmoe (1985) is missing in section 7

Figure 8: Legend “Max discharge”

Page 11, line 2: (Renberg and Hansson, 2008). Samples

Page 11, line 39 add “if k=0 (Gumbel distribution)” on the second part of equation (1)

Page 22, line 18: A second assumption is that the river

Page 22, line 20: Hogaas and Langva (2016) give an age of 10 – 10.4 cal ka BP in conclusion

Page 22, line 22: Based on Klaeboe (1946) and Hegge (1968) the threshold

Page 22, line 26: According to Hegge (1968), the… in 1967 CE

Page 22, line 38: and regional

Page 23, line 15: reference of Moberg et al. (2015) is missing in section 7

Page 24, line 14: Velle et al., 2010

Page 24, line 22: and in the central alps

Page 25, line 4: Storen et al. (2012)

Page 26, line 10: the threshold for historical floods is too low

Page 27, line 25: 7. References