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## Reply on RC1

Gerardo Benito et al.

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Author comment on "Enhanced flood hazard assessment beyond decadal climate cycles based on centennial historical data (Douro Basin, Spain)" by Gerardo Benito et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-320-AC1>, 2021

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Dear Prof. Amorim,

First of all, thanks for the constructive comments. In the below lines, we have replied one by one all comments.

### REVIEWER COMMENT:

The article is an excellent methodological approach to an increasingly important theme: the study of past flood occurrences and how it serves "to increase public confidence in any proposed solution that ultimately involves a large economic or social expense for hazard mitigation" (lines 708-709). I consider that the main contribution of this article is the systematic use of proxy and instrumental long-term data, crossing the two dimensional of hydraulic modelling (referred in 3.3). I considered this article a pilot project of a methodology application that could be replicate in other cases.

### RESPONSE:

We appreciate very much the words of the Prof. Amorim as a recognised expert on the study of historical flood events and social perception of flood risks.

### REVIEWER COMMENT:

A first suggestion to clarify the extent of this article is the inclusion, in the title, the mention to the space: the river and place (River Douro and Zamora, Spain). Indeed, the article is mainly an approach to the analysis of the river Douro floods in the Spanish area, between Zamora and the first dams, that were constructed in 1960s after Zamora town. The article is a case study, a methodological research about a particular section of Douro River, with its own characteristics (as was explain in the contain).

### RESPONSE:

Thanks for this comment. We initially omitted the river name and place to avoid a consideration of this work as local study. We wanted to highlight the methodological approach and the message of the importance of understanding long-term flood frequency/magnitude changes at decadal and centennial scale for improving flood hazard

assessments. However, after the reviewer suggestion we agree to include details of the study site in the title as follow:

“Enhanced flood hazard assessment beyond decadal climate cycles based on centennial historical data in Zamora (Duero River, Spain)”

COMMENT: A second suggestion is the possibility to add extreme dates in the title, even if is difficult to fixed the scope, because sometimes are mentioned (and effectively was study) the last 500 years, and in other occasions the period between 1250-1871, maybe because they faced «a non-continuous dataset between 1250 and 1545» (I understand the expression «centennial» in the title).

RESPONSE:

Thank you for this comment. We think that the expression centennial already indicates the use of data records of several hundreds of years. Moreover, the historical temporal framework differs when considering isolated flood data and continuous flood registers. The period between CE 1250 and 1511 has some isolated non-continuous flood data, particularly on extreme events, and therefore, it cannot be included in the flood frequency analysis. Because only reading the paper, the reader will get an idea of the different temporal frameworks for the continuous/discontinuous datasets, we think that is better not to indicate the time framework in the title.

COMMENT:

The authors made a remarkable comparative approach putting its case in a larger frame. I suggest another comparative analysis using an article that tried to estimate the frequency of extraordinary floods of Douro River in the Portuguese territory, till its estuary. (Silva, J.D. da; Oliveira, Manuel de Sousa - *As cheias na parte portuguesa da bacia hidrográfica do rio Douro, ps/p/*. Available <https://grupo.us.es/ciberico/.../porto2diasdasilva.pdf>).

RESPONSE:

Sorry, I tried to download this pdf but it seems there is not available at this moment, and I couldn't find. Nevertheless we have used other available publications by Loureiro, and consulted some internal reports by the Instituto da Agua (Rui Rodrigues and colleagues) providing historical flood discharges in Regua and Porto. We think that a comparative analysis between the Portuguese Douro and the Spanish Duero sites is outside the framework of this study, but it was avoided on purpose because the paper is already quite long.

COMMENT:It could be important to insist in a comparison between rainfall contrast characteristics consequences (line 181 and further), i.e., the flood peaks contrast between Régua and Porto at the lower basin of Douro, with Valladolid and Zamora and its consequences. The period 1250-1871, in which were identified 69 floods (including ordinary ones), is a number very low if compared with the floods of the Douro in Porto just for the period between 1727 and 1799, in which were found 54 floods (see the quoted article by the authors). Perhaps this increasing number of floods was related to the tidal peaks and the siltation of the estuary, but this contrast of occurrences could open an outlook about long Douro River course behavior, before and after dams' construction.

RESPONSE:

We agree with Prof. Amorim about the strong contrasts on flood peaks between the Portuguese and the Spanish Douro/Duero river and their consequences. It is incredible that some large peaks in Porto were not recorded as large floods in Zamora, but the data

shows that the rainfall characteristics are very different. We agree that this topic should be addressed in the future and perhaps an opportunity to collaborate with Portuguese colleagues. Regarding the difference on the number of floods, it is difficult to compare using relative flood classifications, as the ones applied by Alcoforado et al., 2021 and in our paper. In the case of Alcoforado et al., 2021 the frequency of extraordinary floods is once in each 1.33 years, which is approximately the bankfull discharge of rivers in temperate climates. In the case of Zamora the conditions are drier and probably the historical accounts of high flows without damages are lower than in Porto, where even small floods had important influence in the navigation and port operations. However, the number of large floods are not so different at both sides; in Porto there were six catastrophic floods between 1727 and 1799 (as referred in Alcoforado and colleagues paper) whereas in Zamora we recorded seven floods within relative categories of catastrophic and extraordinary floods in both cases causing moderate to severe damages. As Prof. Amorim knows the tidal conditions were critical in Porto in terms of water stage reached at the lower Douro.

#### COMMENT:

A final remark: line 575, authors wrote "includes the largest flood on record (Dec 4-6 1739) that reached a stage of 12 m at Dom Luiz I Bridge (Loureiro, 1904; Taborda, 2006)". The bridge doesn't exist in 1739 (only constructed between 1881-1886) but Loureiro (and Taborda quoting Loureiro), used the currently existing bridge as a mark (rebuild the sentence will be enough).

RESPONSE: Thank you very much for this comment, and indeed it is a mistake in the way in which it was indicated the observation site. Indeed, the observation point on stage and flow velocity used by the Porto and Leixões port authorities directorate is located at a rocky river bank on the right margin, immediately upstream of the D. Luiz bridge, and as the reviewer said was brought to their flood marks as a reference to the Dom Luiz Bridge.

"that includes the largest flood on record (Dec 4-6, 1739) that reached a stage of 12 m in a bedrock section at the right margin just upstream of the Dom Luiz I Bridge (Loureiro, 1904; Taborda, 2006)."