**Revision of the paper: "Nonstationarities in the occurrence rates of flood events in Portuguese watersheds"**
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## GENERAL COMMENT

The present work describes the variability of floods and extreme precipitation events in different watersheds of Portuguese rivers during past decades. This is a very relevant topic of research for water planning and management, as it can contribute to improve the strategies of prediction and risk assessment. Results of the work describe, in fact, a non-stationary behavior of flood occurrence, which contradicts the current framework of models used in Portugal for flood forecasting, that are based on the assumption of stationarity. The authors base their results on the performing of a robust statistical approach to the daily streamflow and precipitation series; however, the same effort was not put on the assessment of the quality and homogeneity of data series, which therefore invalidates all the statistical analyses and the obtained results. Together with it, the structure of the paper is rather confusing and should be re-structured in a more intuitive way.

My recommendation, based on the significant drawbacks that I specify below, is to reject the paper in its present form, with the possibility to be re-submitted if these drawbacks are overcome.

## MAJOR ISSUES

### A) Structure of paper

In my opinion this constitutes one of the main drawbacks of the paper. The structure is somewhat of a "chaos", and rather un-intuitive, leading to confusion to the reader: methods and results appear together mixed in section and sub-sections; preliminary results are shown in "data section"; results are discussed, but no mention of "discussion" is made in any section title; references and discussions also appear in the "conclusions" section, etc…  The paper should be re-structured in a more intuitive way. (I suggest a re-distribution at the end of this explanation)

List of things to correct:

1) The section "data" should be "Data **and Methods"** and it should include all the methodology aspects of the paper, and not preliminary results.

2) There is no mention of any characteristic of the studied watersheds. On a paper dealing with variability in streamflows and precipitation, at least basic climatology of the study area should be shown. There must be obvious differences in the climate (not to metion lithology / geology, topography…) between watersheds in the north and the south. So at least climatic differences should be clarified by adding some information in table/fig 1 and some paragraph in sub-section "streamflow and rainfall data" or in a new section (study area).

3) If the results are interpreted, the section should be "results **and discussion".** This section shall not have methodological explanation, maybe some clarification but not large paragraphs.

4) Sub-section 2.3 "preliminary data analysis" should be moved into the results section. Even if they are not the main objective of the paper, these analyses refer to variability in the magnitude of floods, so even if "preliminary" they are in fact results.

5) Sub-sections 3.1, 3.2 and 3.3 should all be moved into "data and methods" section

6) NAO section should be placed in the "results and discussion" section
   - The first paragraph (NAO explanation) should be moved into the introduction
   - The second paragraph, except the NAO definition, (NAO calculation and acquisition) should appear in the data and methods section, as this is in fact data collected and processed.

**7)** In "conclusions" section should not appear discussions and references, references are not conclusions of your work. Conclusion should be 3 or 4 bullet points with the most important findings of the work. Thus, next paragraphs should be moved into the "results and discussion" section or removed:

Page 8624, lines 8 – 11: should be deleted

Page 8624, lines 25-29. Discussion section

Page 8635, lines 4 -7. Discussion section

**My suggestion:**

1) Introduction
2) ¿characteristics of study areas??
3) Data **and Methods**
   3.1. Rainfall and streamflow data.
   3.2. Peaks over-threshold data
   3.3. Nonparametric occurrence rate estimation (just the methods)
4) Results **and discussion**
   4.1. Preliminary data analysis (varibility in magnitude).
   4.2. Nonstationarity on flood occurrence
   4.3. Relationship flood – NAO

5) Conclussions and future research.

## B) DATA QUALITY

I have serious concerns about the quality of the data used and its suitability for the analyses. The authors use robust statistical approaches to characterize variability and nonstationarity of flood and intense precipitation events, however, if the sample data does not accomplish quality criteria, all the assumptions and results obtained could lead to erroneous interpretations. I next summarize the main concerns about data:

1) Whilst the authors mention the source of the NAO index (climate research unit), no mention in the manuscript is done about the source of the streamflow and precipitation data. What institution/s provided such data? Is it open access data? Please clarify it in the text.
2) There is no mention about the quality of data. The reader does not know anything about the homogeneity of the series. The presence of gaps is rather usual in precipitation and streamflow data, especially on daily series, and no

information is given about it. Are all the series used free of data gaps? If there were gaps, were they filled/ what method was used to fill data?

3) The authors mention that the watersheds analyzed are "geographically spread over Mainland Portugal" (page 8612 , line 20). However, what one see in Fig. 1 is that most of the watersheds are located in northern Portugal, only 2 are located in the south of Portugal, and all central Portugal (and what its most important, the watersheds of the Tejo river) remain unstudied. The reader, therefore, must doubt about the representativeness of the selected series when the authors state: "*The similarities in the behaviour of λ(t) among different watersheds that are geographically spread over the Portuguese territory, and between rainfall and streamflow suggests that the observed trends are inherent to the natural multi-year variation of the hydrological cycle, as opposed to potential anthropogenic influence on the catchments themselves*". Is it not possible to include a sample of watersheds from central Portugal?

4) Inhomogeneous period of study. This is probably the most critical drawback of this paper and the most important in terms of comparability and representativeness of results. Results yielded from the analyses cannot be comparable if the longitude of the series is not homogeneous, thus conclusions drown are not reliable. Long-term mean of the series are used to calculate POT, if the longitude of series is not the same, how can the resulting POT series be comparable? They are also used to remove dimension and make series comparable, but these average values correspond to different time periods!!

5) Inconsistent number of precipitation series with respect to streamflow series. Even if it's not possible to have the same number of series of both variables, a higher number of precipitation series would be desirable to make results comparable and consistent.

All these considerations make the reader hesitate about the criteria established to select the streamflow series… Was there any criteria? What are the reasons for selecting those series and no others?

**Overall, my suggestion is that the authors repeat the analyses with a sample of series selected upon robust criteria**, i.e.: common study period, quality of data, and (if possible) homogeneous spatial distribution. ¿is that possible?

**MINOR ISSUES**

Please change /correct the following

- Page 8615, line 8: "… Fig. 2b and c…" should be "Fig. 2c and d", is that right?
- Page 8617, lines 1-2: "… the year $K$ in the horizontal refers to the hydrologic year …" I don't think it is necessary to repeat this, as it was previously clarified in data section.
- Page 8617, line 5: "from the late 1950s to the late 1960s". Could you change in figures 3 and 4 the time scale of the X axis, with lapses every 10 years? i.e.: 1920, 1930, 1940 and so on.
- Page 8621, lines 9-10: How do the readers know that these rivers are not regulated? Any data/ information to support such assertion are needed. Maybe the Impoundment Ratio index (Batalla *et al.* 2004)
- Page 8621, lines 14-16: I suggest including a figure with a couple of examples of the streamflow and precipitation λ series plotted together in the same scale to see if they really exhibit similar trends.
- Page 8623, lines 3-5. "*Fig. 8 clearly shows that for every analyzed sample: (i) the majority of years without floods have positive NAO indices, and (ii) the years with the highest flood occurrence do not occur in positive NAO phases*". It is known that the control of NAO on precipitation/streamflows on the Iberian Peninsula is not homogeneous in space, being stronger its influence in the southwestern part, than in the northwestern sector (Martin-Vide 2001, Lorenzo-Lacruz 2011). Thus, these 2 features observed should be more evident in the watersheds located in the south of Portugal. Is it really like that? Is there any way / analysis of representing it in the same figure? (The sample of series in the south of Portugal is, however, too small (just 2) to make any comparison, thus I suggest that you increase the number of watersheds in southern Portugal to be analyzed)
- Page 6824, lines 20-23. When one looks at the graphs in Fig. 6, it is noticeable that after the peak in the 60s, there is a decrease in the flood occurrence rates until recent years; in fact the authors state in page 8621 lines 7-8 that "the graphs with data until the late 1990s and 2000s exhibit lower occurrence in the more

recent years." At this stage the reader misses an interpretation of such decrease from the 60s. In the introduction (page 8611, lines 4-6) it is stated that circulation models project and aggravation in extreme precipitation in northern Portugal. Results here seem contradictory with such assertion, thus and interpretation and explanation of results should be given.

- Fig. 6. Could you re-organize the figure in such way that floods and precipitation graphs are more clearly distinguished? (in separated columns, for example)
- Page 8627, line 3, (Lorenzo-Lacruz et al.): Please correct the surname of the co-author "González-Hidalgo"
- Page 8627, line 9, (Morán-Tejeda at al.): Surnames of co-authors should be written instead of their names. Please change them.

Batalla, R. J., Gómez, C. M. & Kondolf, G. M. 2004. Reservoir-induced hydrological changes in the Ebro River basin (NE Spain). Journal of Hydrology 290:117-136. Doi:10.1016/j.jhydrol.2003.12.002.