Hydrol. Earth Syst. Sci. Discuss., 8, C5005–C5009, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C5005/2011/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Nonstationarities in the occurrence rates of flood events in Portuguese watersheds" *by* A. T. Silva et al.

A. T. Silva et al.

artur.tiago.silva@ist.utl.pt

Received and published: 17 November 2011

We thank the anonymous referee for his/her valuable comments and suggestions.

1. We agree with the referee and will reorganize the paper according to the suggestions proposed by referee #1.

2. Comments on data quality will be added to the revised version.

3. We agree with the referee. About the number of samples used, please refer to the second authors' reply to referee #1. Regarding the spatial coverage: in the revised

manuscript the findings' limitations due to the number of samples will be pointed out.

4. In our research we have tried different criteria for threshold definition and decided to apply the one presented in the manuscript since that criterion was common among the samples. In the revised manuscript, a more descriptive comment on that issue will be made. Regarding the effect of the selected threshold on the results: when the threshold is raised, fewer events are sampled, leading to a decrease in the mean number of events in a year (lower $\overline{\lambda}$), and vice-versa. This is clearly shown in Fig. 2 c) of the HESSD manuscript, for the sample S5 – Fragas da Torre. In our research however, we are concerned with the fluctuations of $\lambda(t)$ around $\overline{\lambda}$. Fig. 1 of this reply shows that such fluctuations for the 10 watersheds, adopting thresholds of 6, 7 (the adopted one), and 8 times the long term mean daily flow, or modular flow, q_{mod}, behave similarly. As a result, imposing slight variations of the threshold level does not affect the final results and the conclusions of the paper.

Regarding the reviewer's suggestion about integrating a varying threshold in the bootstrap confidence band construction for the kernel occurrence rate estimation: we thank the reviewer for the suggestion as it is novel (to our knowledge) and has sparked an interesting reflection on our research. We believe, however, that such an approach may require a completely new setup for our experiment (or perhaps a different statistical procedure) in order to account for uncertainties due to a variable u in $\lambda(t)$. Furthermore, rigorously speaking, when the threshold is altered, an entirely new sample of POT time data is obtained and we cannot see how the theoretical basis that supports the bootstrap resampling method allows for the original sample being altered from simulation to simulation. Hence, we think that uncertainties due to threshold selection cannot be integrated into the overall measures of uncertainties as estimated via the bootstrap.

5. Regarding our statement in the Introduction about the academic research related to flood hydrology in Portugal: we agree that it should be rewritten and we thank the

referee for bringing it to our attention. We will substitute some of the references by works written in English and will change the sentence so that the cited references are the object of the remark, rather than the Portuguese academic research in general.

Regarding the novelty of the work: to our knowledge, nonstationarities in $\lambda(t)$ have not been previously studied as systematic flood records only are concerned; the methods proposed by Mudelsee and co-workers have been applied to data sets that include centuries-long historical flood records in Germany, which incorporate non-systematic data from pre-instrumental period, that have been collected from documentary data. Our work, based on the same methods developed by Mudelsee and co-workers, shows that the kernel occurrence rate estimator, coupled with the bootstrap confidence band algorithm, is also useful to detect nonstationarities in flood samples usually available to hydrologists, particularly as collected according to the POT sampling technique. We think our experiment opens up prospects to assess the stationarity assumption in other regions of the world, some of them with larger samples and possibly more uniformly distributed over a given geographic area. As we progressed in our work, the next logical step was to explain what caused nonstationarities found in the samples. As the NAO index has been the object of extensive research linking it to droughts and monthly/seasonal rainfall or runoff in the Iberian Peninsula, as correctly stated by the referee, the logical step followed the attempt to explore possible connections between the NAO index and the flood occurrence rates, which, according to our literature survey, has not been reported before. We did not find a predictive relationship for $\lambda(t)$ as a function of the NAO index, but there is a "connection" between these variables, which we think should be explored in more detail in future research. We believe the connections we found, although not definite, are worth to be reported as a first step along this path.

As the practical value of our research is concerned, an immediate consequence of having λ varying with time refers to the flood quantile associated with a given annual exceedance probability, which is now allowed to change as a function of time, even

for stationary peak exceedances over a threshold. Such a possibility changes, for instance, the characteristic values that engineers use to design and operate hydraulic structures and other flood-related works, and introduces a different viewpoint towards flood risk assessment. We did not intend to fully explore these issues in the present manuscript, the main goal of which was to report the nonstationarities in flood occurrence rates detected using the kernel occurrence rate estimator, coupled with a bootstrap algorithm applied to POT time data in Portuguese rivers. However, the additional and important issues mentioned earlier are part of the research we are planning to carry out, as we have mentioned in the conclusions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 8609, 2011.

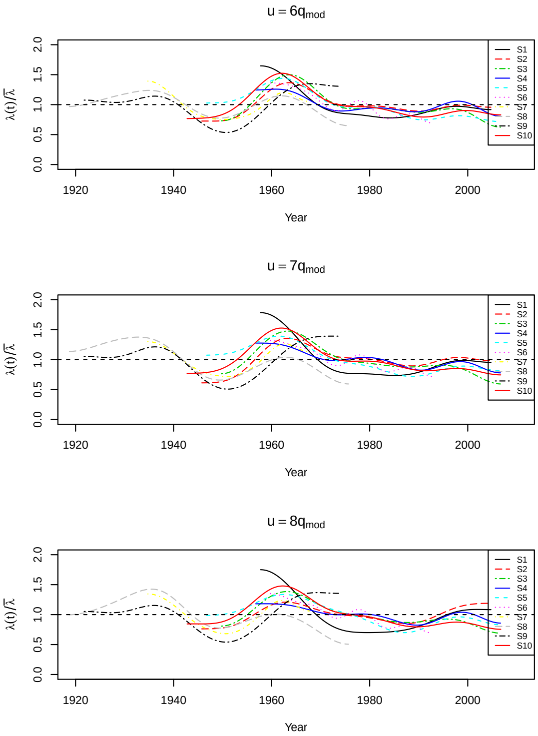

Fig. 1. Fluctuations of lambda(t) around mean lambda for different threshold levels.