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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Application of a hybrid approach in nonstationary flood frequency analysis – a Polish perspective" *by* K. Kochanek et al.

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Reply to interactive comment on "Application of a hybrid approach in non-stationary flood frequency analysis – a Polish perspective"

by

K. Kochanek et al.

Anonymous Referee #2

Dear Anonymous Reviewer,

The authors would like to thank you for the careful reading of the manuscript, honest review and comments. We do hope that our answers and corrections made in the text will satisfy the Reviewer.

The authors compared two methods of nonstationary flood frequency analysis: a twostage (TS) method consisting in removing the linear trend in the mean and standard deviation of the investigated time series and estimating parameters of assumed distributions by L-moments, and the maximum likelihood (ML) method applied to the distributions with parameters assumed to be linearly time-dependent. The Monte-Carlo (MC) simulations were used to compare the ML and TS trends and quantiles. Both methods were applied to 31 Polish 55-year series of annual maximum flows. The synthetic flow data used in the MC experiments were generated from the GEV distribution with two of its parameters linearly time-dependent. Two of the three adopted options were widely analysed: option (i) with 7 competing distributions including GEV, and option (iii) with GEV only. For each option-(i) simulation the best distribution was selected by the Akaike information criterion (AIC), which resulted in that probably all the 7 distributions had their share in each of the 1000 series of both the ML trend coefficients and the TS and ML quantiles.

The question arises here of what is the informative value of a statistic (e.g., of mean quantile), calculated using a series containing a mixture (e.g., of quantiles) from the 7 distributions, and, in consequence, what is the rationale for using such a statistic for comparison with single-distribution equivalent or for other purposes.

Our idea was to provide a handy tool for non-stationary flood frequency analysis (NFFA) for practitioners, therefore, we show advantages of TS method over the MLM method in conditions as close to reality as possible. We concentrated on the practical aspects of these two tools (which was mentioned a few times in the text) and, particularly, on their universality rather than on theoretical laws. In the practical (N)FFA the most suitable distribution is fitted to the data according to a certain criterion (AIC in our case), because the true distribution is not known. Please note that except the 'mixture' of 7 distributions, i.e. option (i), we also calculated and presented the results for the option as if the true underlying distribution was known, i.e. option (iii). In the latter case the MLM proved to give slightly better results (at least in terms of relative bias of time-dependent quantiles) than TS method, but the situation when we know the underlying distributions never happens in reality.

The problem of existence of nonstationarity is in the context of climate warming very appealing. However, typical hydrological sample size is about 50 or less implying rather large uncertainty which may hide the existing time series trend, especially when its intensity is low. So in hydrological practice the problem of trend detectability is important. The Authors provided no information about how many of the estimated trends were significant, both for simulated and for Polish real flows.

The subject of our study was neither proving the existence of non-stationarity in flood regime in the context of climate warming (which was already proved, accepted and discussed by many authors and organisations), nor detection of trends by means of classical significance inference. We totally agree that typical hydrological sample size implies large uncertainty and that is why the smoking gun proof of the climate-change-induced trends based on statistical analysis of floods data does not exist, yet. Since there is the strong pressure to assess expected changes for engineering practice with regard to ensuring an adequate safety level of hydraulic structures, we have assumed that climate change does cause trends in flood regime (even weak). Then we tried to account for them in the most reasonable way to find the appropriate time dependent upper quantiles of peak flows values which are the base of design procedures. The trends cannot be assessed apart from the data, but, as we have showed (TS versus ML method), it is important not to introduce other sources of uncertainty i.e. the distribution choice and its parameters estimation as long as possible. Almost the same rationale underlies the MC simulations when we have imposed trends in parent population and checked how the estimation procedures will deal with their identification in samples. From this point of view there no need to look at significance levels, however it will be

interesting for other 'circumstantial evidence' of climate change consequences issues.

Specific comments and corrections:

A. page 6006: the following statements in the last paragraph require explanation as no estimation method is error-free: lines 12-14: " (...) it [TS method] eliminates the estimation errors in moments (...)" lines 18-20: "(...) when the model is different from the Normal distribution function for which the estimation errors of moments are 0. Similarly, the estimation error for the mean value is 0 when Gamma and Inverse Gaussian (...)".

Indeed, the reviewer is, of course, right! We changed these unfortunate sentences. Now they are: 'What is more important, it diminishes the estimation errors in moments, especially when the skewness coefficient (CS) of the dataset is small (close to 0). These errors are particularly large for the method of maximum likelihood when the selected distribution function (model) is incorrect (i.e. does not fully represent the population it describes) or when the population model is different from Normal for which the asymptotic estimation errors of moments are equal to 0. Similarly, the asymptotic estimation error for the mean value is 0 for Gamma and Inverse Gaussian distributions. It is worth mentioning that the estimation errors of moments in both the TS and ML grow with the CS.'

B. page 6007, lines 8, 9, 11, 12: unclear denotation of the parameters of equation (1): why not use "slope" and "intercept"?

True! We added the clarification of the parameters – they are more meaningful now.

C. page 6011, equation (4): the expectation symbol is lacking as the estimated quantile is a random variable

Thank you very much. It was corrected.

D. page 6012, lines 5-7: " (...) we can conclude that although the trend estimation results using both methods are similar, the TS method proved better when calculating the time-variant flood quantiles." RRMSEs in Fig. 2 suggest the opposite, especially for hydrological-size flow samples.

Indeed, we re-phrased this fragment of the text: ‘To sum up the numerical experiment, we can conclude that although the trend estimation results using both methods are similar, the TS method proved better when calculating the time-variant flood quantiles in terms of the relative bias of upper quantiles (the root mean square error is technically indifferent). Therefore, when we do not know the model and the parameters of the populations of the time series, it is safer to use the TS approach.’ Please also, that we changed the Figure 2 with the more meaningful graphs.

E. page 6023, Fig. 1. "Average values of the estimated trends" - not precise; "(WLS – the thicker lines and ML)" - unclear F. page 6024, Fig. 2. " (TS – the thicker lines and ML)" – unclear

Indeed the captions were not only unclear but also a bit misleading. We resigned from the distinction of the lines by its thickness – they are coloured and there is a legend that is more informative than the description. Now the captions are: Figure 1. The values of the estimated trends (slope – a, c and intersect – b, d parameters) in mean and standard deviation got by the WLS and MLM methods averaged over 1000 Monte Carlo simulations. Figure 2. The quantile XtF=0.9 estimation errors got by the TS and MLM methods and selected discrete time – average values in 1000 Monte Carlo simulations.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/1/C2795/2014/nhessd-1-C2795-2014-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 6001, 2013.