Reassessing Flood Frequency For the Sussex Ouse, Lewes: the Inclusion of historical Flood Information since AD 1650

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General remarks

"Reassessing flood frequency for the Sussex Ouse, Lewes: the inclusion of historical flood information since AD 1650" by N. Macdonald, T.R. Kjeldsen, I. Prosdocimi and H. Sangster is a very interesting description of a huge amount of impressive hydrological research and investigative work done by the Authors.

The work was performed in the frame of 'applied hydrology paradigm' by which I mean the conviction that all carefully prepared and checked historic hydrological or paleo-hydrological information can significantly increase our understanding of temporal and spatial patterns of river flow and, in particular, extreme events and improves the estimation of design values generated by statistical models, in this case FFA models. This paradigm is extremely important in relation to the general knowledge but ought to be supplemented by detailed statistical research to confirm or reject assumed gain in quantiles accuracy also taking into account the system of design procedures of water depending structures.

List of the sources of documentary data on historical floods available in the UK is enviable and so are the methods of data calibration and harmonisation applied by Authors.

I totally agree with the statement that during the largest flows single stage-discharge relationship can be used, however it has to be noticed that uncertainty of upper limb of the rating curve imposes significant uncertainty of discharge assessment in this case. The Authors express the same opinion on the page 7628 writing that "we will only consider the sampling uncertainty, but acknowledge that especially the data uncertainty and the difference between gauged and historical events could be a significant factor." Moreover, only the part of upper quantiles' MSE – the variance – is estimated. It is obvious that the assessment of the quantiles' bias cannot be done but by MC simulations and this is out of scope of this article. It would be advisable to refer to in the text of this article and in the conclusions. Additionally it is worthy to notice, that strong sensivity of the result to the perception level can be the signal of the bias importance in MSE of estimated upper quantiles.

Other discussion issue is the problem of choosing the distribution of annual maxima in the context true – false distribution. Model misspecification results in bias of parameters, consequently translated to the bias of quantiles estimates. Good asymptotic properties of estimation methods vary significantly when the model is untrue, what is the case in FFA, where we do not know the parent distribution of maxima. Authors' statement that "GLO might not be the true distribution" (p. 7627 and 7628) seems to represent excessive cognitive expectations in relation to models and the role they play. However accepting the saying of René Thom (I quote from memory) “The truth is not limited by the false, but by the lack of significance”, it will be better perhaps to think that the model might be not good enough to describe the parent population with sufficient accuracy.

My last remark concerns the question: Is this huge and time-consuming work to prepare all historical information worth the reduction in standard deviation of about 6 percentage points? And what about the design quantiles? For the Soussex Ouse at Lewes the 100-year flood is much lower when estimated using historical data than only the AMAX events in gauged record. Which value ought to be taken for the design?

Detailed comments

1. What is the catchment area at analyzed hydrological station Lewes?
2. Page 7625, line 18 and 19 – in place of pdf and cdf it will be more clearly to use f_X and F_X, or both.
3. Page 7625, line 20 – the expression for pdf ought to be checked, it seems that the correct form is:

$$f_X(x) = \frac{e^{-(1-\kappa)\cdot y}}{\alpha \cdot (1 - e^{-y})^2}$$

where

$$y = \begin{cases} -\kappa^{-1} \cdot \ln\left(1 - \frac{\kappa(x-\xi)}{\alpha}\right), & for\ \kappa \neq 0 \\ \frac{x-\xi}{\alpha} & ,\ for\ \kappa = 0 \end{cases}$$

And the support in both cases ought to be add $(1 - \frac{\kappa(x-\xi)}{\alpha} > 0$ in the case if $\kappa \neq 0$ and $(-\infty, +\infty)$ if $\kappa = 0$)

4. Formal remarks concerning Eq.3 p. 7626 are not important but for the sake of coherence:

$$f_X(y) = f_X(y|y > X_0)(1 - F_X(X_0)) + f_X(y|y \leq X_0)F_X(X_0)$$

5. Page 7625, Eq.5 on the left side the notation of likelihood function should be used and the round parenthesis for Newton symbol (also in Eq.6 and Eq.7). The index *i* in the a-factor is missing.

   $L = \prod_{i=1}^{n} f_X(x_i) \cdot \left\{\binom{h}{k}\right\}$....

   It will be better to put the b-factor at the beginning.
6. Page 7627 Eq.7 – it will be better to leave the last factor in the form such as in Eq.5 $(1 - F_X(X_0))^k$
7. Page 7627 Eq.8 – mistaken brackets, missing condition $\kappa \neq 0$, for which the equation is valid.

8. Page 7628 Eq.9 and 10 – notation *T* used in two different meanings.
9. Page 7631 line 1 – "…contains only the 1772 events in the historical dataset." I've found this expression misleading. "contains only 1772 event" or "contains only one event in 1772"
10. Page 7641, Fig. 1. – There is no watershed line on this figure, so the title is inappropriate.
11. Page 7643, Fig. 3. Combined historical and gauged series of AMAX events for the Sussex Ouse. "at Lewes" ought to be added.
12. Page 7644, Fig. 4. – "at Lewes with confidence limits at 95% level" ought to be added.
    What is the formula used to calculate plotting position for AMAX? One can find that the circle corresponding to the biggest peak flow has the return period about 70 years while the series contains 49 elements only.
13. Page 7645, Fig. 5. There is no gauged data neither historical data marked on the graph as indicated by the key of symbols.