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Hydrology and Earth System Sciences Discussions

Interactive comment on "A framework for assessing flood frequency based on climate projection information" *by* D. A. Raff et al.

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This paper addresses an issue, i.e., the impact of climate change on flood frequency and risk assessment, which will only grow in importance as time goes on. Current flood frequency analyses and flood estimation procedures are founded on the assumption of "stationarity". The very notion of flood frequency itself depends upon the validity of the stationarity assumption. With current uncertainty about future climate, including the possibility about climate change, the assumption of nonstationarity and hence the notion of return period are no longer applicable. Therefore how do we assess the risk of flooding for structures that are already in place, and how do we design flood control structures in the future? This paper deals with these issues, using as examples four dam catchments in four diverse geographical regions of the United States.

The paper adopts a process-based approach based on (1) generation of climate change scenarios based on stochastic downscaling, (2) weather scenarios based on stochastic downscaling down to from monthly projections to 6-hour weather sequences, (3) application of a rainfall-runoff-flood model to estimate floods and then construct flood frequency curves.

First of all, before getting into details, let me state that I am in general agreement with the approach adopted here, and want to congratulate the authors for the substantial and thorough analyses they have carried out. The authors may want to consult with an invited commentary that has been accepted for publication in Hydrological Processes, which addresses the exact same issues that the authors address in this paper. The only difference is that the invited commentary presents the elements of the methodology with the use of an illustrative simple example (involving three different regions of Australia). The reference is:

Sivapalan, M. and J. M. Samuel (2009). Transcending limitations of stationarity and the return period: A process-based approach to flood frequency analysis and risk assessment. Hydrological Processes (in press), DOI: 10.1002/hyp.7292 http://www3.interscience.wiley.com.proxy2.library.uiuc.edu/cgi-bin/fulltext/122262449/PDFSTART

I am prepared to engage in continued discussions with the authors on some of the details. There are three major concerns that I have with respect to what the authors have done.

(1) The presentation of the methodology was very highly detailed, yet it was so dense that I could not determine answers to key critical questions.

The description of the downscaling from monthly climate projections down to 6-hourly rainfall sequences raises concerns. First of all, does this downscaling generate intermittent rainfall events? That is the true nature of rainfall intensities, i.e., intermittency. There was no comment on this aspect.

Also, how do we know that this disaggregation is done right? The authors could have done this using past records, and demonstrated the disaggregation worked well. Was this done? If so, can they demonstrate that this was satisfactory? This is important since floods are normally caused by rainfall events, although in these examples combination of rainfall and snowmelt could cause major floods.

(2) I found the description of retrospective and lookahead flood frequency analysis very confusing. It is possible that these procedures reflect what is routinely done in USBR, but to most others these are potentially confusing. The authors have a responsibility to explain these well. I think the paper requires revision to make these procedures more clear to readers.

(3) Because I did not understand the methods used, I have major, fundamental concerns about the results of their flood frequency analyses.

As the authors themselves acknowledge in their introduction, and in the HP Today paper cited above, when one acknowledges that the climate is changing (even if for the sake of argument one assumes that the climate was stationary in the past), then probability of exceedance of annual maximum floods over a future design horizon is no longer stationary, ie it can itself evolve. The authors do seem to admit this in the later parts of the paper, for example they say that the flood frequency curve is reflective of a given climate.

If this is the case, I do not understand how they can continue to use the notion of the return period. Again this is partly due to my not understanding what they have done, but in the case of the various flood frequency curves they present in the final figures, are they for different (but stationary) climates? In my opinion they can only be valid, if each of the curves represents stationary climates.

(4) Assuming (and hoping) that the computed flood frequency curves are for stationary climates only (ie different scenarios), then there is one final step of combining these and carry out flood risk assessment, perhaps assuming that each of these scenarios

are equally likely, or using some other probabilistic assessment.

In conclusion, I am seriously concerned about the construction of the flood frequency curves presented in the paper. I would expect the authors to clarify this point urgently, and address the remainder of my comments in their revision. If these concerns are addressed satisfactorily this paper will make a substantial contribution to flood frequency analysis and risk assessment under climate change.

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