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Hydrology and Earth System Sciences Discussions

Interactive comment on "Using comparative analysis to teach about the nature of nonstationarity in future flood predictions" *by* S. B. Shaw and M. T. Walter

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Using comparative analysis to teach about the nature of non-stationarity in future flood predictions by S. B. Shaw and M. T. Walter

I really like the ideas behind this paper and want it published, after some revisions. The ideas behind this paper resonate with many ideas that are being explored and propagated in the literature under many guises. Their embrace in hydrology education is a long-felt need.

(1) Firstly, the paper discusses a teaching approach focused on process based ap-

proach to the flood frequency curve (which is usually taught rather mechanically using a purely statistical approach). I do agree that the way flood frequency curve is presented without a process basis leaves a lot to be desired.

However, the flood frequency curve is one of many signatures of hydrologic variability – the others being inter-annual variability of annual runoff (as in Sivapalan et al., 2011; Thompson et al., 2011; Jothityangkoon and Sivapalan, 2008: the first two references are cited in the authors' paper), mean monthly variation of runoff (regime curve) (Yokoo et al., 2009), the flow duration curve (Yokoo and Sivapalan, 2011), and the recession curve (Harman et al., 2009; and Nieber and Brutsaert; Rapp and Selker, which are cited therein).

The idea of using any one or more of these signatures as a the focus of teaching is beginning to be practiced in some places, as highlighted in the education paper by Ngambeki et al. (2012). The latter paper reviews student based learning approaches, and one of the examples cited in this paper is precisely the teaching approach adopted by myself at the University of Illinois, and by Peter Troch at the University of Illinois. These are not published and publicized formally yet, but they are almost identical to the approach presented in this paper.

The authors may want to put their approach in some perspective, given the above facts as it will improve the narrative.

(2) I really liked the authors' discussion of the traditional approaches to teaching (reductionist, process based, or Newtonian), and the alternative holistic, data-based or Darwinian (or natural history) approach they are proposing. This idea, too, is flagged in the papers by Thompson et al. (2011), Sivapalan et al. (2011), and Ngambeki et al. (2012). This idea is also highlighted in terms of the change of discourse proposed in Sivapalan (2009), which also contrasts the boundary-value problem approach used in the past in hydrology, and the more data-based approaches used in well established sciences such as psychology, economics or even social sciences.

The authors may be able to bring out this changed perspective, in the context of watersheds as self-organized co-evolved entities, which requires a synthesis of the Darwinian and Newtonian perspectives to fully decipher.

(3) While I agree with the educational philosophy of using signatures (flood frequency curve) in a comparative manner, the authors did not provide any details about how they have implemented it in their teaching. For example, how does flood frequency fit into the rest of the teaching? Surely, one cannot focus exclusively on flood frequency for a semester-long course, be it at the undergraduate or graduate course. It can only be a component of a course: what shape does the rest of the course take, and how are the various elements integrated?

In my case (and in the case of Peter Troch at Arizona), we have taught advanced undergraduate (and first level graduate) courses in hydrology, where we teach hydrology in a traditional bottom-up (process-based) approach, with the data-based approach focused on a suite of key signatures to provide an philosophical alternative. This is discussed in some depth in Thompson et al. (2012).

Alternatively, I have taught advanced graduate level course in hydrology where I have got students to adopt an approach going even further than the authors in pursuing the physical basis of the signatures. The last time I taught this course, a group of students pursued the physical basis of the flow duration curve (FDC) in a comparative manner for 200 catchments across the continental United States. One year later, the students are close to finalizing a 4-part paper which they are about to submit to HESS.

(4) The paper is missing quite a lot of the literature on (i) comparative hydrology, (ii) process controls on flood frequency. There was a book titled “comparative hydrology” as far back as 1989 (Falkenmark and Chapman, 1989), although I admit that it does not have much bearing on what is presented in this paper.

Similarly, there is considerable literature on the process controls of flood frequency, starting with the pioneering paper by Eagleson (1972), and in recent times there has

been an explosion of new results, including data-based approaches in Austria (the group of Günter Blöschl). I do completely agree with causative processes, and how these can be extracted from available data.

I do completely agree with causative processes, and how these can be extracted from available data. For example, why not broaden the study to do resampling the flood frequency curve on a monthly basis, and look at how the annual maximum floods are seasonally dependent and how that varies with return period? This is fairly straightforward, and the authors’ paper already goes down this path, but there are a range of approaches that one can follow.

(5) How about building simple models to explore the patterns they extract from the data? Why stop at analysis of data alone? Advanced students can put together models that combine processes and use these to explore the regional and temporal patterns?

Overall, I really like the ideas in the paper. I hope these will embolden and inspire others to introduce ideas similar to these in their teaching. My comments are not to be seen as criticism, but rather as ideas to put the ideas in the paper in some perspective in respect of recent thinking, especially in terms of a synthesis of Newtonian and Darwinian approaches to teaching and research. I also apologize for trumpeting many of my own papers (due to lack of time, I did not do a thorough literature review, except for those included in the papers cited).

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