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Hydrology and Earth System Sciences Discussions

Interactive comment on "Hydrologic system complexity and nonlinear dynamic concepts for a catchment classification framework" *by* B. Sivakumar and V. P. Singh

Anonymous Referee #2

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Outline of paper:

This paper hypothesizes that by using a particular type of hydrograph analysis (phase space reconstruction), catchments can be classified into useful groups, and that the groups reflect differences in complexity (meaning the dimensionality of a dynamical system). In my opinion, this assumption is scientifically plausible, and worth testing. If that first step succeeds, then the authors propose there would be a search for a method to link complexity to catchment/climate characteristics. If that second step is successful, there would be a PUB (Prediction in Ungauged Basins) method for classification.

This would be a considerable advance for hydrology science.

Overview Comments:

I find this paper to be more speculative than is usual for publication as a regular paper in HESS. It is a proposal supported by review, rather than a paper which comes to a substantive conclusion.

As the author states on p3: "The present study attempts to offer some workable guidelines for an appropriate basis and a suitable methodology towards a classification framework in hydrology". In my view, a set of guidelines and a proposed methodology don't generally constitute sufficient material for a regular scientific paper.

The manuscript could be improved by shortening the review material in sections 3-5, and showing phase space results in section 6 from enough river flow records to demonstrate that sites do cluster in a way that can be interpreted in terms of other hydrological knowledge.

Section 2:

Section 2 reviews some previous approaches to catchment classification. I would contest the author's claim that "these studies and their different forms do not adequately account for some inherent properties of hydrologic systems and processes (e.g. nonlinearity and chaos) and, thus, are largely insufficient for a generic classification framework." While it may be true that catchments do possess nonlinearity and chaos, it has not been demonstrated that these features are a necessary part of a coherent, workable classification system. However, I do agree with the author's immediately following sentence: "At the least, a coherent effort to bring these disparate forms together for a workable classification framework is missing."

Sections 3-5:

The majority of the content in the paper (Sections 3, 4, 5) is review of previous studies on complexity, nonlinearity and chaos. The author has previously published reviews on

these topics (e.g. Sivakumar 2009), and I don't feel that this review adds significantly to those previously published.

Section 6:

Section 6 contains some new material, but is currently too brief to stand alone, and its value to science remains untested. Ideas on new ways to classify catchments are a welcome development (though these ideas are closely related to those of Sivakumar, 2004 and Sivakumar, 2008), but I do not see that the brief proposal in Section 6 for a new method is sufficient for publication.

The idea of using phase space reconstruction and/or embedding dimension as a means of classifying catchments remains untested because it has been applied to too small a sample of catchments. In my opinion, what has been shown so far is that four daily river flow records (Mississippi, Kentucky, Chao Phraya and Stillaguamish – see Sivakumar et al 2007) produce four relatively distinct phase space diagrams, two of which are reproduced in this paper. What is required is that the phase space reconstructions (or embedding dimensions) will provide useful clustering and separation of catchments. No information has yet been presented showing that clustering occurs, nor that the clustering groups are hydrologically meaningful or useful (that is, members of a cluster have some commonality of hydrological processes). My preference for the clusters to have an interpretation in terms of hydrological processes is perhaps a matter of opinion, but if no meaning can be assigned to the clusters, then it is unclear to me what is the purpose of the classification.

References:

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