Hydrol. Earth Syst. Sci. Discuss., 8, C6595–C6599, 2012
www.hydrol-earth-syst-sci-discuss.net/8/C6595/2012/

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

B. Sivakumar and V. P. Singh

s.bellie@unsw.edu.au

Received and published: 25 June 2012

We thank the referee for his/her positive and constructive comments on our work as well as for his/her careful scrutiny of the presentation. We are pleased with the referee's positive evaluation of our work that it addresses a very interesting and actual topic. Overall, we agree with the referee on his/her comments and suggested improvements. As we have discussed in detail in our "General Response to Guest Editor Comment (EC), Referees' Comments (RCs), and Short Comment (SC)," we have substantially revised our manuscript in light of the various comments and concerns raised by the

RCs, SC, and EC. As discussed therein, we have now focused on the essential first step in the classification proposal (i.e. identification of complexity), with analysis of streamflow data from a large network of 117 gaging stations in the western United States. We have also incorporated all the relevant review comments (both technical and presentation), including removing certain sections/significant portions of the text. Some of the comments by this referee are more relevant in the context of the overall proposal we presented earlier, including those associated with Step 2 and Step 3. We will investigate these aspects in great detail in the future, as we proceed with further implementation of our ideas. Here, we briefly respond to some of the comments.

Referee Comment – Anonymous (RC – C2384): The review part of your paper can be shortened. p. 4437 line 2ff: ": : : Therefore, the present study is, in a way, an inverse approach to study the classification framework." Inverse to what? Please explain.

Author Response: As we have discussed in our General Response, we have substantially modified the review part: Section 3 (Complexity and hydrologic systems) and Section 4 (Nonlinear dynamic concepts and relevance to hydrology). All of previous Section 3 (Sections 3.1 and 3.2) and Sub-section 4.1 have now been combined together and significantly shortened and presented as Section 3. For the benefit of the readers, it is important to review some basic information on complexity and nonlinearity in hydrologic systems, and this is what we have presented in the revised manuscript. Also, Sub-section 4.2 has now been revised (and condensed) and presented as Section 4, focusing on Correlation dimension method (with Phase space reconstruction described as an initial step of the correlation dimension method). The phrase 'inverse approach' was meant to indicate going backward from outputs (i.e. data of hydrologic variables, e.g. streamflow) to identify/link/understand catchment properties, rather than going forward from catchment properties to outputs (data). Since this may cause confusion to the readers, we have now removed this sentence.

Referee Comment – Anonymous (RC – C2384): Section 5: Your example compares two catchments of completely different size and the information, concluded from the

HESSD

8, C6595–C6599, 2012

data is that the signal from the larger catchment is less complex because it has a clearer attractor and a lower correlation dimension. From my point of view, this might also be an effect of catchment size. From your example, it becomes not clear how classification of catchments will work: How would you quantify complexity, what is your scale: How you define “low”, “medium”, “high” On p. 4445, lin3 8ff you write: “these observation and numerous others on nonlinear dynamic analysis of hydrologic time series: : :”: Why you are not presenting at least an example classification based on a larger number of time series? Which allows showing that you get distinct groups of catchments.

Author Response: As discussed in our General Response and above, we have now applied the correlation dimension method on a very large number of streamflow time series (117). The reconstruction of phase space is a first step in the correlation dimension method, and we have also presented the phase space diagrams. Based on careful examination of phase space diagrams and correlation dimension results, we have identified four reasonably distinct groups, based on dimensionality: (1) Low-dimensional (L), with d ïĆč 3.0; (2) Medium-dimensional (M), with 3.0 < d ïĆč 6.0; (3) High-dimensional (H), with d > 6.0; and (4) Unidentifiable (U). As may be seen from Table 1 in the revised manuscript, there is no consistent relationship between catchment area and complexity. We will conduct a detailed analysis on the possible relationships between catchment properties and dimensionality (and other nonlinear properties) in our future studies.

Referee Comment – Anonymous (RC – C2384): Section 6: p. 4445, lines 15-24: Fig. 3 contains exactly the same information! p. 4446, line 25: “It is premature, at this stage, to provide definitive guidelines: : :”, this means, that, at this stage, you are not introducing a complete classification framework at all: : :?!

Author Response: With the focus now on the first step of our proposal (Identification of complexity), the previous Section 6 and also previous Figure 3 have now been removed. The sentence read as: “It is premature, at this stage, to provide definitive

HESSD

8, C6595–C6599, 2012

guidelines on the exact structure of the classification framework and on the specific number of groups and sub-groups." The emphasis was on "exact structure of the classification framework and on the specific number of groups and sub-groups." The exact structure and number of groups can be identified only through a rigorous analysis of the data and catchment properties. The proposal we presented was only a general framework. In any case, since the previous Section 6 has now been removed, this sentence has no effect in the revised version.

Referee Comment – Anonymous (RC – C2384): I recommend rearranging the paper as follows: -Shorten sections 1-4: focus on methods applied in your example classification; -Introduce your classification framework: -Add a complete classification example: 1. Detection of data patterns and determination of level of complexity/dimensionality 2. Determination of classification framework based on these results and classification of sample catchments into groups based on data patterns system complexity 3. Discussion of results in a hydrological context (e. g. catchment properties) The number of sample catchments should allow the formations of more than two clearly distinguishable groups of catchments based on a least one attribute based on data patterns and one attribute based on system complexity.

Author Response: As mentioned earlier, we have substantially modified/shortened the manuscript as much as possible. Our revised manuscript focuses on only the first step (Identification of complexity), which we have done through application of the correlation dimension method to streamflow time series from 117 gaging stations in the western United States. Consequently, the analysis, results, and discussion section (Section 5) is completely different now. Based on correlation dimensions (and phase space diagrams), we have classified the 117 time series into four reasonably distinct groups. Study of the links between the dimensions and the catchment physical/process properties will be the next step of our proposal, and we will discuss the details in our future publications.

HESSD

8, C6595–C6599, 2012

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 4427, 2011.

HESSD

8, C6595–C6599, 2012

Interactive Comment