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Interactive Comment

Interactive comment on “A measure of watershed nonlinearity: interpreting a variable instantaneous unit hydrograph model on two vastly different sized –watersheds” *by* J. Y. Ding

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Comments on “A measure of watershed nonlinearity: interpreting a variable instantaneous unit hydrograph model on two vastly different sized watersheds” (HESS-2005-0087) by J. Y. Ding

GENERAL COMMENTS:

This study attempts a simplified approach for representing catchment processes, with particular focus on nonlinear ones. Specifically, use of an input-dependent or nonlinear kernel (in a linear convolution integral) for establishing connections between overland flow, channel routing and catchment runoff process is investigated. For this purpose, a simple two-parameter variable instantaneous unit hydrograph (IUH) model is applied to two catchments of vastly different sizes in the United States, each having a family of four or five unit hydrographs: (1) the Edwardsville catchment in southern Illinois, with an area of 11 hectares; and (2) the Naugatuck River at Thomaston in Connecticut, with an area of 186.2 km2. A host of parameters, including shape parameter, scale parameter, and size of time step (and also their interactions), is estimated. The results are also discussed and interpreted particularly in light of those reported by two earlier studies on these catchments, respectively, i.e. Minshall (1960) and Childs (1958).

The need (and also potential) for simplification in catchment process representation (or in modeling any hydrologic process/problem, for that matter) has been gaining increasing attention in hydrology in recent times (e.g. Grayson and Blöschl, 2000; Beven, 2002; Sivakumar, 2004; Dooge, 2005). A wide variety of issues, ranging from difficulties in data collection to uncertainty in parameter estimation, are discussed and debated in support of this. However, research in this direction is still at a preliminary stage, and further efforts are certainly needed for advancement.

As the present study makes an attempt to move forward in the direction of simplification, especially in catchment process representation, it is a useful contribution to hydrologic literature. Therefore, publication of this work in a well-recognized hydrology related journal, such as Hydrology and Earth Surface Processes, should be strongly encouraged. The paper is technically sound. It is generally well-written, and the methods, analyses and results are fairly clearly presented [see below for specific comments]. However, it is my opinion that the paper can be significantly improved towards a better contribution for the benefit of the readers. In view of these, I recommend acceptance of the paper, subject to moderate revisions, responding to the following comments.

SPECIFIC COMMENTS:

1. One major concern on the paper is the lack of information as to the potential utility of unit hydrograph (especially the shape parameter) for the representation of nonlinearity in catchment processes (including where, when and how). While there are bits

and pieces of information, the author fails, in my opinion, to present a solid and coherent presentation on this aspect. Inclusion of additional information on this in an earlier section of the paper would certainly benefit the readers; this would pave the way for additional discussions and interpretations later in the paper, also serving as a verification mechanism as to whether what was assumed/said before is indeed correct.

2. The author makes some general discussions and interpretations, but such are not exactly supported by the results themselves. This problem may be seen with respect to at least three different aspects, as follows:

(a) Section 7.2, Scale Parameter: By stating that “The lowest Ch value is associated with the 20 July 1948 storm which has the longest duration of 17 min, compared to that of 10 to 14 min for the rest,” the author seems to present an inverse relationship between Ch and duration. If this were indeed the case, then the 27 May 1938 storm event, which has the second longest duration (with 14 min), should have the second lowest Ch among the five events. This is simply not the case [see Table 2b]. Even worse, this event has the highest Ch, and indeed much higher than those for the remaining three events that have “medium range” durations.

(b) Section 8.1, Shape Parameter: In the discussion of the results for the Naugatuck River, by stating that “The smallest N value of 1.92 and the largest of 2.68 are associated with the smallest and largest flood events, respectively,” the author clearly tries to establish a direct relationship between N and the ‘magnitude’ of flood events. This, however, is not entirely true even for the Naugatuck River [see the second and third event results in Table 5a]. And such an interpretation is certainly wrong for the Edwardsville catchment [Table 2a], since the largest event has the smallest N value.

(c) Section 8.2, Scale Parameter: Comparing the average Ch values for the Edwardsville catchment and the Naugatuck River, the author states: “Ě the larger the watershed size, the smaller the discharge coefficient.” Such an interpretation is not sufficiently supported, since only two catchments are studied. Moreover, such an in-

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terpretation may be wrong, since the discharge coefficient also depends on catchment characteristics (e.g. slope) and land uses.

In view of these observations, and may be others, sufficient caution needs to be exercised in the discussions and interpretations of results. Generalization should be avoided, unless sufficiently supported by the results.

3. The estimation errors obtained for peak rate and time to peak are not sufficiently discussed. One conspicuous observation is for the Edwardsville catchment: there is a significantly large error (-42.2%) in the estimation of peak rate, but there is absolutely no error in the estimation of time to peak [Table 2c]. I am not sure if one can expect such results. I would think that for such a large magnitude event, one would have great difficulty in correctly estimating the time to peak too, in addition to peak rate. The above concern is further strengthened by the fact that even much smaller events result in errors in the estimation of time to peak (both for the Edwardsville catchment and for the Naugatuck River]. Further, no mention of the measurement errors and their effects on peak rate is made, which is especially important for large magnitude events.

4. It is my opinion that, there is a lack of continuity in the presentation, and the readers may find it a bit difficult to follow. As an example: There are far too many places, where a certain issue is mentioned to start with, but then is left to a later section for further details. Careful attention to this, and others, would certainly improve the readability of the paper.

5. I think, it would be more appropriate to combine Tables 2(a), (b), and (c) and present in a single table [as Table 2]. There will be a total of 17 columns in such a table, which could still be arranged in one. The same goes for Tables 5(a), (b), and (c).

6. The areas of the two catchments are presented in different units [hectares for the Edwardsville catchment, and km2 for the Naugatuck River]. It would be more appropriate to present them in the same unit, especially when the catchment area forms the basis for discussions and interpretations.

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EDITING COMMENTS:

The manuscript is generally well written, but there also exist a few errors. I suggest that the author read the manuscript more carefully and carry out all the necessary corrections. The Reference List needs some formatting. The reference Wu (1982) is cited in the Text, but not included in the List.

FINAL REMARKS:

This paper is a useful contribution to hydrologic literature. However, the paper can be significantly improved, responding to the above comments. The required revision is only moderate and I believe the author can complete the revision within a short period of time. I would be willing to review the revised version, if needed.

REFERENCES:

Beven, K. J. (2002). Uncertainty and the detection of structural change in models of environmental systems. In Environmental Foresight and Models: A Manifesto, Beck, M. B (ed.). Elsevier Science, The Netherlands, pp. 227-250. Dooge, J. C. I. (2005). Bringing it all together. Hydrology and Earth System Sciences, 9, 3-14. Grayson, R. B., Blöschl, G. (2000). Spatial Patterns in Catchment Hydrology: Observations and Modeling (ed.). Cambridge University Press, Cambridge, UK. Sivakumar, B. (2004). Dominant processes concept in hydrology: moving forward. Hydrological Processes, 18(12), 2349-2353.

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