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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The Heterogeneous Discrete Generalized Nash Model for Flood Routing" *by* Baowei Yan et al.

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General Comments

The manuscript "The Heterogeneous Discrete Generalized Nash Model for Flood Routing" by Yan et al. presents a methodological improvement to the Discrete Generalized Nash Model (DGNM) developed for river flow routing by the lead author (Yan et al, 2015, in JoH). The proposed modification in the model aims to address the issue of representing spatial heterogeneity in rivers (mainly due to river topography). The new model's performance, called HDGNM ("H" for heterogeneous), is tested on a case study from China, the middle Hanjiang River – its channel slope varies greatly. The results from HDGNM are compared to that of HIUH (Li et al., 2008) with respect to

"Relative error of peak discharge" and "Nash–Sutcliffe efficiency coefficient".

In general, the manuscript has some potential which is limited and hidden in its current version. The theoretical value is not weak, however, it is not too strong either as it lacks proper conceptual as well as structural presentation of the research framework. Please see below the major issues (that I could identify as a non-expert in Nash models, like the Referee #1) all of which need to be thoroughly addressed before any further decision on the manuscript's future in HESS (which I believe will highly depend on how well and how much of its hidden potential will be unraveled through the revisions by the authors who are indeed the experts in Nash models).

The Title reads very nicely at a first glance. However, looking at the relevant literature, one can see that its style is very similar to the previously published papers of the author (on Generalized Nash Model, GNM – listed below). I strongly believe that bringing forward explicitly the novelty of the paper in a more attractive way through the title will benefit the paper immensely, especially in the long term. Please see my suggestion below.

- Yan et al. (2015, JoH): The generalized Nash model for river flow routing

- Yan et al. (2019, JoHE): Discretization of the Generalized Nash Model for Flood Routing

- And now in HESS Discussions: The Heterogeneous Discrete Generalized Nash Model for Flood Routing

- New title (recommended): "Addressing Spatial Heterogeneity in the Discrete Generalized Nash Model for Flood Routing: the case of Hanjiang River, China" (second part is optional)

The Abstract: A more coherent and appealing layout supported with a broader and insightful perspective on the literature can be adopted. The current text does not adequately reflect the wider scope of the study in terms of how the literature's progress

has shaped efforts on (conceptual) hydrological modelling, particularly for operational purposes. The manuscript, in general, lacks the perspective required to highlight its contribution to hydrology research and practice. This is a fundamental limitation making the manuscript too narrow for the audience of HESS, and should be addressed in the Introduction and the Conclusions parts as well. The potential implications of the research findings for hydrological modelling should be discussed in the manuscript thoroughly.

Research Question & Objectives: There must be a solid paragraph where one reads the research questions addressed within the scope of this study. A good overview (in the text format) is given on how the literature progressed over the years after Nash, 1957. Yet, the authors fail to mention the gaps in the literature and explicitly explain how their research align within the greater picture. Dear authors, please make sure to state the questions & objectives formulated for this research in a concise and fluid manner. It is also important that why the discrete generalized Nash model (DGNM, by Yan et al. 2019), but not others, is chosen for addressing the issue of spatial heterogeneity in IUH.

Literature review (P2, P3, P4): A table summarizing each cited work, for example, with the columns: (1) author-journal-publication year, (2) the type of application (rainfall-runoff modelling, river flow routing etc.), (3) the approach of effort towards making IUH semi-/distributed (e.g. replacing equal reservoirs with unequal ones vs. dividing watersheds into a number of subwatersheds), (4) visual representation of the proposed reservoir system (i.e. to show how the system is conceptualized), (5) case study, (6) reported performance (if available). It would be great if you can insert in a column a simple schematic of how the reservoir system is configured in each study (see column 4). This will prove extremely valuable for highlighting how and why your contribution contributes the literature on development of Nash's Instantaneous Unit Hydrograph theory. Hence, a new figure should be inserted (in the Methodology part) to show the configuration this study is based on). A further couple of lines can be added to explain

the limitations and gaps in the literature.

Layout: The current layout is not clear and the content is mixed in several (apart) sections. The "Case Study" section is too long as it covers both the case study description and the results. As a remedy, adopt the following changes:

- Open a new section called "Heterogeneous Discrete Generalized Nash Model (HDGNM)" which will include the parts "Conceptual interpretation of the DGNM", "Heterogeneous S curve", and "Derivation of the heterogeneous DGNM" as subsections. Also, shorten the text where appropriate.

- Open a new section called "Methodology" which will include: Case study (P10 L195 - P12 L220); Model comparison (P12 L221-222 & P13 L230-242); Model calibration (P12 L222 - P13 L230 & P14 L245-247)

- Open a new section named "Results and discussion" which will include: P14 L247 - P15 L265; Table 1 & Figure 2

Results and discussion: In its current form, there is a very limited presentation and discussion of results. The manuscript can greatly benefit from a thoroughly written discussion which integrates the results obtained from different models (definitely include HIUH in the comparison, even better the model by Wan et al, 2016 too). Building upon such robust discussion the authors could more reasonably justify the significance of their findings.

Conclusion: It is very weak. It doesn't address the results obtained at all. Writing of this part deserves the most critical attention. The authors are strongly encouraged to address key limitations of their study with possible recommendations.

Specific Comments

P1 L11. "conceptual interpretation of the DGNM" is a rather vague description for highlighting the methodological novelty in this (specific, and perhaps narrow) research contribution.

P2 L24-25. Please elaborate on the concept of the linear reservoir cascade with a focus on its physical interpretation for a catchment.

P4 L39-79. Please cite any references on how DGNM's performance compares with other models, and justify openly why DGNM was decided to be improved by incorporating HIUH.

P4 L79-80. Add a paragraph describing how the paper is structured.

P7 L131-132. "leads to" doesn't sound right here. This one long sentence can be replaced with these two sentences: "The DGNM is developed on the basis of the Nash's IUH. However, unlike HIUH, DGNM fails to address spatial heterogeneity when applied to . . . ".

P7 L132-134. Does the sentence refer to the introduction of HIUH into DGNM? The previous sentence is about DGNM. Reading the whole paragraph, one can take to mean that the matter is about improving DGNM by incorporating HIUH in its theoretical framework. If so, please add "into DGNM" before "can reflect". (Well, reading the next section I understand that indeed this is exactly what is meant.)

P12 L218-220. Please put a new figure showing the discharge data, preferably a time series plot, where the selected flood events are indicated.

P12 L219. What do you mean by "low proportion of the lateral inflows (time interval Δt = 3h)"?

P12 L220 & P14 L245-247. 8 flood events for calibration, 2 flood events for validation: What is the basis of your calibration and validation data selection? What are their statistical properties? *** Very important note on the terminology: If your aim is to test model performance during calibration process (also called training), such data set is called "cross-validation". This set basically imitates the test set (also called validation or verification data) and used to avoid the issue of overfitting. On the other hand, the validation data set is needed to validate the model's performance after it's built, i.e. to

imitate the model in operation. *** So, it is not clear from the given text if the results presented under the name "validation" are indeed for validation, or cross-validation. Please clarify.

P12 L221-222. Include this information in the abstract and introduction, too. Also, it would be interesting to include HIUH (Li et al., 2008) in model comparison. Could you please add HIUH model in your comparative analysis between HDGNM and DGNM? To bring variety in terms of types of models, you should also compare the results with a model (e.g. Wang et al., 2016) that adopts the second approach (i.e. dividing the watershed into sub-watersheds).

P12 L225-2230. The optimization procedure has not been explained adequately. Please describe the parameters optimized for these two models, and justify the logic behind the selected objective function (L226-227). Also, give examples of references where SCE-UA has been used for optimization of hydrological model parameters (and how its performance compares to other optimization methods.)

P13 L235-242. Model evaluation metrics: Please justify the reasons behind your selection of the error measures, if possible citing relevant papers in the literature. What are the weaknesses and strengths of these measures? What do their magnitude imply? Please add explanations.

P13-14 Table 1. Please convey the information graphically where the comparison can be visually made much more easily.

Minor Edits

- P1 L8. developed > recently developed

- P1 L17. The middle Hanjiang River > The middle Hanjiang River in China

- P1 L18. It is not appropriate to use "suggested" here. What comes next is the finding of your study. Better to simply use "found" or, "The results show that" . Also, "performs better" sounds rather vague – instead: "The HDGNM outperforms the DGNM in terms

of model efficiency and relative error . . .”

- P2 L27. It would be good to refer the readers to “Dooge, J.C.I., O’Kane, J.P., 2003. Deterministic Methods in Systems Hydrology. A.A. Balkema Publishers, Swets and Zeitlinger B.V., Lisse, The Netherlands.” for further details on IUH theory.

- P3 L46. to consider > to account for

- P4 L73-74. Revise the sentence (it is grammatically incorrect).

- P7 L130. to the basin with > to basins with

- P8 L145-1466. K > K (It should be written in italic, right? Please be consistent throughout the manuscript.)

- P12 Figure 1. Please enlarge the figure, it is too small.

- P15 Figure 2. The resolution is poor, please increase the quality of the figure.

- References cited reflect the literature on Generalized Nash Model well. Citations are appropriately made. Only check the publication year of the reference: “Kalinin, G. P., and Milyukov, P. I.: On the computation of unsteady flow in open channels, Leningrad, Russia, Meteor. Gidrol. Zh., 10, 10–18, 1957.” – It is cited in the text as 1958.

Cited references in the comment

- Li, C., Guo, S., Zhang, W., and Zhang J.: Use of Nash’s IUH and DEMs to 345 identify the parameters of an unequal-reservoir cascade IUH model, Hydrol. Process., 22(20), 4073-4082. 2008.

- Wan, H., Xia, J., Zhang, L., Zhang, W., and Xu, C. Y.: A generalized concentration curve (gcc) method for storm flow hydrograph prediction in a conceptual linear reservoir-channel cascade, Hydrol. Res., 47(5), 932-950, 2016.

- Yan, B., Guo, S., Liang, J. and Sun., H.: The generalized Nash model for river flow routing, J. Hydrol., 530, 79-86, 2015.

- Yan, B., Huo, L., Liang, J., Yang, W., and Zhang, J.: Discretization of the generalized Nash model for flood routing, J. Hydrol. Eng., 24 (9), 04019029, 2019.

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