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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Characterising hydrological response in urban watersheds based on inter-amount time distributions" *by* Marie-Claire ten Veldhuis and Marc Schleiss

Marie-Claire ten Veldhuis and Marc Schleiss

j.a.e.tenveldhuis@tudelft.nl

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Review of "Characterising hydrological response in urban watersheds based on inter-amount time distributions" by ten Veldhuis and Schleiss. Referee #2

RC: Reviewer comment; Reply: authors' reply

RC: This paper applies an existing framework (Schleiss and Smith, 2016) for analysing inter-amount-times (IAT) to time series of daily streamflow from 17 urbanised watershed monitored by the USGS. The stated aim of the paper is to explore how IAT can be used to characterize the hydrological response and compare results to analysis based on traditional analysis techniques. In general I found the manuscript difficult to read

for a number of reasons; The introduction is very unstructured. It starts by discussing effects of urbanisation, then gives a general A-Z of general challenges in applied hydrology, incl. flood frequency analysis, flow duration curves, multivariate statistics, unit hydrographs, baseflow separation, before ending-up with a very detailed summary of scaling issues with a high level of assumed knowledge on behalf of the reader. I suggest a much more focussed introduction is necessary to better justify the scientific gaps being addressed by the study.

Reply: We agree with the reviewer's suggestion for a more focused literature review in the introduction and propose to make the following changes: (1) Frame the analysis more clearly as a statistical analysis and clearly state shortcomings of traditional statistical/frequency analysis approaches: separation between peak flow analysis, based on annual maxima or POT values versus low flow analysis, based on annual flow minima or 75-99% exceedance flows. Combining both in one analysis is difficult because flow distributions are highly skewed. (2) We will focus the literature review on 3 topics: Statistical analysis of flow time series - existing approaches for flood frequency analysis, low flow frequency analysis, benefits of being able to combine both aspects in a single framework, especially for analysing impacts of change in flow regimes such as for urbanisation impacts on hydrological response; Flashiness index (as requested by reviewer #1): review existing flashiness indices, esp. most frequently used R-B flashiness index (Baker, 2004); Scaling analysis: summarising literature on scaling relationships based on traditional flow time series; studies have shown scaling results to be dependent on the original resolution of the analysis (daily/hourly/5-min data aggregations show different scale breaks). More robust scaling relationships are needed to provide reliable results for up- and downscaling of flow data.

RC: The aim is presented very loosely as 'to explore how inter-amounts can be used to characterise hydrologic response for a range of (semi)urban watersheds in North Carolina, US.' I think it would be more convincing if the aim could be linked more strongly to a distinct problem/gap when using existing methods for analysing the hydrological

response from urban watersheds. What is the actual scientific and/or applied problem being addressed here?

Reply: we will rephrase the objective of the paper to make it more specific, addressing representation of high flows and low flows in frequency distributions (lower CVs for IAT, differences in skewness and medcouple values), flashiness characterisation, scaling behaviour

RC: I was struggling with some of the technical description in Section 2. This is partly down to a number of key places where the notation is hard to follow (see more detailed comments below), but also because I could not follow how this method was going to add new insight that was not available from a direct analysis of runoff time series. Again, I think a more focussed and readable introduction might have been helpful here.

Reply: We appreciate the reviewer's comment and understand that the notion of inter-amount times and what differences it implies for data sampling strategy and statistical representation of the data are hard to grasp at first view. We will add explanation on the expected benefits on IAT analysis, as explained above, we will rephrase the objective to provide better guidance for the reader.

RC: The results discussion (Section 3) is hard to follow. Maybe consider introducing more subsection and better explain how the different analysis comes together to answer the scientific aim, rather than at present where I get the impression it is a series of independent and individual analysis undertaken because it is possible.

Reply: We will follow the reviewer's suggestion and add subsection headings in Section 3 as well as make sure to reflect more clearly on how results answer to the objectives of the study.

RC: The main conclusion seems to be that flashiness is related to watershed area, but that no link to urbanisation could be identified. While this is, of course, not the fault of the researchers it does perhaps suggest that the title of the paper (urban watersheds)

is not really appropriate as no new insight into the effects of urbanisation seems to have been discovered.

Reply: Indeed, no direct link between urbanisation and IAT properties could be identified. However, we believe IATs still provide an interesting alternative framework for studying flow properties across scales. They come with many advantages, e.g., less variable distributions across scales and better scaling, and can therefore be of advantage in many statistical analyses. As such, the IAT approach is meant to complement traditional analysis techniques, not replace them. We will modify the text to better convey this message and put less weight on the urbanisation issue.

RC: I don't think the strong conclusion on page 17, line 21-22 is justified as it is not clear what characteristics is being referred to that could not have been established using conventional time series?

Reply: the motivation for this conclusion is provided in the sentences following lines 21-22: IAT analysis: patterns of low regulation could be identified more clearly, the loss of information on flow variability during high flows could be quantified and different aspects of flashiness were identified compared to traditional flashiness indicators. We will rephrase this section to summarise the arguments more distinctly, with more explicit links to the presented results.

RC: Detailed comments:

Reply: we will review notations and definitions and make sure to correct and add additional explanation as indicated by the reviewer

RC: I think HESS uses British rather than US spelling, so catchment rather than watershed Page 2, line 25: Define 'scale-break' Page 3, line 5: Not sure what 'moments q[0.1-4]' signifies? Eq. (4): this equation sums over qi, but in the lines above the sample flow time series is defined in terms of r (line 14). Should it be 'r' in Eq(4) or else 'qi' need to be defined somewhere Eq (5): I don't understand the notation used in this

equation. What does ‘Qt,nq-nq’ mean? Eq (6): I don’t know how to link this equation to Eq. (5) – I think some more explanation is required here. Eq(7): ‘T’ is not defined anywhere? Page 6, lines 23-24: Given that the flashiness is one of the main conclusions of the study, I think a more comprehensive description of the concept is required, for example include a conceptual figure. Page 7, line 16: What is ‘Scott’s rule’? Page 19=0, line 14: what does ‘cq’ refers to?

References:

Baker, D. B., et al. A new flashiness index: Characteristics and applications to midwestern rivers and streams1. (2004): 503-522.

Schleiss, M. and J. A. Smith. Two Simple Metrics for Quantifying Rainfall Intermittency: The Burstiness and Memory of Interamount Times. Journal of Hydrometeorology 17.1 (2016): 421-436.

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