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Discussions

Interactive comment on "Calibration event selection for green urban drainage modelling" *by* Ico Broekhuizen et al.

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We would like to thank the referee for taking the time to provide comments on our manuscript. The several issues raised by the referee are addressed one by one below.

General comments

Referee's comment: The Authors propose a suitable procedure for selecting calibration events of a hydrodynamic model of a predominantly green urban catchment. A two-stage calibration procedure is used for calibrated first the parameters related to impervious areas, using a set of rainfall events, followed by the pervious area parameters using another set of rainfall events. The selection of calibration events was carried out based on some characteristics such as precipitation intensity, runoff flow rate, flow

volume, flow volume as percentage of rain and precipitation duration. The overall ranking of the different calibration scenarios in the validation period is estimated using the statistics of both NSE (Nash-Sutcliffe Efficiency) and RMSE (Root Mean Square Error). The paper address scientific questions within the scope of HESS even if it does not present new concepts or ideas but a rather useful procedure. The scientific methods and assumptions are clearly outlined and the overall presentation is well structured and clear.

Authors' response: we thank the referee for their supportive comments on the manuscript. Two points require some clarification: First, we would like to clarify that the model performance in the validation period is also assessed based on the flow volume error and the peak flow ratio, and these two statistics are actually the ones where some of the most notable differences between different calibration scenarios are visible. Second, although the ideas of using different types of calibration events and two-stage calibrations are not new in general (as pointed out by the referee), we believe that these issues have not been addressed in any published urban drainage modelling articles, and papers that come close to or touch upon these issues are often focused on urban drainage systems not containing many green areas. Although urban drainage modelling has commonalities with general hydrologic modelling, there are also some key differences, and so findings from natural catchment modelling should not be assumed to also apply to urban drainage modelling. Furthermore, including green areas in urban drainage modelling includes additional processes / process descriptions, and so findings from predominantly impervious catchments (see previous paragraph) should not be assumed to apply in the same way to greener catchments. This can be clarified in the introduction.

Changes in manuscript: add on page 2, end of line 18: Findings from studies of predominantly impervious catchments (see previous paragraph) should not be assumed to apply in the same way to greener catchments and need to be checked for greener catchments.

Specific comments

Referee's comment: While the calibration strategies (single- and two stage) was already presented by the Authors in a previous paper (1), the different metrics for selecting calibration events from a larger group of candidate events is rather innovative and well described.

Authors' response: we thank the referee for their supportive comment.

Changes in manuscript: -

Referee's comment: The risk of using rainfall multipliers is to attribute to the rainfall all the errors due to an incorrect estimate of the model parameters as well as of the model itself. The Authors indicate that the rainfall multipliers compensate for discrepancies between the observed and best-fitting rainfall, rather than for other aspects of catchment runoff modelling by using the baseline model but it is not clear how they reach this conclusion.

Authors' response: two arguments support that the rainfall multipliers appear to work as intended, i.e. to compensate for a mismatch between observed rainfall and the rainfall that fits best with the observed outflow: 1. While there is high variability among the obtained parameter values between different calibration scenarios (CSs), there is little variability among the rainfall multipliers for each event as obtained by different CSs. If the multipliers had the effect of compensating for e.g. reduced runoff volumes caused by higher infiltration (e.g. if the calibration parameter saturated hydraulic conductivity was higher), then it would be expected to see inter-CS variation in the rainfall multipliers more similar to that found for the other model parameters. 2. When rainfall input was perturbed by -40Section 3.2.2 of the manuscript can be reorganized to present these arguments more clearly. We would also like to point out that many studies include the catchment area or imperviousness as a way of adjusting flow volumes. The calibrated

area or imperviousness obtained from this will also be affected by the observed vs. best fitting rainfall mismatch. Since high-quality land cover information and field visits were used for catchment delineation in this study we preferred not to further calibrate the catchment size parameter, so as to maintain its clear physical connection to the real system. It was still thought that a mismatch between observed and best-fitting rainfall could be present. Since the other hydrological model parameters (listed in Table 1 and Table 2 of the manuscript) do not have a large effect on the runoff volume, the rainfall multipliers presented a way of accounting for this mismatch.

Changes in manuscript: Reorganize the text in section 3.2.2 so that arguments 1 and 2 above are clearly identifiable as support for the conclusion on the rainfall multipliers. That the role of rainfall multipliers to adjust overall volumes is sometimes filled by calibrating catchment area is already mentioned in section 2.2 (p. 4 line 34 – p. 5 line 2), but the desired effect of maintaining the connection between physical and model catchment size will be added to this sentence.

Referee's comment: It should however be considered that rainfall multipliers tend to treat the spatial variability of rain, which has a dynamic effect on the outflow, through a positive or negative variation of rainfall considered uniform on the single watershed and therefore treated in a static way.

Authors' response: We are fully aware of this issue, but with only one rain gauge and flow sensor being available (and lacking other information on the spatial variability of the rainfall and/or the effect of moving storms in the study area) there was no feasible alternative to assuming uniform rainfall over the catchment. In this light treating the rainfall error as constant over the catchment seems fitting.

Changes in manuscript: add on page 4, line 30: Rainfall multipliers also do not address the spatial variability of the rainfall, but given the lack of multiple gauges or other information about the spatial variability of rainfall in the catchment no clear alternative was available.

Referee's comment: Figure 5 is not clear and should be conceived in a new way.

Authors' response: We understand that the figure may be somewhat difficult to interpret, but also like that it contains a lot of information in a small amount of space. Improvements can however be made in the way in which the figure is explained. Better labelling of the different numbers in the figure, addition of units for parameter values, and more explanation in the figure caption can be added. It can also be considered to split the figure into multiple panels, each showing a subset of the calibration scenarios.

Changes in manuscript: new version of figure 5

Technical corrections

Referee's comment: Table 8 does not contain bold characters as indicated in the text Authors' response: the bold font was inadvertently left out. Changes in manuscript: bold font will be added in the table to indicate the best value in each column.

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