Hydrol. Earth Syst. Sci. Discuss., 11, C3226–C3235, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C3226/2014/

Hydrology and Earth System Sciences
Discussions
Open Access

Interactive comment on "On the sensitivity of urban hydrodynamic modelling to rainfall spatial and temporal resolution" *by* G. Bruni et al.

G. Bruni et al.

g.bruni@tudelft.nl

Received and published: 19 August 2014

We thank the reviewer for his time and effort in commenting our manuscript. Our response:

RC1: A pedagogical and presentation effort should be made with regards to all the parameters presented. Their significant number makes the paper quite hard to read. A first idea could be to move the presentation of "scale lengths" in data presentation (a way to characterize catchment and rainfall) and only keep the ratios in the methodological section (the purpose of the paper).

AC1: This concern was also addressed by Reviewer #1, we wrote a deeper description of dimensionless parameters (please see AC9 of Reviewer #1 response). We believe

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

the scale length description should go together with the dimensionless parameters in order to make a unique and consequential chapter about methodology. To make it clearer for the reader, we split the description of the indices in sub-paragraph (listed by sub-headers).

RC2: Results are potentially strongly biased by the fact that rainfall events were centred on the studied catchment. See detailed comments below. A possibility could be to carry out simulations with other storm locations.

AC2: The authors agree with this comment, results are affected by the position of the storm with respect to the catchment. However, we chose 4 different rainfall events, some affecting both central and northern part of the catchment (Event 1), some of them central part (Event 3 and 4) and some other both central and southern part (Event 2). In general results show a flattening on rainfall gradient in all cases, which in turn affects model outcomes. Therefore, we believe the position of the storm is an interesting factor to be analysed once data of more storms become available. Still, conclusions drawn in this paper about the effects of rainfall gradient flattening on model outcomes remain valid, indepedendent of storm positioning.

RC3: The conclusions drawn from the curves are not always obvious and the threshold values for the dimensionless numbers seem rather arbitrary.

AC3: we changed the conclusion and removed the threshold chosen (see also AC20 reviewer #1).

RC4: I think it would be interesting to show not only relative results (%) but also absolute ones (ex: superposition of hydrographs)

AC4: The superposition of hydrograph and water depth trends also, is an interesting aspect to be analysed. However, it would be space demanding in terms of figures and discussion, since the study accounts for 4 storms, so four rainfall scenarios and eleven points of interest. Therefore we chose to summarise outcomes in terms of relative results. A detailed analysis for a specific locations has been done in a recent presentation at the European Union General Assembly (Bruni et al., 2014).

RC5: The use of fully distributed model, which could possibly be more suited for such study, should at least be mentioned.

AC5: We agree with this suggestion, we will add the sentence in section:" 2.1 Case study and model description". The sentence will be as follows: "Although fully distributed models best describe the effect of rainfall variability on catchment, the use of a highly detailed semi-distributed model with runoff areas of approximately the same size or smaller than rainfall input resolution, is a close alternative" For comment on the level of detail of our model, please refer to AC6 in response to a comment of Reviewer #1.

RC6: Given that rainfall is intrinsically a space-time process it would interesting to change both the spatial and temporal resolution at once.

AC6: This is a very interesting point. We did apply both space and time resolution change, including results in "4.2 Effects of temporal resolution". More robust analysis will be proposed once more rainfall events will be available.

RC7: Although I am not a native English speaker I noticed some errors (p 5997 l 20 : "madre"; p -6006 l17: "to" should be "of"). Please carefully check.

AC7: The authors apologise for the typos and other language mistakes, as we stressed to Reviewer #2, a deeper language screening will be performed for the final version.

RC8: p. 5993 l.27: "rain gauges", I would rather mention "rain gauges networks".

AC8: the authors agree, it has been changed in the final version.

RC9: p. 5994 l.5-6: "these radars ... C-band radars."; they do not measures intrinsically closer to the ground, it is simply that since the data is usable only with a smaller range than the other radars, indeed the beam is pointing at locations closer to the ground (but

HESSD

11, C3226–C3235, 2014

the same ones as for the other radars within this range).

AC9: the authors fully agree with the comment, the sentence will be rectified into: “These radars measure at high resolutions, both in space and time, and much closer to the ground than S- or C-band radars, which for operational purposes, cover larger distances and thus point higher especially at locations several tens of kilometres away from the radar sites”

RC10: 1st paragraph: may be a figure would be helpful to illustrate the local settings.

AC10: A more descriptive figure of the catchment will be included in this section.

RC11: - For pedagogical purpose, I would include here the definitions of runoff length to characterize the model resolution. The parameter for sewer system should also be mentioned here I think, if discussed (see comments below). - More details about the rainfall-runoff generation should be added.

AC11: Definitions of scale lengths will be better explained and their values moved to the results section (see also reply to reviewer 1 AC9. We think splitting into two sections the definition of scale length (between case study description and method section) will create confusion to the reader.

RC12: - Why these events were selected ? - The temporal evolution of the average rain rate over the studied area should be displayed. - The radar did not measured rainfall over the Rotterdam catchment. It should be discussed the orientation of the storm with regards to the catchment that was chosen.

AC12: For rainfall event discussion please refer to AC1 in answer to reviewer #1. Orientation of rainfall events together with mean speed in m/s will be added to their descriptions.

RC13: More details or additional references should be added with regards to how variograms are practically computed, and also with regards to anisotropic ones.

HESSD
11, C3226–C3235, 2014

AC13: The practical computation we followed is clearly described in the paper of Matherson (1963), the authors agree in adding further references also to better understand the anisotropic semi-variogram, such as Goovaerts (2000), Haberlandt (2007), and Emmanuel et al. (2012).

RC14: I do not understand how the sub-catchments are delineated. Could authors try to reformulate or add more details. Why are they denoted “independent” in Fig. 2?

AC14: A more detailed description on how subcatchments are delineated is included. See AC11 in answers to reviewer #1.

RC15: May be one paragraph per parameter would be help the reader in its reading. Adding the equations and not only sentence would also be a good thing.

AC15: The authors fully agree with the comment. Parameters will be described in independent paragraphs.

RC16: -p.6000 l.20 – p.6001 l.2 : more discussion on this parameter is needed. “Reduction of gradient” : what is meant? At what scale?

AC16: All parameters will be better described, as mentioned above. By “reduction of gradient” the authors mean the smoothing effect induced by aggregating rainfall to lower resolutions: differences between rainfall values of adjacent pixels are reduced. The effect is quantified in Figure 3.

RC17: Is the sewer sampling number really needed? Indeed from my understanding the relevant feature to characterize is the size of areas for which rainfall is considered as homogeneous, which is done by the “runoff sampling number”. I do not really get the added value of “sewer sampling number”, while it adds some complexity for the reader.

AC17: the sewer sampling number accounts for the effect of rainfall coarsening at the sewer hydrodynamic level. It differs from runoff sampling number since in this case only the rainfall-runoff dynamic is taken into account. The description of the two parameters

HESSD

11, C3226–C3235, 2014

will be improved. Please see also AC9 in answers to reviewer #1.

RC18: from my understanding the "lower" should be "greater". Please check.

AC18: This is correct; we will change lower into higher.

RC19: Figure 3 and comments: The mean and standard deviations are computed over what? Why standard deviation =1 for the highest resolution? AC19: the mean and standard deviation refer to the normalised rainfall volumes, i.e. the plot shows the ratio of the mean and standard deviations at all resolutions divided by the mean and standard deviation of the highest resolution. Capture of Figure 3 will be modified for clarity: "Figure 3. Catchment sampling number (RR/CL) vs. normalised rainfall volumes: mean and standard deviation of normalised rainfall volumes computed over all pixels, for the four events."

RC20: As said in the text the "smoothing effect" (Figure 3 and fig 4) is due to the fact that a portion of rainfall is removed from the catchment boundaries because of the averaging. I have the feeling that the conclusions are strongly biased by the fact the storms are artificially "centred" on the catchment, which would not necessarily be the case in reality. For example if the heaviest portion of the storm is nearby the boundary, coarser resolution would "bring" water to the catchment, the decrease observed in the mean would be an increase... More comments/tests/simulations are needed on this point.

AC20: Please refer to AC2.

RC21: - The threshold of 0.2 seems rather arbitrary and if it really exists (see previous comment) it should be justified more in depth.

AC21: The authors agree with this comment; mentioning of thresholds will be removed; results will be discussed in terms of a general trend instead of referring to a particular threshold. More intermediate resolutions would need to be investigated to identify a threshold.

RC22: The title of Figure 3 should be removed or changed.

AC22: The title is superfluous and will be removed.

RC23: p.6004 l.10: “at every node of the model”. If the nodes are not evenly distributed, it may introduce a bias by giving more weight to a portion of the catchment than the others. Furthermore since all the nodes are taken into account, some water “is counted” more than once...

AC23: The fact that nodes could not be evenly distributed is an inherent characteristic of sewer networks in general, thus the mentioned “bias” is rather a result of heterogeneity in the catchment response depending on the topology of the catchment, in this case sewer density. Water is routed from non-overlapping runoff area to the sewer nodes according to natural drainage paths, thus we do not see how water could be “counted more than once”.

RC24: p.6004 l.12-13: it does not seem obvious from the curves..., for instance for event 2 it seems to be the contrary.

AC24: Event 2 in Figure 5 follows the same trend as the other events (with the exception of Event 3, as mentioned in the paragraph): deviations in water depth (top panel) are smaller than deviations in runoff discharge (bottom panel)-looking at upper and lower quartile, not at the outliers. The authors apologise for the heterogeneity of y-axis: the plots will be edited to assign the same y-axis to all plots, to facilitate understanding.

RC25: p.6004 l 14-15: “the largest effect... event 4”: again (see comments in 4.1.1) it could simply be due to the “artificial” location of the heaviest portion of the rainfall. Simulations putting heavy rainfall at the highest resolution on the hedge of the catchment could be an easy way to test this.

AC25: Please refer to our response at AC2.

RC26: p.6005 l2-5: “furthermore . . . depths”: it seems quite hard to conclude this from the data (ex event 2 seems to exhibit the contrary)

AC26: Different scales on the y-axis in the plots make the results hard to interpret; this will be corrected as explained in AC24.

RC27: - Personally for clarity I would include this section in the data presentation section because it is just a way to describe more precisely the rainfall data

AC27: We agree with the reviewer's comment. The description of anisotropic semi-variogram will be moved to the Methods section, while paragraph 4.1.3 will only contain discussion of results.

RC28: More details or additional references on the method implemented should be added.

AC28: We agree, additional references will be provided, see AC13.

RC29: for Evt 3 and 4, it should be computed also for distance greater than 2 km, since the plateau is not reached for some angles.

AC29: The authors agree with this comment: for Event 3 and 4 the sill is not reached. However, since the catchment size is 2 km, we consider that the information shown in the plots is sufficient to say that rainfall fields are de-structured by lowering the rainfall spatial resolution and the de-correlation distance increases with the rainfall coarsening. Determining the exact de-correlation distance of the coarsest resolution is beyond the scope of the discussion of the paper.

RC30: p.6006 l23 -24 : "for all events . . . and 1" it is not obvious from the curves and should be discussed more precisely

AC30: The authors believe that this statement can be immediately checked by looking at the curves of Figure 7: slopes of curves increase starting from rainfall sampling number greater than 0.5, which means that deviations increase.

RC31: Again the 0.9 threshold seems very arbitrary and should be justified.

HESSD

11, C3226–C3235, 2014

AC31: We agree, this will be adjusted. Please refer to AC21.

RC32: p.6007 l.26-27: the average is taken over what?

AC32: The average is computed over maximum peaks of all nodes, separately in each one of the 11 catchments. Text will be added to explain this more clearly.

RC33: p.6008 l.1 : the equal sign should be >? please check. AC33: "From RR/RRL=20 on" was intended to mean "for RR/RRL>20". We will change this in the final version for clarity.

RC34: p.6008 l.11 : may be 100m2 should be 100 m x 100 m, please check

AC34: 100m x 100m would mean square runoff areas, which is not the case. Here each pipe is associated with an area that could be any shape, the average size of which is 100 m^2.

RC35: p.6008 1.2-13 : "the idea . . . resolution"; this is not completely accurate since the effect mentioned strongly depends on the size of the runoff areas..., which is why I do not fully understand the relevance of this indicator (both runoff and sewer ones are strongly linked)

AC35: The authors agree with the fact that runoff areas and sewer network are strongly linked, still processes are not the same: the first one refers to rainfall-runoff transformation, the second one to sewer hydrodynamics. Please also refer to AC17.

RC36: p.6008 l.17-18 : two regimes are mentioned, which is in contradiction with the linear trend showed on Fig 9. Please clarify

AC36:"Deviations are low" (p.6008 l.16) means that at low sewer sampling number, deviations are little. It does not mean that deviations decrease. The word "low" will be changed into "little" for clarity.

RC37: I believe that much more comments are needed (the loss of concavity for event 3 . . . among other)

AC37: The authors agree with the reviewer that the change in shape of the semi-variogram can be object of a deeper discussion on the rainfall de-structuring along the different time resolutions. However, the study is focused on the effect of that de-structuring on the urban catchment hydrodynamics. Thus we believe a further in-depth description is out of the scope of the paper. The authors highlighted the fact that the range, namely the de-correlation distance, increases not only along the spatial coarsening but also along the time coarsening, which affects results in hydrodynamic variables.

RC38: the duration of the intense period of the rainfall should be added to the discussion of the observed time shift.

AC38: The duration of the intense period of the rainfall will be reported as part of an extended description of the rainfall events in the new version of the paper.

References

Bruni G., Reinoso R., van de Giesen N., Clemens F., ten Veldhuis M.C., Sensitivity of urban hydrodynamic modelling to high resolution radar rainfall, Geophysical Research Abstracts, Vol. 16, EGU2014-10814, 2014, EGU General Assembly 2014, © Author(s) 2014. CC Attribution 3.0 License

Goovaerts, P.: Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall, Journal of Hydrology, 228(1-2), 113-129, doi:10.1016/S0022-1694(00)00144-X, 2000.

Haberlandt, U.: Geostatistical interpolation of hourly precipitation from rain gauges and radar for a large-scale extreme rainfall event, Journal of Hydrology, 332(1), 144-157, 2007.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 5991, 2014.