Rainfall in urban and natural systems
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UrbanRain15

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Rainfall in Urban and Natural Systems

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Workshop Objectives and Proceedings

Extreme weather, and especially heavy rain, has a major impact on urban populations and landscapes. Urban flooding and the damage to infrastructure and society are problems in both developing and developed countries. Some key challenges in urbanized areas are to provide good quality detailed weather forecasts, to accurately measure high resolution space-time precipitation fields, to be able to predict impacts on urban drainage systems and their vulnerability, evaluate flood risk and potential practical counter-measures. Similar challenges apply to the effects of rainfall in natural landscapes, the triggering of floods, landslides, debris flows, and other natural hazards. Climate change provides a critical uncertainty to deal with when analyzing potential impacts of heavy rainfall in the future. All of these require the attention of a wider community of scientists, research managers, consultants and practitioners working in urban rainfall.

Following the tradition of previous UrbanRain workshops (1989, 1990, 1994, 1997, 2000, 2003, 2006, 2009 and 2012)[1] the main objective of this meeting was to provide a focussed forum for exchanging ideas, experiences, and state-of-the-science in order to bridge the gap between novel research topics and critical issues that need to be addressed in practice. UrbanRain15 took place on 1-5 December 2015 in Pontresina, Switzerland.

This Proceeding collects the abstract or short papers of all 85 papers presented at the UrbanRain15 workshop. The abstracts/short papers cover the four key themes of the workshop: (1) Precipitation measurement, modelling and statistics; (2) Radar rainfall and precipitation forecasting; (3) Rainfall impacts in urban and natural systems; and (4) Climate change. They are organized in the Proceedings in alphabetical order by first author. The abstracts/short papers were not peer-reviewed or language edited. Each abstract/short paper is identified by a unique ID number and the Proceedings are available through the ETH Zurich E-Collection electronic open-access document repository. Further information about the UrbanRain workshops can be found on http://www.ifu.ethz.ch/urbanrain.

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(Editors)

Example of paper citation:

Peleg, N., Blumensaat, F., Fatichi, S., Paschalis, A., Molnar, P., Burlando, P. (2015) High-resolution stochastic generation of rainfall for urban drainage model applications. In Molnar, Peter & Peleg, Nadav (Eds.), *Rainfall in urban and natural systems*. Proceedings of the 10th International Workshop on Precipitation in Urban Areas (UrbanRain15), Pontresina, 1-5 December 2015 (Paper UR15-57). ETH-Zürich, Institute of Environmental Engineering, doi:10.3929/ethz-a-010549004.

[1] Proceedings of the previous workshops were published as special issues of Atmospheric Research, vol. 27 (1991), vol. 42 (1996), vol. 77 (2005), vol. 92 (2009), vol. 103 (2012), and of Water Science and Technology, vol. 37 (1998), vol. 45 (2002). Selected paper from UrbanRain15 will appear in a Special Issue of the open access journal Hydrology and Earth System Sciences titled "Rainfall and Urban Hydrology" online in 2016.

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Temporal rainfall disaggregation using a multiplicative cascade model for spatial application in urban hydrology

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Abstract

For urban hydrology rainfall time series with a high temporal resolution are crucial. Observed time series of this kind are very short in most cases, so they cannot be used. On the contrary, time series with lower temporal resolution (daily measurements) exists for much longer periods. The objective is to derive time series with a long duration and a high resolution by disaggregating time series of the non-recording stations with information of time series of the recording stations.
The multiplicative random cascade model is a well-known disaggregation model for daily time series. For urban hydrology it can be assumed, that a day consists of only 1280 minutes in total as starting point for the disaggregation process (e.g. Molnar & Burlando, 2005). Three new variants for the cascade model have been analyzed, which are functional without this assumption. These methods are extensions of the uniform splitting approach with a branching number b=3 in the first disaggregation step of the cascade model, introduced by Müller and Haberlandt (2015). For all further disaggregation steps b=2 is applied, so that temporal resolutions of e.g. 15, 7.5 or 3.75 minutes are achieved.

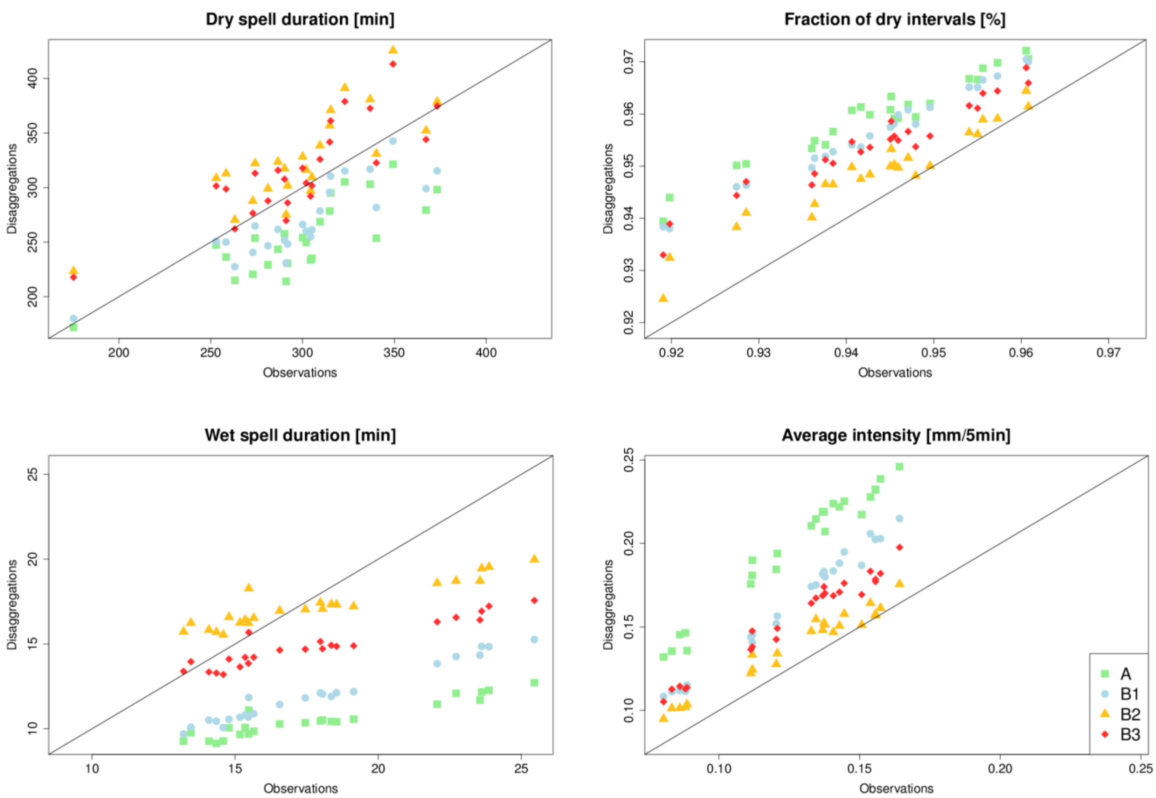

Fig. 1: Average event characteristics of observed versus disaggregated time series for 24 stations in Lower Saxony, Germany.

The existing 1280 minutes approach (called method A) is outperformed by the so-called method B2 regarding time series characteristics like wet and dry spell duration, average intensity, fraction of dry intervals (Fig. 1) and extreme value representation (Fig. 2). To achieve a final resolution of 5 minutes, in B2 a linear interpolation of the 7.5 minutes time steps is carried out.

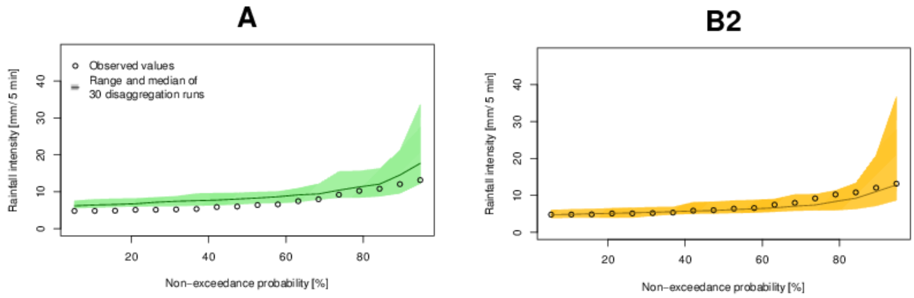

Fig. 2: Rainfall extreme values (partial duration series, 5 minutes) for station Uelzen (time period July 2003 – December 2012).

However, in both approaches rainfall time series of different stations are disaggregated without consideration of surrounding stations. This yields in unrealistic spatial patterns of rainfall. We apply a simulated annealing algorithm that has been used successfully for hourly values before (Müller and Haberlandt, 2015). Relative diurnal cycles of the disaggregated time series are resampled to reproduce the spatial dependence of rainfall. To describe spatial dependence we use bivariate characteristics like probability of occurrence, continuity ratio and coefficient of correlation. Investigation area is an artificial combined-sewer system with three rain gauges. We show that the algorithm has the capability to improve spatial dependence. Without spatial dependence, manholes and combined sewer overflow volumes are strongly underestimated. However, after the implementation results are comparable to those from the observations (see Fig. 3).

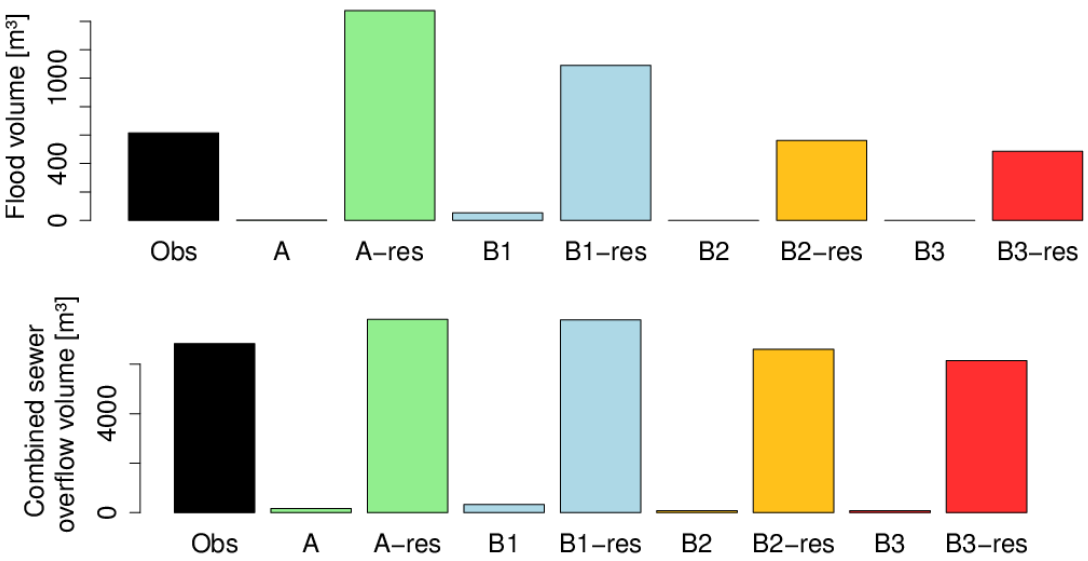

Fig. 3: Manholes (upper part) and combined sewer overflow volume (lower part) resulting from extreme values with a return period of 4.4 years at the master station (30 minutes duration, ‘res’ indicates the resampled analogues for each variant).

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