Disaggregation of continuous Rainfall Time Series for Applications in Urban Hydrology – a Case Study
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Motivation & Aims
The changes in the world’s climate are of great interest to the dimensioning of urban sewage networks. The accuracy of rainfall-data from climate models, however, decreases with increasing spatial and temporal resolutions. Urban hydrologic simulation commonly requires high resolution rainfall data. To fill this gap we can use a rainfall-disaggregation-model. In this case study we start with the disaggregation of hourly rainfall-volumes into sub-hourly (5-minute-) values. This will be expanded to larger time steps (e.g. 24 h to 5 min).

Study Region & Data
- Study region: City of Hamburg (Northern Germany)
- Data: Rainfall-data of two stations (R008 and R012 in Fig. 2) were combined to one time series (30 a)
- The catchment Hamburg-Susebek has a total area of 620 ha of which 383 ha are storm sewered with 152 ha impervious area

Methods
The disaggregation of hourly data is based on the disaggregation model of daily to hourly values introduced by Güntner et al. (2001).

Results
The disaggregation was validated with the following two steps:
1. Statistical analysis:
   - Good agreement of observed and disaggregated rainfall characteristics (Tab. 1) and extreme-values (Fig. 3)
   - Extreme values are slightly underestimated

   Tab. 1 Comparison of observed and simulated precipitation
<table>
<thead>
<tr>
<th></th>
<th>mean [mm/5min]</th>
<th>standard deviation [mm/5min]</th>
<th>skewness [-]</th>
</tr>
</thead>
<tbody>
<tr>
<td>observed</td>
<td>0.10</td>
<td>0.18</td>
<td>14.47</td>
</tr>
<tr>
<td>disaggregated</td>
<td>0.09</td>
<td>0.16</td>
<td>14.36</td>
</tr>
</tbody>
</table>

Fig. 1 Rainfall-disaggregation with the model of Güntner et al. (2001)

Basic principles of the disaggregation-model (see Fig. 1):
- Successive division of the rainfall-volumes V into two parts of the same duration (V₁ and V₂)
- Calculated with the formulas V₁ = w₁ * V and V₂ = w₂ * V
- Possible weights: a) w₁=1, w₂=0; b) w₁=0, w₂=1; c) w₁=x and w₂=1-x, with 0<x<1
- Probability of the distribution-types: P(1/0), P(0/1) and P(x/x) with P(0/1) + P(1/0) + P(x/x) = 1
- All Parameters are assumed to be scale-invariant (i.e. constant over all levels)

In the validation the hydrodynamic rainfall-runoff simulation model HYSTEM-EXTRAN was employed.

This model consists of a hydrological surface-runoff simulation (HYSTEM) and a hydrodynamic sewer simulation (EXTRAN). Further information can be found in itwh (2005).

2. The plausibility analysis was accomplished by comparison of the empirical extreme value distribution of the results from a sewer simulation (HYSTEM-EXTRAN) using observed 5 min-, observed 60 min- and disaggregated 5 min-rainfall-time-series as input data.

Conclusions & Future Work
- Hourly values can be disaggregated with the model
- Disaggregation is important for peak flows in urban hydrology
- Next:
  - Application on larger time steps as input data (e.g. daily data)
  - Application on other rainfall time-series
  - Application on climate scenarios

Literature

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