Stochastic rainfall synthesis for urban applications using different regionalization methods

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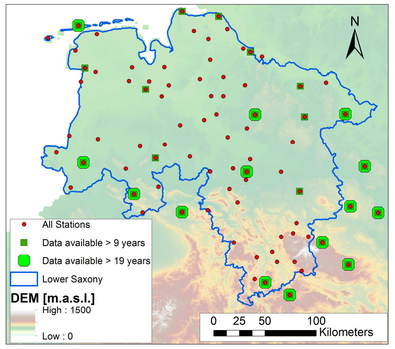
1. Motivation & Objectives

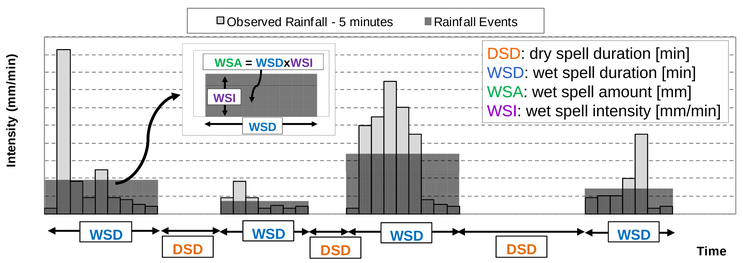
- Design and operation of urban drainage systems require **long and continuous** rain series.
- *Problem*: Short data availability (temporal and spatial required resolutions).
- *Solution*:
  - Development of a **precipitation model**; (Callau Poduje & Haberlandt, 2017)
  - **Regionalization** of the model;
  - Generation of **long synthetic** series.

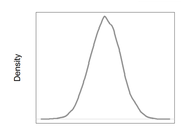
2. Study Area & Data



- State of **Lower Saxony**
  - Surface: 47,624 km^2,
  - Location: North-west Germany.
- **Rain Gauge Stations:**
  - 81 stations (Fig. 1),
  - 6-21 years of record ,
  - Temporal resol.: 5 min.
- **Site Descriptors (SDs) :**
  - climatic & non-climatic.
- **Fictional drainage system:**
  - Combined sewer system,
  - Total size: 168 Ha, Pipes: 5150 m.

3. Methodology





DSD / WSD / WSA

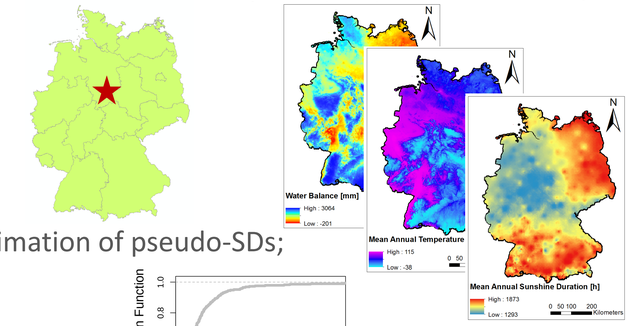
L-moments: LM_1, LM_2, etc.

Regionalization of LM_i:

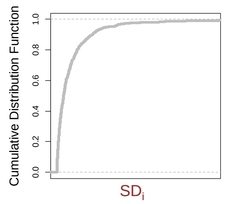
- **Copula** based method
- **MLR**: Multi-linear regression
- **RFA**: Regional frequency analysis (Hosking & Wallis, 1997)

Details of **Copula** based regionalization method:

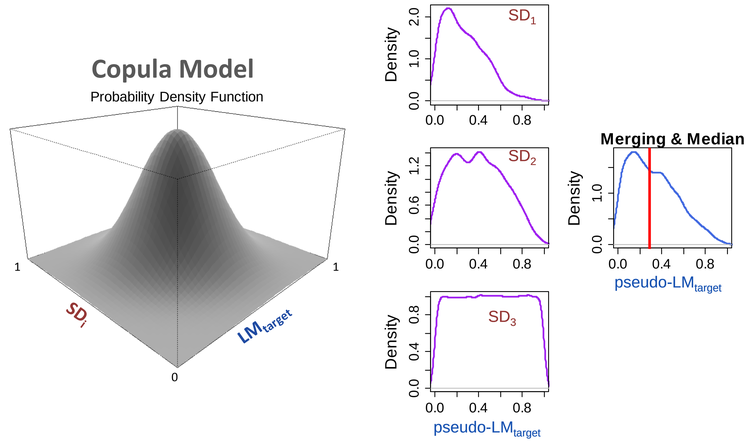
- Selection of a location for the regionalization;
- Extraction of site descriptors (SDs) for the location;



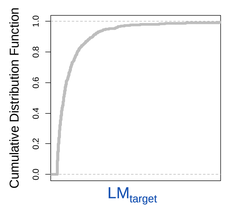
- Estimation of pseudo-SDs;



- Simulation of pseudo-LM_{target} conditioned to pseudo-SD_i;
- Merging of simulated values using several SDs;



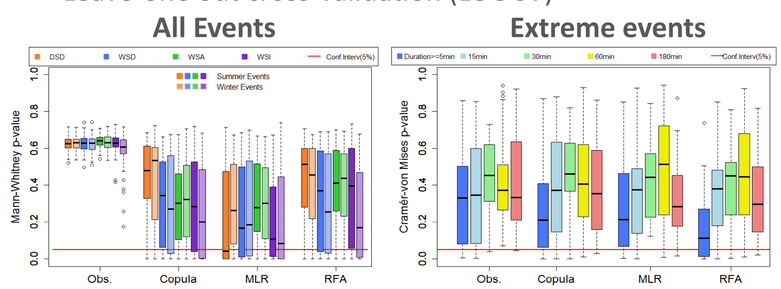
- Converting median of pseudo-LM_{target} to LM_{target};



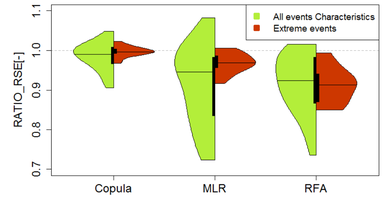
- Estimation of model parameters using different order of regionalized LM_{target}.

4. Results

- Leave-one out cross-validation (LOOCV)



- Robustness analysis

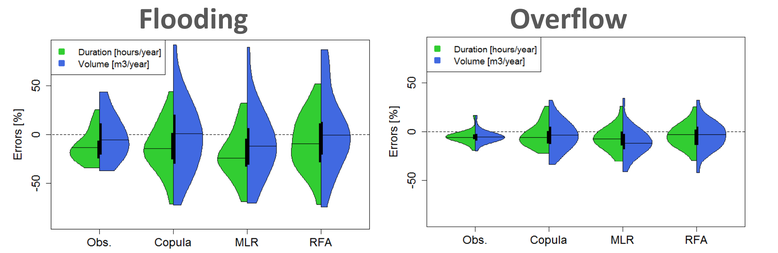


$$RSE[-] = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{Z_i^* - Z_i}{Z_i}\right)^2}$$

$$RATIO\_RSE[-] = \frac{RSE_{ALL}[-]}{RSE_{LOOCV}[-]}$$

$$Error[\%] = \frac{Z_i^* - Z_i}{Z_i} \cdot 100$$

- Urban hydrological modeling



5. Summary and Conclusions

Evaluation Criteria	Copula	MLR	RFA
All events	✓	✓	✓
Extreme events	✓	✓	✓
Robustness	✓	✗	✗
Flooding & Overflow Events	✓	✓	✓

References: Callau Poduje, A. C., Haberlandt U., 2017. Short time step continuous rainfall modeling and simulation of extreme events. Journal of Hydrology, 552, 182-197. Hosking, J. R. M., Wallis, J. R., 1997. Regional Frequency Analysis. An Approach Based on L-Moments. Cambridge: Cambridge University Press.

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