Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Institut für Umweltingenieurwissenschaften
Institute of Environmental Engineering
Chairs of Urban Water Management

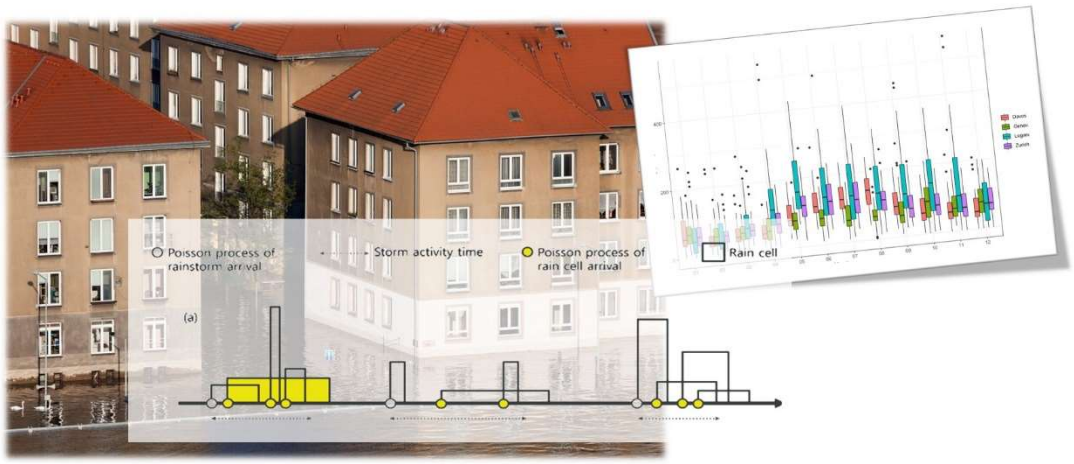
Master Thesis:

Optimal planning and operation of urban drainage systems with synthetic rainfall

Valid from: April 2024 Valid Until: December 2024

Why synthetic rainfall?

In Switzerland, sewer networks are the most expensive infrastructure of municipalities and cities. Sewer networks are designed to fail once in 5 to 20 years. This means that proper design and operation fundamentally depends on adequate rainfall information. However, traditional design methods in urban drainage use idealized model rainfalls, so-called “design storms", which assume that the return period of precipitation corresponds to those of water levels or discharges. However, modern approaches do not require this assumption by directly assessing the hydraulic performance on continuous hydraulic simulations with long-term precipitation series. Where long-term observations are missing, synthetic rainfall series can be used.



The performance assessment of urban drainage networks requires adequate rainfall series to capture the variability. Where long-term observations are missing, synthetic rainfall series can be used.

Project Goals

In this thesis, available rainfall generators (Kim & Onof, 2020) (Bárdossy, et al., 2020) will be applied to produce synthetic rainfall series for the entire CH, based on available rainfall information from MeteoSwiss, e.g. from rain gauges, weather radar and statistical analysis and other sources. It will thus basically improve first results with more detailed rainfall data from various sources. In addition, suitable interpolation techniques which consider the complex Swiss topography must be investigated to produce time series with a 1x1km resolution for Switzerland.

For a single MSc thesis, the project objective is limited to the comparison of different rainfall generators and interpolation techniques based on historical data.

For a possible group work, it should be investigated how future climate information can be best integrated to predict high-resolution rainfall in 2080. For this, results from detailed climate simulations will be made available.

Potential work steps

1. Assessment of available methods of stochastic rain generators and interpolation techniques.
2. Analysis of available Meteoswiss data from rain gauges,
3. Analysis of other available rainfall data sources, e.g. from sewer operators, municipal or cantonal monitoring networks, etc.
4. Define test, validation, and verification datasets
5. Select 2-4 suitable hydrodynamic and hydrological models to perform the runoff analysis
6. Testing and evaluating rainfall generators
7. Evaluate the predicted runoff
8. Document and interpret the obtained results
9. Document the code on versioning platform, e.g. GitLab.

Requirements

Interest in spatio-temporal data analysis, an affinity for mathematical models, basic knowledge of a programming language like R, Python, Matlab, Julia, etc.

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References

Bárdossy, A., Birkholz, P., Eisele, M., Fangmann, A., Fuchs, L., Haberlandt, U., . . . Sympher, K.-J. (2020). *Synthetische Niederschlagszeitreihen für die optimale Planung und den Betrieb von Stadtentwässerungssystemen II.* Hannover: Leibniz Universität Hannover.

Kim, D., & Onof, C. (2020). A stochastic rainfall model that can reproduce important rainfall properties across the timescales from several minutes to a decade. *Journal of Hydrology*.