***MSC internship/thesis topic: GNN-based urban surrogate model for flood hazard quantification – Xiaohan Li & Ruben Imhoff, Deltares***

**Background:** Urban flooding poses unique challenges due to diverse local conditions and the need for rapid assessments. Traditional flood models (e.g., SWMM, HEC-RAS, Infoworks, D-HYDRO) are often city-specific, limiting adaptability and broader impact. And has limited computational efficiency to meet the need for probabilistic rainfall nowcasting in cities.

A surrogate modeling approach offers a model-agnostic solution by utilizing network-like (1D) data from various modeling tools to address urban drainage complexities while enhancing computational efficiency. For example, logistic regression has effectively predicted flooding probabilities using precomputed physical dynamic variables to simplify urban hydrodynamics (Li & Willems, 2020).

Recent AI advancements, such as Graph Neural Networks (GNNs), excel in time-series predictions of complex network processes. Studies with SWMM (Garzón et al., 2024) and Delft-3D (Bentivoglio et al., 2024) demonstrate promising results for urban sewer modeling in non-extreme events. GNNs also capture complex physical processes, highlighting their potential as a robust, model-agnostic approach for urban flood prediction.

**Objectives:** this project aims to adapt the GNN method to predict extreme conditions, specifically flooding, in 1D urban drainage networks. We will integrate effective assumptions and insights by Li & Willems (2020) into the open-source method developed by Garzón et al. (2024) to improve GNN performance in capturing urban flooding complexities. Eindhoven serves as the pilot case, providing a dataset of over 100 events from previous project efforts.

**Activities**: Updating GNN model assumptions to account for flooding scenarios. Revising the model’s input/output data if needed to align with flooding process. Optionally incorporating structural elements using defined assumptions. Setting up, training, and validating the model for the **Eindhoven case study**.

**Expected outcome:** An adapted GNN model that focus on the quantification of flood, i.e. optimized for extreme events.

**Who we are looking for:** MSC students that has strong AI background and interest in the application of AI to the domain of hydrology. We are looking for a start ideally before summer.

**Supervisors:**

**Xiaohan Li** (xiaohan.li@deltares.nl ) – supervisor in urban flood modelling

**Ruben.imhoff@deltares.nl**(ruben.imhoff@deltares.nl ) - supervisor in nowcasting

**Reference:**

[A Hybrid Model for Fast and Probabilistic Urban Pluvial Flood Prediction - Li - 2020 - Water Resources Research - Wiley Online Library](https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019WR025128)

[Transferable and data efficient metamodeling of storm water system nodal depths using auto-regressive graph neural networks - TU Delft Research Portal](https://research.tudelft.nl/en/publications/transferable-and-data-efficient-metamodeling-of-storm-water-syste)