

Spatial Modeling of Urban Pluvial Flood Risk on Sewer Networks: A Bayesian Approach for Climate Adaptation in Swedish Municipalities

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Spatial Prediction of Flood Risk on Sewer Network

Trelleborg Municipality, Sweden (2006-2023)



Abstract text

Climate change is intensifying short-duration rainfall extremes, increasing urban pluvial flood risk across Swedish municipalities. This study develops a novel spatial statistical framework for basement flood risk assessment using Log-Gaussian Cox Process (LGCP) models on metric graphs, applied to 17 years of flood records from Trelleborg, southern Sweden.

Unlike conventional approaches that treat flood locations independently, our method captures spatial correlation along the sewer network topology. Results reveal that flood risk is correlated within approximately 400 meters of pipe network, identifying neighborhood-scale vulnerability clusters. The 60-minute rainfall intensity emerges as the critical driver, with flooding frequently occurring below the 10-year design standard (21-23 mm/h threshold), indicating systematic underestimation of risk in current planning frameworks.

Model comparison demonstrates that network-based spatial models significantly outperform traditional 2D Euclidean approaches, confirming that sewer topology—not geographic proximity—governs flood propagation. Combined sewer systems show elevated risk compared to separated systems, though both remain vulnerable under moderate rainfall conditions.

These findings provide municipalities with data-driven tools for identifying high-risk network segments, prioritizing infrastructure investments, and developing early-warning systems. The

methodology is transferable to other urban contexts, supporting evidence-based climate adaptation aligned with Sweden's 2024 national adaptation strategy.

Keywords: Urban Flooding, Climate Adaptation, Spatial Statistics, Sewer Networks, Metric Graph, Bayesian Modeling