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Comparing design assumptions with actual observations for a rain water infiltration system in a residential neighbourhood

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Managing storm water runoff in cities is becoming increasingly complex facing the demand for sustainable solutions of different stakeholders and to adapt to climatic and demographic changes with their high uncertainty. Although the degree of surface sealing is high in cities, there are still natural processes taking place such as infiltration, evapotranspiration and groundwater recharge, though in an altered way.

To manage storm water in terms of Best Management Practices, the separated sewer system has been favoured for the last two decades in Germany. Combined with rainwater infiltration systems it is regarded as a good solution to reduce storm runoff in an economical and ecological way with positive effects e.g. improving the micro-climate in cities.
To design these systems in a new development, many assumptions are made regarding total amount of generated runoff, concentration times, roughness, infiltration rates, composition of the subsurface, rainfall events etc.

Long term data series of precipitation can only be used if models are applied to simulate the designed drainage system. Unfortunately, as in most cases, no data is available to calibrate or verify the model. Despite the shortcomings during the planning and design phase, urban stormwater facilities are rarely evaluated after the construction. With this study we want to provide an example how this gap between design and real functioning could be closed with observations from an experimental urban watershed.

The watershed is in a residential neighbourhood in Freiburg built with a separated sewer system from 1997 to 2004. Storm runoff is discharged into vegetated infiltration ditches that are combined with soak-aways due to high ground water levels and low permeable topsoil. For planning, hydraulic-engineering calculations were carried out using a 10-minutes rainfall event with a return period of 10 years extracted from a time series of a nearby weather station. Data from the experimental watershed with observations of water tables in ditches, soak-aways, groundwater wells, precipitation input and the overflow discharge to the nearby stream could now be used to test the design assumptions with the model KOSIM. The comparison between simulations and measurements show the discrepancy between design and the actual processes taking place. Especially the influence of groundwater is often neglected when designing urban stormwater systems but could play an important role for the infiltration of the ditch system.

Our study provides a basis for testing hydraulic-engineering models and helps to improve the understanding of hydrological processes in an urban context. A better process conceptualization will improve future management strategies e.g. by considering also the effects of groundwater and infiltration on the quantity and quality of the surface and subsurface water.