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Quantifying hydrological processes in an experimental watershed in an ecologically planned neighbourhood

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The surface sealing especially in urban areas increases stormwater runoff and shifts the natural water balance to the disadvantage of groundwater recharge and evapotranspiration. The latter one playing an especially important role regarding microclimate and heat islands in cities. The challenge for future stormwater management strategies is to manage precipitation as a resource within the realms of sustainability. An intensified collaboration between water managers, urban planners, and architects should be in the interests of water and waste management, environmental protection, but should also meet the demands of the urban population on landscape and microclimate. Furthermore it will be challenging to find solutions that are adaptive enough for future climate changes such as increasing storm intensities and dry periods.

Besides the actual reduction of storm runoff to prevent flooding, important aspects of storm water management are the restoration of the natural water balance, groundwater recharge, and the improvement of ground and surface water quality. Since only little comprehensive data exist that permit to characterize and actually quantify hydrological processes in urban areas, we have set-up a 20ha experimental watershed in a residential neighbourhood in the city of Freiburg, Germany, that was developed in the 90s.

Storm runoff is drained by a separated sewer system into a system of vegetated ditches to enhance rain water infiltration. The ditches are combined with soak-aways because of the low permeable soil and the high groundwater table. Other structures that are partly measured include a variety of different roof types, especially green roofs, private rain water reuse, young and old trees, public green spaces and a nearby stream that acts as an overflow in times of heavy rainfall.

Since the beginning of 2010 a monitoring network has been installed measuring surface runoff, water levels in the ditches and ground water levels in combination with soil moisture and meteorological on-site data. The gathered time series with a temporal resolution of up to one minute allow us to characterize and quantify important hydrological processes in an urban environment. We could describe the effects of constructional means such as green roofs and infiltration ditches on the runoff response for various precipitation events. The observed water level and soil moisture in the infiltration ditches, soak-aways and groundwater wells in combination with temperature and electric conductivity allow us to quantify the performance of the rain water infiltration system under different conditions and study the interaction between ground and surface water in an urban environment. Discharge gauging of individual sub-catchments and at the outlet is necessary to calculate the water balance for the urban watershed and to verify the assumptions for the flood protection of the river.