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Quantification of urban-rural water fluxes for different land use scenarios in Lower Saxony, Germany

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Urbanization and the associated urban sprawl are ongoing global trends. Urban sprawl dynamics can be measured by the expansion of urban areas to the periphery, the scattering of settlement areas as well as the land uptake per capita. For example within some regions population densities decline, at the same time, new areas are opened up for residential constructions, resulting in high land uptake rates per person. Due to these urban sprawl dynamics, the amount of impervious surfaces is highly variable across settlements and regions; moreover, affecting ecosystem services. In general, an increase in impervious surfaces causes intensified surface runoff and inhibits infiltration. This in turn can reduce water quality of streams, urban groundwater recharge or increase the risk of flooding.
This study investigates land use dynamics in two areas covering small and middle-sized cities in Lower Saxony, Germany. Different scenarios for urban-rural development are formulated based on information on the development of settlement areas and green spaces derived from the current public discourse and from regional trends described in literature and reports. Regional population dynamics are taken from population projections carried out by the statistical office of Lower Saxony. Then, the formulated scenarios are translated into percentages of settlement area and green space as well as population densities on a 1 km^2 grid.
We simulate the changes in urban and rural water fluxes for the different scenarios using the surface urban water and energy balance scheme (SUEWS) (Järvi et al., 2011). The land use scenarios are assessed both, on a local scale, in per capita surface runoff per 1 km^2, and on a regional scale, in surface runoff per study region. Finally, the scenarios are ranked according to the ratio of local surface runoff to regional surface runoff. Furthermore, growing and shrinking areas are defined. Based on the ranking, development potentials and their effects on the water balance will be discussed.

Järvi, L., C. S. B. Grimmond, and A. Christen. 2011. “The Surface Urban Energy and Water Balance Scheme (SUEWS): Evaluation in Los Angeles and Vancouver.” Journal of Hydrology 411:219–37.