Quantification of stormwater retention capacity and groundwater quality as ecosystem services in urban environments

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Case study: single-house residential area

- municipal growth in Lower Saxony occurs to a large extend in the form of suburban single-house residential singlapses
- case study in a single-house residential area near Brunswick, Lower Saxony
- changes in stormwater retention capacity and groundwater quality as ecosystem services for 3 development scenarios are addressed

Ecosystem services

- surface sealing and pollution reduce the capacity of local ecosystems to provide ecosystem services for human well-being
- in the project a criteria catalogue is developed to assess different aspects of these scenarios and to conclude on ecosystem services or disservices

Stormwater retention capacity

Tab. 1: Preliminary water balance for the three scenarios. Simulations were conducted in EPA SWMM 5.1. For all simulations an Euler Type II 15-minute precipitation event of two years return period is applied. Results are shown after 6h of simulation time. Scenarios (1) & (2) scales have to be revised

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>(1) built according to plan</th>
<th>(2) status quo 2016</th>
<th>(3) draft urbanized quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration [% of precipitation]</td>
<td>67.3</td>
<td>58.1</td>
<td>67.9</td>
</tr>
<tr>
<td>Surface runoff [% of precipitation]</td>
<td>30.6</td>
<td>39.1</td>
<td>29.2</td>
</tr>
<tr>
<td>Storage [% of precipitation]</td>
<td>2.3</td>
<td>3.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Continuity error [% of precipitation]</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Fig. 3: Maximum infiltration rates at pervious surfaces (garden, park and gravel areas). Simulation remarks: scenario (1): 12% - 25% of parks are impervious pathways; scenario (2): 20% of sealed surfaces are permeable; scenario (3): 50% of pathways are permeable.

Summary & Outlook

- increased surface sealing results in increased surface runoff
- infiltration capacity of small gardens might be reached immediately during heavy rain events
- to make scenario (3) comparable to (1) & (2) scales have to be revised
- nevertheless, in terms of reduced surface runoff per capita, scenario (3) is already the most sustainable scenario
- holistic approaches are needed to implement sustainable development strategies

Groundwater quality (in progress)

Fig. 5: Boundary conditions as well as pressure distribution at steady state (without source terms). Plane indicates groundwater level (pressure = 0).

Summary & Outlook

- wind drift simulation and particle transport are preliminary (Fig. 6)
- coupling of SWMM and OGS via infiltration rates
- reduction of mass rates as ecosystem service

Fig. 6: Neumann source terms at upper boundary: infiltration of mean annual precipitation and particle positions (red dots) at ground surface.