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What surface water tells about groundwater in lowlands – and what it does not

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Lowland regions often exhibit a high density streams, lakes, ponds and wetlands. This holds, e.g., for Northeast Europe. As a consequence of heterogeneous sedimentation during and after glaciation, and temporarily dead ice blocks left behind in the late stage of the last glaciation, the landscape is now spotted by small depressions that are often filled with water, called kettle holes.

Tight coupling between groundwater and surface water with non-stationary gradients and flow directions is often considered rather complex and surely is a challenge for hydrological models. However, on the other hand, close links imply that the one system bears information about the other and vice versa. For example, for the 170 km2 Quillow catchment in Northeast Germany a detailed groundwater map was generated from airborne remote sensing data exclusively, that is, from laser scan data of water level elevation in streams and kettle holes. On average, about 12 points of support per km2 were used. Such a high density can hardly be achieved at that scale based on groundwater wells.

The resulting map was checked for consistency and plausibility. The groundwater map allowed delineating the catchments of the single kettle holes in order to assess the impact of land use of water quality. These catchments differed substantially from those determined based on topography. In general, the former usually exhibited a clearly elongated shape of up to some km length, resembling more single groundwater flowpaths rather than exhibiting the typical shape of stream catchments.

Analysis of water quality monitoring data revealed that kettle hole water reflected the concentration of earth and alkaline earth metals of the shallow groundwater. However, this did not hold for nutrients and redox sensitive solutes due to rapid biogeochemical turnover in the eutrophic to hypertrophic small lentic systems.