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Development of concepts for the management of shallow geothermal resources in urban areas - Experience gained from the Basel and Zaragoza case studies

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In urban areas the shallow subsurface often is used as a heat resource (shallow geothermal energy), i.e. for the installation and operation of a broad variety of geothermal systems. Increasingly, groundwater is used as a low-cost heat sink, e.g. for building acclimatization. Together with other shallow geothermal exploitation systems significantly increased groundwater temperatures have been observed in many urban areas (urban heat island effect).

The experience obtained from two selected case study cities in Basel (CH) and Zaragoza (ES) has allowed developing concepts and methods for the management of thermal resources in urban areas. Both case study cities already have a comprehensive monitoring network operating (hydraulics and temperature) as well as calibrated high-resolution numerical groundwater flow and heat-transport models. The existing datasets and models have allowed to compile and compare the different hydraulic and thermal boundary conditions for both groundwater bodies, including: (1) River boundaries (River Rhine and Ebro), (2) Regional hydraulic and thermal settings, (3) Interaction with the atmosphere under consideration of urbanization and (4) Anthropogenic quantitative and thermal groundwater use. The potential natural states of the considered groundwater bodies also have been investigated for different urban settings and varying processes concerning groundwater flow and thermal regimes.

Moreover, concepts for the management of thermal resources in urban areas and the transferability of the applied methods to other urban areas are discussed. The methods used provide an appropriate selection of parameters (spatiotemporal resolution) that have to be measured for representative interpretations of groundwater flow and thermal regimes of specific groundwater bodies.

From the experience acquired from the case studies it is shown that understanding the variable influences of the specific geological and hydrogeological as well as hydraulic and thermal boundary conditions in urban settings is crucial. It also could be shown that good quality data are necessary to appropriately define and investigate thermal boundary conditions and the temperature development in urban systems.

Groundwater temperatures in both investigated groundwater bodies are already over-heated and essentially impede further thermal groundwater use for cooling purposes. Current legislation approaches are not suitable to evaluate new concessions for thermal exploitation. Therefore, novel approaches for the assessment of new concessions which take into account the complex interaction of natural boundaries as well as existing shallow geothermal systems have to be developed.