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Model-based assessment of the potential of seasonal aquifer thermal energy storage and recovery as a groundwater ecosystem service for the Brussels-Capital Region

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Urban areas are characterized by their concentrated demand of energy, applying a high pressure on urban ecosystems including atmosphere, soils and groundwater. In the light of global warming, urbanization and an evolving energy system, it is important to know how urbanized areas can contribute to their own energy demands. One option is to use the possibilities aquifers offer as an ecosystem service (BONTE et al., 2011). If used effectively an improvement in air and groundwater quality is achieved. Additionally, the more efficient distribution of the used energy may also lead to a decrease in primary energy consumption (ZUURBIER, 2013). Therefore, investigations of the potential of seasonal aquifer thermal energy storage and recovery (ATES) for the Brussels-Capital Region, Belgium is being conducted. The potential of ATES systems are of special interest for energy demands in high density urban areas because of such infrastructure as office buildings, schools, hospitals and shopping malls. In an open water circuit ATES systems consist of two or more groundwater wells, where in seasonal cycles one subtracts and the other recharges water to the aquifer. Heat pumps use the heat capacity of water for heating or cooling a building. An important limitation of the methodology is the quality of the groundwater used (i.e. precipitation of Fe- or Mn-oxides can decrease the yield). However, ATES systems on the other hand can also improve groundwater quality and groundwater ecosystems. The current knowledge of the potential for ATES systems in the Brussels-Capital Region is based on geological assessments from VITO (2007). The Brussels-Capital Region is divided into a western and eastern section with respect to geology. While the western part has less favorable conditions for ATES, the eastern is composed of the Brussels Sand formation, which is a 20-40 m thick aquifer layer that has the highest potential for ATES systems in the region. By applying groundwater flow and heat transport models on several pilot sites within this region, our study aims to better quantify the potential for ATES systems in these aquifers. Covering several dozen square kilometres, the models investigate interaction processes between ATES installations and other competing groundwater usages, including groundwater abstraction. Based on the model results ecological and economical balance calculations should better define the effects of ATES systems. Aimed at experts and decision makers this research project delivers a detailed foundation for the exploitation of seasonal aquifer thermal storage in the aquifers of the Brussels-Capital Region as an ecosystem service, and should assist in establishing guidelines for planning, building and maintaining high performing ATES systems.

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