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Development of exploration and monitoring techniques for the sustainable thermal use of the shallow subsurface

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The increasing use of shallow geothermal energy, especially the rising numbers of geothermal ground source heat pumps that are installed to nowadays heat entire residential neighborhoods and the increasing use of ground water to cool residential buildings, as well as industrial facilities have led to an increasing need to assess possible effects of the use of shallow geothermal energy and to model subsurface heat transport. Potential effects include depletion of groundwater quality with resulting reduction of ground water ecosystem services. Heat and mass transport by groundwater dispersion and convection may lead to a carryover of effects into groundwater dependent ecosystems. These effects are often not directly accessible. Therefore, conflicting interests between geothermal energy use and groundwater protection as well as conflicting use between geothermal energy users are expected to arise especially in densely populated urban areas where the highest demand for the use of shallow geothermal energy is located but exploitation of shallow geothermal energy is limited and, at the same time, groundwater vulnerability is at its highest.

Until now, only limited information about the potential effects of the intensive use of ground source heat pumps are available. Analyses conducted in the course of regulatory permission procedures consider only single applications and often rely on models that are solely parameterized based on standard literature values (e.g. thermal conductivity, porosity, and hydraulic conductivity). In addition, heat transport by groundwater dynamics is not considered. Due to the costs of conventionally applied geothermal in-situ tests (e.g. Geothermal Response Test – GRT) these can often only be applied at larger project scale. In this regard, our study will showcase the necessity for the development of novel geothermal monitoring and exploration concepts and tools based on a case story of a thermal intensively used residential neighborhood. We will show that the development of new monitoring and exploration techniques is the prerequisite for the sustainable thermal use of the shallow subsurface in the framework of a geothermal resource management.