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Unravelling the shallow geothermal energy potential in Germany: a workflow for the realisation of national-scale harmonised site-suitability maps

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The successful realisation of climate protection and energy transition goals in Germany is contingent on an effective heat transition strategy. A key aspect of this strategy is to increase the use of shallow geothermal energy (SGE) resources for ground-sourced heat pump (GSP) applications. To date, however, the characterisation of the near-surface geothermal potential is highly heterogeneous across the country. The information is fragmented and discordant among its sixteen federal states, and it is often not readily accessible. These factors significantly challenge the achievement of the established goals of expanding SGE utilization.

This work is part of the ongoing WärmeGut project, which aims to i) assess geothermal potential and site-suitability for GSP applications across Germany, ii) compile, standardise and harmonise geoinformation on a national scale, and iii) bridge the (geo-)data accessibility gap by integrating SGE information into GeotIS – the well-established geothermal information system of Germany. Currently, GeotIS places emphasis on geological information for depths beyond 1500 meters. In this contribution, we present a concept and workflow developed for evaluating the near-surface geothermal suitability, which refers to the possibility of harnessing the SGE resource in designed areas by specific GSP applications (e.g., borehole heat exchangers, geothermal collectors and groundwater heat pumps). For a region to be deemed suitable, geothermal installations must not interfere with any existing land use. Furthermore, it is essential to assess the presence of specific geological conditions in the subsurface that can threaten the stability of geothermal systems and potentially endanger the balance of other natural resources and human activities.

In our workflow, the determination of geothermal suitability is based on the evaluation of a preliminary set of 38 conflict criteria, categorised into four groups: i) national and local regulations that identify conservation areas, ii) geological, iii) hydrogeological and iv) anthropogenic factors. For this purpose, we compile and integrate a vast array of data, encompassing publicly available databases, data from geological surveys, and newly generated information. Data includes, but is not limited to, geological and hydrogeological maps, 3D subsurface models, stratigraphic information, and chemical and physical measurements of rocks and groundwaters obtained from existing wells. We defined three suitability categories: areas unsuitable for SGE exploitation, areas with limited suitability due to risk conditions or land use conflicts, and areas generally suitable for

SGE exploitation. These categories are depicted across the national territory using a traffic light colour scheme.

The preliminary site-suitability maps offer a glimpse into their role in the heating transition in Germany, serving as an essential instrument for showcasing the potential for SGE exploitation across the country. By bridging the current information gap and standardising geodata on a national level, traffic light maps are likely to become the foremost tool employed in the planning and designing of geothermal installations.