Mapping the very shallow geothermal potential in Europe and selected case study areas

Morper-Busch

Lucia Morper-Busch and Hermann Klug | University of Salzburg, Interfaculty Department of Geoinformatics
David Bertermann and Christian Bialas | University of Erlangen - Nuremberg, Geo-Center of Northern Bavaria

Summary of the ThermoMap project

Europe is undergoing an energy transition with the aim to abolish nuclear, coal and other non-renewable energy sources through renewable energy developments. Such renewable energy resources are rapidly gaining importance. Besides the well-researched and already implemented solar, wind and hydropower domain, less research has been done in the analysis of very shallow geothermal energy resources in Europe.

Thus, the ThermoMap project addresses the topic of very shallow geothermal potential or 'vSGP' in Europe, defined as the natural thermal conductivity of the unconsolidated underground, to a maximum depth of 10 meters.

The very shallow geothermal energy within the first 10 meters below the Earth's surface is predominantly influenced by solar energy input rather than by the core of the Earth. Variations of air and soil temperature and heat flow in low depths are controlled by external variables like effective sun radiation, distribution of rainfall, and water infiltration processes based on site-specific soil and geologic conditions. This energy resource can be best exploited in the saturated and unsaturated zone of the unconsolidated rock zone where access to the underground is possible.

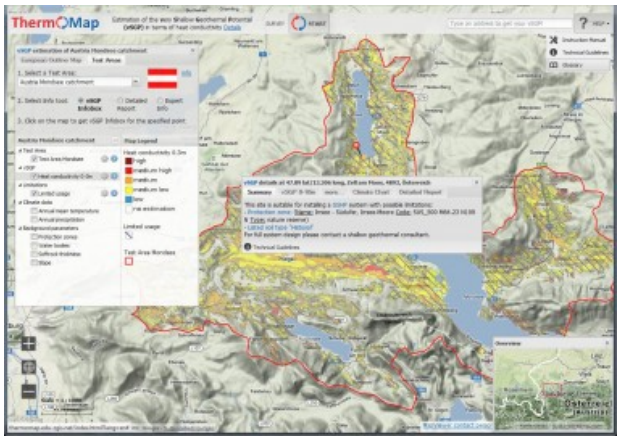
The local soil, climate and groundwater parameters have a decisive influence on the design of very shallow geothermal installations, which are not centralized but in situ systems. This is why it has been extremely difficult to obtain clear and usable specifications for these installations to date. To solve this problem, the ThermoMap project was launched in 2010 to help determine favorable areas for very shallow geothermal exploitation in a very short time and without high costs.

Previously existing spatial data collections including geological, hydrogeological, soil, climate and relief were harmonized and analyzed. For instance, several national classification systems of the grain size distribution, relating to soil texture, as a predominant parameter were harmonized according to the U.S. Department of Agriculture (USDA) classification nomenclature. The ThermoMap consortium chose the U.S. standard because there are many national classification systems but no superordinate European classification system, the USDA system is simple but expedient and scalable and the comparability with research and development outcomes from the U.S. and the English-speaking scope is higher.

Standardized methods (by the use of the KERSTEN formulas: KERSTEN, M. (1949): Thermal Properties of Soil. – Univ. Minnesota, Bull. 28 L11/21, Minnesota) were developed by the consortium to calculate a value for the heat conductivity that represents the very shallow geothermal potential on depth levels of 0 to 3 meters, 3 to 6 meters, and 6 to 10 meters, and furthermore to show locations with or without possible usage limitations (e.g. occurrence of hard rock, protection zones, unsuitable soil types or slope > 15°).

The resulting values from both the pan-European exercise and selected case study areas were integrated into an open-source WebGIS, as well as all necessary background geodata using distributed data sources. For these 14 test areas the geodata and calculated potential values are provided as Web Map Services and visualized on a very detailed level, while a shallow geothermal potential outline map in scale of about 1:250,000 was created for the entire European Union area.

The ThermoMap WebGIS



The distributed data storage is the most important principle in the project context. The data of the 14 test areas are spread across 14 partner servers. In the WebGIS, no spatial analyses are performed. The partners process the data in their local GIS and it remains on the partner servers, from where it is published as WMS layers. The technologies used for the publication of WMS include: ESRI ArcGIS Server and open-source GeoServer with underlying PostGIS database, but the data structure and compliancy to Open Geospatial Consortium (OGC) standards to retrieve the required information are predetermined.

The WebGIS interface was developed using the open-source frameworks OpenLayers and ExtJS 4, which are JavaScript application programming interfaces that make it possible to combine interactive maps with a complex user interface. OpenLayers' functionality is enhanced with GUI components of ExtJS 4, which are required for a demanding layout of map windows, toolbars, map layer trees and legend windows by which the user can interact with the application. The pure client-side JavaScript application is therefore independent of any server technology.

WMS requests from the client, via the client application, are sent to the partner servers, which then return the desired responses to the client. Request and response formats are standardized by the OGC. The used WMS requests are GetCapabilities, GetMap for georeferenced map images, GetLegendGraphic for legend symbols and GetFeatureInfo to attribute values of map layers to a specified map pixel.

With a special query tool, using the GetFeatureInfo response, a clear compilation of all necessary background parameters and results is shown for a selected map location, which also can be displayed in a detailed report as a printable Location Information Sheet which contains up to five pages, enriched with map details and schematic diagrams.

The ThermoMap WebGIS user interface is intended for use by the public, for planners and engineers, public bodies, and scientists, in order to provide an overview or, in the case of different test sites across Europe, more detailed information and usable data about the local geothermal conditions. Private users may check the potential of their residential district; community planning and administration authorities may test the geothermal potential of their entire administrative unit.

In the recently started testing phase of the project, the key objectives are to validate and enhance the user-friendliness of the WebGIS Visualization System and also to analyze soil and soft rock material from the test areas across Europe, optimizing the modeled estimation system.

The ThermoMap Consortium

ThermoMap is a European Commission co-funded project, FP7-ICT Policy Support Programme, with 12 partners from the nine European Union member states of Austria, Belgium, France, Germany, Greece, Hungary, Iceland, Romania and the United Kingdom (Duration, September 2010-August 2013).

Authors

Lucia Morper-Busch studied geography and geoinformatics. She specializes in GIS application development with the programming languages Visual Basic and C#, with a focus on ESRI ArcObjects, JavaScript and Python. Her main interests are the development of Web Mapping Applications and Geoprocessing.

Hermann Klug's research expertise focuses on the development of holistic landscape planning approaches using GIS and Remote Sensing for integrated water resources and landscape management. Involved in several interdisciplinary projects, Klug is working at the interface of the climatology, pedology and hydrology with a special focus on harmonization processes of environmental datasets and setting up of Spatial Data Infrastructures and

WebPortal services.

David Bertermann studied geography at the University of Erlangen-Nuremberg, University of Innsbruck, Austria and University of Bamberg; Minors: geology (Foci: Soil Science and Hydrology), biology (Foci: Botany und Microbiology); research about soil erosion events within alpine regions; since 2004 scientific assistant at the Geo-Center: main fields of research are contaminated sites, regulation of flood runoff by means of natural flood retention as well as shallow geothermal research.

Christian Bialas studied physical geography at University of Erlangen-Nuremberg; focus on theory and methodology of soil science; Minors: geology (exogenic geology, hydrogeology and -chemistry), chemistry (an-/organic chemistry); research about properties of loess surface layers and its influence on soil pedogenesis; since 2011 scientific assistant at the Geo-Center: main fields of research are issues on soil science, including physic-chemical laboratory analytics, contaminated sites and research on shallow geothermal potentials.