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A preliminary study of empirical evaluation models for determining the thermal conductivity of sediments

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Shallow geothermal energy is a renewable energy source that will play an important role in future energy management plans. Densely populated areas are often developed on alluvial plains, which consist of unconsolidated sediments. These have different thermal properties, so their accurate determination is important for planning subsurface heat utilization for heating and cooling of buildings in urban areas. Bulk thermal conductivity (λ_b) is one of the most important ground thermal properties for estimating shallow geothermal potential, as it controls the ability of sediments to transfer heat. The λ_b can be determined with empirical bulk thermal conductivity estimation models (λ_b EM), which define λ_b as a function of the measured physical parameters of the sediment (water content, bulk density) and the fluid. In this contribution, we present a preliminary study of three empirical evaluation models for determining the thermal conductivity of sediments – the Kersten (1949), the Johansen (1975) and the Cote & Conrad model (2005). Validation was carried out with laboratory-measured λ_b using 30 unconsolidated sediment samples classified into 2 different groups (cohesive, non-cohesive) and by water content. The modelled results were evaluated using the coefficient of determination (R^2) and root mean square error (RMSE). The modelled λ_b for non-cohesive sediments has the highest λ_b with the Johansen model. The lowest RMSE was obtained with the Kersten model. For cohesive sediments, the highest λ_b and lowest RMSE, and consequently the best model, are based on the saturation of the sediments. It varies between the Cote & Conrad and the Kersten model. By dividing the sediment samples based on shear strength and water content, we obtained the better agreement of individual groups with estimation models. This showed the importance of the physical parameters in better predicting the modelled results. In the future, we will need to upgrade results with the use of more estimation models, that could improve the modelled results. With such an approach the estimation models can become a useful tool for a faster determination of the shallow geothermal potential.