CONTRIBUTION OF GEOSTATISTICS IN MAPPING SUBSOIL TEMPERATURE EVOLUTION IN URBAN AREAS

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Abstract

Urban settlements influence ground temperature in the shallow layers, this phenomenon called subsurface urban heat island effect at city scale. Heat losses from an individual building generate a bulb-shaped volume of subsurface temperatures higher than in surroundings. Superposing the thermal effect of multiple buildings on the subsoil leads to uncertainties in defining the dimension and shape of the temperature volume. This is due by geological and hydrogeological natural variability and by the practical impossibility of quantifying all heat sources and sinks affecting an area.

Therefore, the use of geostatistics can be useful to predict ground temperature space and time variability in an urban area, by the analysis of available information. The improved quantification of ground temperature by geostatistical techniques, with respect to the application of only deterministic models, can advantage many engineering topics, such as insulation design, heat recovery and shallow geothermal systems.

This work presents a geostatistical simulation of ground temperature variability in 4D space in a delimited area. An urban zone, with measurements of groundwater temperature and borehole temperature profiles, was selected. Groundwater temperature measurements, at fixed depth, were used to calculate the time-varying vertical temperature profile at the point, knowing climate, geological and geothermal information. Then, geostatistical simulation was performed to obtain a set of equally probable images of ground temperature in 4D space, conditioned by boundary, GIS-based, information (land cover and population density). Finally, profiles of borehole temperature data were applied to verify the quality of the most appropriate map solutions. The final aim of the work was to provide a robust quantification and representation of the subsurface urban heat island effect in the study area.

This outcome will give the possibility to feed the design of underground spaces and geostructures with many possible coherent distributions of subsoil temperature. The uncertainty of the results of

numerical models can then be calculated, defining a risk assessment for each project, useful to overcome possible critical conditions.

The results of the work can be repeated and improved for larger and more complex urban areas, and can be useful for further ground temperature assessment on wider urban settlements.