EXPLORATORY SPATIAL ANALYSIS OF TOPOGRAPHIC SURFACE METRICS FOR THE PREDICTION OF WATER TABLE OCCURRENCE

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Abstract

Staring from the premise that water table in aquifers tends to have a relation with a set of metrics or spatial variables to be derived from the topographic surface, as well as groundwater flow direction tends to be consistent with the surface streams flow direction, a new model was defined aiming to predict Static Water Level (SWL) from a set of tailored global spatial variables, using compositions of existent GIS raster standard functions.

It was defined an exploratory spatial data analysis process in order to study the relation of dependent variable (Static Water Level - SWL) with a set of metrics derived from and hydrologicaly functional digital elevation model, obtained through a multi-resolution gradative interpolation method, with forced drainage.

The metrics created include a new calculation of a focal convexity with a multi-radius circular focal method and a global structural convexity, derived through an inverted downstream accumulation process. Elevation and slope were also used in the exploratory analysis.

The study area is the Estremoz-Cano karst Aquifer System and in the surrounding igneous and metamorphic rocks of the Ossa Morena Zone (OMZ), a fractured aquifer system, in the region of Alentejo in Portugal.

The SWL data were obtained by measuring it in dug wells in farms and cottages, afterward the statistical analysis revealed high correlation values with the metrics created, namely elevation and convexity. The study concluded that a Piecewise Linear Regression is the model that best explains SWL as a function of the independent variables.

The model works extremely well for the fractured aquifer of the OMZ with nearly very high correlation coefficient (R = 0.89) and a predictive capacity of 80%. In what concerns the karst aquifer of Estremoz-Cano both correlation and determination coefficients are slightly lowers, 0.84 and 71% respectively, which represents the heterogeneity of spatial water distribution inherent to this type of aquifers. In fact, it is well known that in the karst systems the groundwater level is not so dependent of the topographic surface of the terrains, due to the much higher flow velocity in these hydrogeological systems, which permits the quick outflow of most part of infiltrated groundwater, with a higher tendency for the leveling of the phreatic level.