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# GIS-based assessment of groundwater level on extensive karst areas

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Karst topographies represent unique geographical regions containing caves and extensive underground water systems developed especially on soluble rocks such as limestone, marble and gypsum. The significance of these areas is evident considering that 12% of the ice-free continental area consists of landscapes developed on carbonate rocks and 20–25% of the global population depends mostly on groundwater obtained from these systems. Karst water reservoirs already give the 25% of the freshwater resources globally. Comprehensive studies considering these regions are the key to explore chances of the exploitation and to analyze the consequences of contamination, anthropogenic effects and natural processes within these specific hydro-geological characteristics.
For the proposed work we chose several of the largest karst regions over the ice-free part of continents, representing diverse climatic and topographic characteristics. An important aspect of the study is that there are no available in situ hydrologic measurements over the entire research area that would provide discrete sampling of soil, ground and surface water. As replacement for the detailed surveys, multi remote sensing data (Gravity Recovery and Climate Experiment (GRACE) satellite derivatives products, Moderate Resolution Imaging Spectroradiometer (MODIS) satellite products and Tropical Rainfall Measuring Mission (TRMM) monthly rainfalls satellite datasets) are used along with model reanalysis data (Global Precipitation Climate Center data (GPCC) and Global Land Data Assimilation System (GLDAS)) to study the variation on extensive karst areas in response to the changing climate and anthropogenic effects.
The analyses are carried out within open source software environment to enable sharing of the proposed algorithm. The GRASS GIS geoinformatic software and the R statistical program proved to be adequate choice to collect and analyze the above mentioned datasets by taking advantage of their interoperability. The workflow consists of the automated downloading of the satellite data; updating of the geospatial characteristics; repairing, filtering and evaluating of the datasets organized in GIS-databases and producing meaningful visualization as reports and maps for end-users.
This study presents a flexible GIS and statistical analysis approach to provide information concerning groundwater vulnerability on karst areas by using available satellite-based datasets. The method allows the user to carry out comprehensive analysis within different time frames and scale ranges to explore long term characteristics or direct responses of a given karst system for external influences. The drawback of the method is the resolution of the currently available datasets, although even these results are significant in regions lacking detailed survey data.