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Assessment of groundwater availability using Bayesian Kriging (or Gaussian Process Regression)

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Water scarcity is a major global problem, which is expected to become more significant in the near future. The overexploitation of the groundwater due to intensive agricultural activity and other anthropogenic activities and the ongoing climate change significantly impact the hydrological conditions of the Mediterranean region. Climate projections for the Mediterranean region in combination with an increasing water demand generate concerns over the sustainability of groundwater resources. In this work the groundwater level spatial variability is assessed based on a dataset that includes time series of biannual average data over a period of ten consecutive years obtained from an extensive network of wells in the island of Crete, Greece. A geostatistical analysis based on Bayesian kriging (which is essentially the same as the machine learning method of Gaussian process regression) was conducted in order to generate reliable spatial maps of groundwater level variability and to identify groundwater level patterns over the entire island. The method of Bayesian kriging provides an improved assessment of the groundwater level uncertainty than classical geostatistical methods. In addition, it allows the user to introduce a prior distribution for the parameters of the spatiotemporal model and to assess its impact on the estimation. This work could help decision makers to identify areas where interventions in the groundwater management strategy are necessary. At the same time, it can help scientists to assess the impact of different climate change scenarios on groundwater availability. The method is applied to data from Crete, but it can easily be transferred to data from other Mediterranean regions as well.