EGU23-5801
https://doi.org/10.5194/egusphere-egu23-5801
EGU General Assembly 2023

An artificial neural network as a quick tool to assess the effects of climate change and agricultural policies on groundwater resources

Daniele Secci[1], Valeria Todaro[1], Onur Cem Yologlu[2], Nadim K Copty[2], Irem Daloglu Çetinkaya[2], Marco D'Oria[1], Ali Kerem Saysel[2], Maria Giovanna Tanda[1], and Andrea Zanini[1]
[1]Department of Engineering and Architecture, University of Parma, Parco Area delle Scienze 181/A, 43124, Parma, Italy
[2]Institute of Environmental Sciences, Bogazici University, Bebek, 34342 Istanbul, Turkey

Groundwater is a strategic reserve that is often used to meet water demands in dry seasons and during drought periods. However, the over-exploitation of this vital resources can jeopardize its sustainability. Projected climate change is expected to further exacerbate the situation in many regions of the world. Therefore, it is essential for decision makers to have simple tools to model groundwater flow and to assist in aquifer management. These tools can reduce the computational cost of complex physics-based models, without undermining the reliability of the results. The aim of this work is to develop a surrogate model capable of simulating groundwater flow in the Konya closed basin, a major agricultural region located in central Turkey. The model is used to analyze different future water demand scenarios and evaluate the possible effects of climate change and agricultural policies on groundwater. This aquifer is one of the pilot sites investigated within the “Innovative and Sustainable Groundwater Management In the Mediterranean (InTheMed)” project, which is part of the PRIMA programme. An Artificial Neural Network (ANN) was trained to provide groundwater levels at 30 monitoring points for the period 2020-2039 accounting for different climate and agricultural scenarios. The surrogate model replaces a full numerical surface-subsurface flow model implemented in MODFLOW and calibrated using field data recorded in the period 2000-2019. To define the dataset that feeds the ANN, two multiplicative coefficients were considered: one applied to the historical precipitation and the other to crop water demand. The two coefficients and the current month were considered as input features of the ANN, while the piezometric heads at the 30 monitoring points were the outputs. A dataset of 100 combinations of precipitation and crop coefficients was generated using the Latin Hypercube Sampling method, assuming an increase/decrease range in terms of precipitation equal to +/- 40% and water demand equal to +/- 25%. For each combination of the coefficients, the full numerical model was run starting from January 2020 to obtain piezometric heads at the 30 monitoring points with a monthly time discretization. The final dataset was used to train (70%), validate (15%) and test (15%) the network, highlighting a very good performance of the ANN for all three phases. The fully trained network was used to predict groundwater levels considering three different precipitation scenarios for the period 2020-2039: - 20% of the observed precipitation, no reduction of the observed precipitation and + 20% of the observed precipitation. For each precipitation scenario, the water demand was considered in the range -/+ 20%.

This work was developed under the scope of the InTheMED project. InTheMED is part of the PRIMA programme supported by the European Union's HORIZON 2020 research and innovation programme under grant agreement No 1923.