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Assessment of groundwater availability in the Rhodope aquifer under climate change conditions

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ABSTRACT

In this work, a groundwater assessment of the coastal aquifer of Rhodope-NE Greece is provided under current and future climatic conditions. For this purpose, the FEFLOW software package is used to compile a model based on the regional hydrogeological conceptualisation, calibrate it in steady and transient state modes, and subsequently simulate the groundwater system flow for the period 2002-2019. The calibrated model is used to assess climate change impact on groundwater balance and level fluctuation with bias-corrected climate data for the periods 2031-2050 from RCA4 regional climate model driven by 3 different global circulation models. The results indicate that the fluctuations of precipitation are affecting groundwater recharge and consequently groundwater availability, despite the fact that groundwater recharge contribution to inflows is not high.

1. Groundwater model setup

1.1. Conceptual model

The Rhodope aquifer covers an area of approximately 180 km^2 and the hydrogeological conditions of the wider area were investigated in the past by several researchers (among others Petalas and Diamantis, 1999; Petalas and Lambrakis, 2006; Petalas et al., 2009; Galazoulas et al. 2015). In general, two main aquifers can be identified. A shallow semi-confined aquifer with an average thickness of 35 m and of limited potential and, an underlain thicker one (50–100 m) which is confined and hosts the regional groundwater reserves. To implement the geometric configuration in the FEFLOW environment, we consider three (3) geological layers and four (4) computational slices. In total, the computational domain area is discretised by a finite element mesh of 2,008 nodes and 2,781 triangular prism elements.

1.2. Steady-state model

Fig. 1 shows the inflows-outflows and other boundary conditions applied in the model domain for the flow problem. Recharge (R=0.0753 mm/d) corresponds to 5% of precipitation and together with the lateral inflows of 1 and 10 mm/d from neighbouring geological formations, they constitute the water inflow into the aquifer layers. A constant groundwater pumping of 1,567 m^3/d per well from 90 wells in the aquifer represent sufficiently the actual water abstraction in terms of steady-state modelling. The south-west and south east boundaries of the aquifer interact with surface water bodies (sea or lagoon) and thus a constant hydraulic head boundary condition (H=0 m) is assigned.

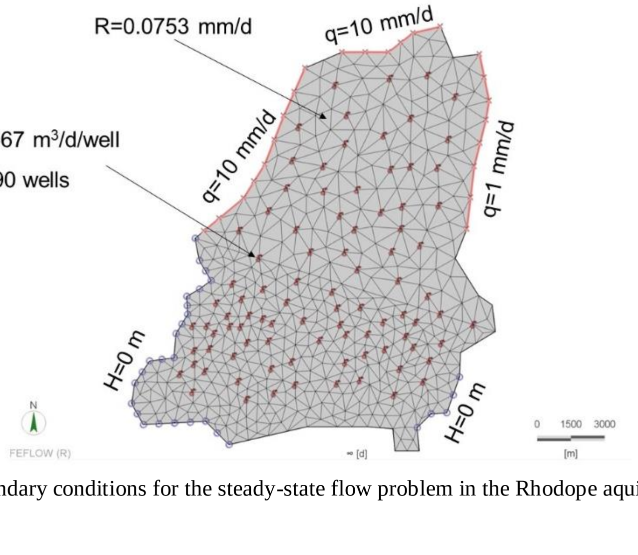

Fig. 1. Boundary conditions for the steady-state flow problem in the Rhodope aquifer

To evaluate the model a sloping line comparative graph of simulated vs observed hydraulic heads at control points was constructed (Fig. 2), from where we can conclude that model results are in quite good agreement with field measurements (R^2=0.83), and thus a reliable groundwater steady-state flow model for the Rhodope aquifer has been developed.

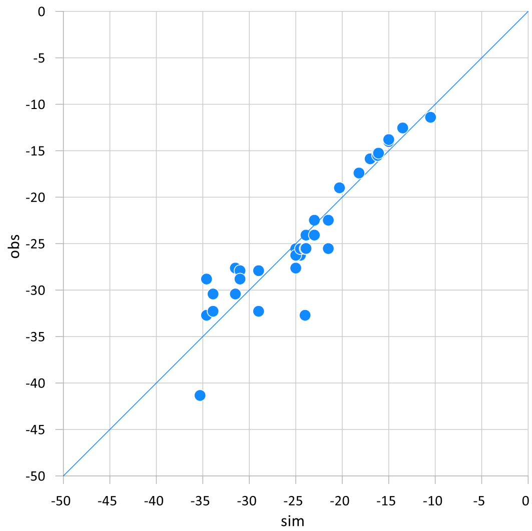

Fig. 2. Sloping line comparative graph of simulated vs observed hydraulic heads at control points.

1.3. Transient state model

The calibration period for the transient model was 4 years and the simulated hydraulic head is compared against field observations to estimate the specific storage (S_s) coefficient for the lower aquifer layer (confined aquifer). More particularly, two runs of the model performed using uniform value of S_s, i.e. one run for $S_s = 10^{-4}$ m^{-1} and another run for $S_s = 5x10^{-4}$ m^{-1}. Based on this modelling exercise, we were able to identify the distribution of the specific storage coefficient, while at the same time the model performance was substantially improved.

2. Climate change scenarios

In order to assess climate change impact on groundwater balance of Rhodope aquifer, climate data from state-of-the-art Regional Climate Models (RCMs) runs under RCP4.5 emissions scenario were collected and bias-corrected. More in detail, data from RCA4 RCM was used forced by 3 Global Circulation Models (GCMs), which were further corrected using the widely applied linear scaling and distribution mapping methods. The results demonstrate considerable variability in climate change signal depending on the GCM forcing the RCM. Nevertheless, the results demonstrate that the decreased groundwater recharge resulting from the decreased precipitation during drought periods, can affect groundwater availability, thus demonstrating the necessity for the development of climate change adaptation strategies, especially for the agricultural sector which constitutes the dominant groundwater user.

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References

Galazoulas, E.C., Mertzanides, Y.C., Petalas, C. et al. (2015) Large Scale Electrical Resistivity Tomography Survey Correlated to Hydrogeological Data for Mapping Groundwater Salinization: A Case Study from a Multilayered Coastal Aquifer in Rhodope, Northeastern Greece. Environ Process, 2:19–35, https://doi.org/10.1007/s40710-015-0061-y

Petalas, C. and Diamantis, I. (1999) Origin and distribution of saline groundwaters in the Miocene aquifer system in coastal Rhodope area, Thrace, NE Greece. Hydrogeol J, 7:305–316, https://doi.org/10.1007/s100400050204

Petalas, C. and Lambrakis, N. (2006) Simulation of intense salinization phenomena in coastal aquifers—the case of the coastal aquifers of Thrace. J Hydrol, 324:51–64, https://doi.org/10.1016/j.jhydrol.2005.09.031

Petalas, C., Pisinaras, V., Gemitzi, A. Tsihrintzis, V. A., Ouzounis, K. (2009) Current conditions of saltwater intrusion in the coastal Rhodope aquifer system, northeastern Greece. Desalination, 237:22-41, https://doi.org/10.1016/j.desal.2007.12.020