# Variable density flow and geochemical processes to assess salinization problems in the Rhodope aquifer, Greece


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## 1. Overview

- A variable density flow and contaminant transport model for the Rhodope coastal aquifer has been complied using the FEFLOW model.
- Geochemical processes in conjunction with field data are investigated with the aim of the PHREEQC model to identify other groundwater salinisation sources than seawater.


## 2. Study area

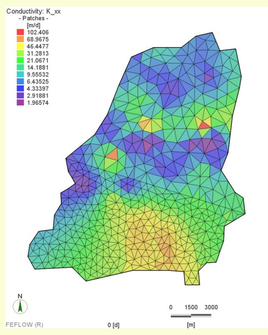
- Rhodope aquifer is located in Northern Greece – the study area is approximately 190 km$^2$
- It is a hilly area, with gentle slopes and with several surface hydrological features at the boundary of the area (lakes, lagoons, ephemeral rivers, coastline is in the south part of the aquifer).
- Groundwater is the main source of freshwater for the area
- Irrigation is the key water use
- Mediterranean climate – precipitation (average annual): 550 mm
- Based on available hydrogeological data for the area, two main aquifer layers can be identified;
  - a shallow semi-confined aquifer layer with an average thickness of 35 m and of limited hydrogeological potential and,
  - an underlain thicker one (50–100 m) which is confined and hosts the regional groundwater reserves.
  - between these two aquifer layers, a semi-impermeable layer with an average thickness of 10 m is considered.

## 3. Model set-up and calibration

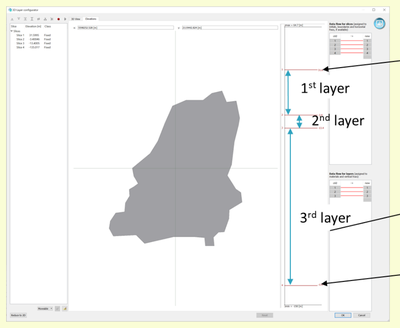
- FEFLOW for 3D variable-density saturated flow
- 3 geological layers / 4 computational slices
- 2,781 mesh elements (triangular prism)
- 2,008 mesh nodes

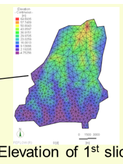
| | Hydraulic conductivity – horizontal (m/d) | Hydraulic conductivity – vertical (m/d) | Specific yield (–) | Specific storage coefficient (1/m) |
|---|---|---|---|---|
| First layer | 21* | 2.1* | 0.05 | $10^{-4}$ |
| Second layer | $10^{-4}$ | $10^{-5}$ | 0.01 | $10^{-6}$ |
| Third layer | 21* | 2.1* | 0.1 | $2.36 \times 10^{-4}$* |

*average value

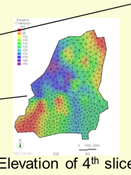


Hydraulic conductivity

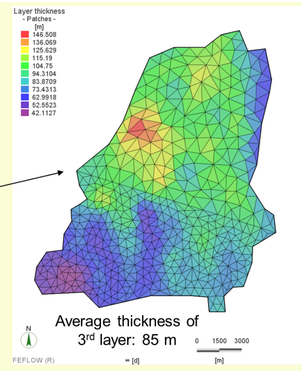


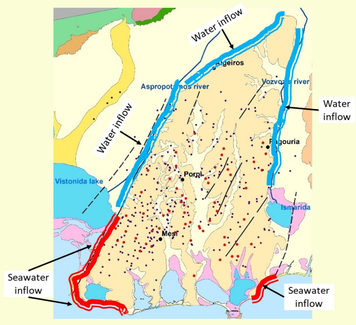



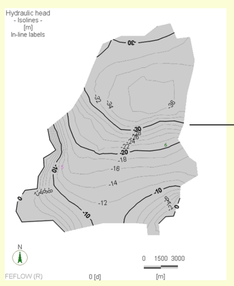
Elevation of 1st slice



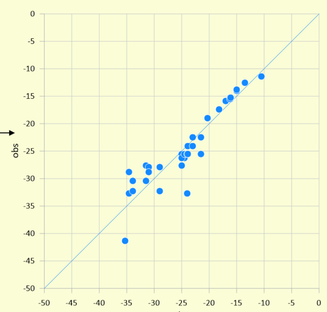
Elevation of 4th slice



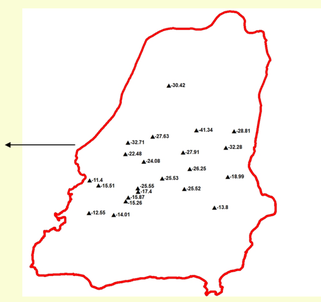



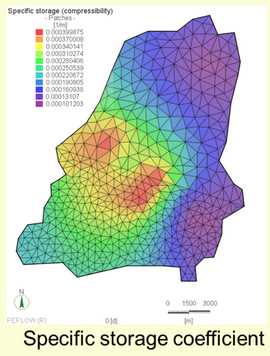
Hydraulic head distribution for the steady-state model



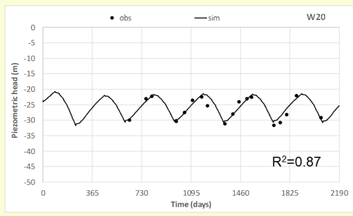
Sloping line comparative graph of computed vs observed heads ($R^2$=0.83)

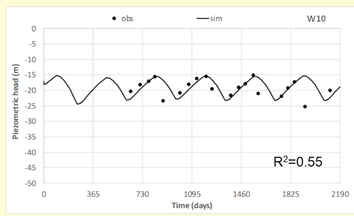


Control points with observed head (April 2002)



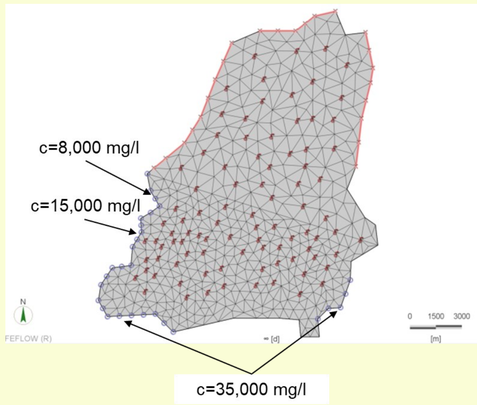
Specific storage coefficient



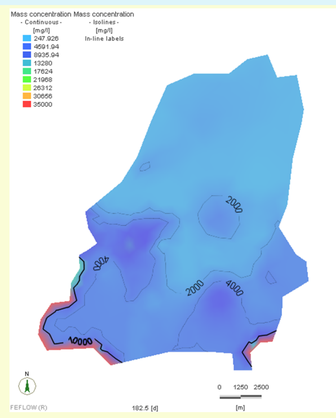



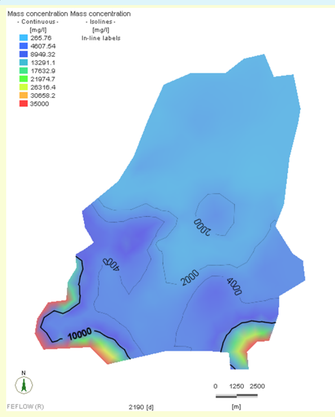

Simulated vs Observed Head

- TDS is the dependent variable for salt concentration; the conversion factor of TDS (mg/l) to EC (μS/cm) was taken equal to 0.65
- Seawater is assumed to have a constant concentration of c=35,000 mg/l
- In areas where the aquifer is in contact with Lake Vistonida, the boundary condition varies from 8,000 to 15,000 mg/l




**Salt concentration – TDS (mg/l)**





## 4. Further development of the groundwater model

The hydrogeochemical evolution of the groundwater will be identified with the aid of PHREEQC model. Key minerals related to dominant processes and salinization will be selected as input variables to exercise an inverse modelling approach.


**Acknowledgements**

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