Bundesanstalt für Geowissenschaften und Rohstoffe

Institut für Strömungsmechanik und Umweltphysik im Bauwesen

Masterarbeit

Numerical investigation of transient water flow in the Chtouka Aquifer, Morocco

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Background Seawater intrusion is a worldwide phenomenon naturally occurring in coastal aquifers due to the density difference between seawater and freshwater. However, groundwater pumping can induce a landward movement of the freshwater-saltwater interface, which may lead to an increased salinity of the pumped water. In Morocco, the Chtouka region is a major producer of fruits and vegetables intended for exportation. This is only possible through irrigated agriculture and a combined use of surface water and groundwater resources. Intense pumping in the Chtouka aquifer is responsible for the observed water table decline, which exacerbates seawater intrusion and threatens freshwater resources. A recent geophysical survey detected seawater intrusion up to 2.5 kilometers inland. In the near future, water demand is expected to increase due to population growth, increased demand for irrigation and climate change. Consequently, seawater intrusion may move further inland. To investigate the behavior of the seawater intrusion in the Chtouka aquifer, a numerical model was developed using the SEAWAT code (within the GMS software). This model builds on previous existing models and incorporates newly acquired data. As of now, the model has only been calibrated under steady state conditions.

Objectives In this project, water fluxes shall be simulated numerically under transient conditions. The transient model includes pumping rates in the area, irrigation return flow, and rainfall. The numerical code SEAWAT (with the GMS software) will be used. In particular, the following aims shall be accomplished:

1. Literature review of the current state of knowledge in this field.
2. Build a transient variable-density 3D flow model for the time 1969-2020. Also build a constant-density flow model without seawater intrusion.
    2.1. Impose transient BC (pumping, rainfall, irrigation from recharge).
    2.2. Evaluate the impact of the choice of flux along the Eastern Neumann boundary.

2.3. Evaluate the impact of the choice of the Southern BC (Cauchy vs. Dirichlet).

2.4. Develop a strategy to quantify existing pumping rates in extraction wells. Verify if groundwater wells can be lumped or need to be imposed point-wise.

2.5. Calibrate the constant-density flow model with existing head measurements.

3. Compare the variable-density flow model with the constant-density flow model.

3.1. Verify the impact of seawater intrusion on the water levels near the coast: Is the variable-density (or constant-density) model adequately reproducing the water level variations in the piezometers near the coast?

3.2. Verify if the results from the variable-density flow model are in agreement with the observed data from subsurface monitoring devices (SMD) and geophysics surveys (TEM).

3.3. Adjust the calibration of the variable-density flow model accordingly

The following additional aims are also anticipated:

4. Generate scenarios (of climatic change and of future water use) in collaboration with the ABHSM, the local partner. Which scenarios to be co-developed will depend on ABHSM interests and data availability.
5. Evaluate their impact on the availability of freshwater resources in the future (water fluxes, seawater intrusion).