DENSITY-DEPENDENT SALTWATER INTRUSION MODELING WITHIN AN INTEGRATED WATER RESOURCE MANAGEMENT FOR AN AGRICULTURAL USED COASTAL ARID STUDY REGION IN OMAN

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MOTIVATION AND CHALLENGES

FIG.1 NOWADAYS AGRICULTURE

The study region features a coastal aquifer near Muscat, Oman, that is intensively used as a source of fresh water for agricultural irrigation purposes. Excessive groundwater abstraction rates, estimated to exceed nowadays twice the upstream inflow, lead to two major problems:

(i) reduction of groundwater level (quantitative constraint), and
(ii) marine saltwater intrusion due to reversion of groundwater gradient (qualitative constrain).

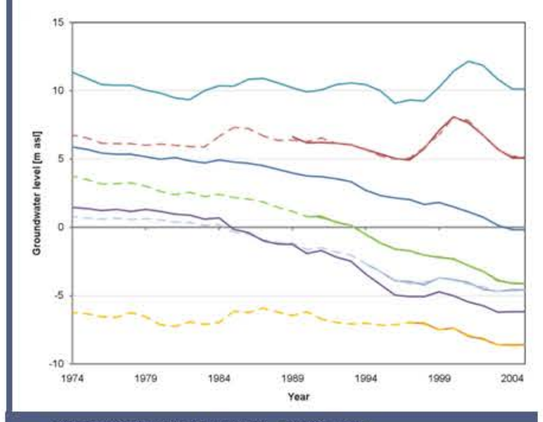

FIG.2 GROUNDWATER LEVEL DECLINE

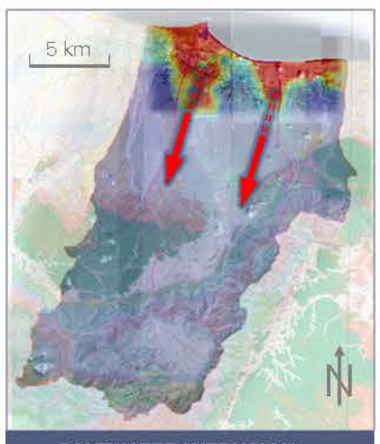

FIG.3 SALTWATER INTRUSION

We are utilizing the scientific open source software package OpenGeoSys (OGS) as a numerical modeling tool for evaluating possible future scenarios reducing the saltwater intrusion.

MODEL DOMAIN AND SETUP

The model domain is the near-coastal aquifer system primarily containing sediments of aeolian, fluviatile and marine origin (clay, silt, sand, gravel).

Boundary conditions are zero-level pressure head and marine saltwater concentration (north), pumping abstraction at several points (near coast) and upstream inflow (south).

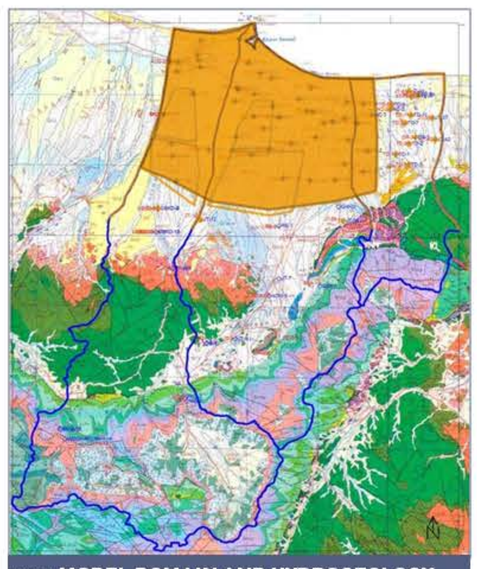

FIG.4 MODEL DOMAIN AND HYDROGEOLOGY

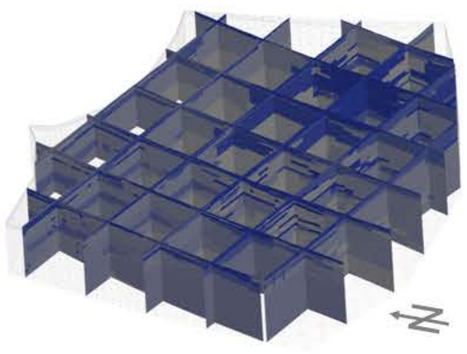

FIG.5 CROSS SECTIONS OF INTERPOLATED DOMAIN

Applying an adapted inverse weighted distance approach to a collection of hydro-geological data (e.g. borehole logs), the model domain could be parameterized.

STEADY STATE CALIBRATION

Abstraction is presumed to be constant until 1970s. From 15 measured and 25 extrapolated groundwater levels, a steady state calibration could be achieved for 1974 using PEST on OGS (biased correl. coeff. > 0.9).

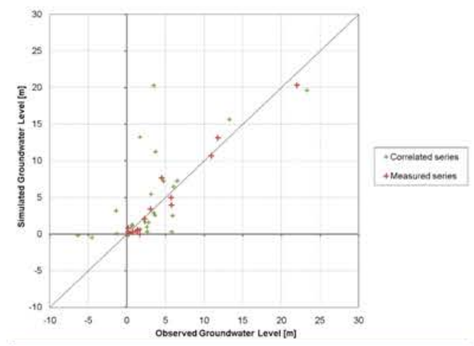

FIG.6 SCATTER PLOT STEADY CALIBRATION

SCENARIO SIMULATIONS

Applying the estimated development of the groundwater abstraction rate, a transient mass transport simulation has been carried out showing close results to saline intrusion measurements.

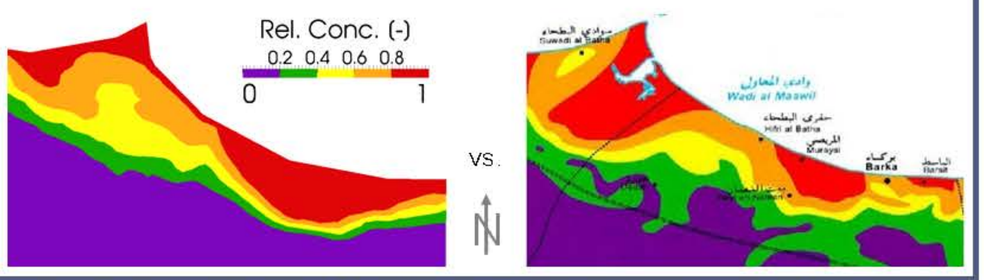

FIG.7 MASS TRANSPORT SCENARIO SIMULATION VS. SALTWATER INTRUSION MEASUREMENTS

The 3D flow field reflects the highly heterogeneous model domain and regional specialities, like the highly permeable area in the centre of the domain: the "Ma'awil trough".

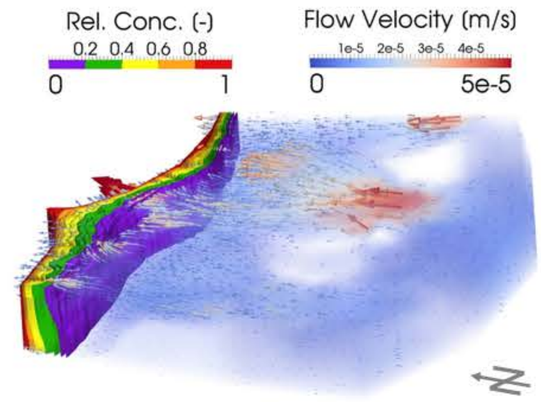

FIG.8 FLOW FIELD AND INTRUDING SALTWATER FRONT

OUTLOOK

After the model has been calibrated for a transient state, additional scenario simulations can be carried out. Also, a coupling to overland flow and recharge processes will be done.

ACKNOWLEDGEMENTS

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