3D- GEOLOGICAL AND GROUNDWATER FLOW MODELLING OF DROUGHT IMPACT AND RECHARGE POTENTIALITY IN KHATT SPRINGS AREA, RAS AL KHAIMAH EMAREATE, UAE

by

P. Wycisk , M. Al Assam, S. Akram, M. Al Mulla, D. Schlesier, A. Sefelnasr, N. B. Al Suwaidi, M.S. Al Mehrizi, and A. Ebraheem

Joined Research Work of

Ministry of Environment & Water, Dubai, U.A.E.

Martin-Luther University, Halle, Germany

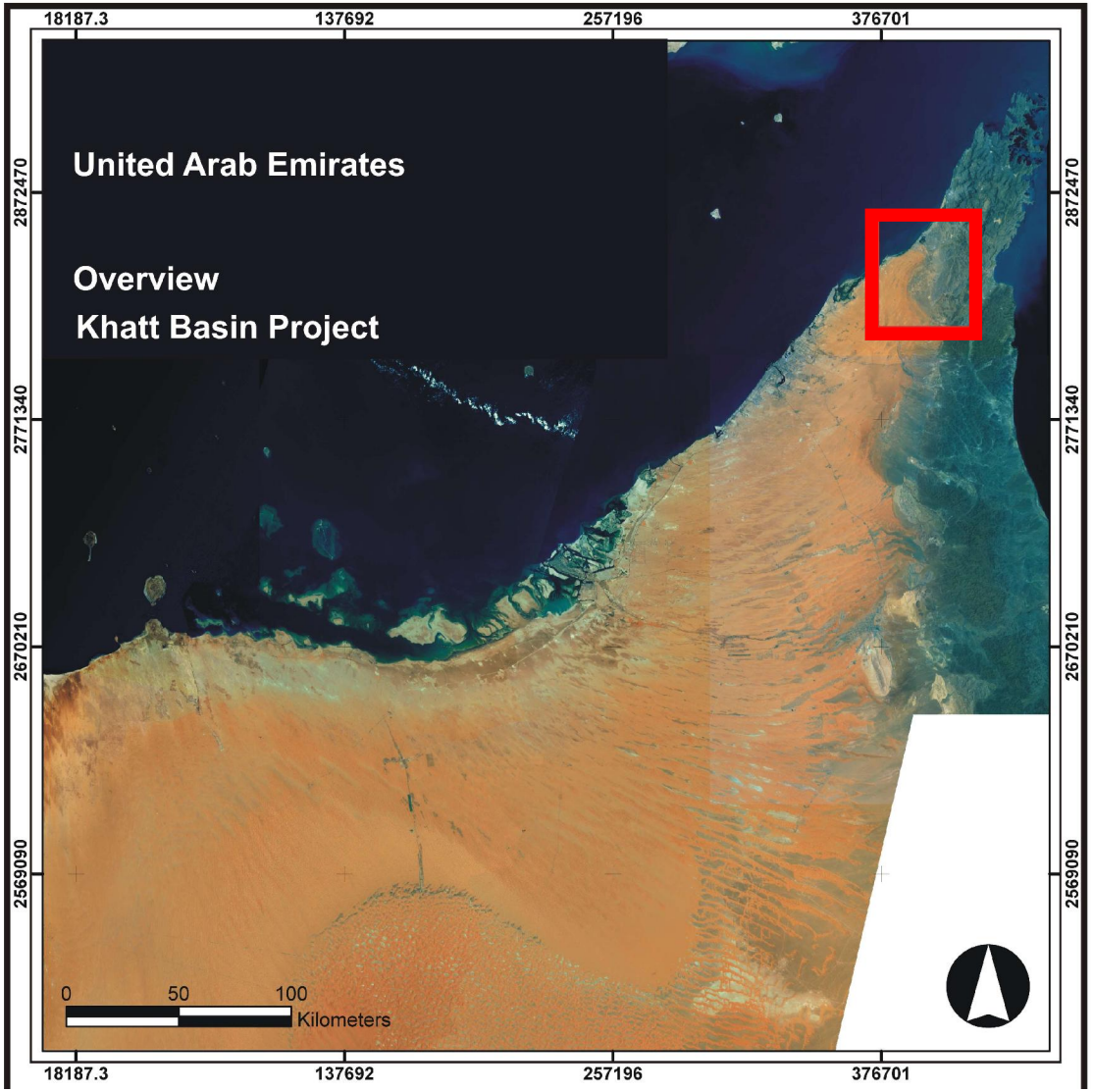
Khatt Spring Pilot-Project

United Arab Emirates

Data Source: Satellite Image by Ras Al Khaymah Municibility

Khatt Spring Pilot-Project

Overview



Area of the Khatt Basin Project

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Data Basis of the Khatt Spring Pilot-Project

Khatt Spring Pilot-Project

DEM = „Digital Elevation Modell“

Legend:

- Intervall Contours of DEM
- 50 Altitude in m
- City

Data Source:

DEM by USGS (2003)
Seamless Data Distribution System
Earth Resources Observation and Science

Satellite Image by USGS

DEM processing by Andrea Hanf

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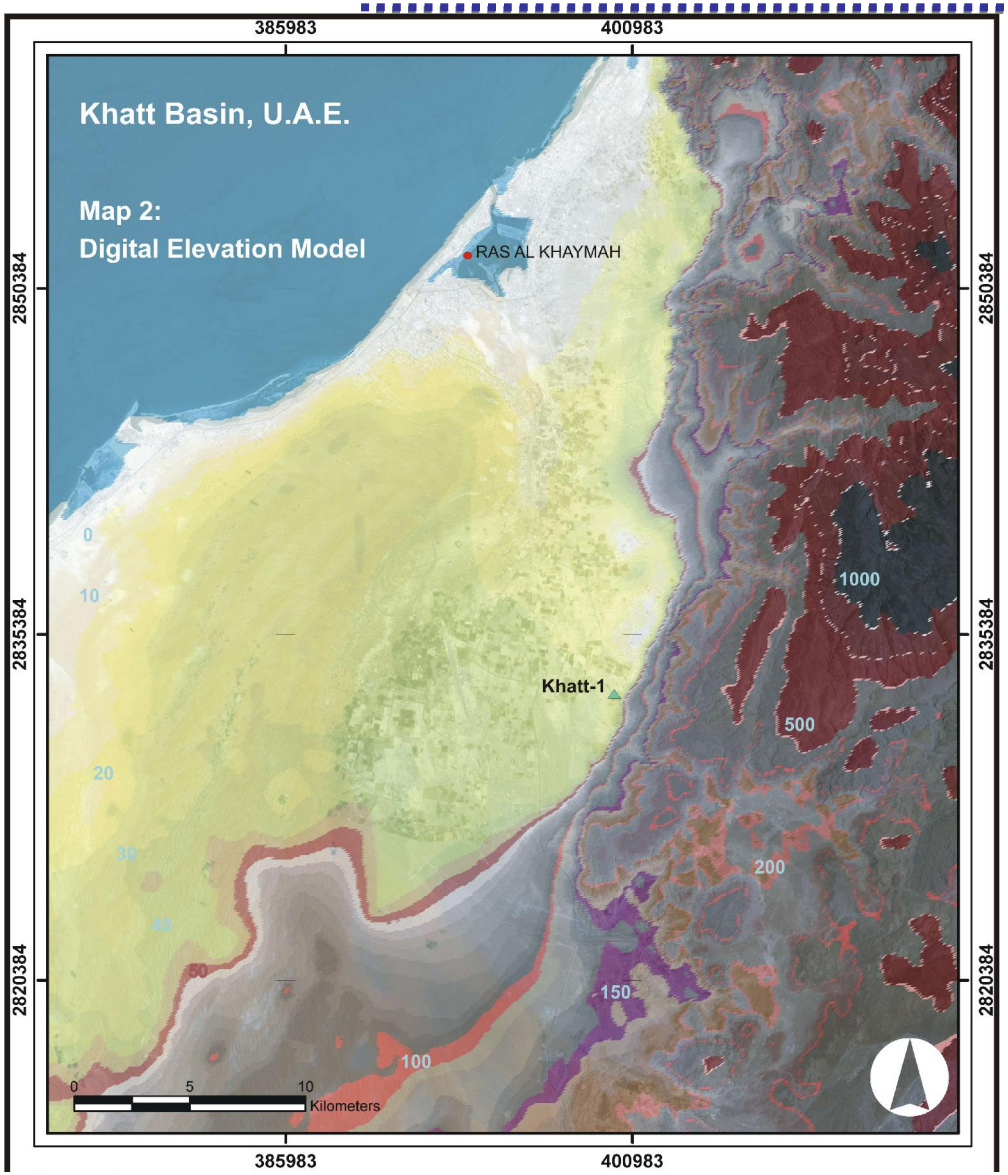


Khatt Spring Pilot-Project

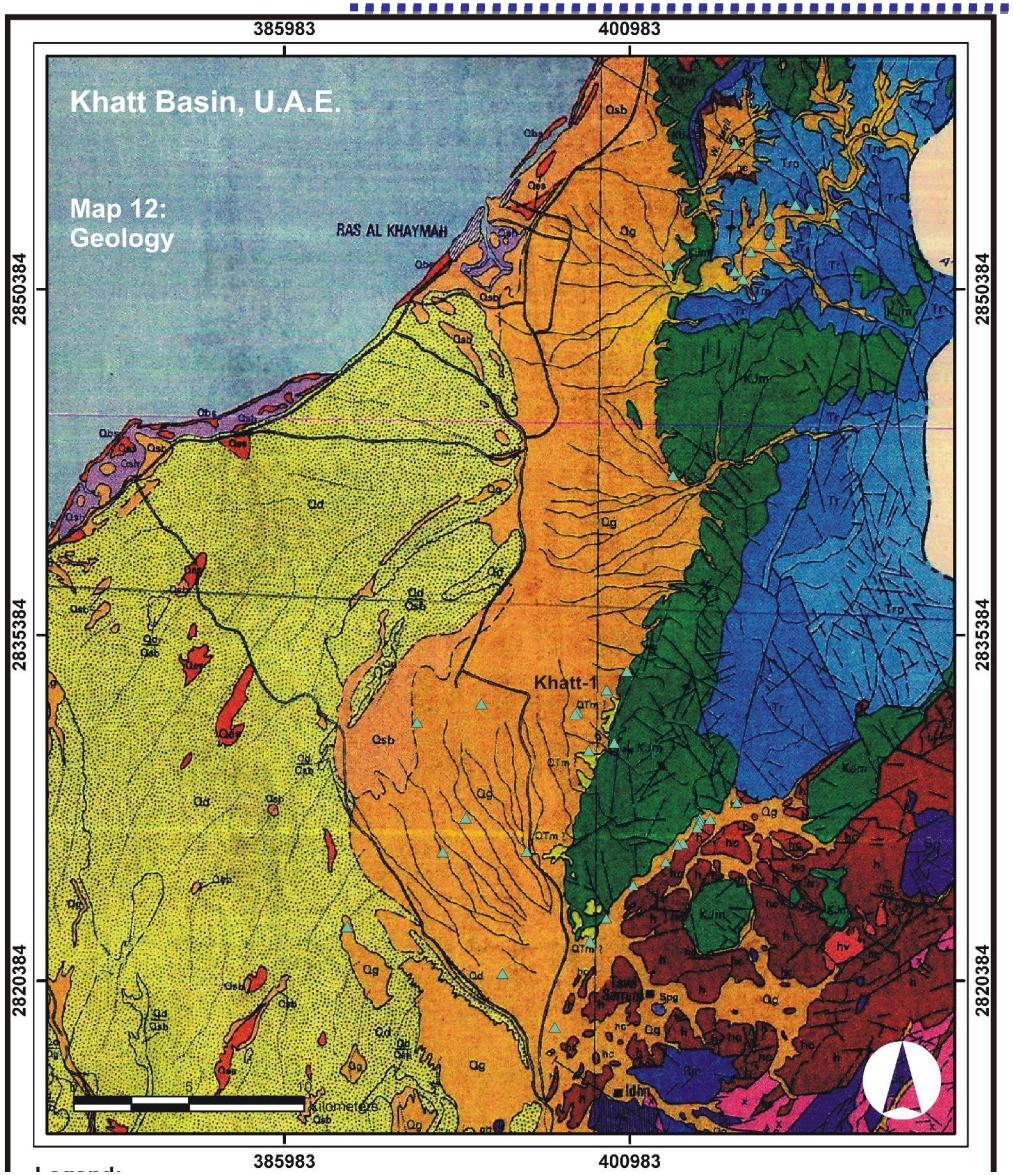
Geology

Legend:

Quaternary	carbonate sand	
Quaternary	fluviatile deposits	
Quaternary	sand dunes	
Cretaceau	Shale, Clay	Hawasina-Formation
Jurassic-Creataceau	Limestone	Musandam-Formation
Permo-Triassic	Limestone	Musandam-Formation
Cambrium	Gabbros and Ultrabasios	
Cambrium	Metamorphios Quartzite	
Location of Project wells		

Data Source:

Geological Map (1979) by
Government of the UAE
Ministry of Petroleum and Mineral Resources



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Wells and Profiles

Legend:

- Location of Project wells
- Geophysical Profil
- Geological section
- City

Data Source:

Satellite Image by
USGS

wells by IWACO

Geophysical Profile by A. M. Ebraheem, and others

Geological section by IWACO (1986)

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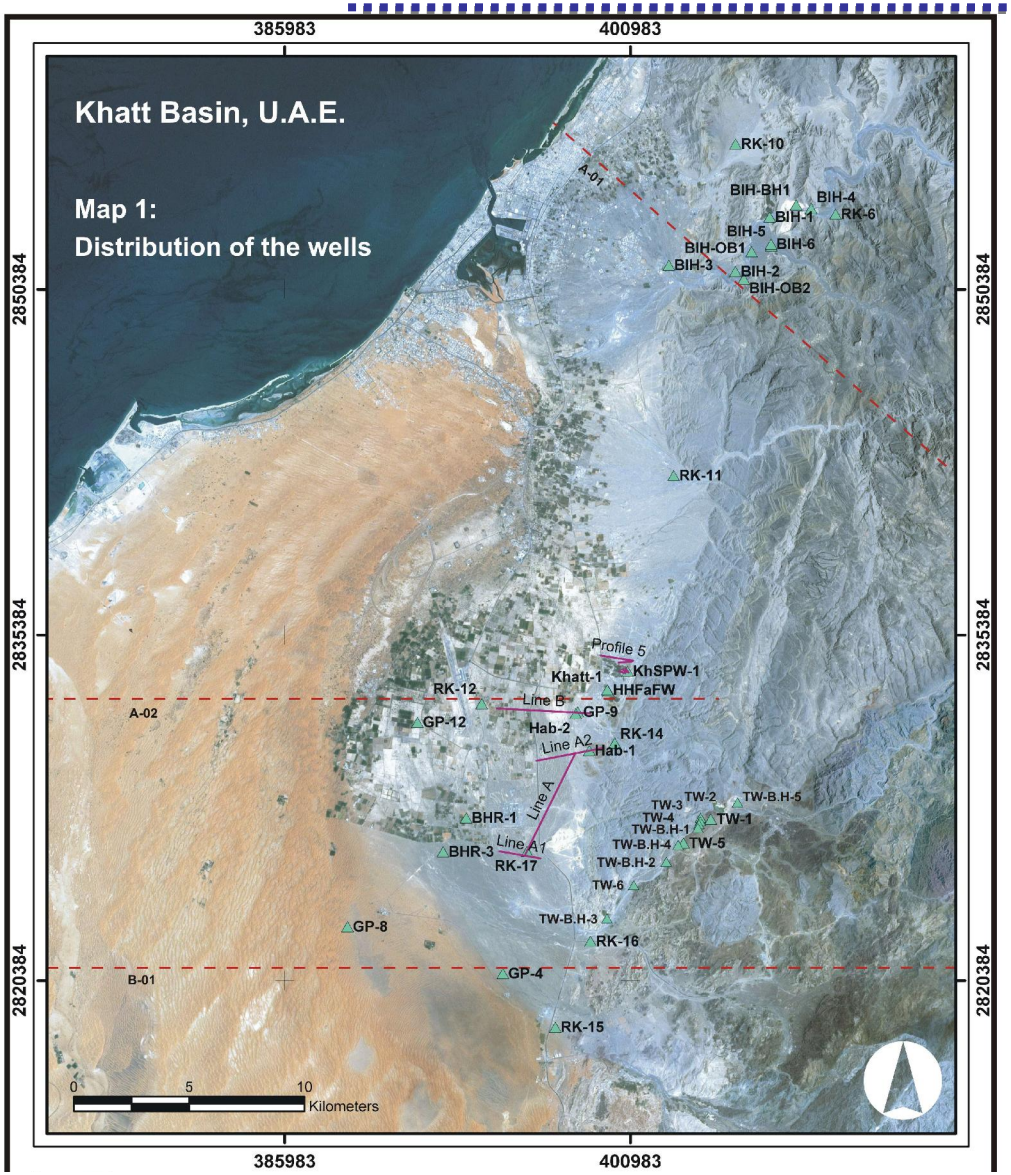
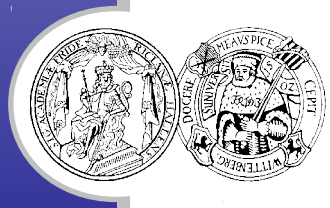
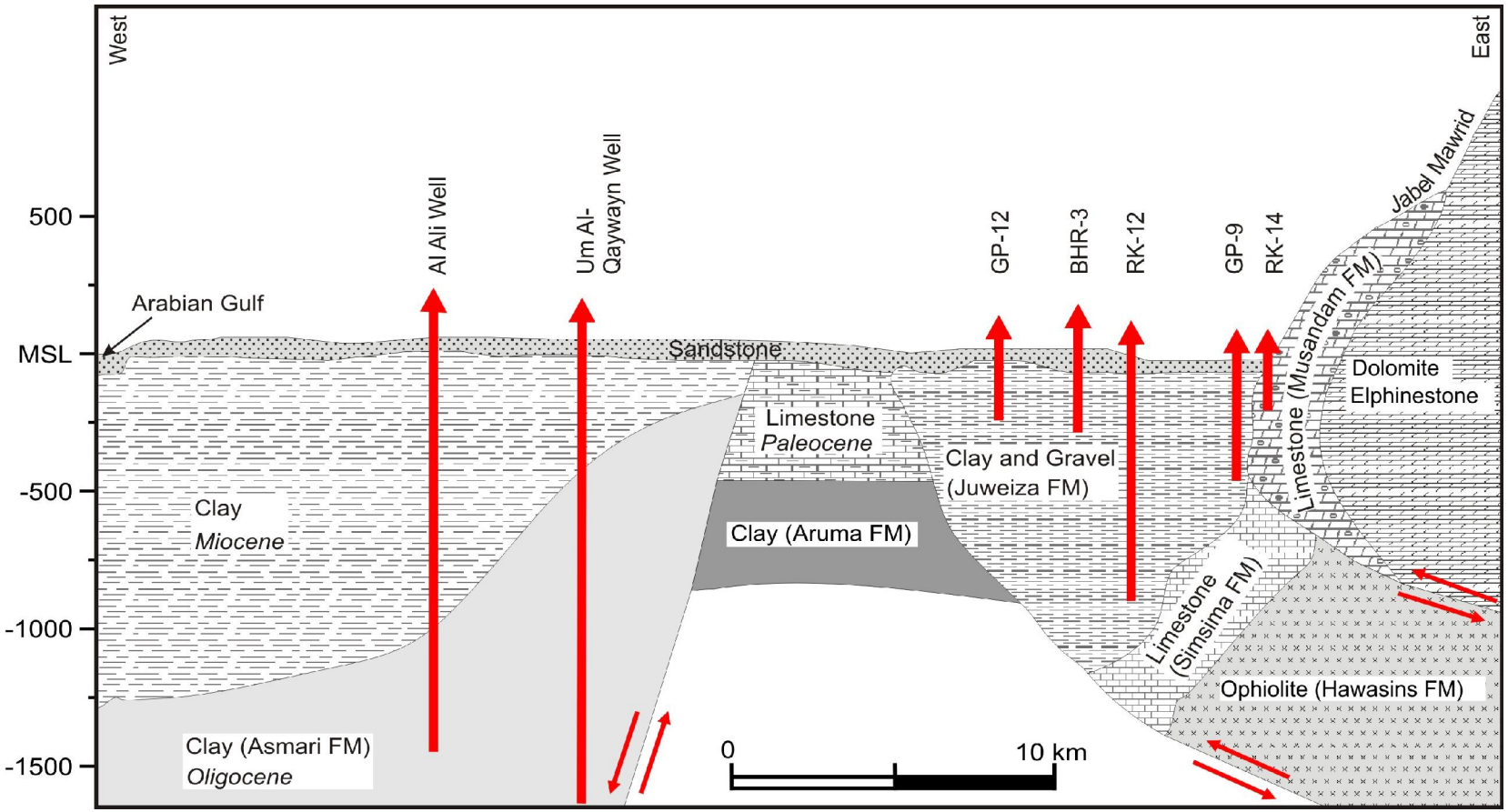




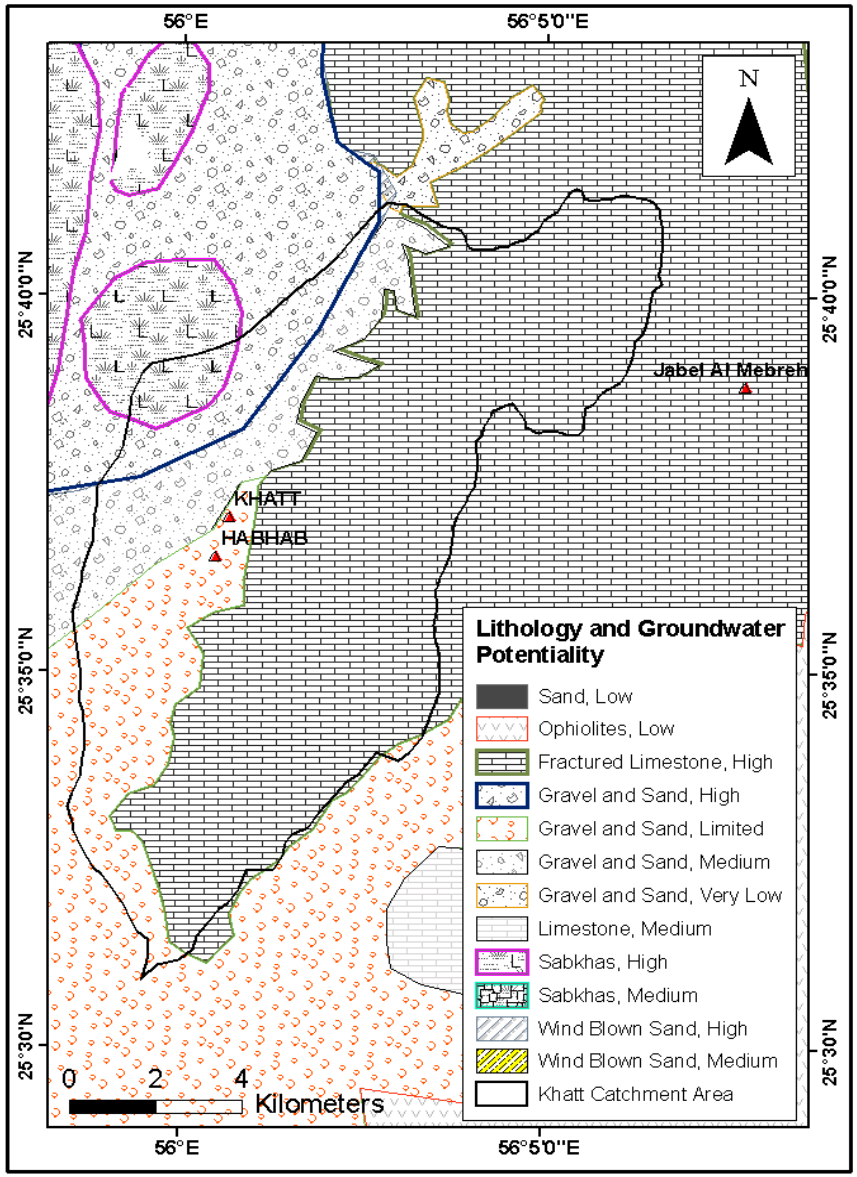
Khatt Springs Project



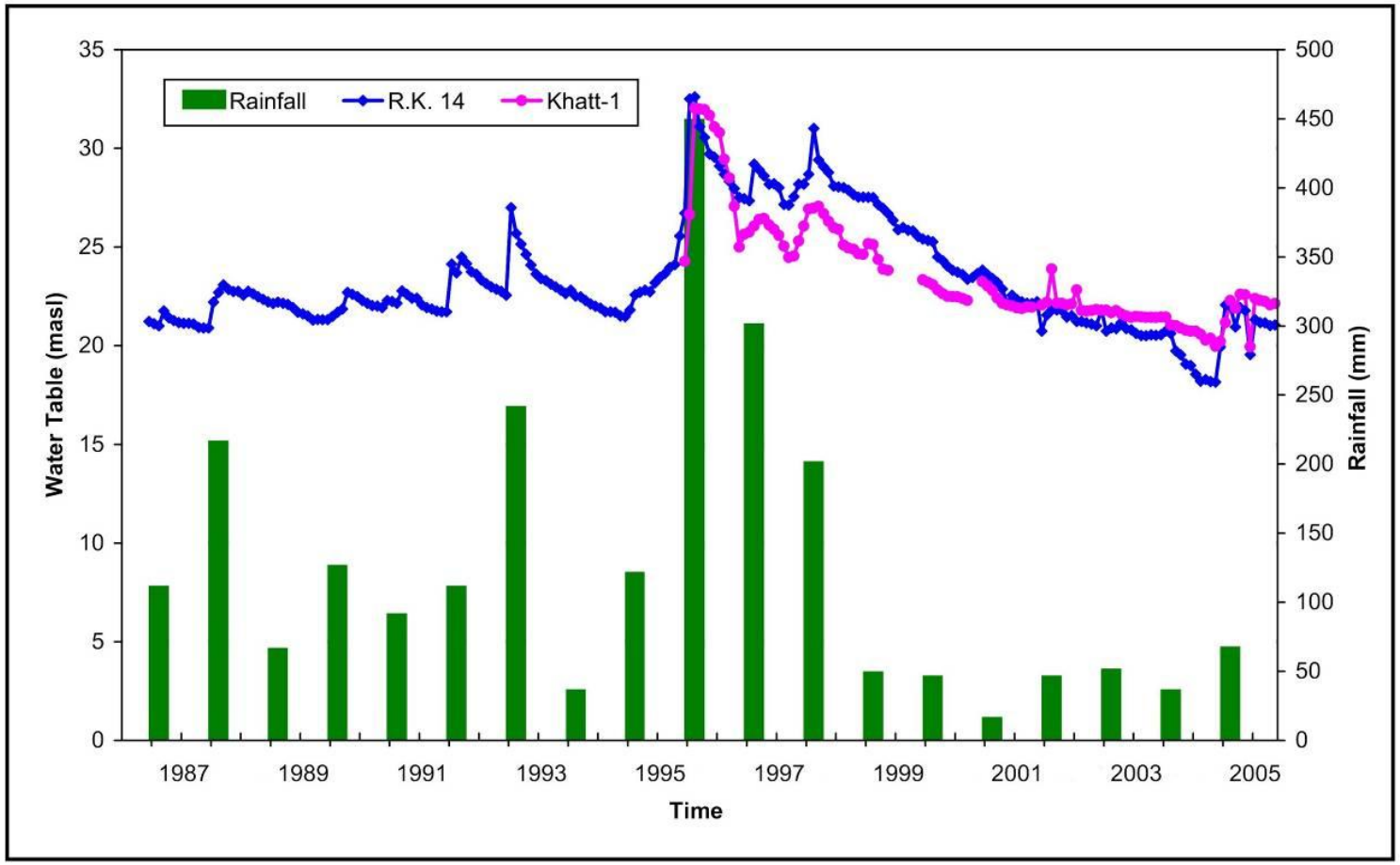
A subsurface geological cross section in the east- west direction

Khatt Springs Project

Hydrogeological map of the study area

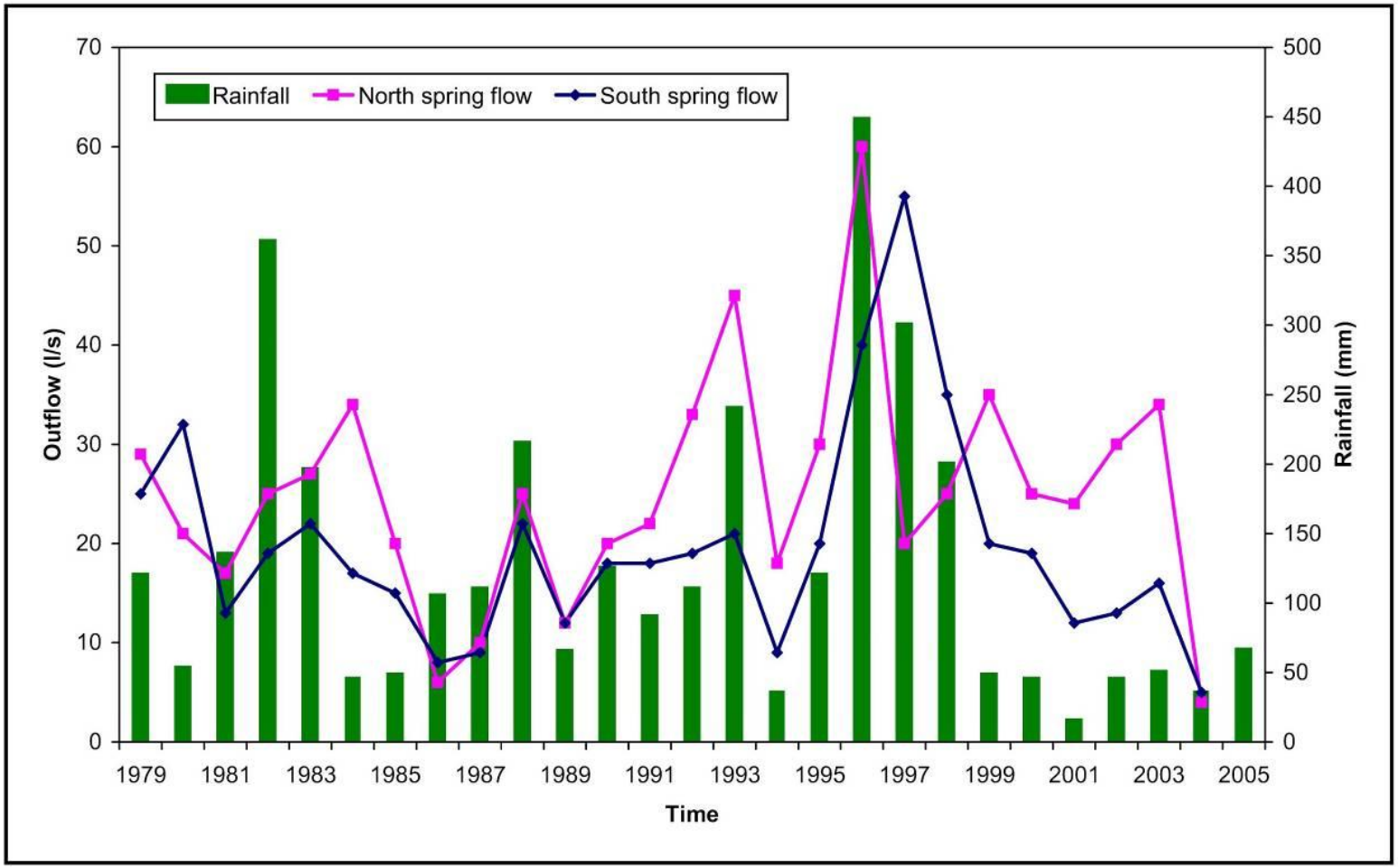


Khatt Springs Project



Water table fluctuations in wells RK-14 and Khatt-1 in response to the amount of annual precipitation. The water table measurements are shown as monthly values

Khatt Springs Project



Annual flow rate variations in the north and southern springs in response to the yearly amount of precipitation.

Development of the Drawdown of the Groundwater Level

Khatt Spring Pilot-Project

Groundwater Level 1969

Legend:

30 Groundwater Level in 1969 amsl in m

Data Source:
Satellite Image by USGS
Groundwater Level Data by IWACO
thematic setting up by A. M. Ebraheem

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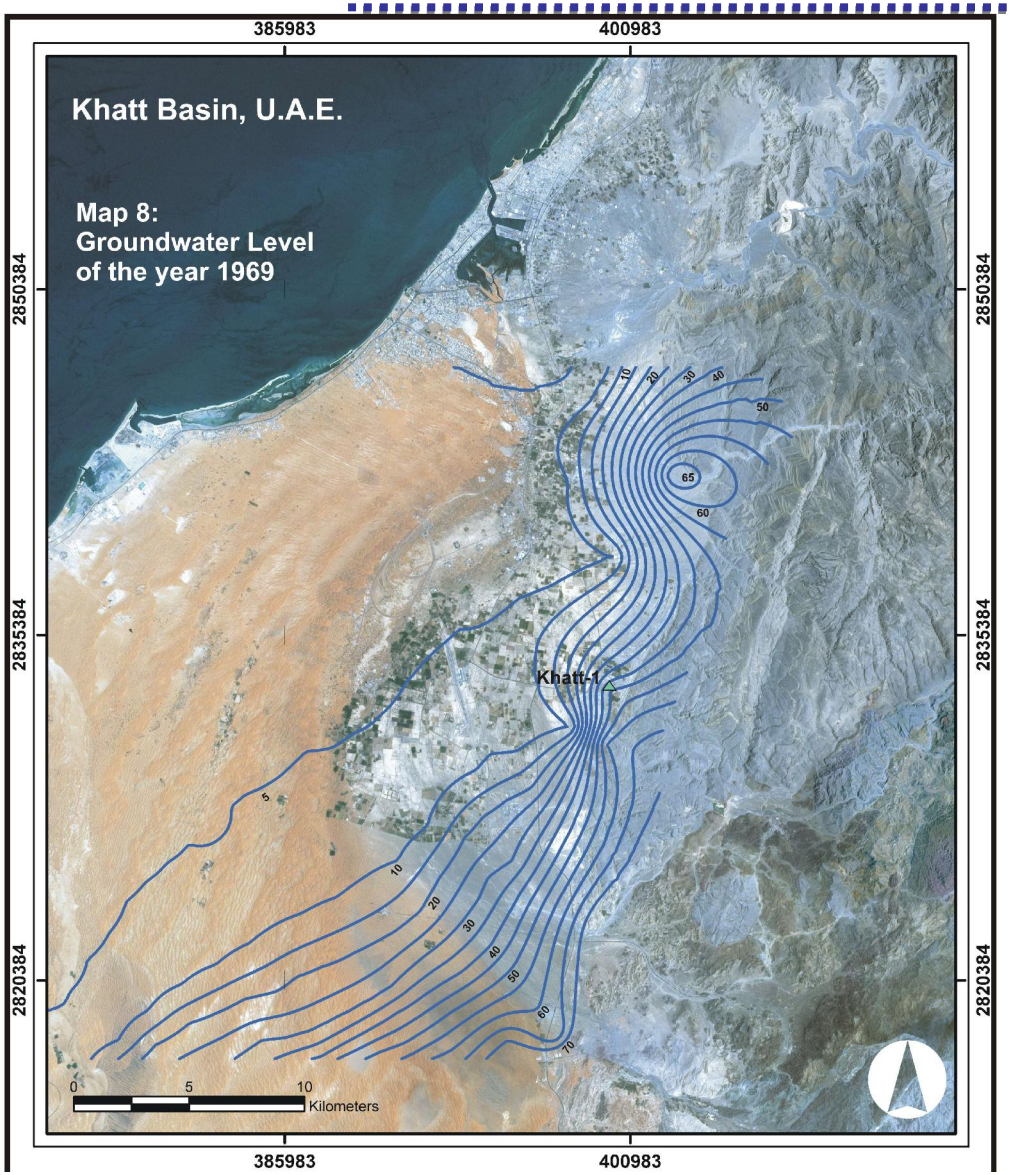
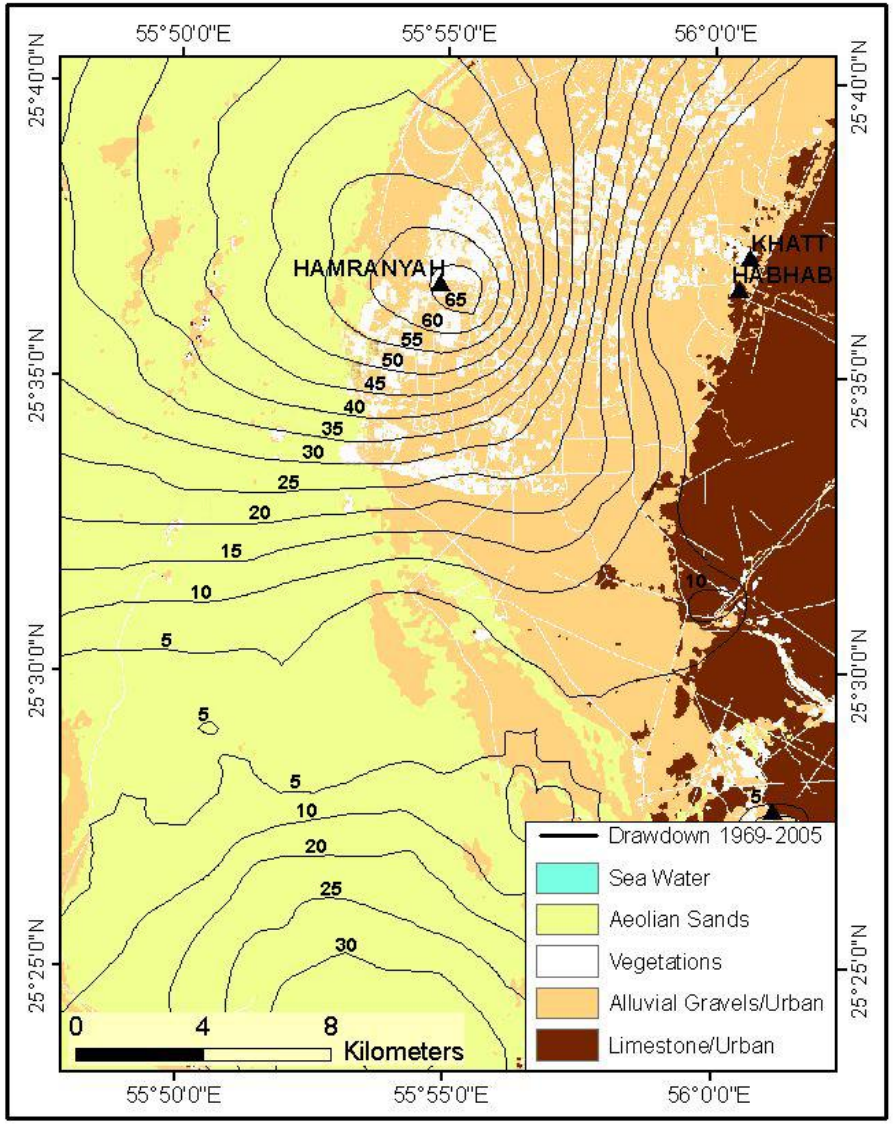


Khatt Springs Project

Drawdown of Groundwater Level from 1969 - 2005

A drawdown of up to 65 meters happened in this period.

Major geomorphologic units and agricultural lands are also shown.



Khatt Spring Pilot-Project

Groundwater Level 2005

Legend:

30 Groundwater Level in 2005 amsl in m

Data Source:
Satellite Image by USGS
Groundwater Level Data by IWACO (2005)
thematic setting up by A. M. Ebraheem

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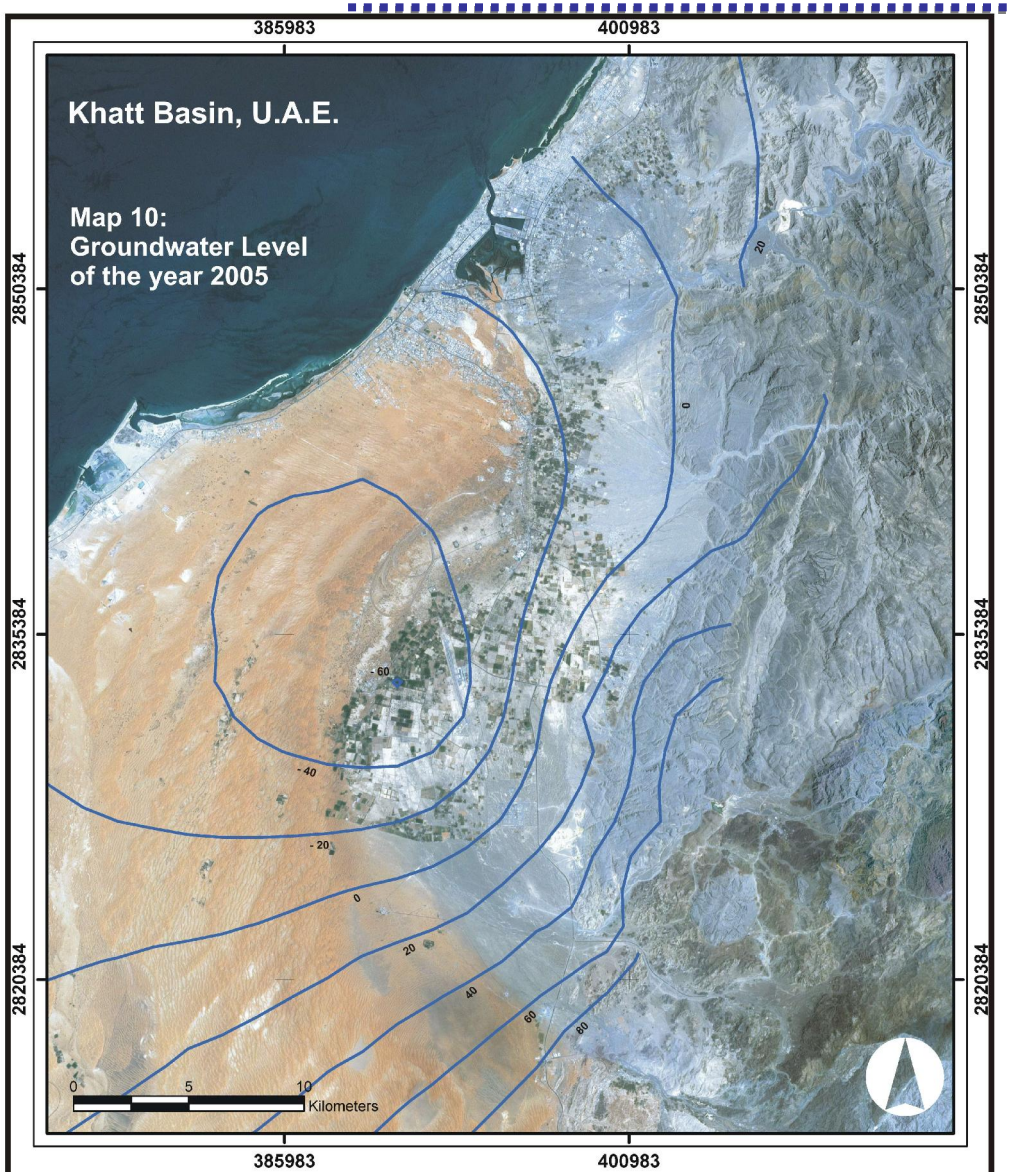
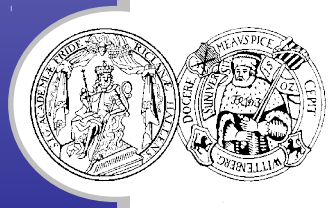


Development of the Groundwater Salinity



Khatt Spring Pilot-Project

Groundwater Salinity 1969

Legend:

1000 2000 Groundwater Salinity of the year 1969 in mg/l

Data Source:
Satellite Image by USGS
Salinity Data by IWACO (2005)
thematic setting up by A. M. Ebraheem

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Groundwater Salinity 1986

Legend:

1000 2000 Groundwater Salinity of the year 1986 in mg/l

Data Source:

Satellite Image by USGS

Salinity Data by IWACO (1986), Groundwater Study (Project 21/81)

thematic setting up by A. M. Ebraheem

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Groundwater Salinity 2005

Legend:

1000 2000 Groundwater Salinity of the year 2005 in mg/l

Data Source:
Satellite Image by USGS
Salinity Data by IWACO (2005)
thematic setting up by A.M. Ebraheem

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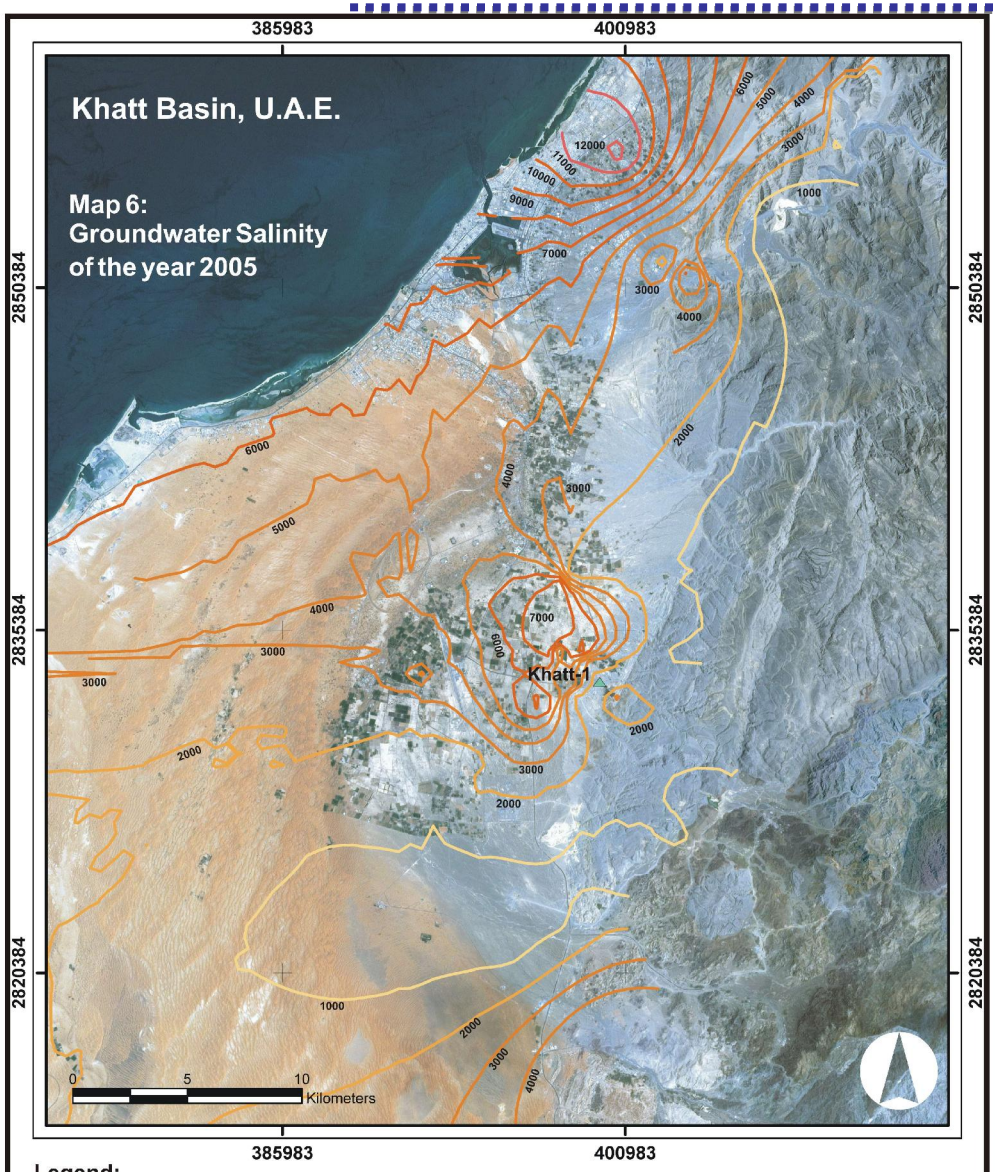

Khatt Spring Pilot-Project

Difference of Groundwater Salinity from 1969 - 2005

Legend:

1000 2000 Difference of the Groundwater Salinity in the period 1969-2005 in mg/l

Data Source:

Satellite Image by USGS

Salinity Data by IWACO (2005) and by Halcrow and Partners (1969)

thematic setting up by A. M. Ebraheem

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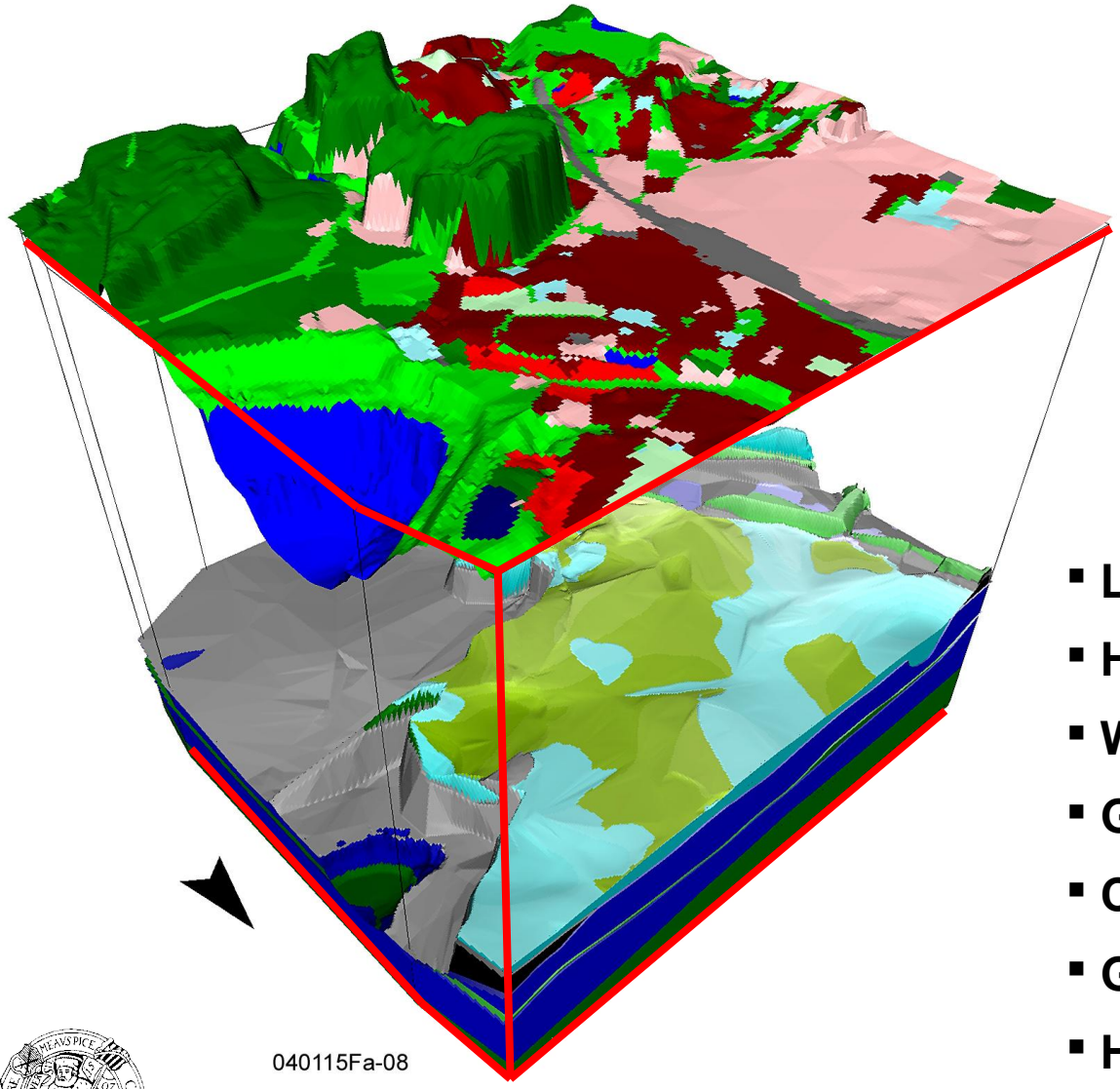
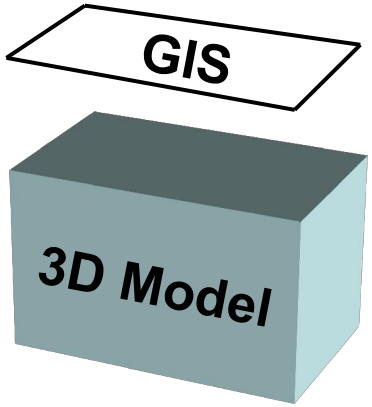
3D Geological Model of the Khatt Basin Area

Khatt Spring Pilot-Project

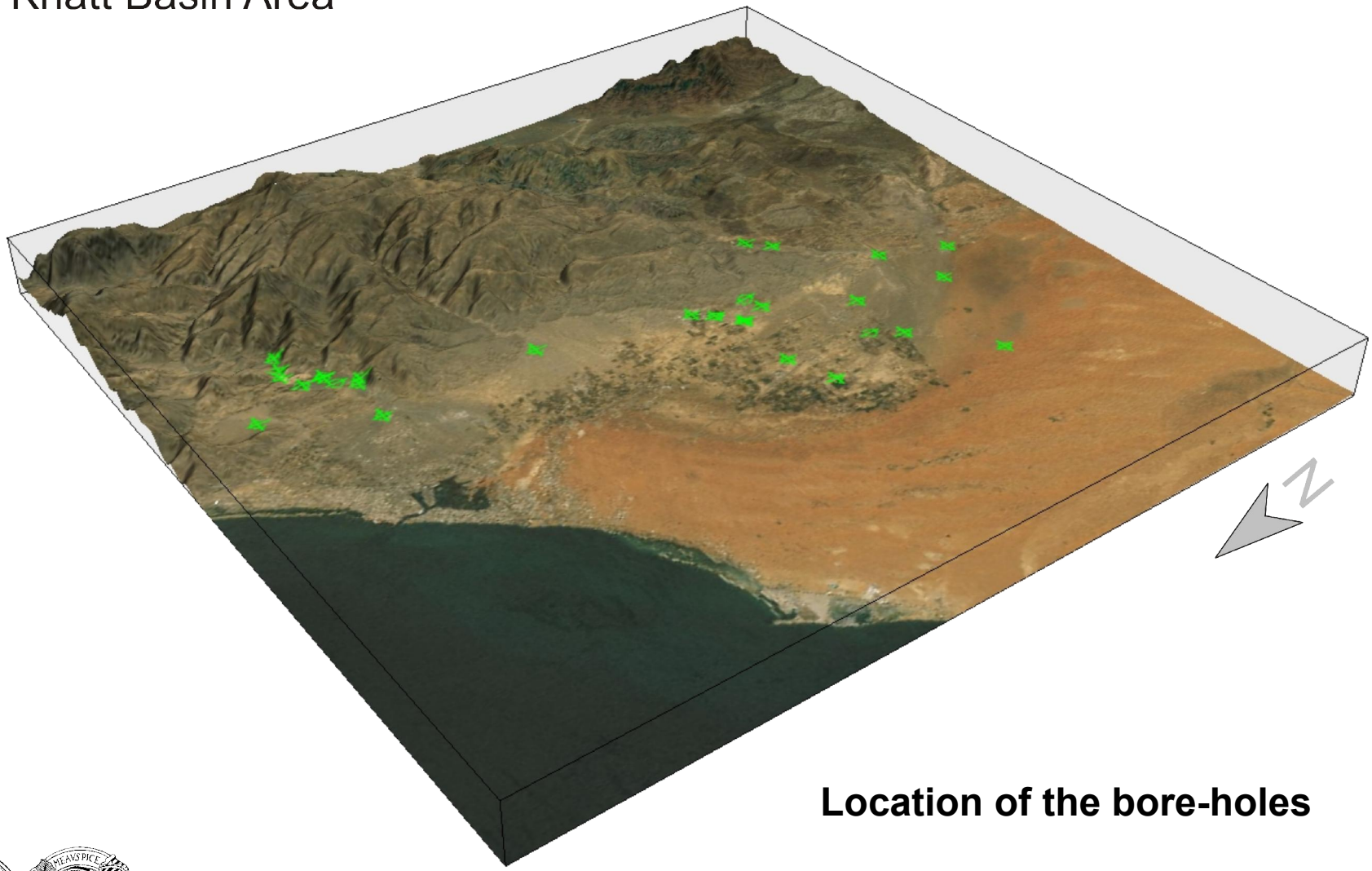




- Land-Use
- Hydrostratigraphy
- Water / Groundwater
- Groundwater Salinity
- Contaminants
- Geology
- Hydrogeologie

Khatt Spring Pilot-Project

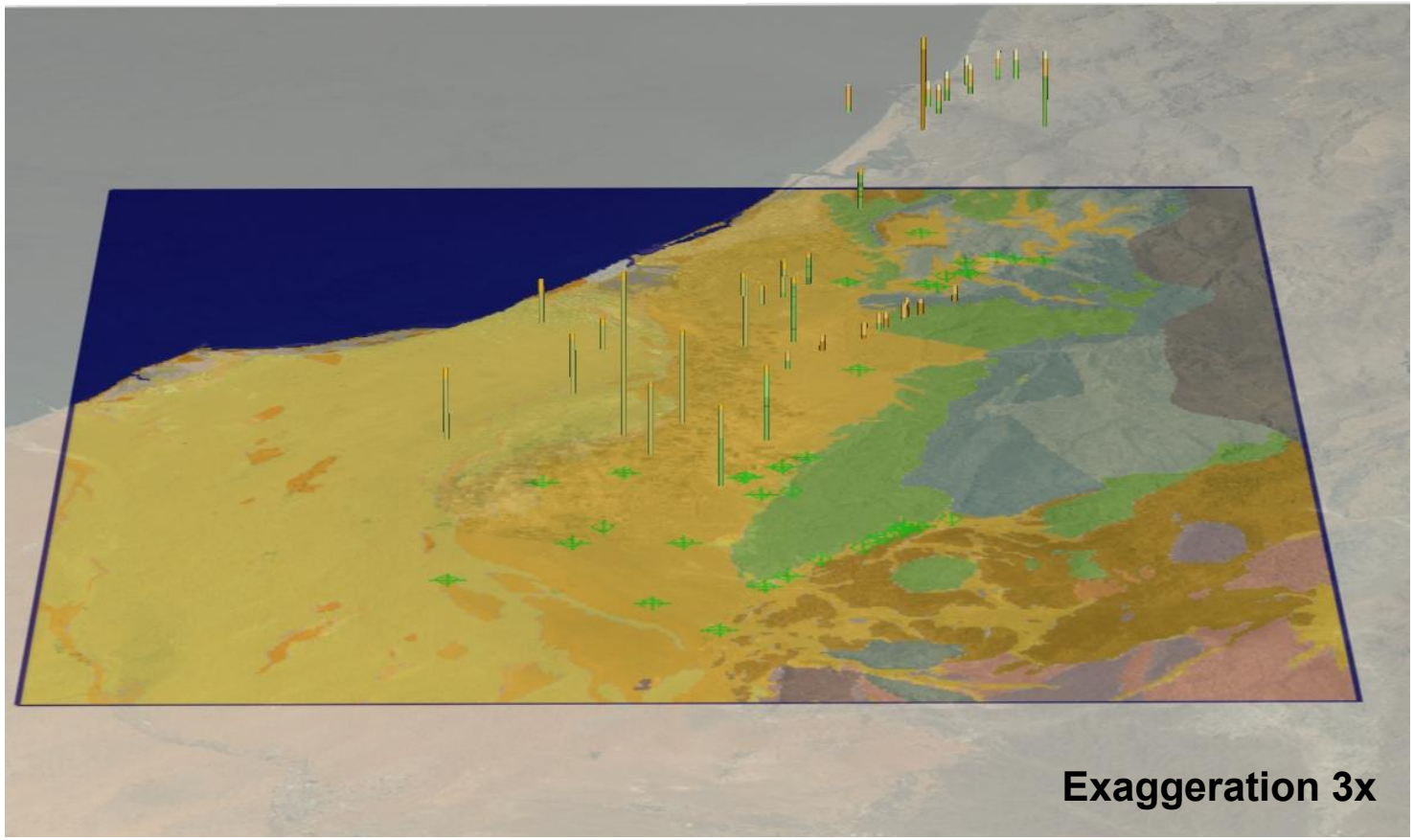
Khatt Basin Area



Location of the bore-holes

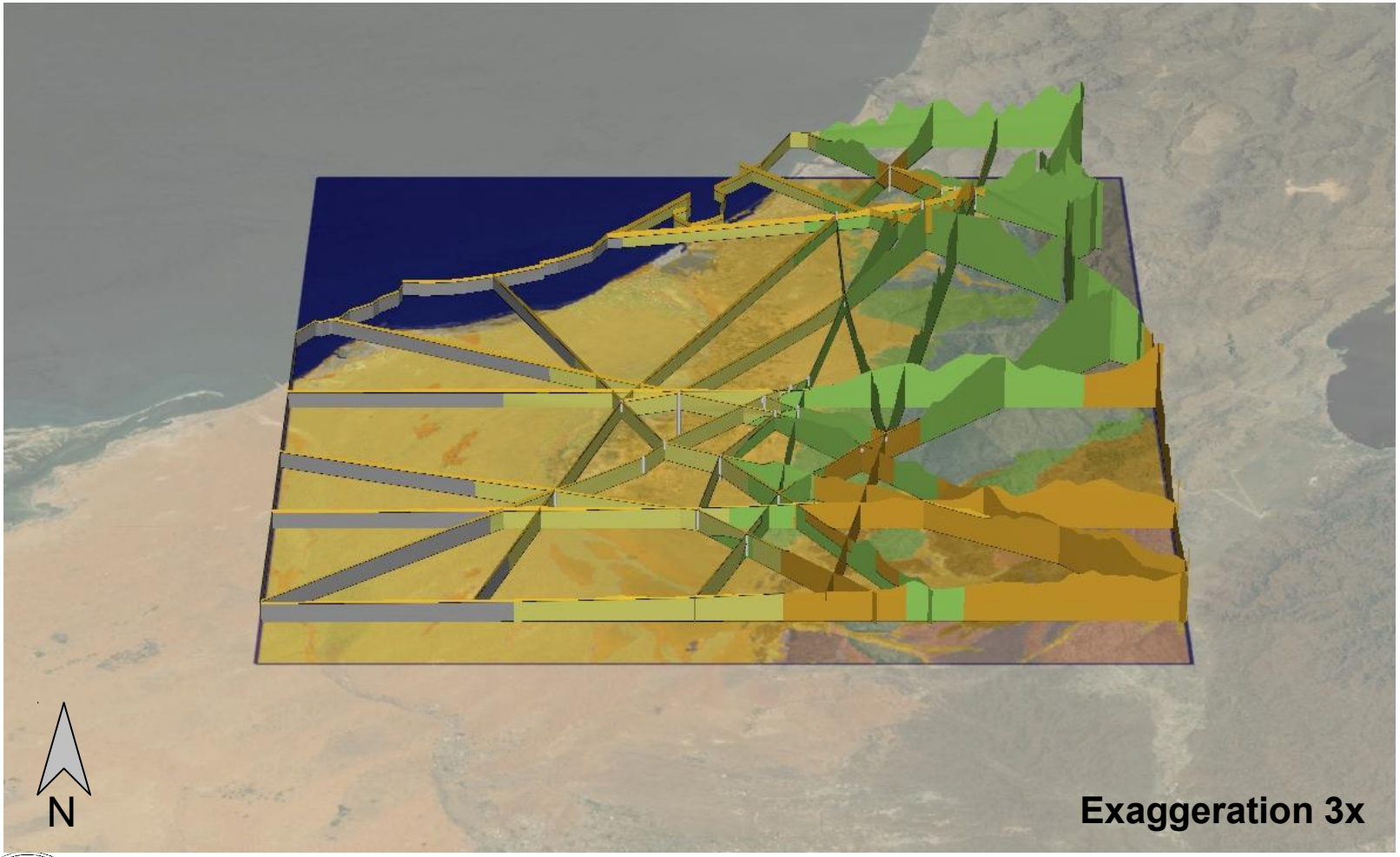
Khatt Spring Pilot-Project

39 used bore-holes overlying the georeferenced satellite image and a transparent geological map



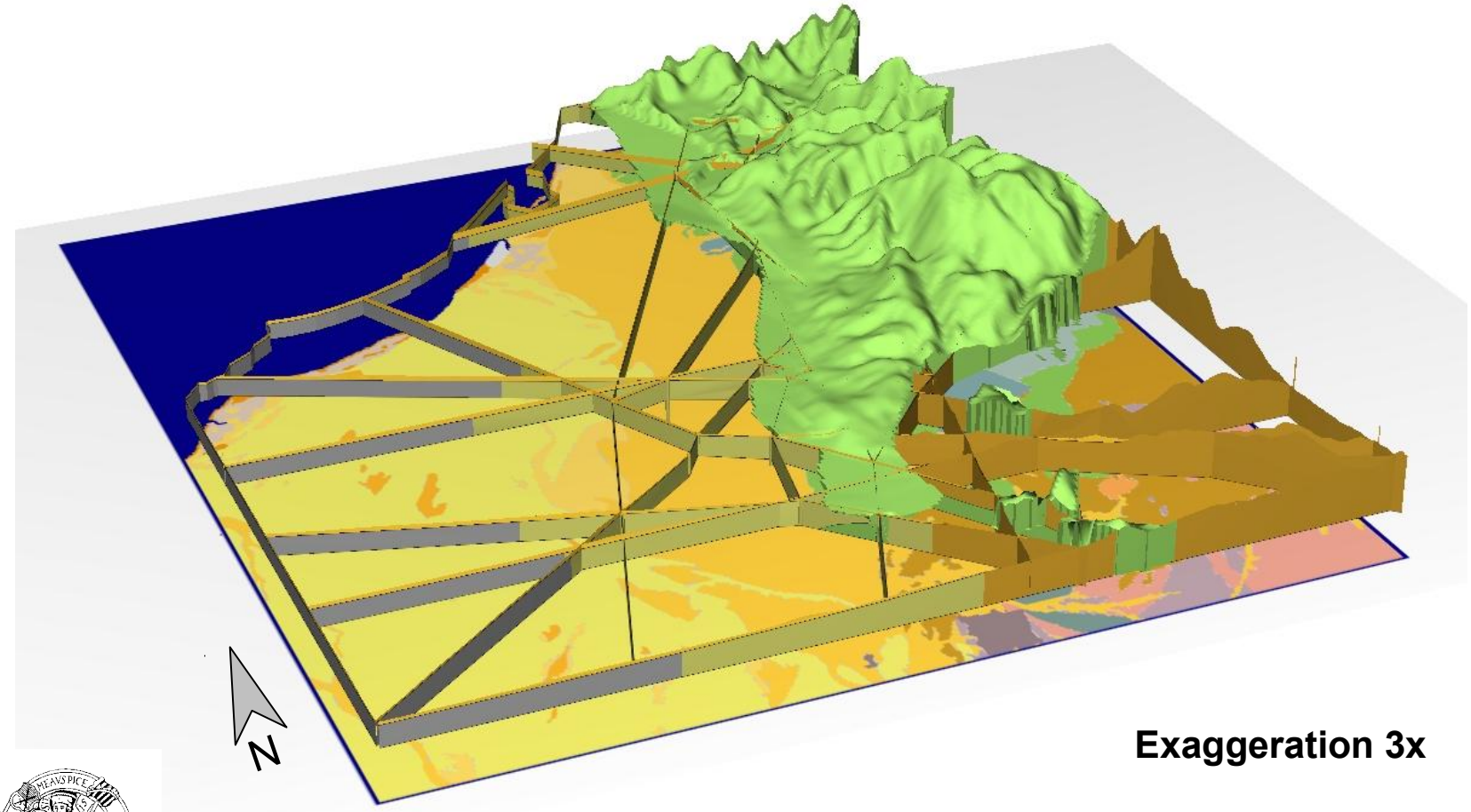
Khatt Spring Pilot-Project

39 constructed cross-sections, satellite image and gelogical map



Khatt Spring Pilot-Project

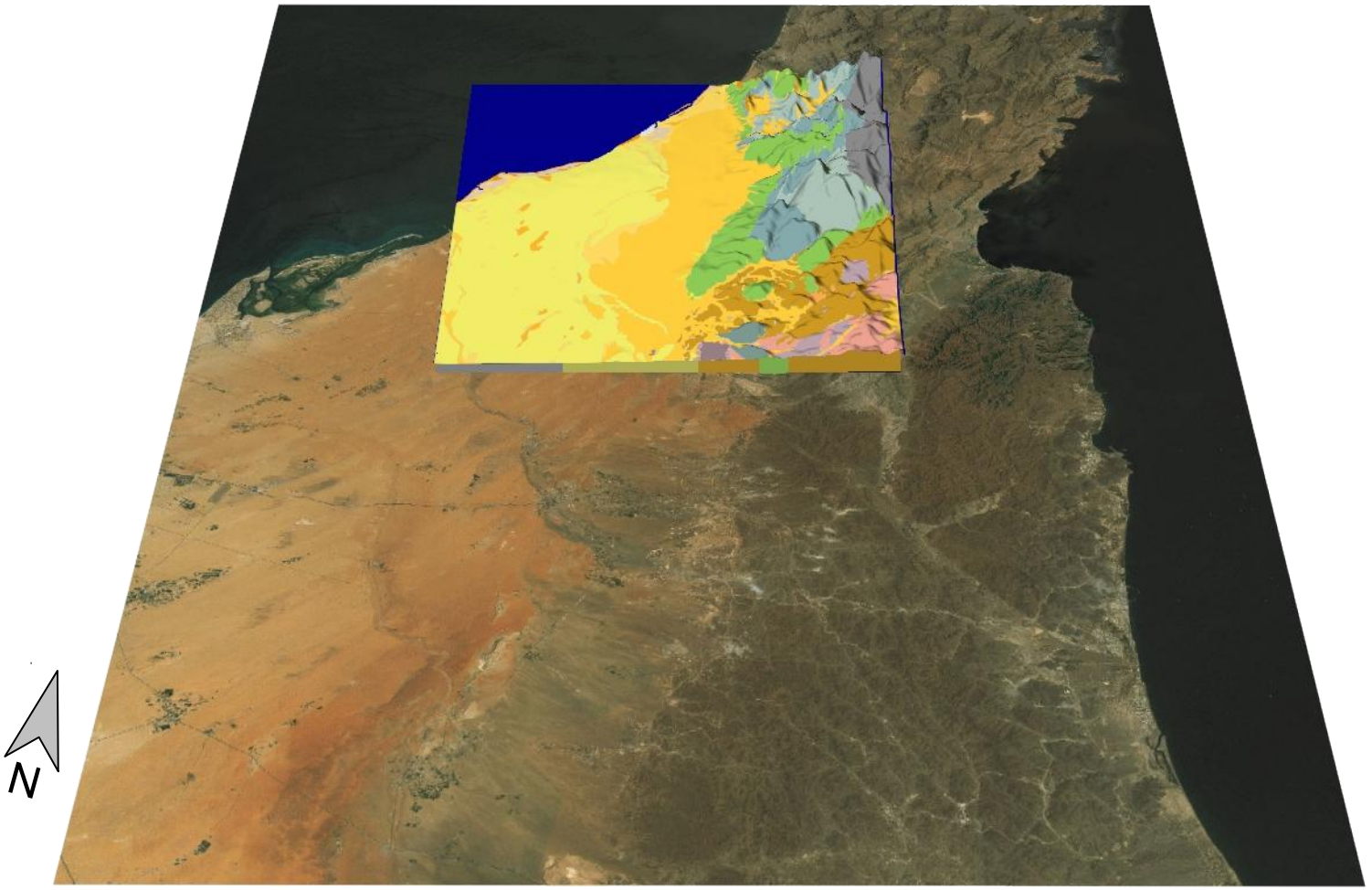
Volume body of the Musandam-Limestone (green) and 39 constructed cross-sections



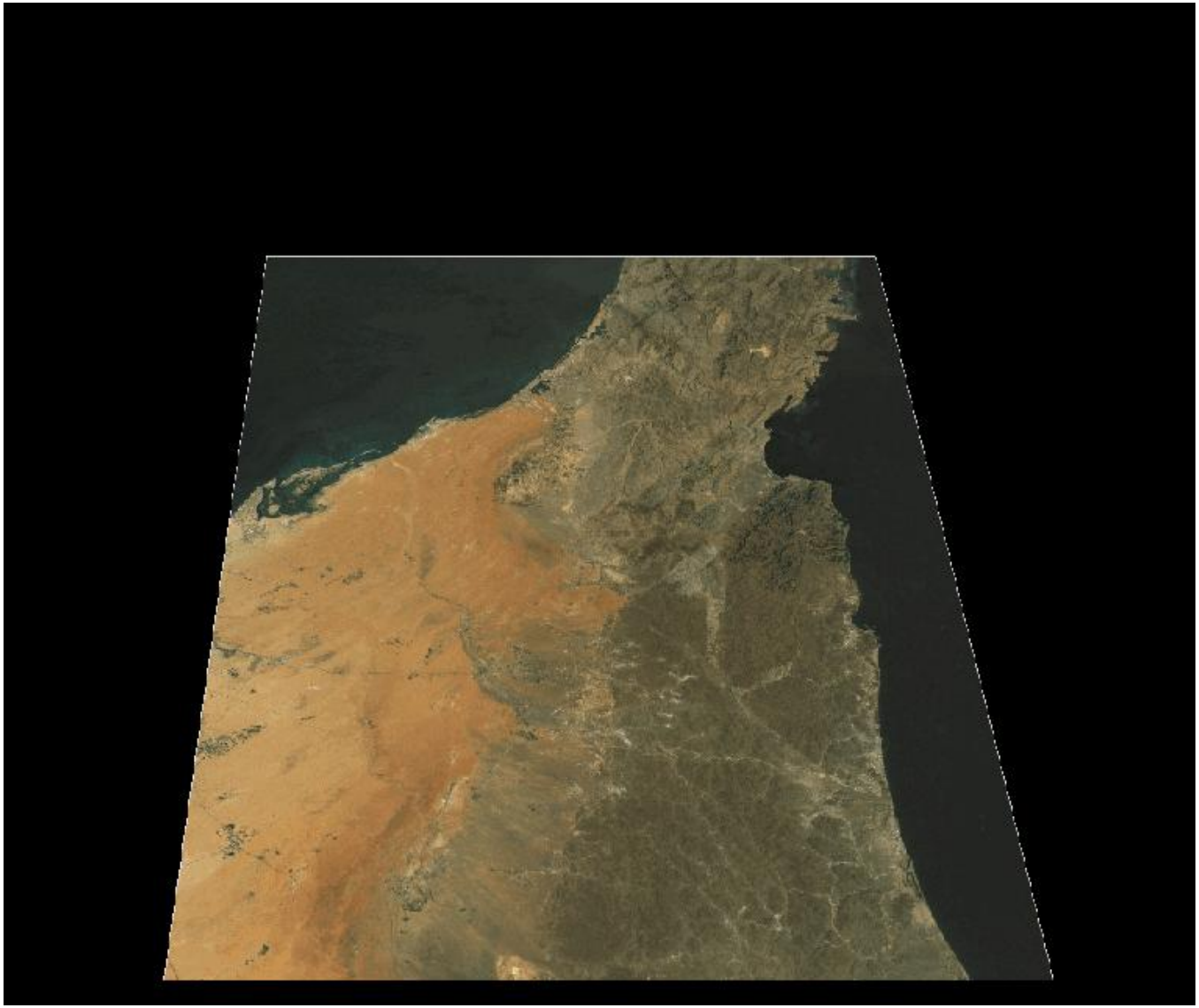
Exaggeration 3x

Khatt Spring Pilot-Project

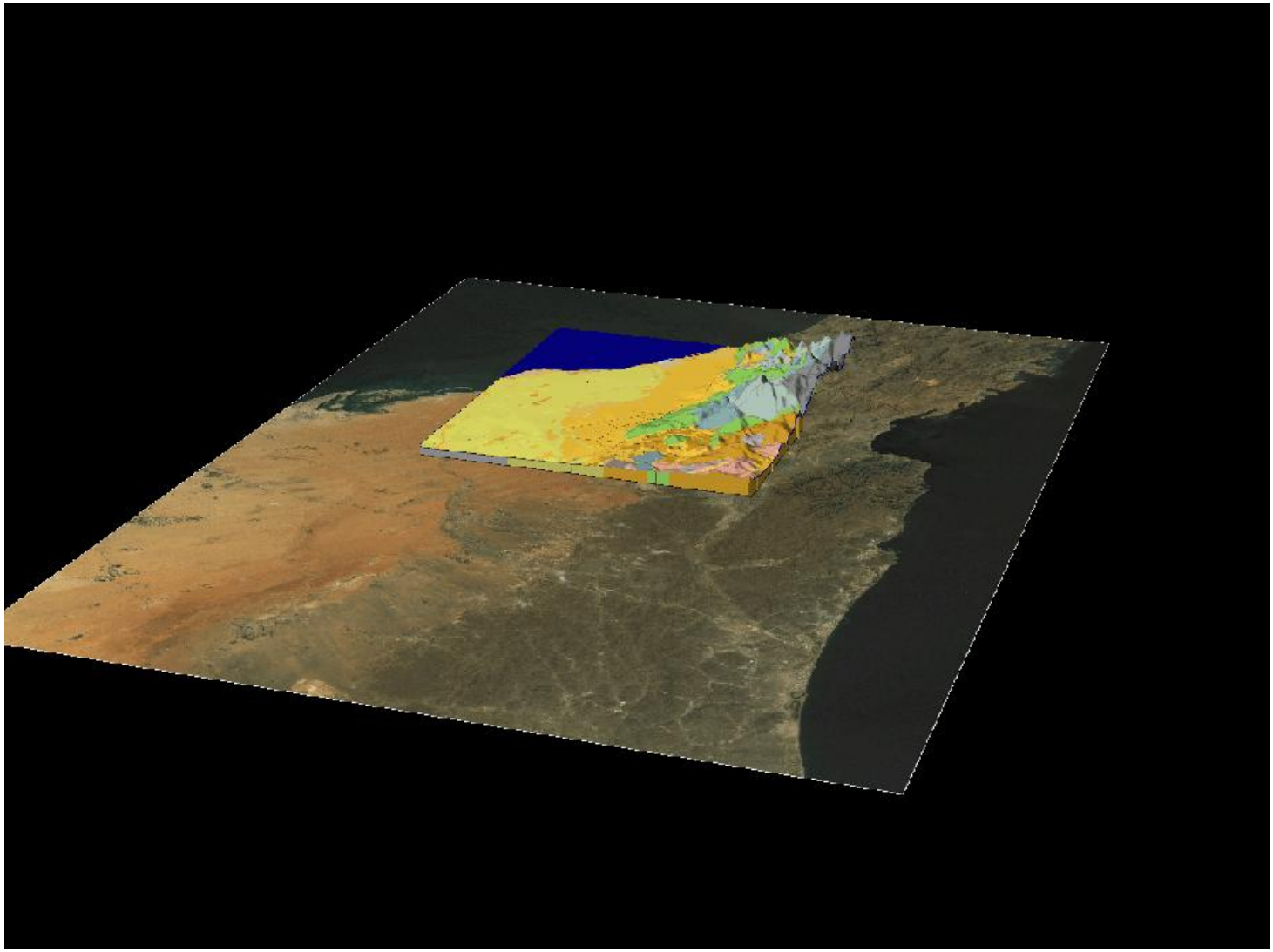
Overview study area (ca. 2000 km^2), geological map linked to the DEM (200 x 200 m)



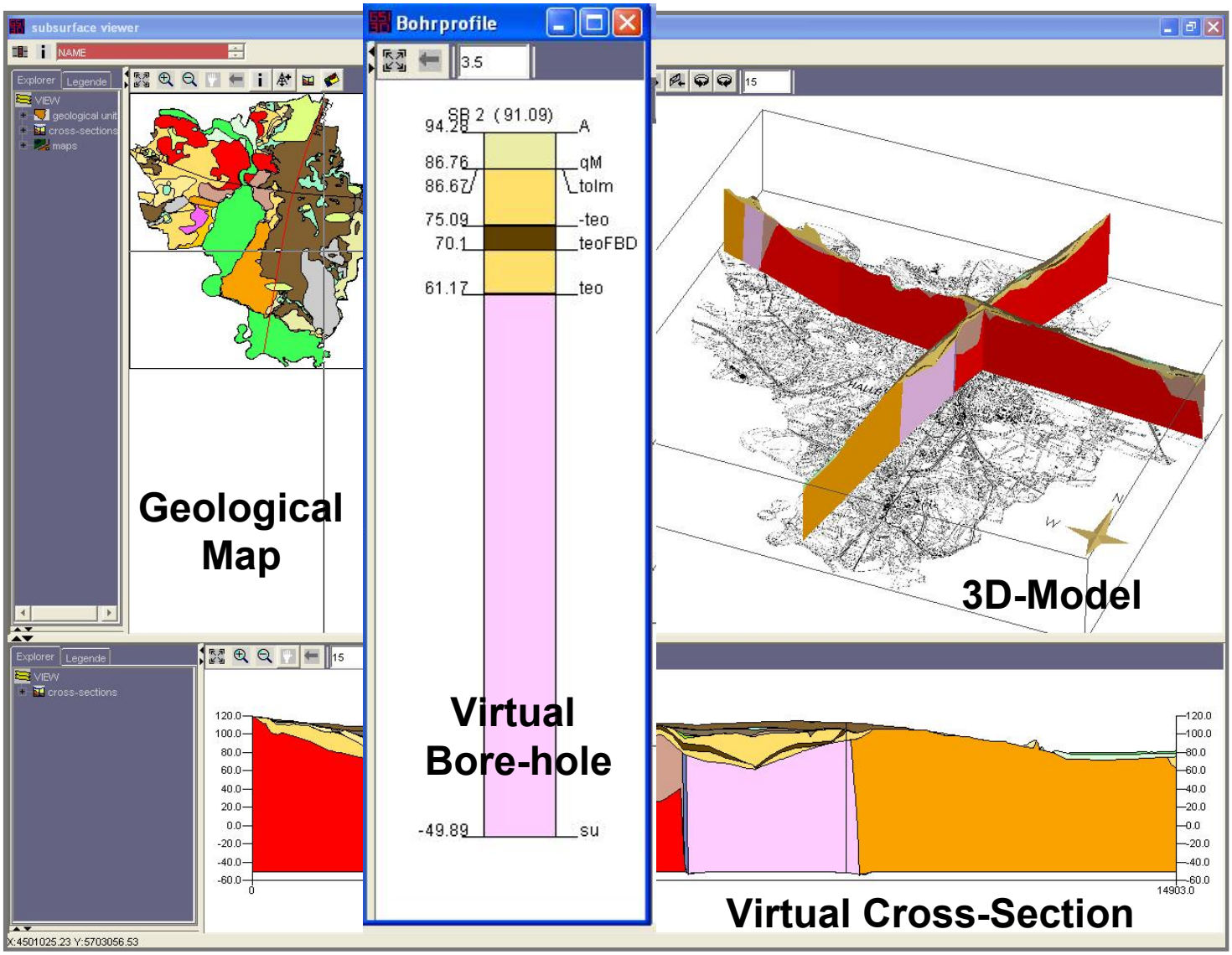
Khatt Spring Pilot-Project (animation)



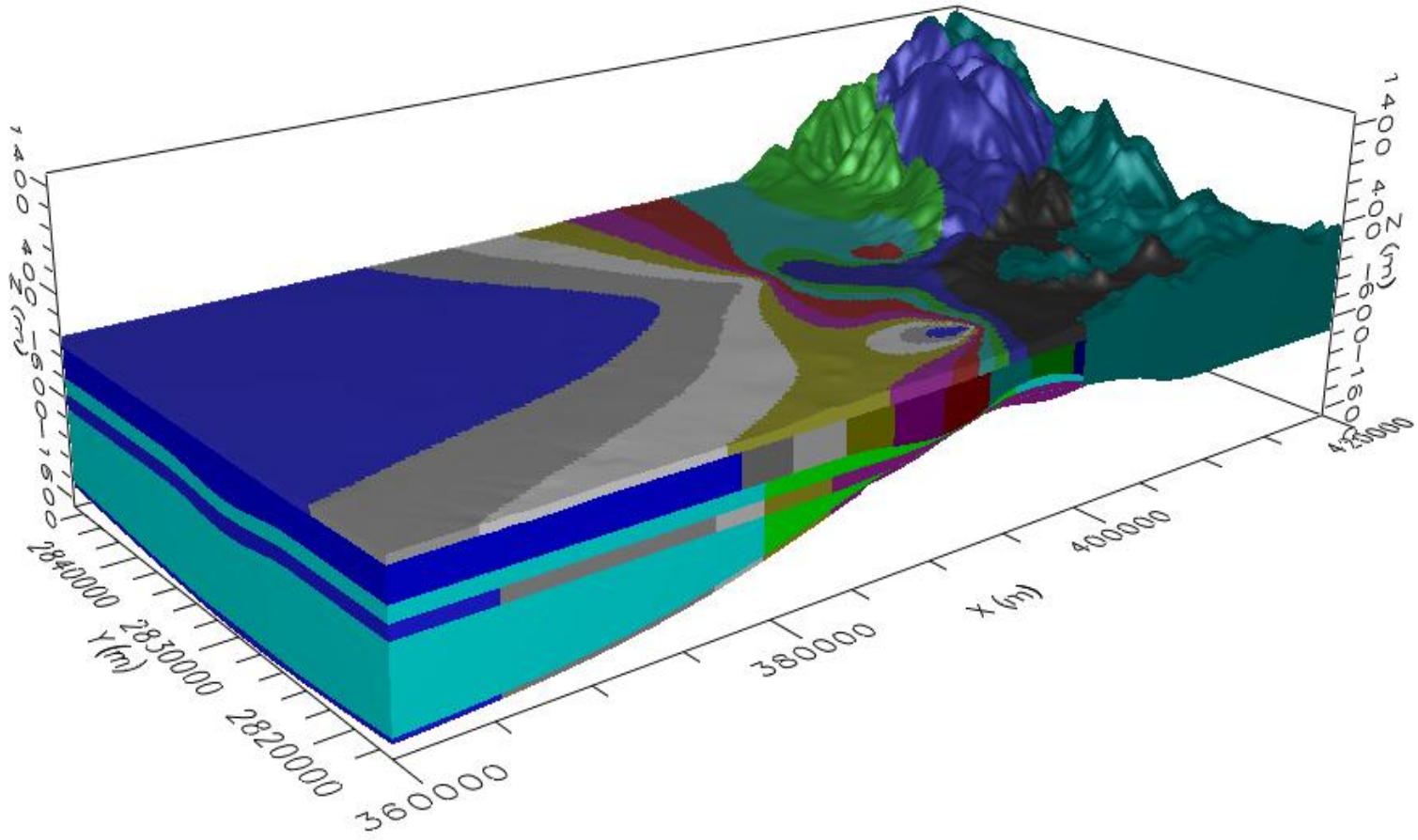
Khatt Spring Pilot-Project (animation)



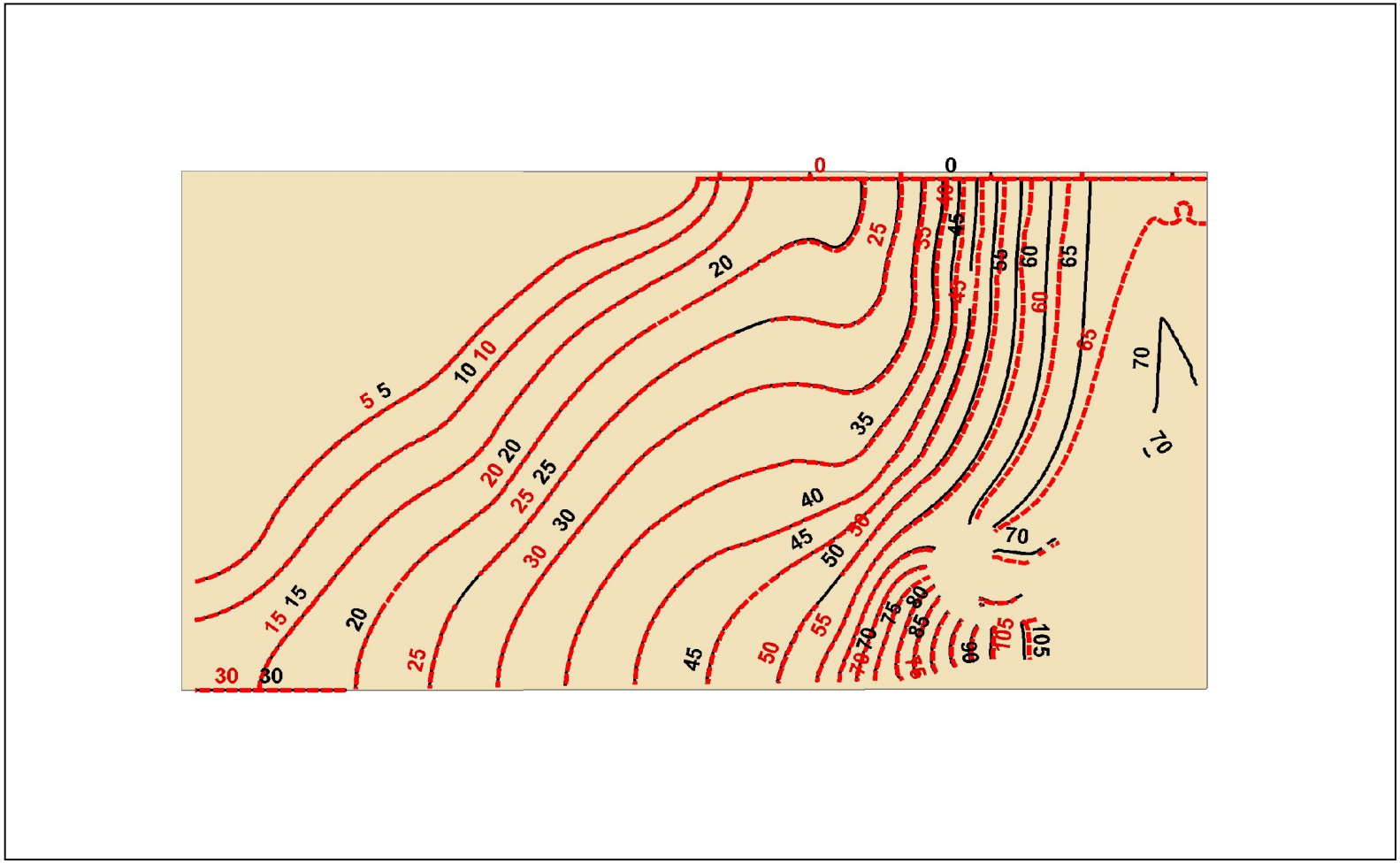
Khatt Spring Pilot-Project



GIS-baed 3D Groundwater flow model for WRM in Khatt Spring Area



GIS-baed 3D Groundwater flow model for WRM in Khatt Spring Area



GIS-baed 3D Groundwater flow model for WRM in Khatt Spring Area

Conclusions & Recommendations

- GIS tools were used to build a complete data base in khatt spring area. This data base has been very useful for building the first 3D geolpogical model for an area of about 2000 km2 .

- The developed 3D geological model of Khatt Springs area allows different types of visualization, calculation and predictions as well as the subsequent operation within hydraulic models. It also minimized the need for statistical or geostatistical interpolation between stratified scattered boreholes which in most cases give inadequate results.

- The time scale of groundwater recharge was correctly implemented in the groundwater flow model and the simulation results showed the necessity of a transient model approach.

- The simulation results of the GWF model indicated that it could be possible to rehabilitate the Quaternary Aquifer in this area and stop salt water intrusion in this area IF the socio economical impact can be tackled in the first 15 years.

Khatt Springs Project