

APPLICATION OF 2D EARTH RESISTIVITY IMAGING TOMOGRAPHY AND GIS FOR THE SUSTAINABLE MANAGEMENT OF WATER RESOURCES IN NORTHERN EMIRATES

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Introduction

- ❖ The availability of water in the right quantities and quality as well as the proper management of this precious resource are essential for the sustainable social and economical development.
- ❖ Successful Management of WR depends largely upon:
 1. the precise knowledge of the available WR
 2. the capability of predicting the impact of a certain management option







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Challenges of the Sustainable Management of Water Resources in the Arid Regions

- ❖ Unavailability of complete, well- documented spatially and temporarily varied environmental data 
- ❖ Need for integrated Water resources management with EIA for each engineering project 
- ❖ Scarcity of fresh water resources in the Middle East Area 
- ❖ **Groundwater Depletion:** The ever increasing demand for water has increased groundwater exploitation rates from non-replenished and replenished aquifers causing severe groundwater depletion and saltwater intrusion problems 



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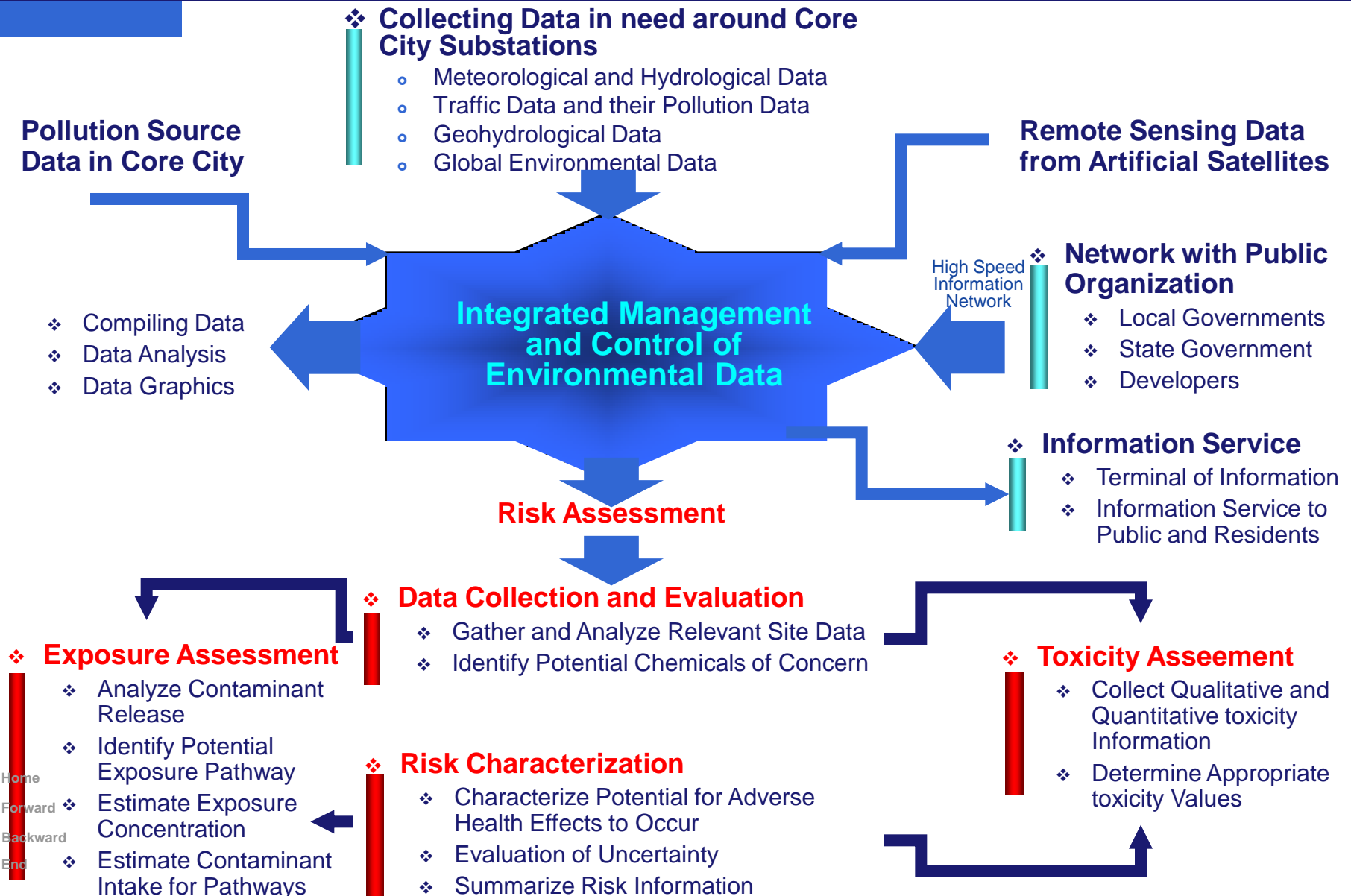
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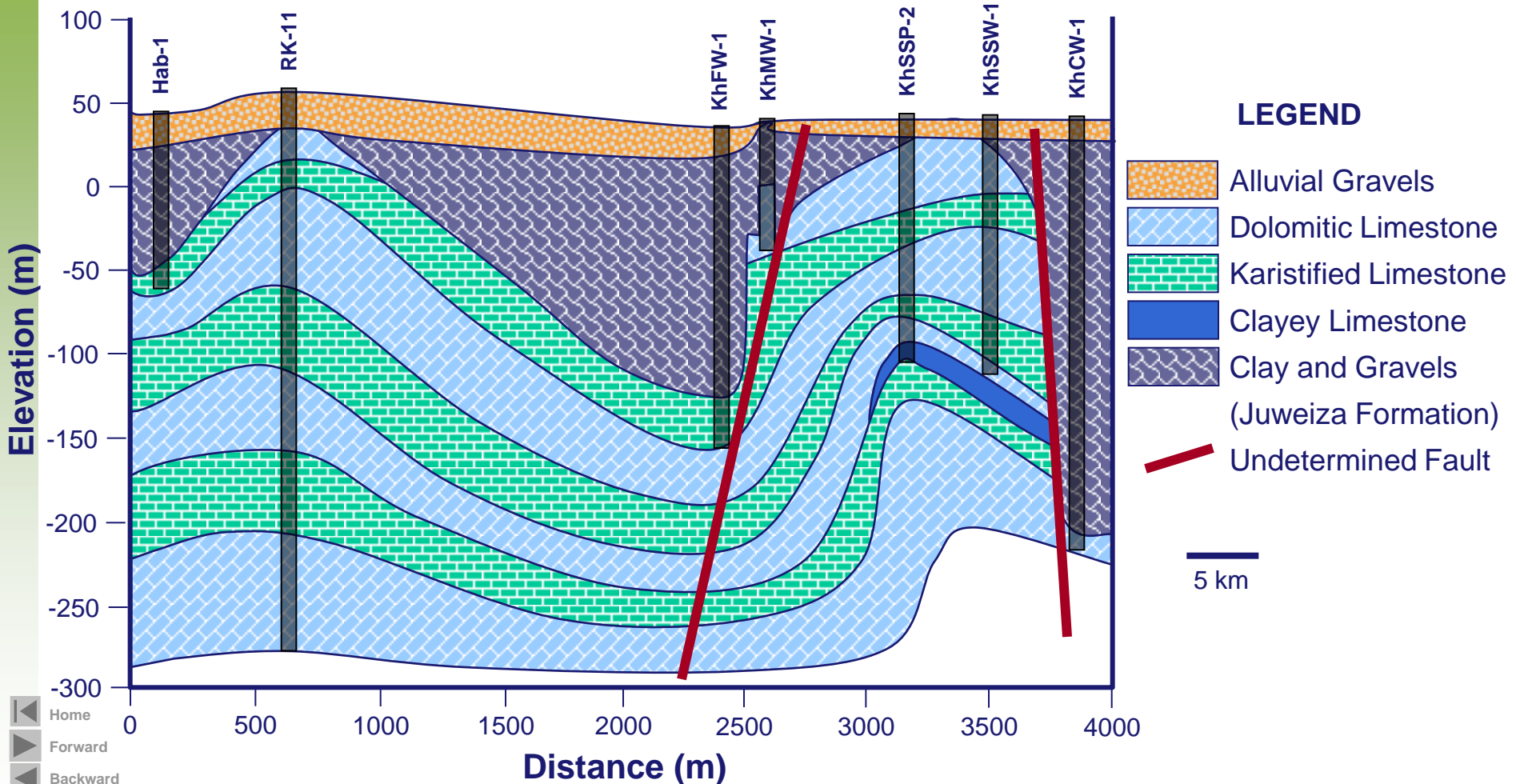
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Good Monitoring and Management of Environmental Data

(modified after Sato and Hirayama, 1995)

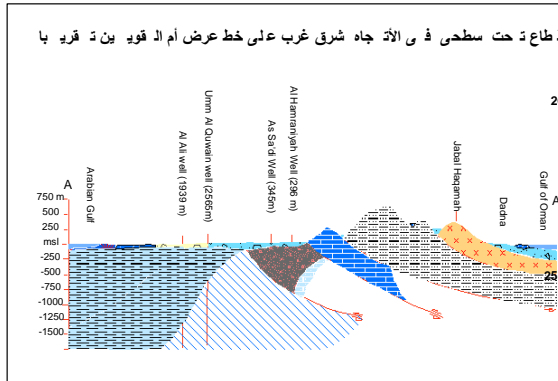


Building and updating database of environmental data using GIS and Hydrogeoanalyst Software



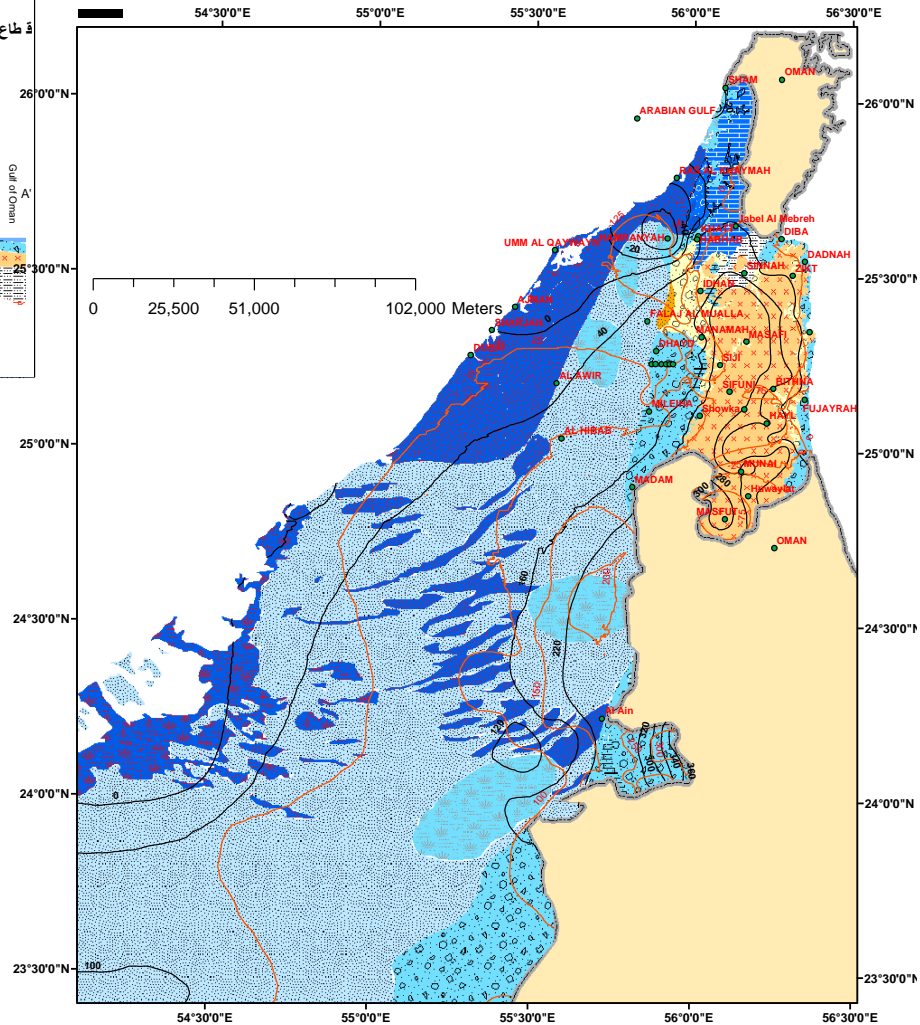
Digital Hydrogeological Map of UAE

(after Al Suwaidi, Ebraheem and Al Mehrizi, 2005)

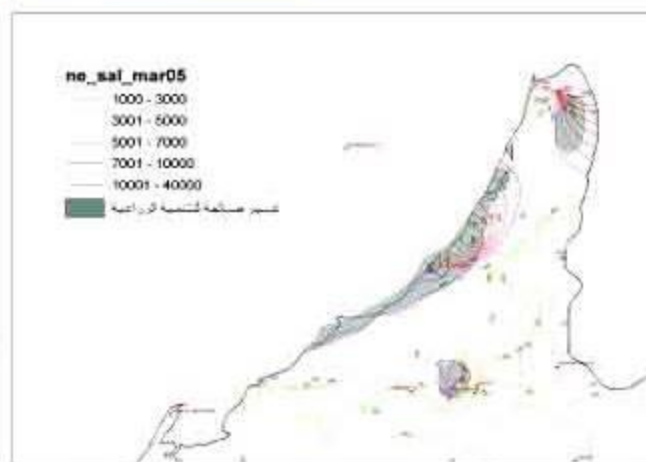
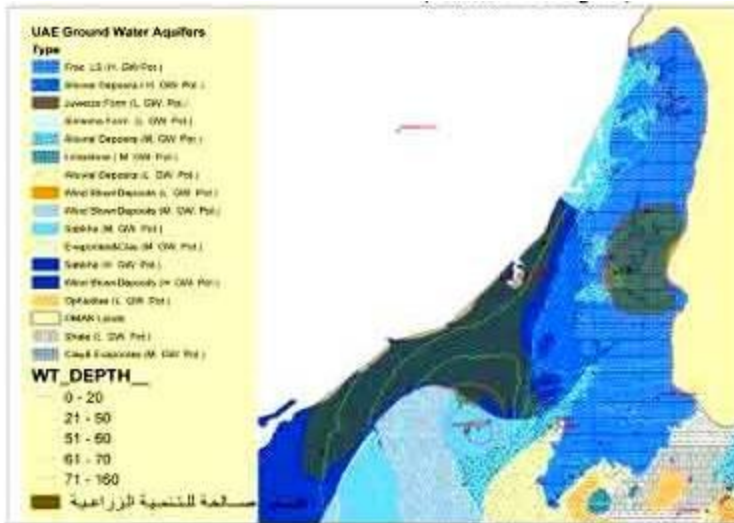


UAE Ground Water Aquifers Type

- Frac. LS (H. GW. Pot.)
- Alluvial Deposits (H. GW. Pot.)
- Juweiza Form (L. GW. Pot.)
- Simsima Form (L. GW. Pot.)
- Alluvial Deposits (M. GW. Pot.)
- Limestone (M. GW. Pot.)
- Alluvial Deposits (L. GW. Pot.)
- Wind Blown Deposits (L. GW. Pot.)
- Wind Blown Deposits (M. GW. Pot.)
- Sabkha (M. GW. Pot.)
- Evaporites & Clay (M. GW. Pot.)
- Sabkha (H. GW. Pot.)
- Wind Blown Deposits (H. GW. Pot.)
- Ophiolites (L. GW. Pot.)
- OMAN Lands
- Shale (L. GW. Pot.)
- Clay & Evaporites (M. GW. Pot.)
- wt_level_jan05
- uae_shaq_base_elv

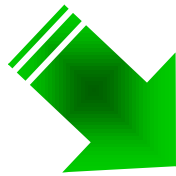


Application of GIS for RAK Land Use Development Plan Evaluation



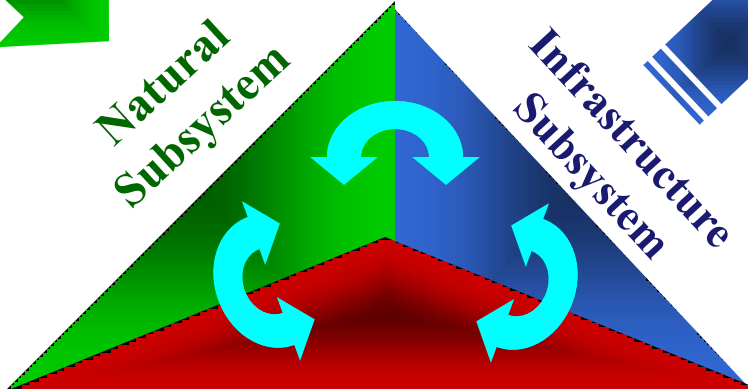
Water Resources System

Input
Energy
Capital
Labour
etc



**Natural
Subsystem**

**Infrastructure
Subsystem**



Product Output
Irrigation Water
Drinking Water
Industrial Water
Hydropower Output
Water for

**Scenario
Condition**
Natural
Social
Economic
Political



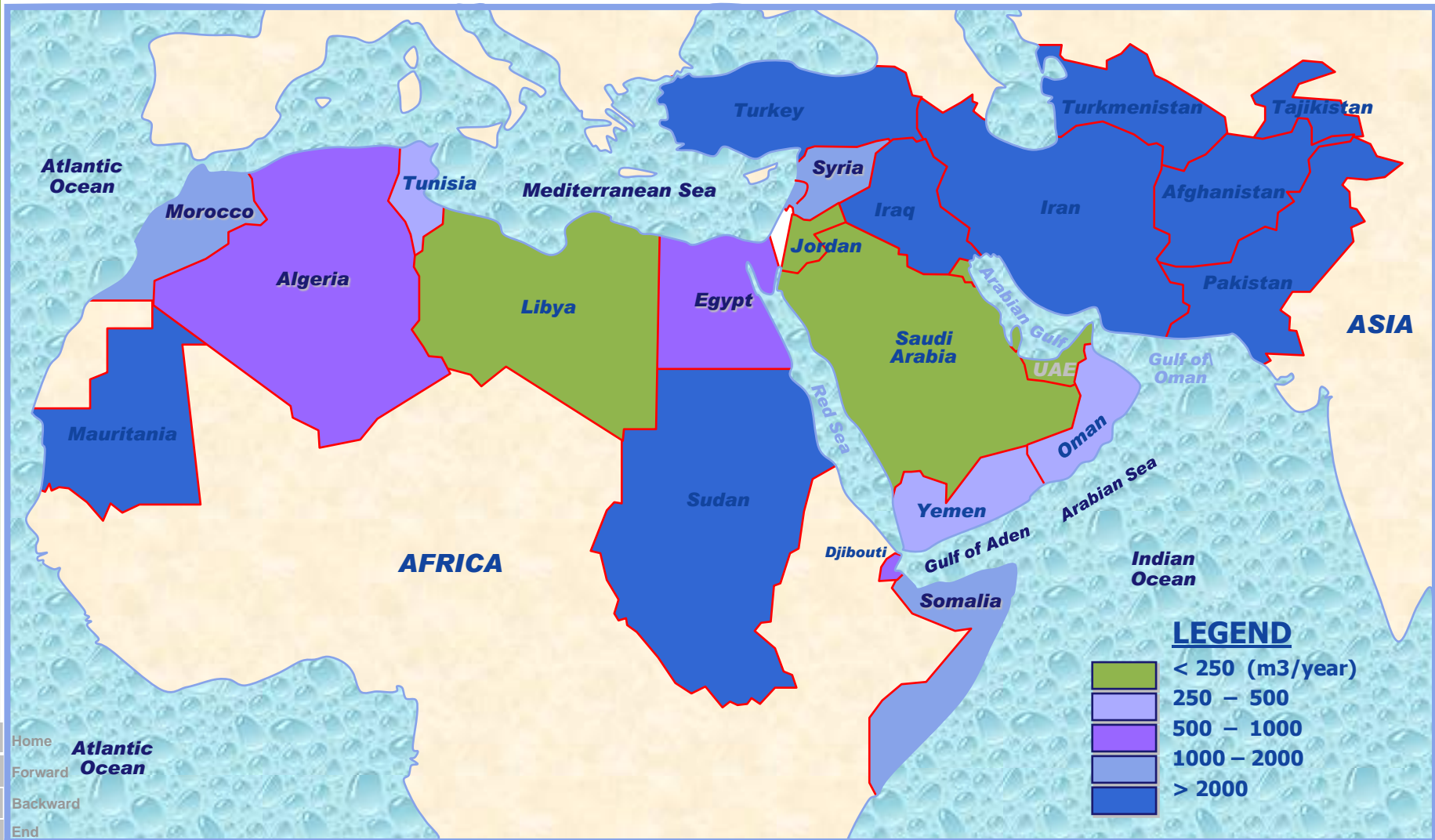
**Institutional
subsystem**



Non-Product Output
Sediments
Flooding
Ecosystem Damage
Environmental Impacts



Annual Actual Renewable Water Resources per inhabitant (2005)



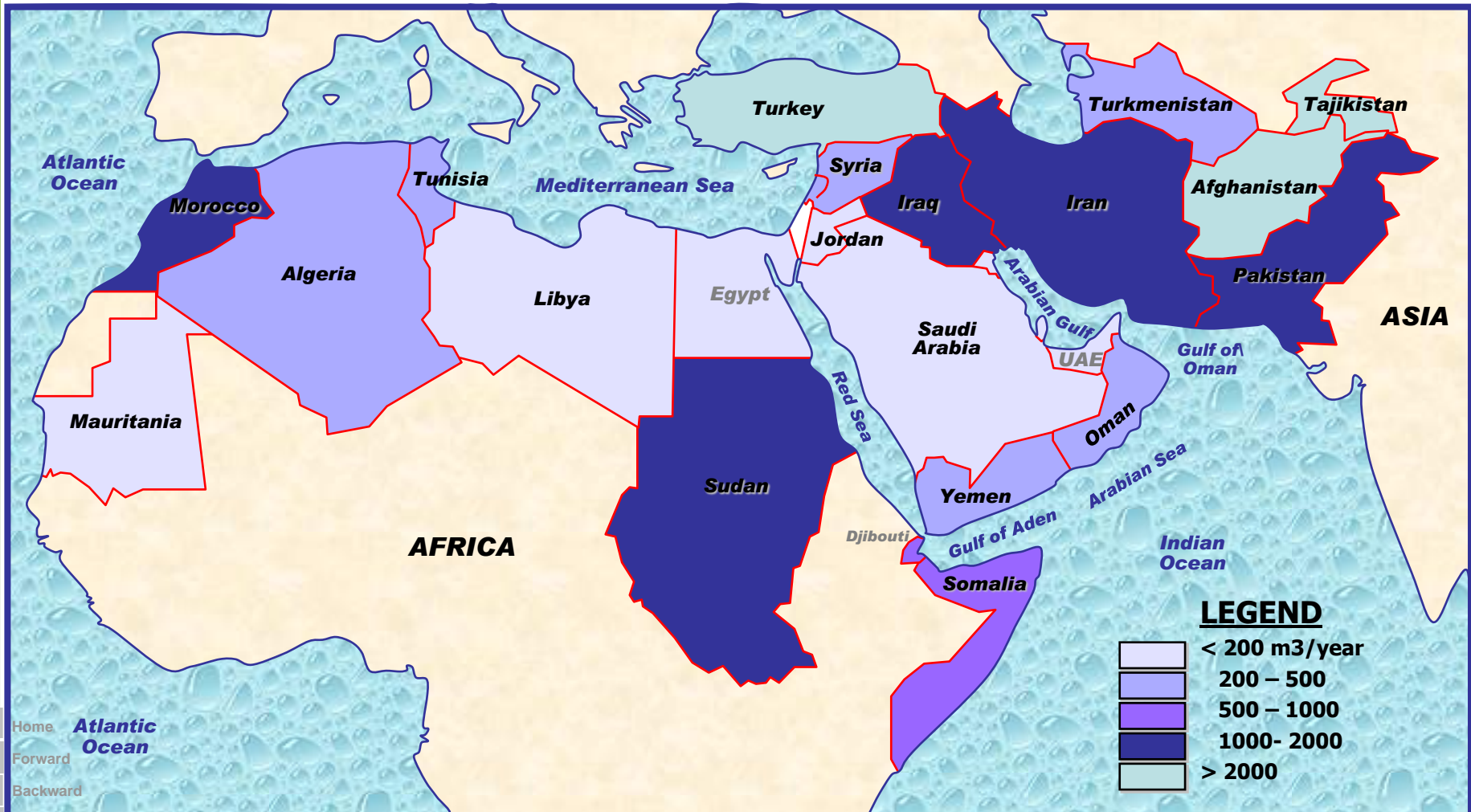
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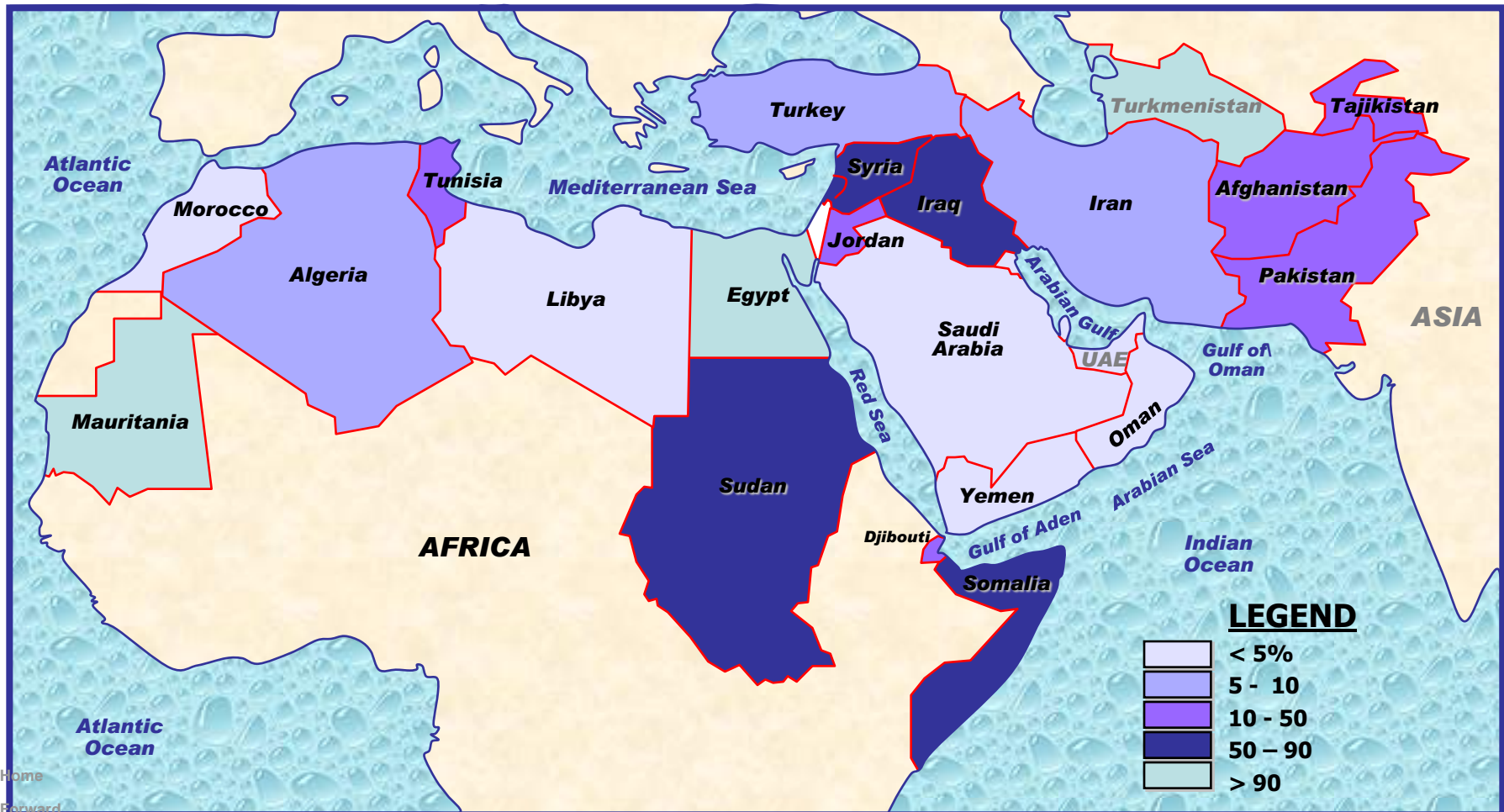
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Annual Internal Renewable Water Resources per inhabitant (2005)



Renewable Water Resources Dependency Ratio



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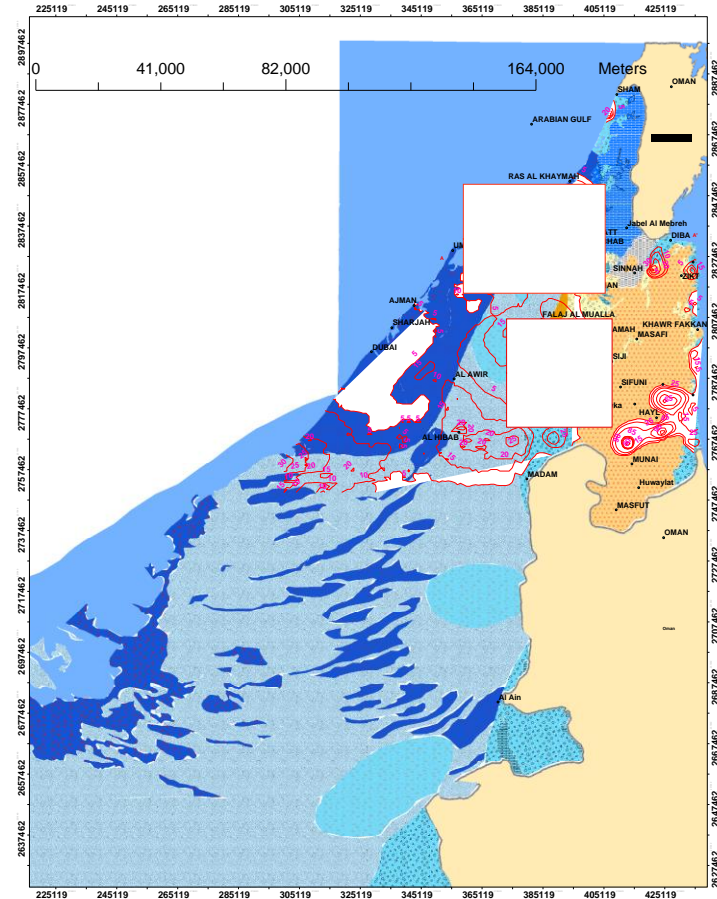
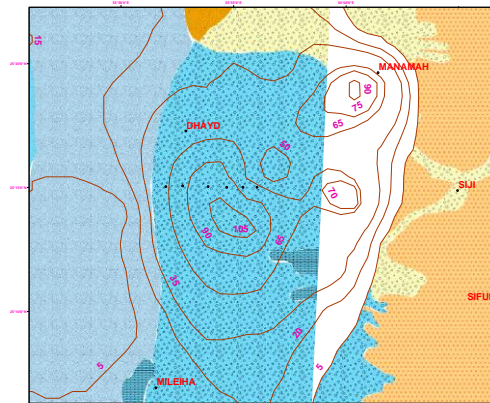
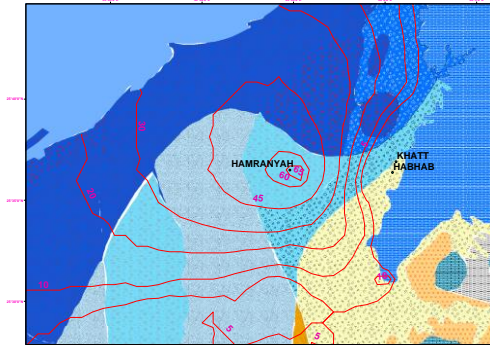
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Groundwater Depletion in the Quaternary Aquifer of the Northern Emirates

Drawdown in the period 1969-2005



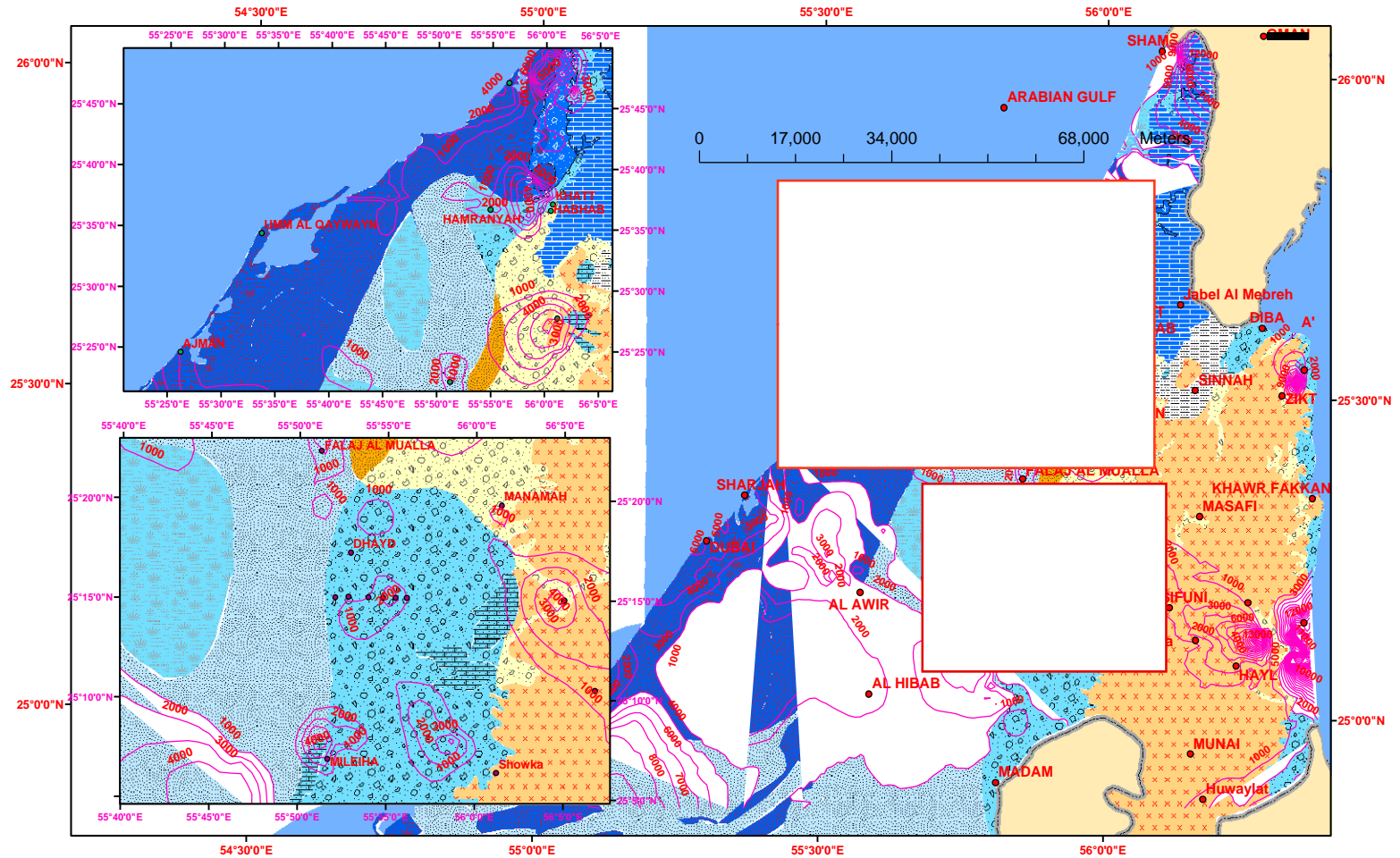
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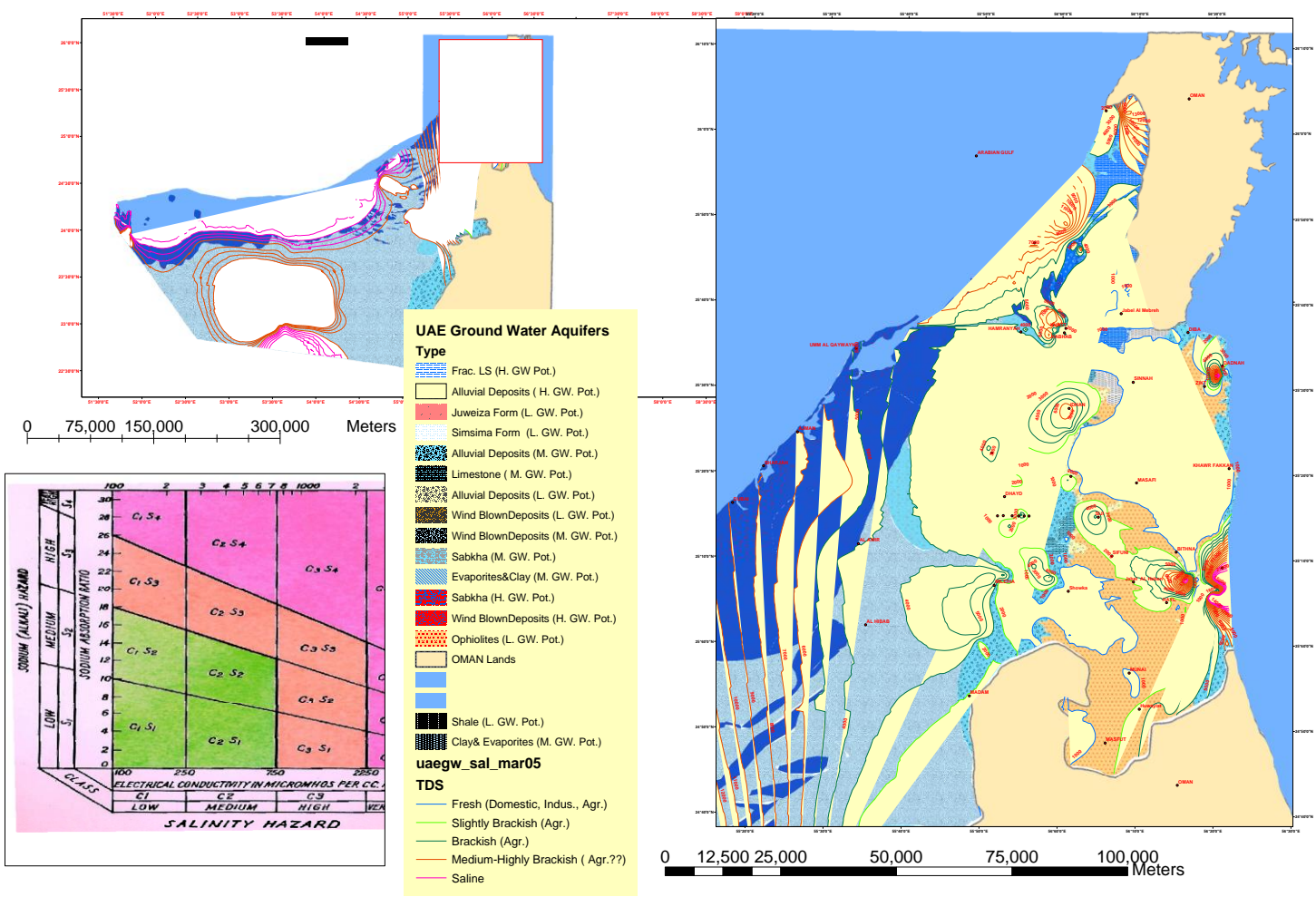
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Groundwater Salinity Increase caused by salt water intrusion and/or upward coning of deep saline water



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Groundwater depletion and saltwater intrusion in the Quaternary Aquifer, (Northern Emirates)



Solutions to Water Scarcity and Groundwater Depletion Problems

Precise knowledge of the quantity and quality of available water resources

- ❖ Exploration and evaluation of groundwater aquifers
- ❖ Rainfall harvesting and artificial groundwater recharge
- ❖ Application of surface geophysical and solute transport model techniques for monitoring and modeling saltwater intrusion



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Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK

- ❖ The most interesting feature of these springs is the high temperature of the water about 39 C° as compared with a range of 25- 32 C° for all other groundwater in the northern Emirates. TDS of the spring water is less than 1500 mg/l
- ❖ In 1979, the northern spring was developed and it has been used for recreation purposes. Outflow from the pools are drained into channels and falajs to supports a substantial cultivation of date palms and other market produce



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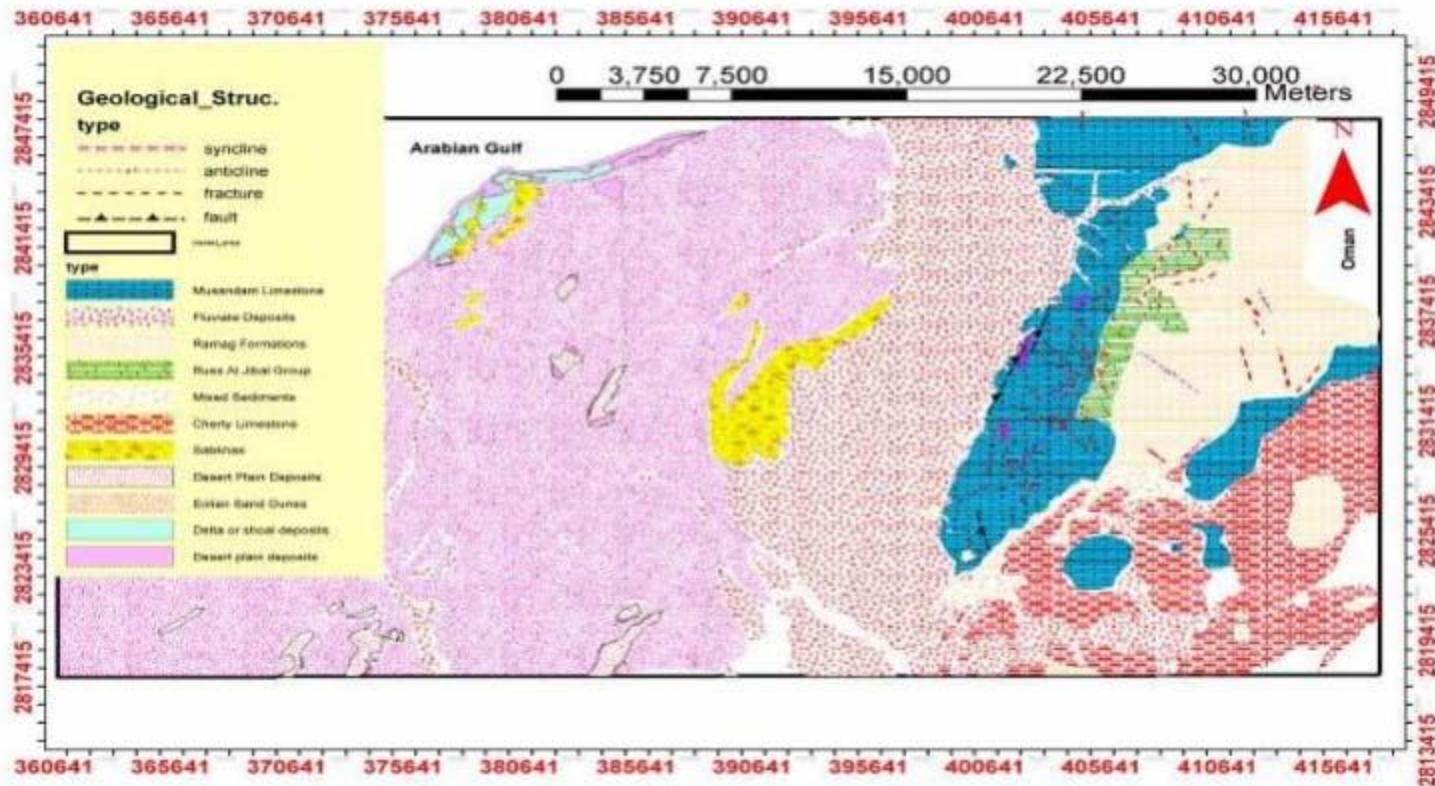
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Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK

- ❖ Digital Geological map of Khatt (an output example of the GIS database built in the period 2003-2005)



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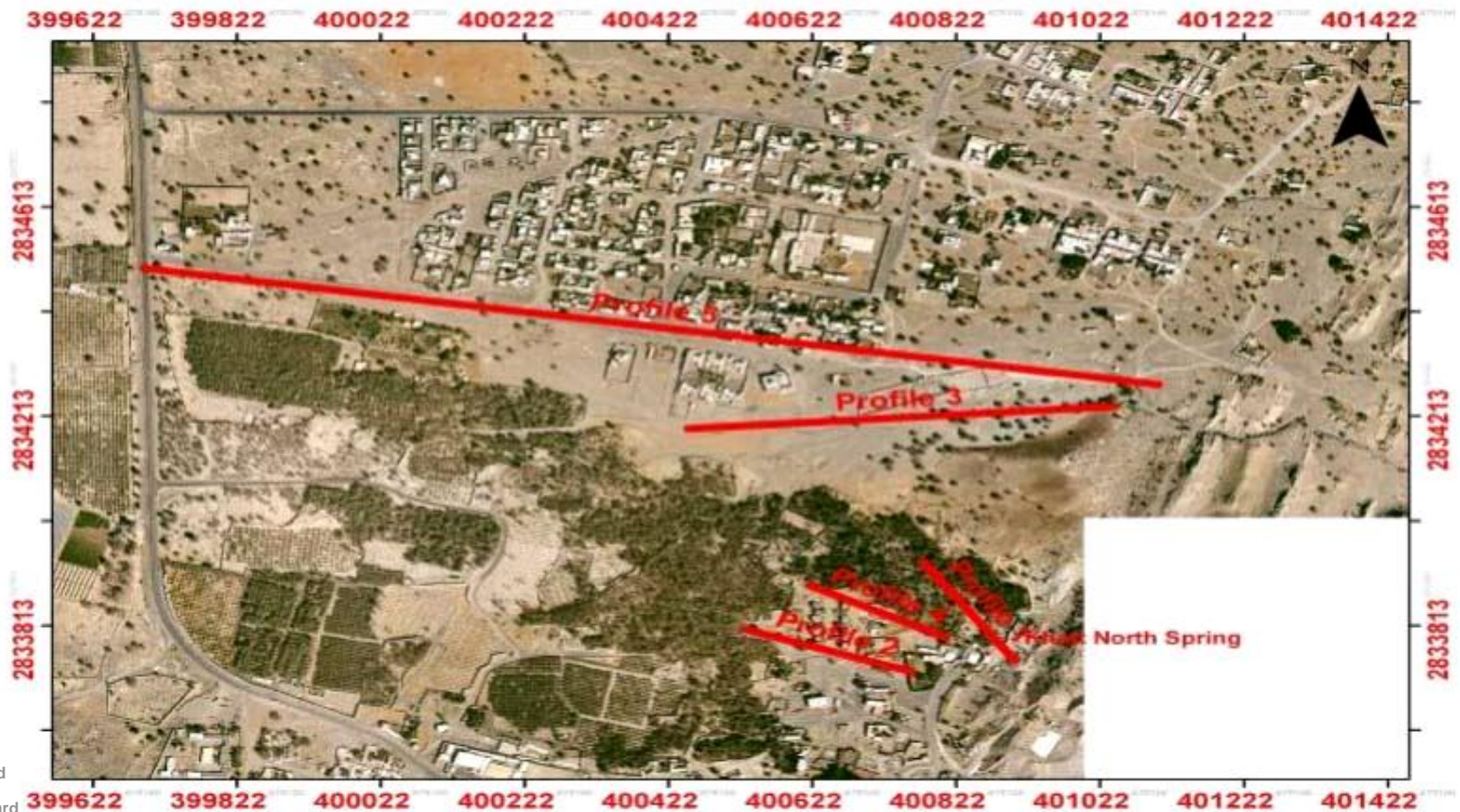
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Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK, UAE

❖ 2D earth Resistivity imaging tomography Survey



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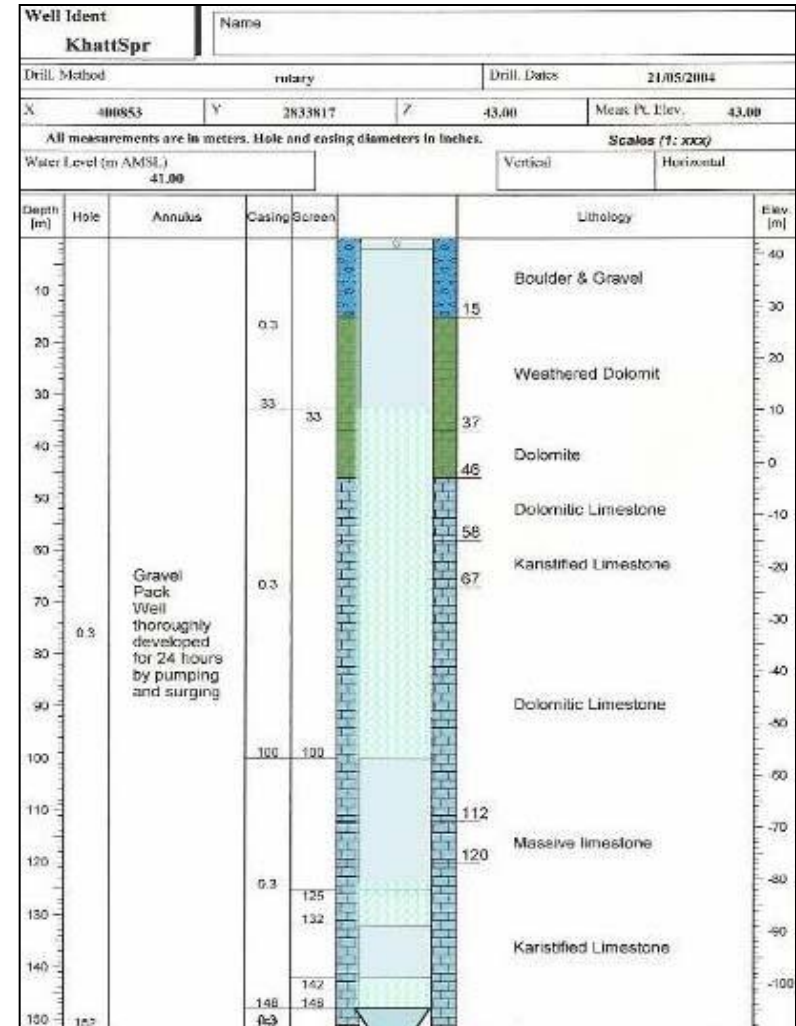
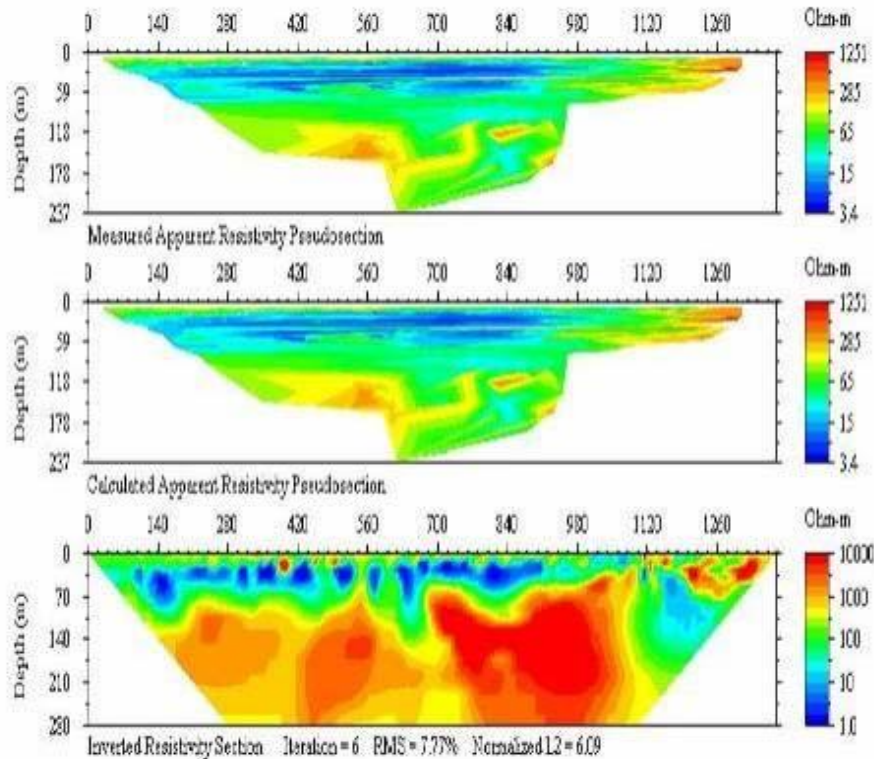
Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK

❖ 2D earth Resistivity imaging tomography field work



Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK

KHAT1_trial14.stg



Groundwater Exploration for Solving the 1999-2004 Drought Impact on Khatt Springs, RAK

❖ Pumping test analysis for Khatt Spring Well



Pumping Test			
Well Ident	Name		
KhattSpr-1			
Obs. Well Distance [m]	Average Pump. Rate [m ³ /day]	Duration [min]	Initial Sat. Thickness [m]
0.15	751.55	153.00	140.00
Results			
Transmissivity [m ² /day]	Storage Coefficient	Leakance [1/day]	Estimation Error [m]
39.7		0.024256	2.25
Fit Method	Hantush Method		



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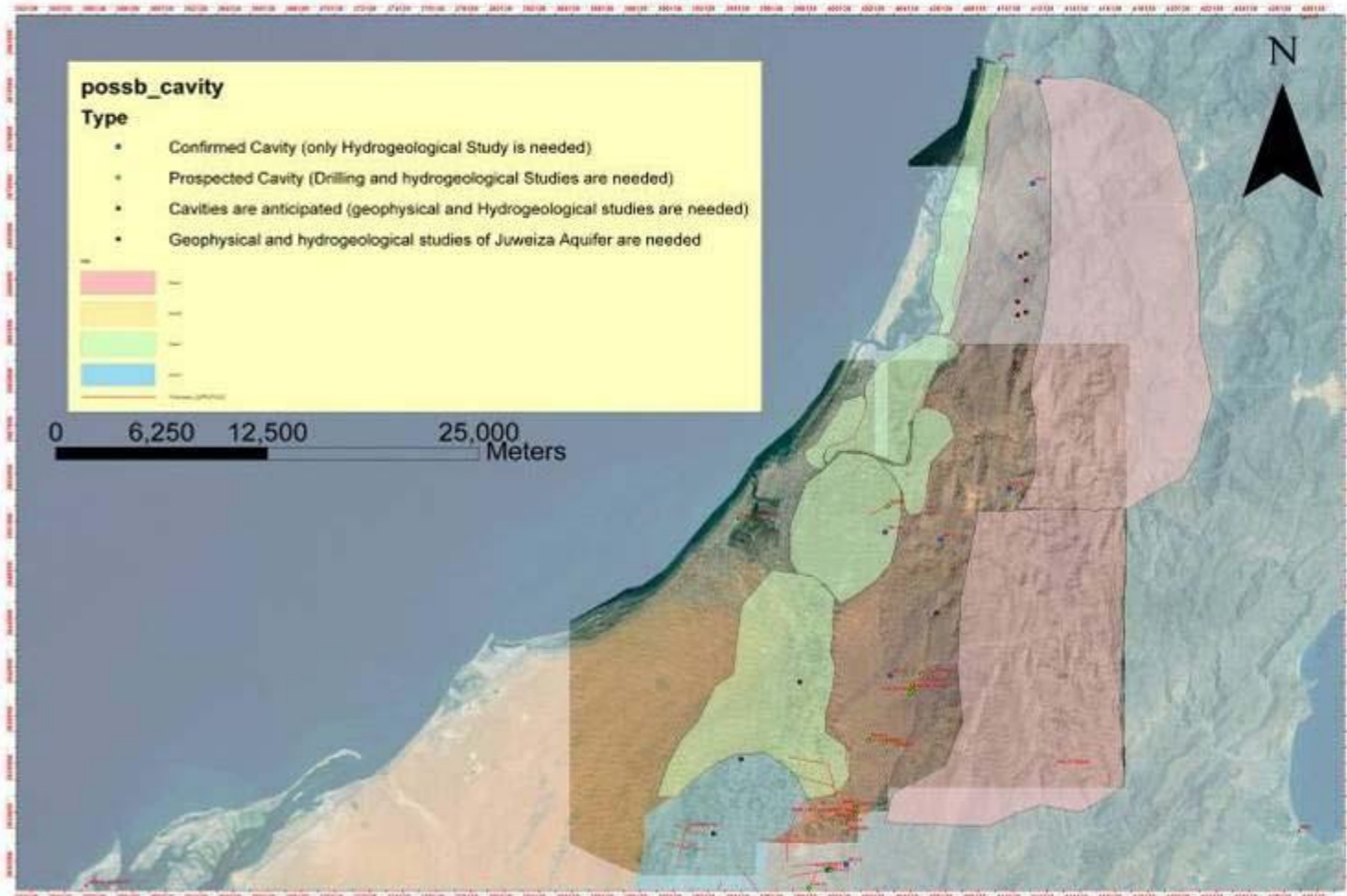
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Exploration and Evaluation of Hajar Aquifer in RAK

Location and type of studies needed for the evaluation of the available water resources in the Emirate of Ras Al Khaimah



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Applications of 2D Earth Resistivity Imaging Tomography for Delineating Saltwater Intrusion in Wadi Ham Area

(after Sherif, M., Ebraheem, A. and others 2004)



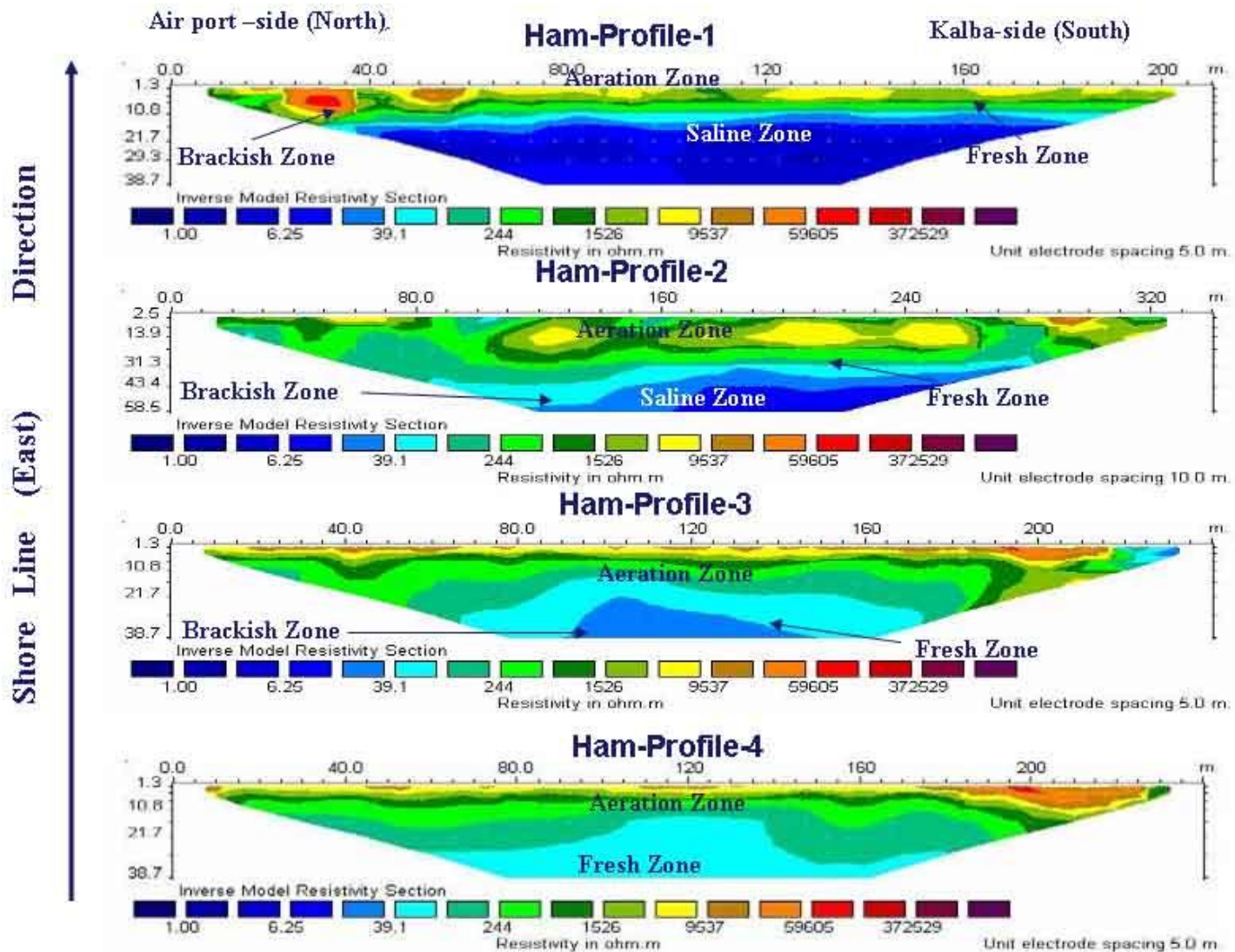
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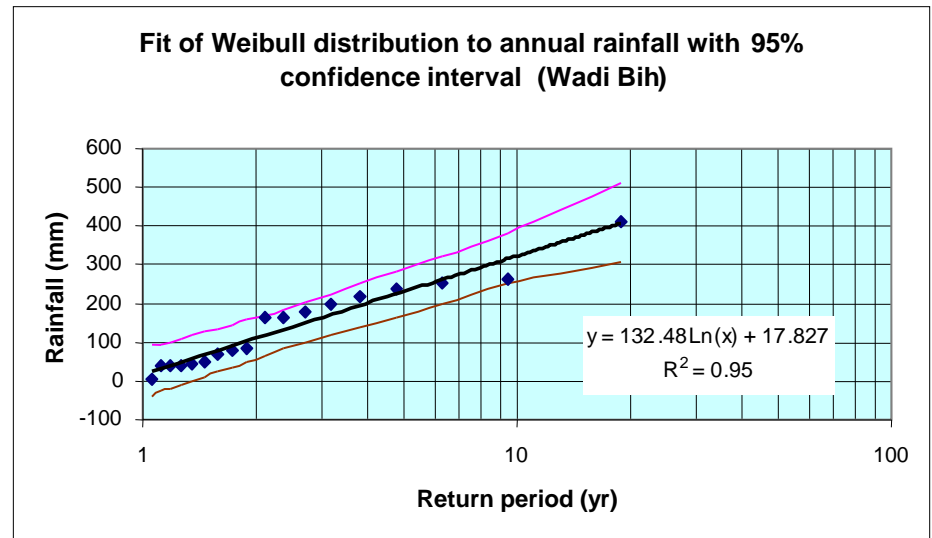
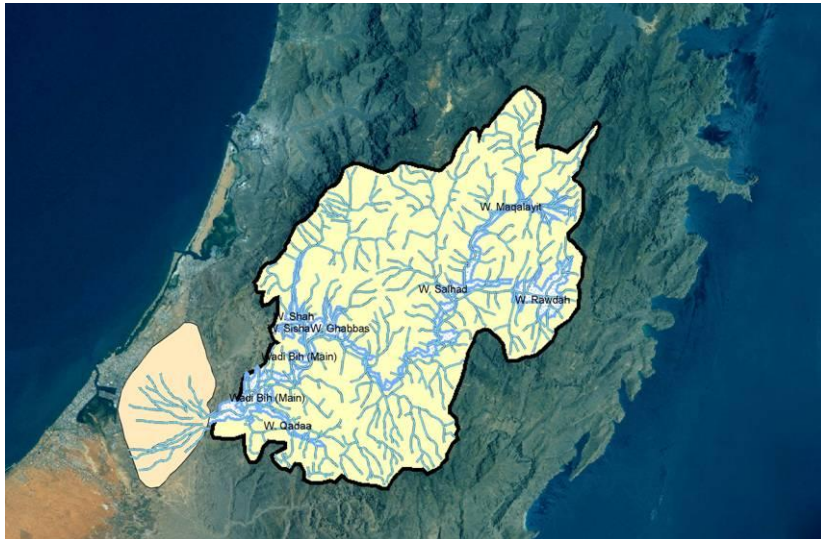
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Study Salt Water Intrusion in Wadi Ham



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Wadi El Bih Catchment's Area and it Drainage Pattern



Probability graph for the annual rainfall with 95% confidence interval (Bih)
 $R = e^{((RI(mm)-18)/132.5)}$

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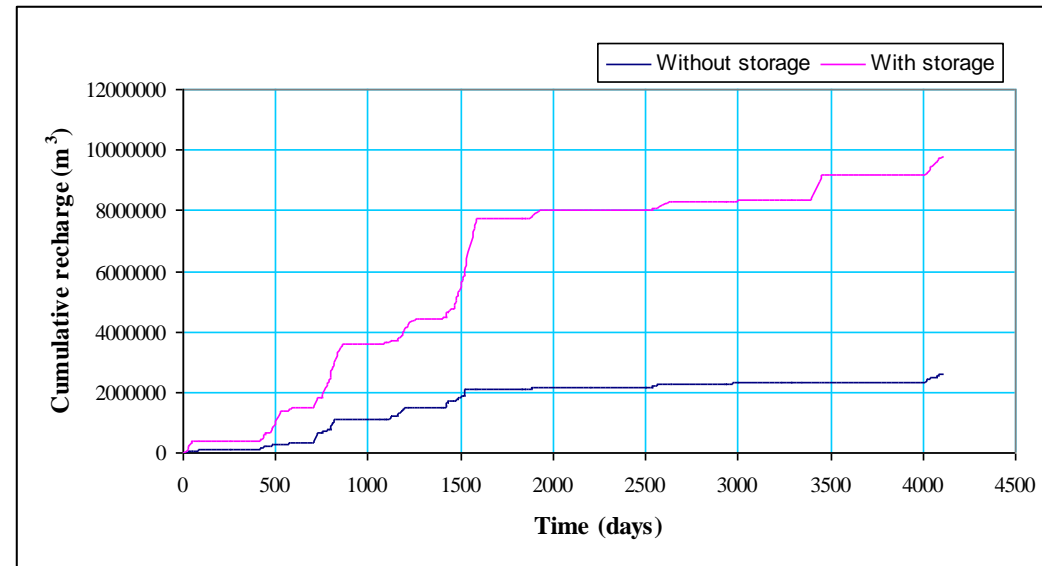
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Rainfall Harvesting by Retention and Detention Dams

- ❖ Comparison of cumulative recharge curve of storage and without storage at the BiH dam (Sherif M., A. Shetty, A. Ebraheem, and S. Akram, 2005)



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Negative Environmental Impact of Retention and Detention Dams *(No EIA has been made)*



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Conclusions

- ❖ Yes we have a water scarcity (severe groundwater depletion) problem, but with our full cooperation, the solution is possible:
- ❖ **International Solutions**
 - Due to groundwater depletion problem, groundwater type in shallow aquifer in the arid region is continuously changing from fresh to brackish type. According to FAO data, about 40% of the World is affected by salinization in some form or other.
 - Under these circumstances we should seriously consider cultivating halophytes (as source of food, animal feed, vegetable oil, chemical and other raw materials) to utilize saline soil and save freshwater resources.



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Conclusions

❖ International Solutions

- We should learn from the past mistakes in dealing with our freshwater resources and use the present GIS and mathematical modeling capabilities to develop a sustainable and integrated management schemes for our brackish and even saline water resources in the coastal and inland sabkhas areas.
- Full Cooperation between Trans boundary aquifer Countries in terms of sharing data, formalizing well documented GIS databases and complying with the sustainable extraction rates.
- Scientific and Political efforts are always needed.

Conclusions

❖ National Solutions

- Improving our Irrigation System ..
- Re-use of drain water is encouraged but ..
- All possible ways of water conservation must be applied
- Exploration and utilization of groundwater resources in many areas are encouraged but we have always to keep in mind their sustainability.
- Improving our monitoring network is crucially needed.
- Improving our prediction capabilities using mathematical models and GIS
- Train scientists in our research institutions about orienting their research efforts toward solving their community problems. One important step in this goal is writing “good and convincing proposals” for financial support

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Thank you

