# Correlation of Impacts of Pumping between Agricultural Pumping Wells and Domestic Pumping Wells in Eastern Province, Saudi Arabia, Using GIS


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*CRP514 Presentation*

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# Outline

- Background
- Essential Terminologies
- Why the Eastern Province?
- GIS-Enabled Well Locations
- Conceptual View – Numerical Model
- Analytical Model
- Results
- Conclusions and Recommendations

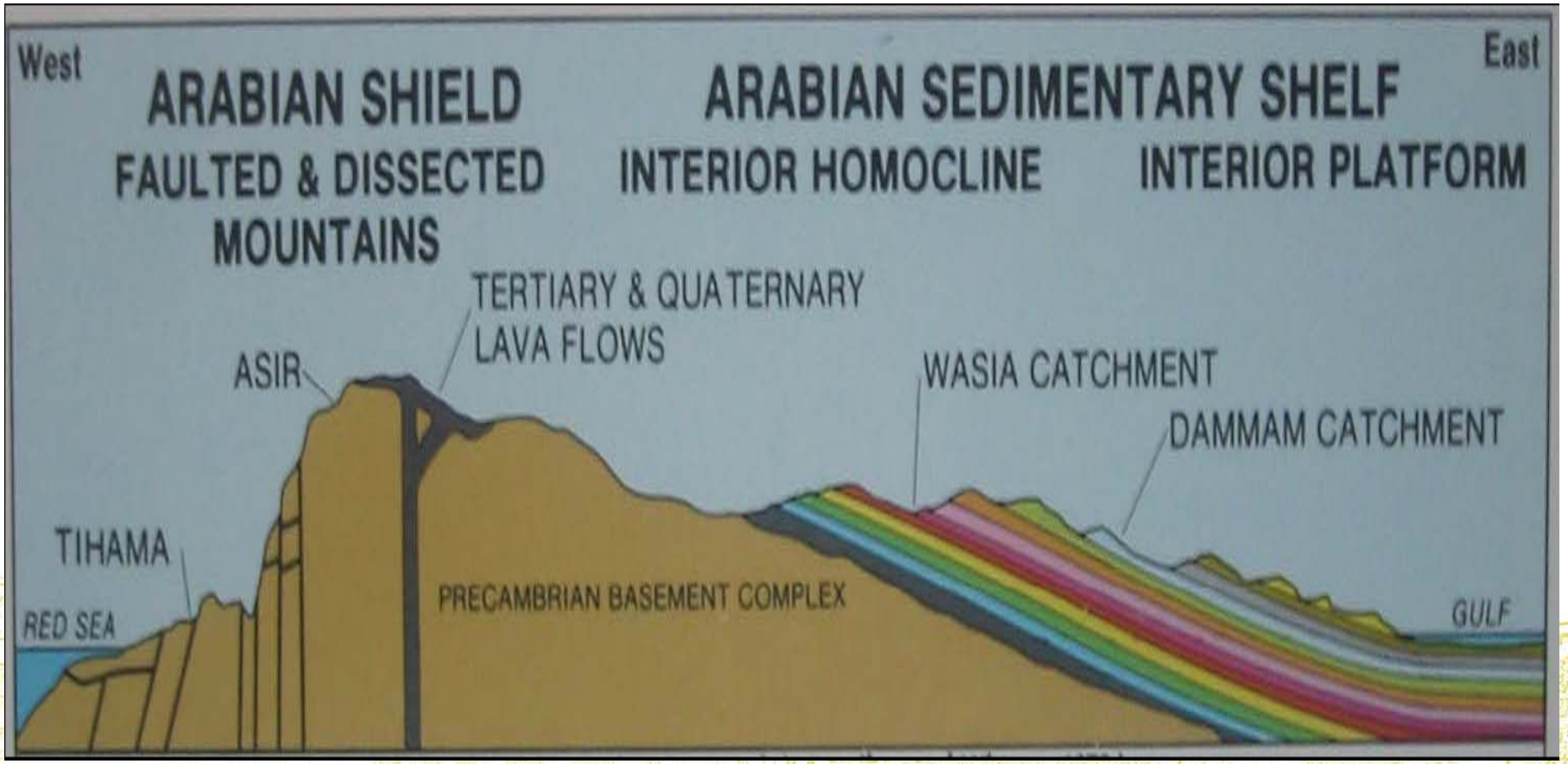
# Background

- During the 1970s and 1980s, the government undertook a massive restructuring of agriculture in Saudi Arabia
- The stated objectives were food security through self-sufficiency and improvement of rural incomes
- In order to meet the agricultural water demand, groundwater use has increased drastically in the last four decades (1980 – 2010)
- This has posed enormous stress on the aquifer system resulting in environmental impacts

# Essential Terminologies

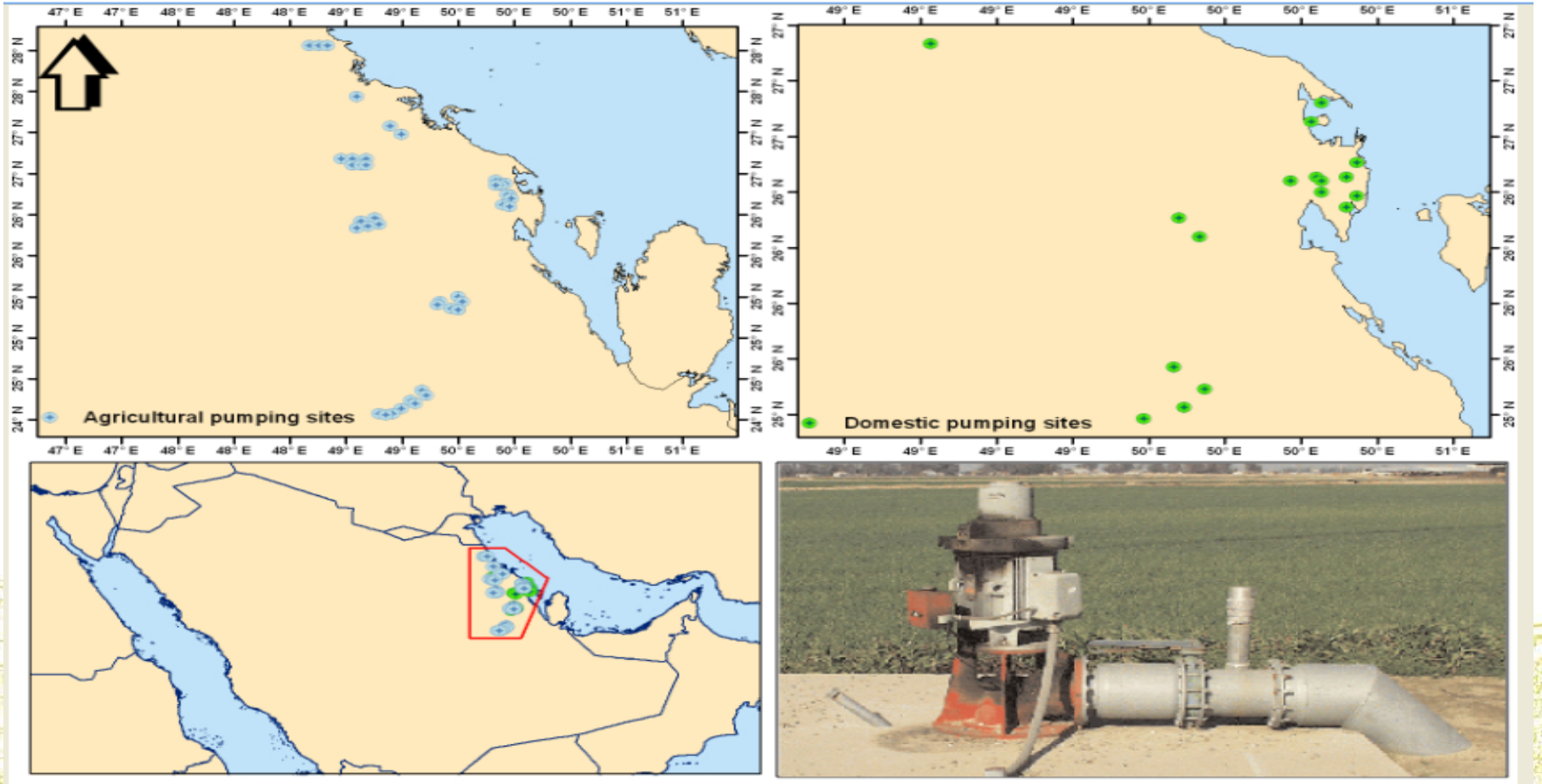
- Aquifer is a saturated region of the subsurface that produces economically feasible water to a well
- Aquitard is an impermeable zone that restricts the flow of water
- Formation is the fundamental unit which consists of rock strata that have comparable properties
- Member is a subdivision of a formation
- Drawdown is the change in hydraulic head observed at a well in an aquifer due to pumping

# Why the Eastern Province?



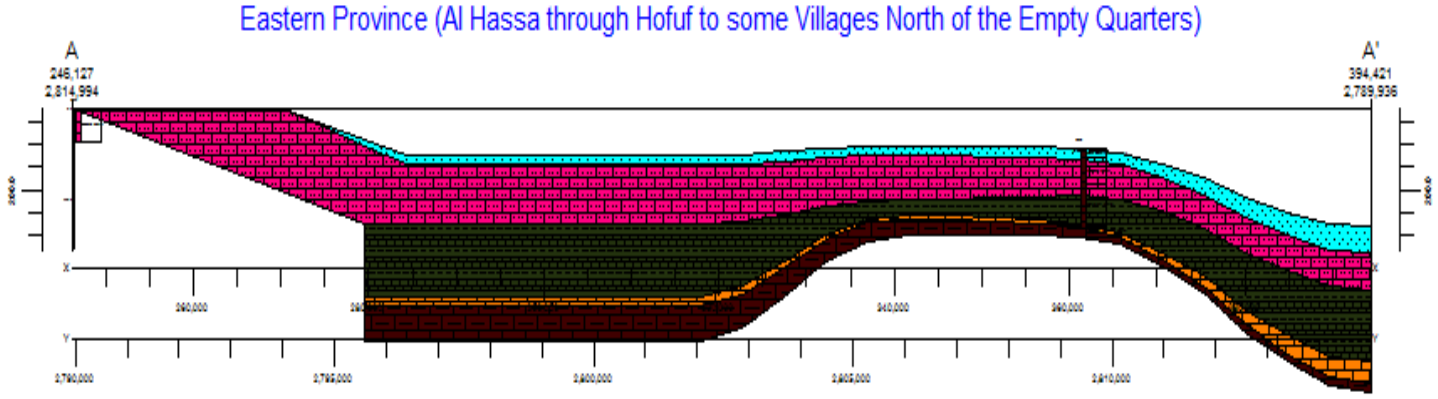

Generalized geological section of Saudi Arabia (modified from MAW, 1984)

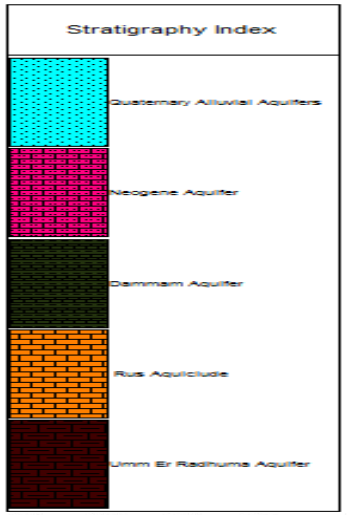
# GIS-Enabled Well Locations

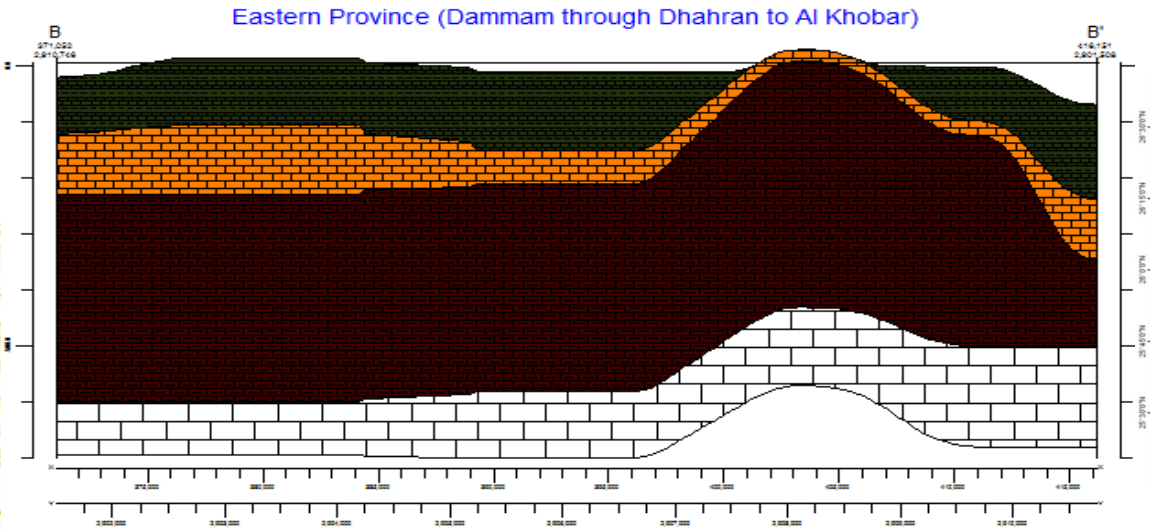


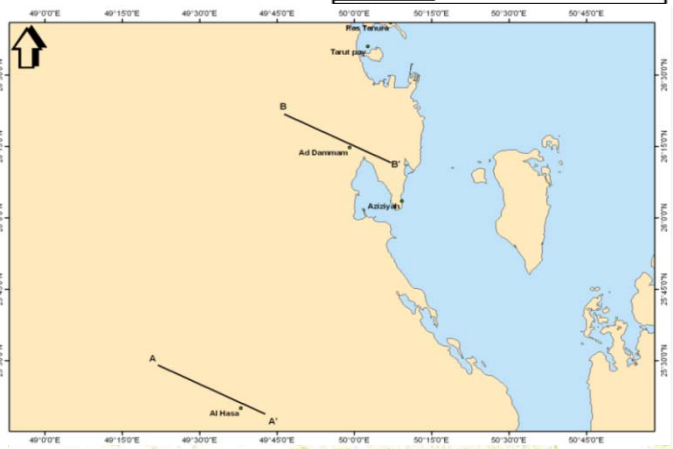

Well Locations in Eastern Province, Saudi Arabia (data were collected from KFUPM Report, 2009)

# Conceptual View – Numerical Model



# Analytical Model

- T. V. Theis (1935) postulated a theory that let us evaluate the behavior of a well pumping in a confined aquifer under transient condition

$$u = \frac{r^2 S}{4Tt}$$

$$s = \frac{Q}{4\pi T} W(u)$$

$$s = b - (b^2 - 2s'b)^{1/2}$$

- **Assumptions**

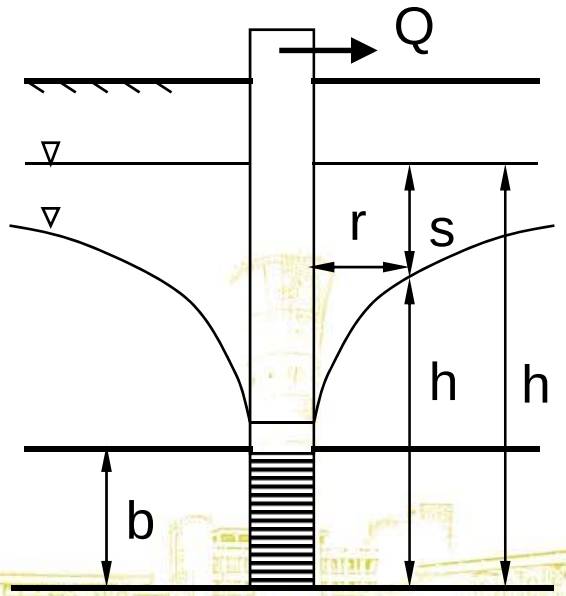
  Isotropic, homogeneous, infinite aquifer, 2-D radial flow

- **Initial Conditions**

  $h(r,0) = h_0$ for all r

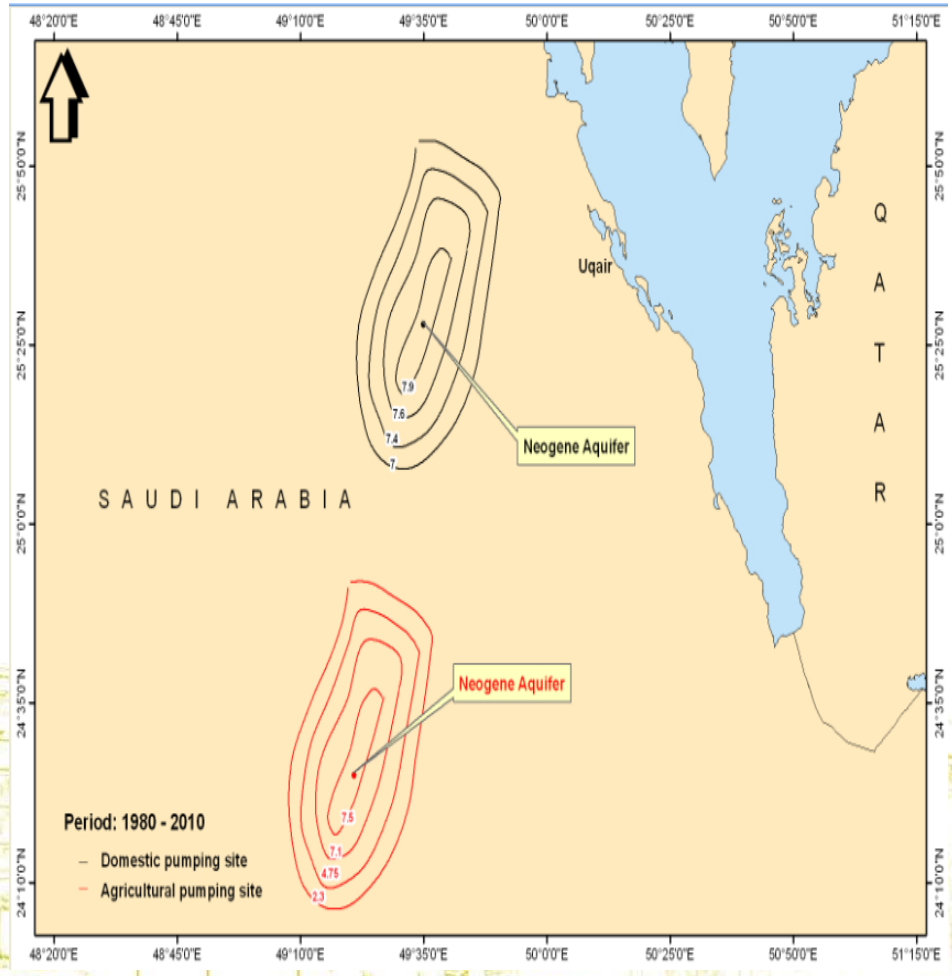
- **Boundary Conditions**

  $h(\infty,t) = h_0$ for all t




With the hydraulic parameters known, we can calculate the past, present and future drawdowns in a pumping well

# Results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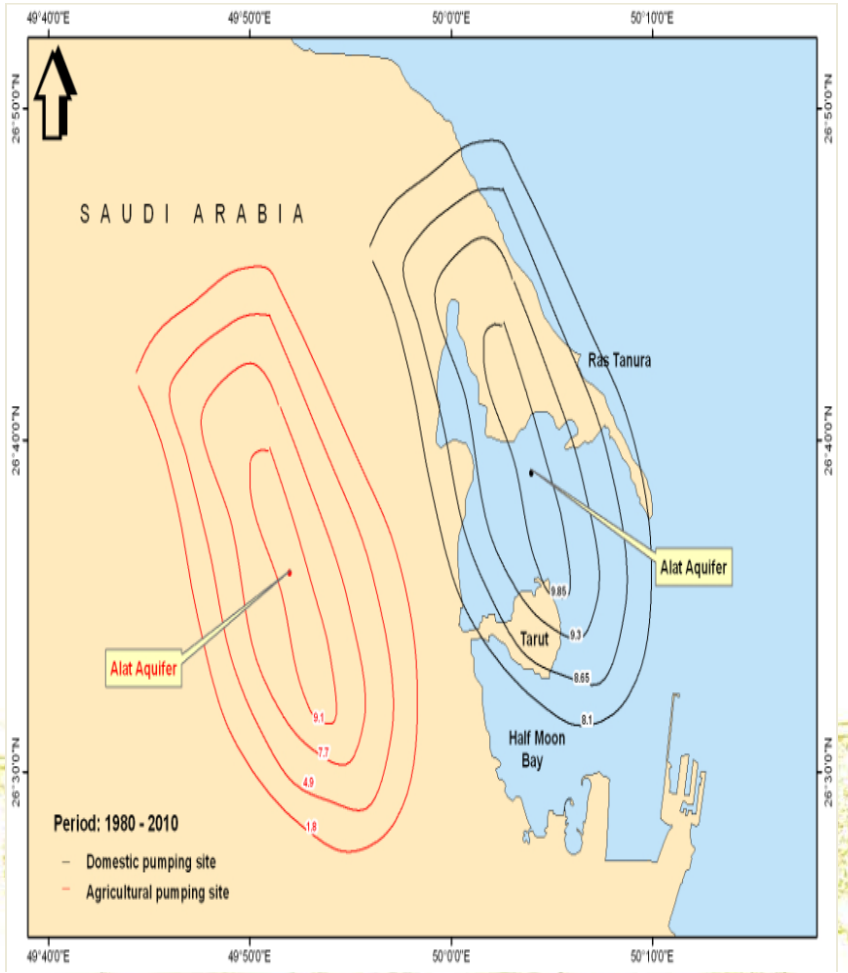
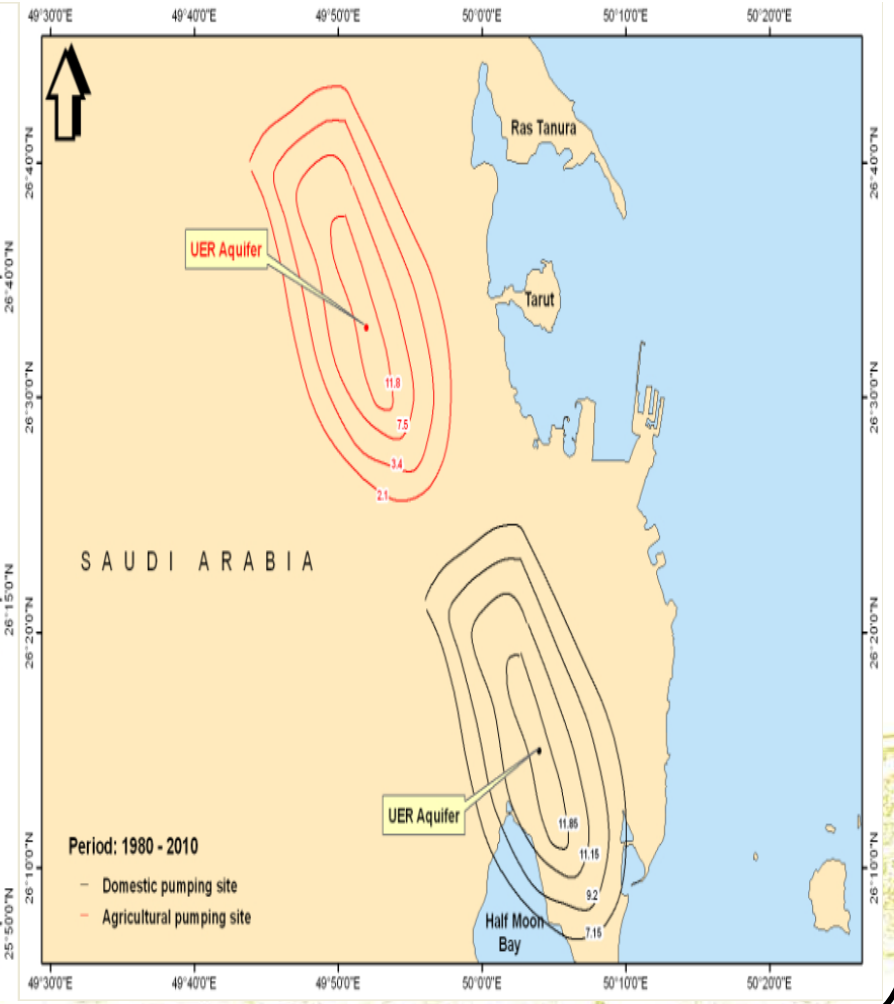
48°45'0"E
49°10'0"E
49°35'0"E
50°0'0"E
50°25'0"E
50°50'0"E
51°15'0"E
25°50'0"N
25°25'0"N
25°0'0"N
24°35'0"N
24°10'0"N
Uqair
Q
A
T
A
R
SAUDI ARABIA
Neogene Aquifer
Neogene Aquifer
7.9
7.6
7.4
7
7.5
7.1
4.75
2.3
Period: 1980 - 2010
Domestic pumping site
Agricultural pumping site


49°40'0"E
49°50'0"E
50°0'0"E
50°10'0"E
26°50'0"N
26°40'0"N
26°30'0"N
SAUDI ARABIA
Ras Tanura
Alat Aquifer
Alat Aquifer
Tarut
Half Moon
Bay
9.1
7.7
4.9
1.8
9.05
9.3
8.65
8.1
Period: 1980 - 2010
Domestic pumping site
Agricultural pumping site

# ...Results


SAUDI ARABIA
Ras Tanura
Tarut
Khobar Aquifer
Khobar Aquifer
Half Moon Bay
BAHRAIN
Period: 1980 - 2010
Domestic pumping site
Agricultural pumping site
5.8
4.3
2.6
1.7
6.5
6.1
5.9
4.85


SAUDI ARABIA
Ras Tanura
Tarut
UER Aquifer
UER Aquifer
Half Moon Bay
Period: 1980 - 2010
Domestic pumping site
Agricultural pumping site
11.8
7.5
3.4
2.1
11.85
11.16
9.2
7.16

# Conclusions and Recommendations

- GIS ensures precision and accuracy in the location of pumping sites on a real map
- It enables efficiency in the use of well data and enhances clear presentation of results
- Results of this work indicate that if the current trend of pumping is continued, especially in agricultural pumping sites, considerable additional impacts would occur
- Proper groundwater management and conservation scheme need to be adopted


Thank You