Proposing the best groundwater utilization for Haddat Al Sham arid region aquifer, Western Saudi Arabia

El-Hames, A. S. and Al Thobaiti, A.
Dept. of Hydrogeology, King Abdulaziz University, Jeddah, Saudi Arabia
E-Mail: a_hames@hotmail.com

BACKGROUND

Haddat Al Sham area is located in the Western region of Saudi Arabia which is categorized as arid and its groundwater aquifer suffers from shortage of water. This study lays guidelines for the best management practice for utilizing this aquifer by exploring areas with high groundwater potential and the safe and optimum pumping rate which can be operated with minimal influence on the groundwater aquifer at the medium term. In order to accomplish these objectives, advanced hydrogeological modeling practice was utilized with different pumping scenarios by utilizing MODFLOW. In order to furnish MODFLOW with the required data, intensive fieldwork has been carried out through which well inventory and pumping tests have been performed.

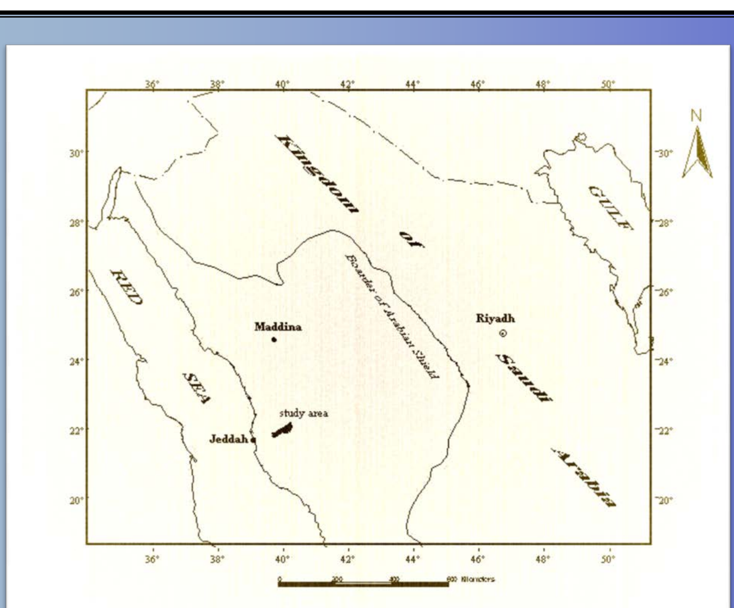
RESEARCH OBJECTIVES

The main goals of this study can be listed as follows:

1. Determination of areas with high groundwater potential and accordingly best locations for well drilling in the study site.
2. Determination of maximum pumping rates which can be utilized at a sustainable rate to specify maximum number of wells in a certain area.

STUDY AREA

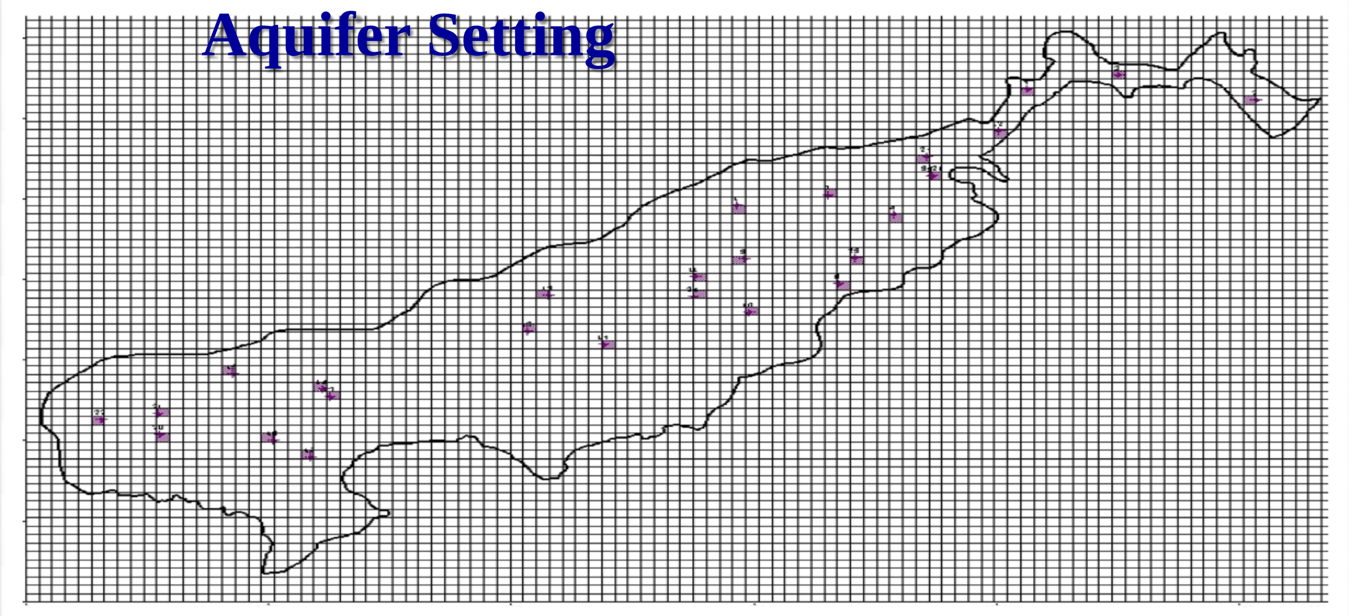
Haddat Al Sham catchment outlet is located about 70 Km (on the road) northeast of Jeddah city in the western province of Saudi Arabia figure 1. It extends between 39º 30' and 40º 15' east and 21º 45' and 22º 10' north. It starts at the western slope of Sarawat escarpment and spreads west towards Wadi Ashamiya, which drains towards the Red sea. The wadi catchment area covers about 980 km² and is made of three main sub-basins: Hishash, Aalaq, and Madrakah. These sub-basins feed into the main wadi, which is called Al Lusub. This area is characterized by a typically arid climate with annual average precipitation of 113 mm recorded at Madrakah village, located at about 600m above mean sea level, and temperatures vary from 13 to 40°C from winter to summer.



MATERIALS AND METHODS

- Test different pumping rates on the groundwater change when all existing pumping wells are in operation.
- Four different pumping rates were used; these are 50 m³/day, 100 m³/day, 200 m³/day and 400 m³/day.
- 9 observation wells are placed into the three unique areas at aquifer:
  - The upper area
  - The middle area
  - The lower area

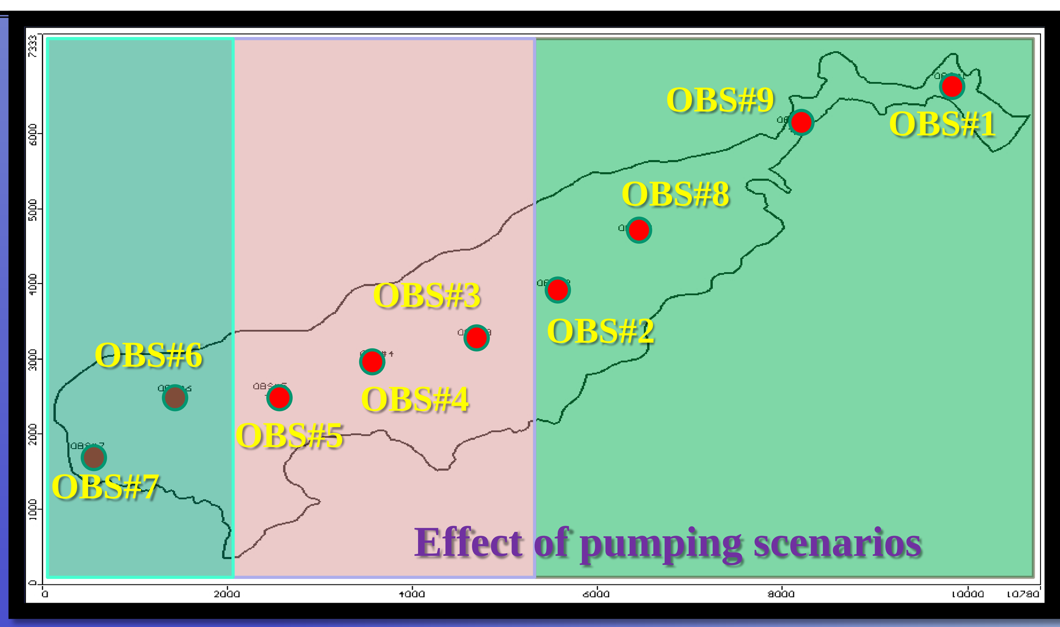
Aquifer Setting



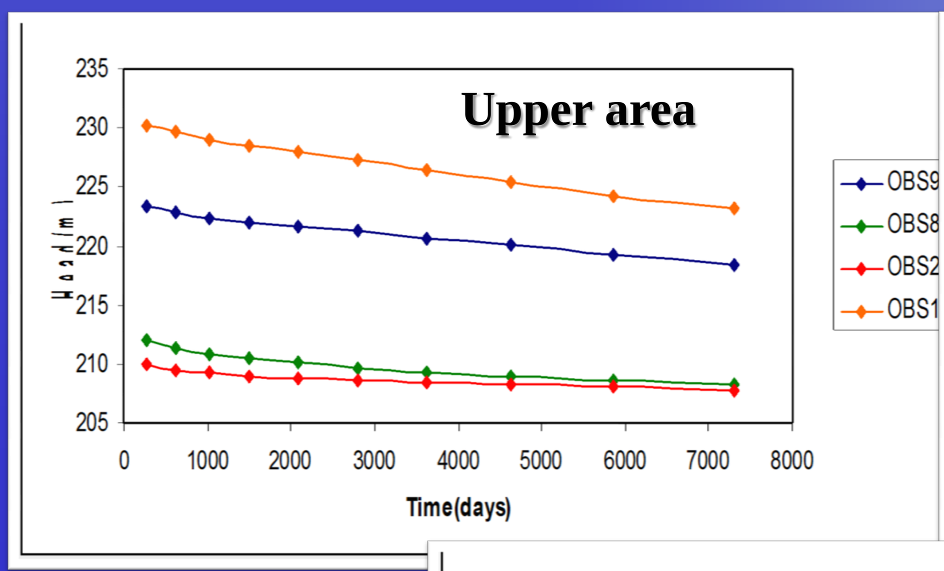
Steady state scenario

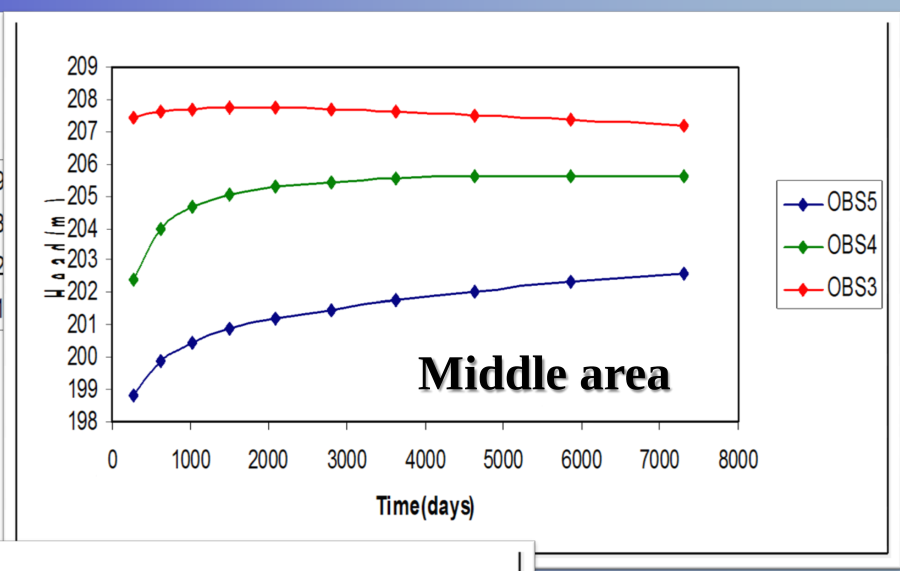
RESULTS AND ANALYSIS

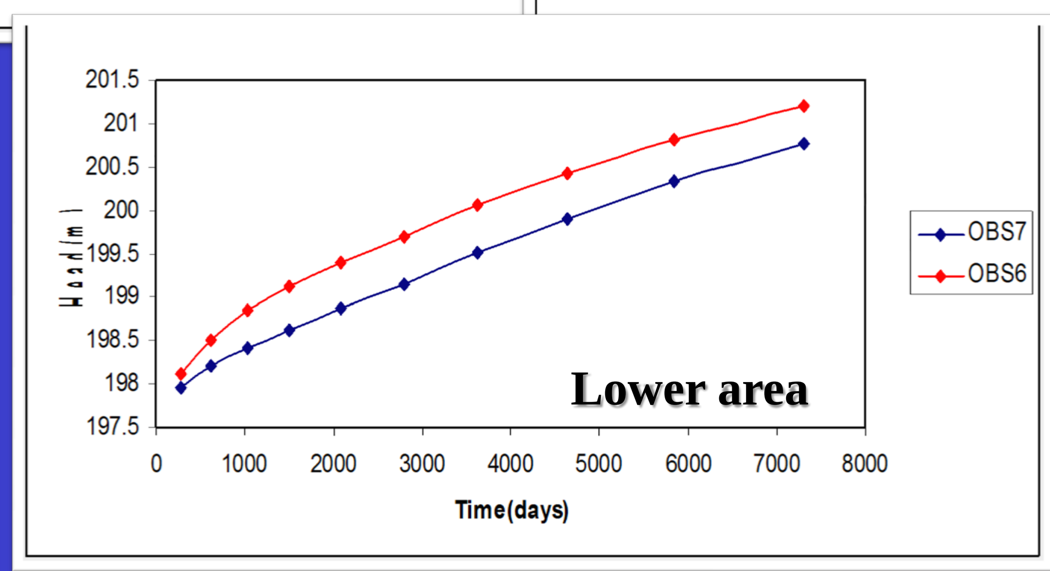
The scenario simulations show that the aquifer can be divided into three areas each of which shows identical behavior to the groundwater pumping. These areas are located in the upper, middle, and lower parts of the aquifer. It is observed that the aquifer in the upstream area is very shallow and it is inclined towards the downstream, while the downstream area acts as a pond that receives the incoming water from the upstream of the aquifer. It can also be concluded that the most promising area in terms of water quantity is that located in the downstream of the aquifer and the worst is that located in the upstream area. The study has shown that it is best to utilize the downstream area for pumping purposes with maximum pumping rate not exceeding 400 m³/day for the wells located in this area.



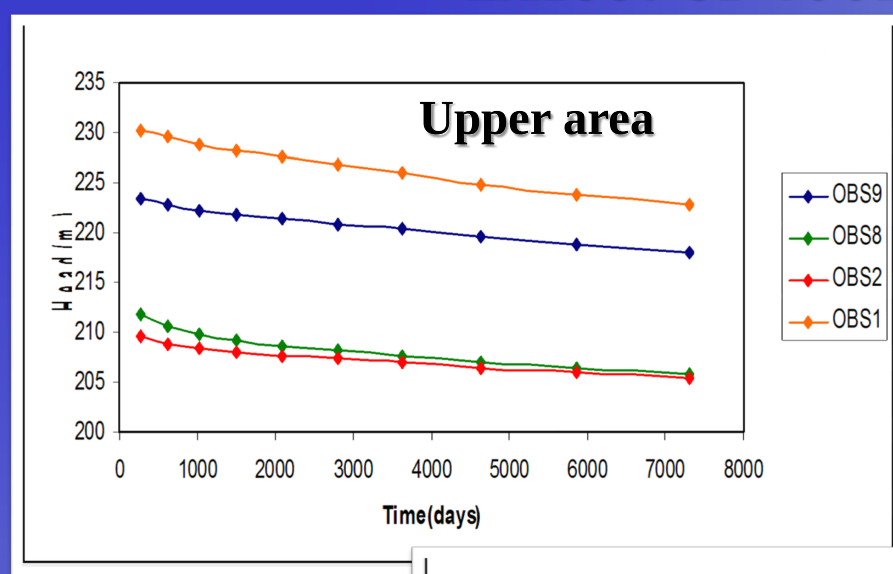
Effect of 50m³/day pumping

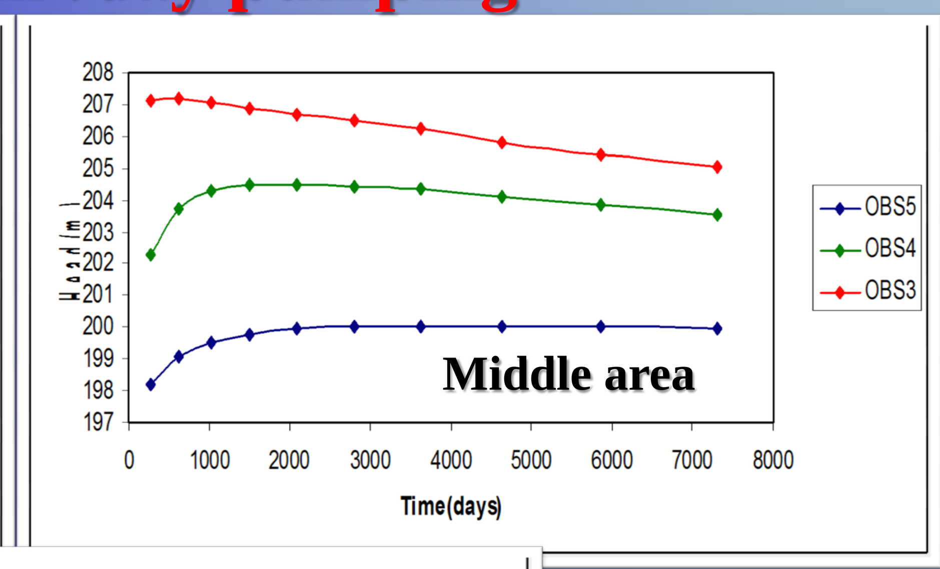


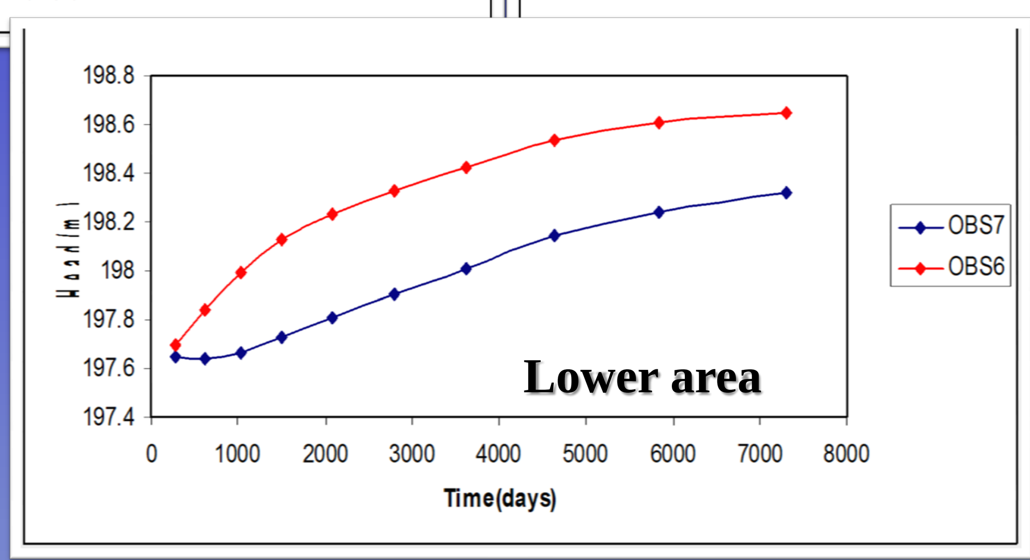


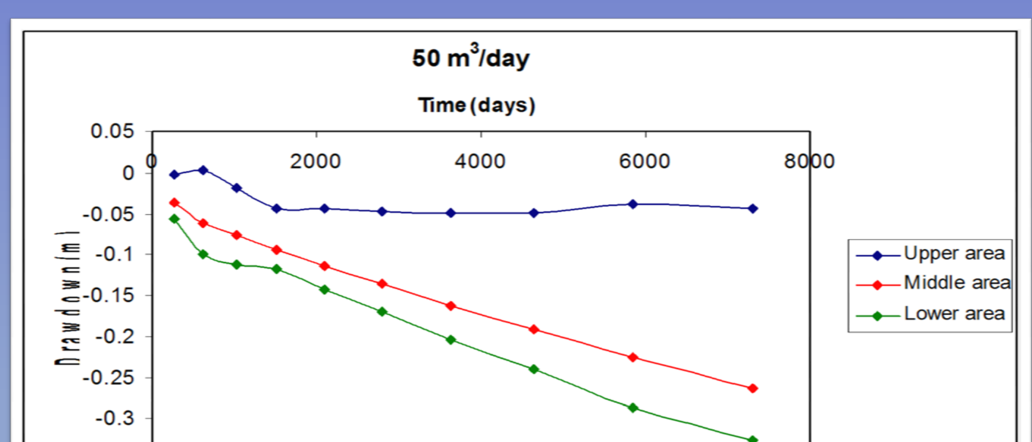


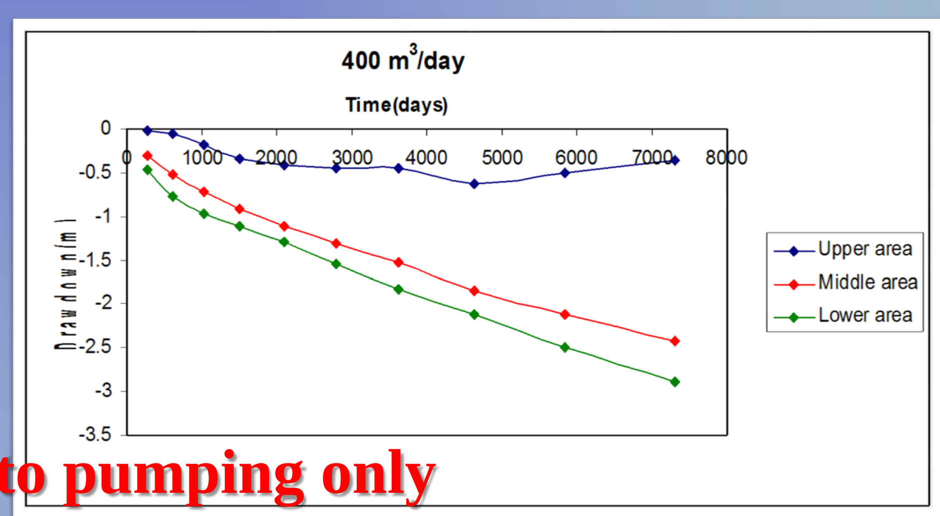
Effect of 400m³/day pumping











Drawdown due to pumping only

CONCLUSIONS

- Pumping has no effect on upper area as lateral inflow is more significant and water table tends to decline at 1 m/year with or without pumping due to lateral flow.
- Upper area around wells #1 and #9 dries up after about 17 years if there is no recharge.
- Water table at middle area tends to show slight decrease at no pumping due to lateral inflow and it shows a decline of 0.5m at 100 m³/day pumping and 2m at 400 m³/day pumping over 20 years.
- Water table at lower area tends to show significant increase at no pumping due to lateral inflow but it declines by 0.3 m at 50 m³/day pumping and by 0.5 m at pumping of 400 m³/day over 20 years.