Aquifer Decontamination using MODFLOW and MT3D in GMS (Groundwater Modeling System)

Saubhagya Singh Rathore[1]; Mohit Kumar Gupta[1]; Dr. Eldho T.I.[2]
[1]B.Tech (Hons), [2] Professor, Civil Engineering, Indian Institute of Technology Bombay, India

ABSTRACT

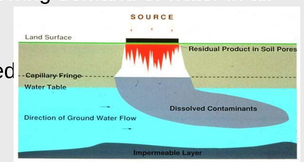
Groundwater pollution is nowadays most serious problem for drinking water due to increased contamination by various domestic, industrial and agricultural sewer . So new effective, efficient and economical remediation techniques needs to be evolved. For the effective decontamination of aquifer, simulation of flow and transport model are required. This study presents a simulation model based on FDM to obtain the optimal pumping rates at appropriate locations to clean up a contaminated confined aquifer. GMS (Groundwater Modeling System) interface is used to make FDM based model using MODFLOW code for flow model and MT3D for contaminant transport simulation. A hypothetical rectangular aquifer is considered for remediation through trial and error using conceptual model to get optimum pumping rates of wells and their efficient locations. The study shows that MODFLOW and MT3D for flow and transport model respectively can be easily and effectively applied in the groundwater remediation.

CONTACT

Saubhagya Singh Rathore and Mohit Gupta
3rd year, Civil Engineering
IIT Bombay

INTRODUCTION

Growing industrialization and planned irrigation of large agricultural fields have caused deterioration of groundwater quality in many parts of the world. Shrinking groundwater potential coupled with ever growing demand of water in all sectors, have forced the attention of water authorities on remediation of contaminated aquifers.



Pump and Treat

- Pump and treat is one of the established techniques (Guan and Aral, 1999) for restoring the contaminated aquifers
- The technique involves locating adequate number of pumping wells in a polluted aquifer where contaminants are removed from the aquifers with the pumped out groundwater

Simulation model based on FDA

- MODFLOW and MT3D codes used to simulate groundwater flow and contamination travelling.
- GMS by Aquaveo provides very easy and quick interface for giving inputs, executing these codes and viewing results.

METHODOLOGY

Conceptual model of a hypothetical rectangular (1800m x 1000m) with 25m thickness confined aquifer was derived with all layer properties and boundary conditions.

Contamination for 10000 days

- Aquifer was discretized using 3D grid (Fig 1) and grid cells properties were assigned by mapping through conceptual model.
- Flow model was obtained by running MODFLOW.
- Aquifer was allowed to contaminated by pond and well with 4000 ppm and 1500 ppm respectively as TDS recharge concentration.
- Transport model with contaminant concentration at the time steps of 100 days was obtained by running MT3D.

Remediation for 6000 days

- 3 pumping well with the pumping rate of 225 m3/d were deployed for remediation.
- Trial and error method was used to locate wells for most effective remediation.

RESULTS

Although this case was some what idealized but the overall approach is realistic. The installation of pumping wells at appropriate locations may be necessary to prevent further spreading of the contaminants to unpolluted areas.

The goal was to get the pumping rates and location of wells for the remediation within acceptable time frame while satisfying constraints on the bounds on pumping rates so that the concentration levels everywhere in the system are lower than the specified concentration limit of 750 ppm.

Mass of TDS in aquifer increased for 10,000 days to 8860327114 gm and then reached to1238423345 gm after 6,000 days of remediation (Fig 1).

After 10,000 days of contamination maximum TDS concentration was 2,550 ppm (Fig 5)and after 6000 days of remediation through pumping by 3 wells it came out to be 795 ppm (Fig 6) which is fairly acceptable.

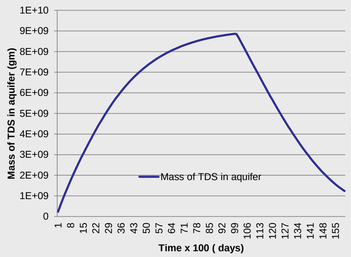


Fig 1. TDS mass in aquifer vs Time

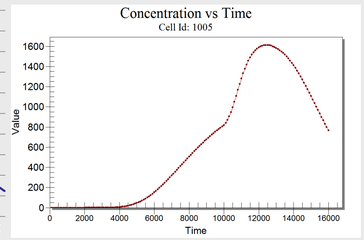


Fig 2. Concentration vs Time for cell id:1005.

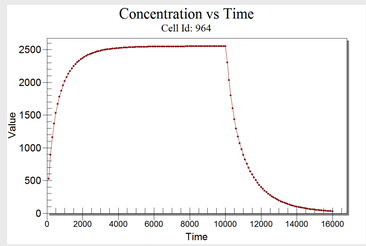


Fig 3. Concentration vs Time for cell id:1005.

Fig 5: TDS concentration distribution in ppm at the end of 10000 days

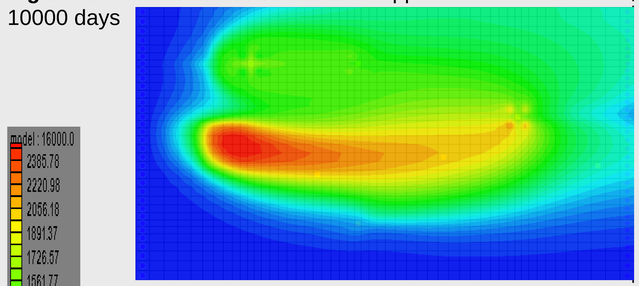


Fig 6: TDS concentration distribution in ppm at the end of 6000 days of remediation.

CONCLUSIONS

MODFLOW and MT3D codes using GMS can be easily used for groundwater remediation. One can make quick changes in model , get different results and hence can easily perform trial and error method to get optimum results.

REFERENCES

S.M.V. Sharief, Eldho T. I, F.ISH, and Rastogi A.K, *"Optimal pumping policy for aquifer decontamination by pump and treat method"*

Mategaonkar Meenal a and Eldho T.I.b
"Aquifer decontamination studies using Meshfree Point Collocation Method "

Todd, David Keith , "Ground water hydrology" *John Wiley, 1959 0*