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A Study on Groundwater and Solute Transport Modeling Using Visual Modflow

Sumit Kumar Gautam[1], Vipin Kumar Swaroop[2]

[1]M. Tech. Student, CED, KNIT Sultanpur

[2]M.Tech.Student, CED, IET Lucknow

Abstract: ***For solving problems of pollution source identification in groundwater. Groundwater modeling is a tool that can help to analyze many groundwater problems. The numerical simulations of flow and contaminant solute transport in groundwater were carried out using MODFLOW. Numerical groundwater models are an important tool for solving the groundwater hydrologist problem. In now a day, many computer techniques and programms are popular and extensively used in ground water modeling. visual modflow are one of them popular software that use finite difference method to solve the equation. modflow can be used to simulate the behavior of complex problem of aquifers including the effects of irregular boundaries, heterogeneity and different processes such as groundwater flow and contaminants transport in the ground system. This study aims to reveals that the suitability of modflow software under various groundwater conditions. The groundwater system may be disturbed by some natural processes or artificially. To predict the groundwater system behavior, visual modflow is the easy to use modeling environment for 2-D and 3-D groundwater flow and contaminant solute transport simulations.***

Keywords: ANN, 2D flow modeling, 3D flow modeling

1. Introduction

Groundwater is a vital source of water due to its availability and good quality, the use of groundwater aquifers is increasing as both a source of water supply and a medium for transport the various hazardous wastes in the ground. As the usage of groundwater increase, our knowledge of groundwater systems must also expand. The Numerical groundwater modeling is a tool that can help in studying groundwater problems and helps us in understanding of groundwater systems. Numerical models have been broadly utilized for groundwater stream, groundwater investigation, quality and amount adjustment and for groundwater administration rehearses. Models are utilized for prescient studies to estimate future field behavior of groundwater. Except this, models are useful for studying different types of flow behavior by examining hypothetical groundwater problem. Before endeavoring such studies, we must be known about groundwater modeling concepts, usage and its limitation.

1.1 Groundwater model

A model is a disentangled variant of a genuine framework that around mimics the pertinent excitation-reaction relations of this present reality framework. Diverse arrangements of rearranging suspicions will bring about various models, each approximating the examined ground-water framework in an unexpected way. The initial phase in the displaying procedure is the development of an applied model comprising of an arrangement of suppositions that verbally depict the framework's piece, the vehicle forms that happen in it, the instruments that oversee them, and the important medium properties. This is imagined or approximated by the modeler with the end goal of developing a model proposed to give data to a particular issue.

1.2 Numerical Models

Once the conceptual model is convert into a mathematical model in the form of governing equations, with associated initial and boundary conditions, a solution can be obtained by converting it into a numerical model and writing a computer program for solving it using a computer.

2. Methodology

2.1 Visual modflow

MODFLOW is a computer program and it is developed by the U.S. Geological Survey. modflow simulates 3-D groundwater flow using a finite difference technique for solving the governing flow equations. MODFLOW used to solves both confined and unconfined flow equations in an irregular flow system to simulate the groundwater flow systems under several types of natural and artificial sources. The flow area is subdivided into many block in which the medium properties are assumed to be uniform. Generally, In plain view the grid are made of mutually perpendicular lines that may be variably spaced. Model layers can have different thickness. A flow equation is written for each block known as cell. Several solvers are available for solving the resulting matrix problem in mudflow. The user can choose the best solver for solve the particular problem. Cumulative volume and Flow-rate for all type of inflow and outflow are computed for each time step. Flow from external sources, such as flow to wells, evapotranspiration, areal recharge, flow to drains, and flow through riverbeds, seepage are simulated. Hydraulic conductivities or transmissivities may different for different area and be anisotropic, and the storage coefficient may be homogeneous or heterogeneous. Specified head, head dependent flux and specified flux boundaries can be simulated.

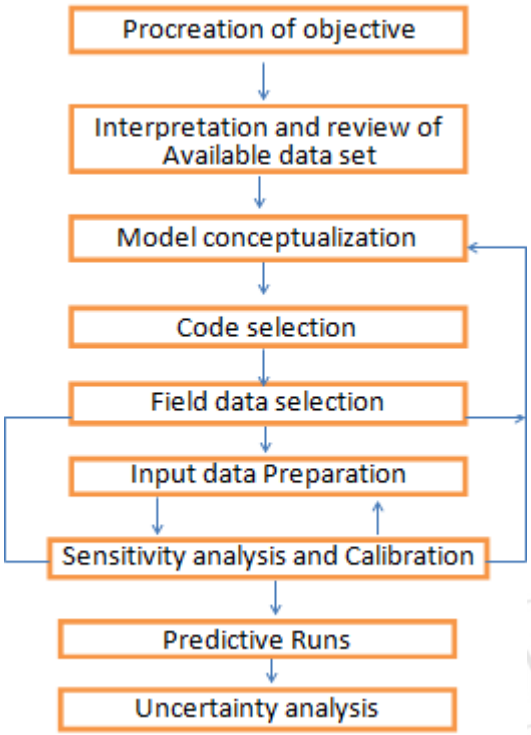

Figure 1: Flow of modeling process

There are three main software and many support modules includes by Visual MODFLOW software package.

(a) MODFLOW software is used for calculate the quantity (volume) , quality and distribution within the ground
(b) The Function of MODPATH software is used for calculating the speed of flow and its direction when it moves through aquifer system.
(c) For calculation of groundwater transportation and diffusion processes with chemical reaction of solutes in the ground MT3D software is used.

2.2 Input data

American Society of Civil Engineers (ASCE) focused the parameters needed for modeling are, Rainfall data, Lithology data, Topography, Groundwater level data, Aquifer properties, Pumping rate. The input parameters required for this software are based on map of study area, Specific storage, Specific yield, vertical and horizontal hydraulic conductivities, total porosity ,effective porosity, thickness of soil etc.,

The input file in the different formats to be given to a model are point data MS Access Database files (.MDB), (XYZ) ASCII files (.TXT, .ASC, .DAT), ESRI Point files (.SHP), MS Excel files (.XLS), USGS DEM files (.DEM), ESRI grid files (.GRD), Surfer grid files (.GRD), and Map info grid files (.GRD).

2.3 Assigning initial and Boundary conditions:

The boundary conditions are used in Visual MODFLOW include drains, constant-head, general head, rivers, walls, recharge, evapotranspiration, constant concentration, (these are flow parameters for MODFLOW), and evapotranspiration concentration, recharge concentration, and point source concentration (these are concentration parameters for MT3Dxx/RT3D).

2.3 Output visualization

Before going to get output visualization, customizing the run time settings for modflow, modpath and mt3d are necessary. When the software engines are finished running, the model will be transferred to the output section, and display the simulation results. The path lines, velocity vectors, water table contours, concentration contours can be seen in 2-D or 3-D according to the selection of area.

2.4 Model Calibration

Every model is calibrated before it is going to be used as a tool for predicting the behavior of a considered aquifer problem. The initial estimates of model coefficients may be modified in the calibration phase. The sensitivity analysis of the model may be postponed until a numerical model and a code for its solution are not selected for the model. In this section parameter and coefficient, all the data sets used in the model calibration are describes

3. Application of Visual Modflow

1) To predict fate and transport of phosphorous in landfill of Seri Pataling, Visual MODFLOW was used. It might be helpful to control pollution in Landfill [4].
2) To quantify groundwater and surface water interaction Visual MODFLOW 3.0 package was used. it is an integrated modeling environment for applications in 3-D groundwater flow and contaminated solute transport simulations based on the finite-difference method.
3) The groundwater modeling play an important role to determine the information about flow direction and magnitude of groundwater with respect to time, location and season under an unconfined coastal aquifer surrounded by saline water bodies condition. Visual MODFLOW Pro 2009.1 was used to simulate the steady state run for Kalpakkam coastal aquifer[1]

4. Results and Discussion

The main Advantages of MODFLOW, it incorporates various facilities for data preparation, the modular structure are easily modified to adapt the code for a particular problem of groundwater, great flexibility in handling the complex problem , easy exchange of data in standard form, extended worldwide, continuous development and availability of the source code. Except simulating groundwater flow, the scope of MODFLOW has been expanded to estimating the solute transport and parameter.

5. Conclusion

Visual MODFLOW software is suitable for forecast the outcome of future groundwater behavior, predict the aquifer conditions and to represent the natural groundwater flow , hydraulic heads and ground water flow rates within and across the boundaries of the system and concentrations of substance dissolved in ground water.

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