

Numerical Groundwater Contaminant Transport Modeling With Spreadsheets

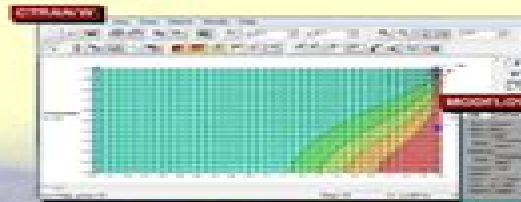
Ali Shokri

University of Waikato, New Zealand



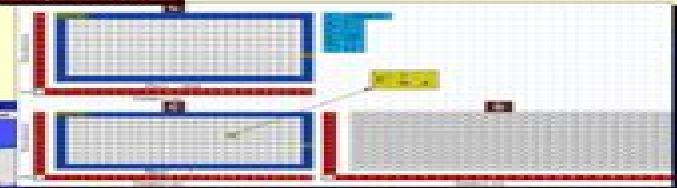
Aims of Using Spreadsheets

There are two main methods for numerical contaminant transport modeling using general commercial software (the software used in CTRANW) or spreadsheets made in languages such as MATLAB or Visual Basic. Both methods have advantages. Commercial software has been developed with a view to solving governing equations and therefore they are not subject to some particular errors. On the other hand, using spreadsheets needs a high level of knowledge of computer programming. This paper describes the Spreadsheets Comparison Model (SCM) which is both flexible, user-friendly, and also helpful for educational purposes.



CTRWAN

A simplified 2D SCM



Methods of Modeling with Spreadsheets

The basis of a spreadsheet based numerical groundwater model is that each cell represents an equal node in a finite difference grid. The model is developed in a spreadsheet and incorporates the contaminant transport governing equation, generally known as the advection-dispersion equation (ADE).
 Co-ordination (X,Y,Z)
 Co-ordinate linear velocity (U,V,W)
 Co-ordinate dispersion coefficient (D_x, D_y, D_z)



Example1: Ogata 1D analytical solution no adsorption and decay

Comparison of SCM with CTRANW and Analytical Solution



Verification

This paper introduces the mathematical framework and techniques for modeling groundwater contaminant transport using spreadsheets. The model is developed in a spreadsheet and incorporates the contaminant transport governing equation, generally known as the advection-dispersion equation (ADE). The model is verified by comparing the results of the spreadsheet model with the results of CTRANW and an analytical solution.

$$C = \frac{Q}{4\pi T} \left(\frac{1}{\sqrt{4\pi D_y t}} + \frac{1}{\sqrt{4\pi D_z t}} \right) \exp \left(-\frac{y^2}{4D_y t} - \frac{z^2}{4D_z t} \right)$$

Where:
 C = contaminant concentration at the source boundary (mg/L)
 Q = injected flow (L/s)
 T = transmissivity (m²/s)
 D_y = transverse dispersion coefficient (m²/s)
 D_z = longitudinal dispersion coefficient (m²/s)

A similar comparison is made with respect to the velocity field. The results of the spreadsheet model are compared with the results of CTRANW and an analytical solution. The results show that the spreadsheet model is in good agreement with the other two methods.

Polluted Lagoon



Example2: 2D numerical model of contaminant transport polluted lagoon

A sample of result of SCM



Results

The SCM model has the required accuracy despite its simplicity. Some of the advantages of the model are:
 - It is easy to use, giving a graphical presentation to user, intuitive process for changing data in each node, quick access to all output data. These advantages make SCM to a suitable method for professional and educational aims. However this method just can be used to make reference calculations and it is not suitable for the more complex models.

Applied Contaminant Transport Modeling

Mark Goltz, Junqi Huang



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Table of Contents Applied Contaminant Transport Modeling

1. Understanding the eBook Applied Contaminant Transport Modeling
 - The Rise of Digital Reading Applied Contaminant Transport Modeling
 - Advantages of eBooks Over Traditional Books
2. Identifying Applied Contaminant Transport Modeling
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Applied Contaminant Transport Modeling
 - User-Friendly Interface
4. Exploring eBook Recommendations from Applied Contaminant Transport Modeling
 - Personalized Recommendations
 - Applied Contaminant Transport Modeling User Reviews and Ratings
 - Applied Contaminant Transport Modeling and Bestseller Lists

5. Accessing Applied Contaminant Transport Modeling Free and Paid eBooks
 - Applied Contaminant Transport Modeling Public Domain eBooks
 - Applied Contaminant Transport Modeling eBook Subscription Services
 - Applied Contaminant Transport Modeling Budget-Friendly Options
6. Navigating Applied Contaminant Transport Modeling eBook Formats
 - ePub, PDF, MOBI, and More
 - Applied Contaminant Transport Modeling Compatibility with Devices
 - Applied Contaminant Transport Modeling Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Applied Contaminant Transport Modeling
 - Highlighting and Note-Taking Applied Contaminant Transport Modeling
 - Interactive Elements Applied Contaminant Transport Modeling
8. Staying Engaged with Applied Contaminant Transport Modeling
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Applied Contaminant Transport Modeling
9. Balancing eBooks and Physical Books Applied Contaminant Transport Modeling
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Applied Contaminant Transport Modeling
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Applied Contaminant Transport Modeling
 - Setting Reading Goals Applied Contaminant Transport Modeling
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Applied Contaminant Transport Modeling
 - Fact-Checking eBook Content of Applied Contaminant Transport Modeling
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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