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Project Summary

OASIS: Parameter Estimation System for Aquifer Restoration Models--User's Manual Version 2.0

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OASIS, a decision support system for ground-water contaminant modeling, was designed to provide a set of tools to help scientists and modelers assess ground-water contamination problems. OASIS was developed around BIOPLUME II, a numerical model that simulates the aerobic degradation of dissolved hydrocarbons in ground water. The system was developed in the HyperCard* environment and contains extensive documentation and onscreen help. Question mark icons throughout lead the user to further discussion and definitions, thereby allowing the system to be fully operational without the aid of paper documentation. The information in OASIS includes documentation, a hydrogeologic database, two chemical databases, several simple hydrogeologic models, and the BIOPLUME II model with preprocessors and postprocessors. The system was developed for use on Macintosh* personal computers and now contains over 1600 screens and 9 megabytes (Mb) of information. The installation of the software requires 10 Mb of disk space.

This Project Summary was developed by EPA's R. S. Kerr Environmental Research Laboratory, Ada, OK, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

OASIS has been developed for the EPA by Rice University, through the National Center for Ground Water Research. As a decision support system, OASIS was designed to provide scientists and modelers with a collection of tools to help assess and analyze ground-water contamination problems. New types of software are being developed for problems that have traditionally been difficult to implement using conventional computer technology. Decision Support Systems (DSS) help the user to deal with broad problems that do not have a clearly defined solution procedure. The use of a ground-water contaminant transport model is a semi-structured problem that requires the scientist to make a series of decisions related to representation of the site, application of available data, and types of simulations to be performed.

HyperCard

OASIS was built using HyperCard, a software package provided with the Apple Macintosh. In the HyperCard environment, each different screen of information is called a "card," and cards are collected into groups called "stacks." The cards within a stack are connected to each other by "links." These links may take many forms. For example, a link may consist of a "button" which sends the user to a particular card or a "field"

*Hypercard and Macintosh are trademarks of Apple Computer, Inc.

which displays data taken from another card. In HyperCard, fields and buttons link together cards, stacks, and other files and programs in the computer. The user is able to navigate through large amounts of information using a series of mouse clicks on active buttons. Thus, instead of going screen by screen through the computer (or similarly page by page in a book), a user is allowed nonsequential access to information in the system. The first card in the OASIS system (the OASIS Home card) contains an Intro button which gives more information about HyperCard. The user is also referred to the HyperCard user's manual for any additional questions.

OASIS System Contents

The OASIS system consists of documentation, a hydrogeologic database, two chemical databases, several simple hydrogeologic models, and the BIOPLUME II model with preprocessors and postprocessors.

Each card in OASIS consists of one screen of information on a picture background. Cards are organized into stacks of related information, with most cards in a stack having similar backgrounds. Several different backgrounds are used in the OASIS system. These backgrounds include pictures of tab cards, open books, notebooks, etc. Text in a card is entered into a text field. Text fields take many different forms: rectangular, opaque (on a white background), shadowed, transparent (only the text can be seen, not the field) or scrolling. Buttons connect information within the OASIS system, thereby providing links between cards. Clicking on a button takes the user to another card within the system or performs some operation on data entered in a field. In the OASIS system, there is a convention for each of the button styles used.

Notebook

The notebook is a system within OASIS that allows the user to transfer information between stacks or from the support system to the models. For example, parameter data can be taken from the chemical or hydrogeologic stacks and put into the notebook for later use in the preprocessor.

Portions of the hydrogeologic and chemical databases also contain a button called Notebook. Clicking the Notebook button will automatically enter data from the card into the notebook and then open the notebook.

Reference Library

The reference stack contains libraries of information related to ground water. Clicking on any of the terms in the flowchart takes the user to contaminant information related to that source. The reference stack also contains information on source by zone, a glossary of terms, the Rokey database which provides discussion of parameters used in ground-water modeling, and a Remediation stack. The Remediation stack contains information on different remediation techniques for contaminated ground-water aquifers and also presents BIOPLUME II simulations, which demonstrate the importance of well placement and source term definition.

Hydrogeologic Database

The hydrogeologic database was developed to take advantage of the many hydrogeologic investigations that have been conducted at waste sites but have not been reported in the technical literature. An extensive technical survey of ground-water professionals was conducted with funding from the American Petroleum Institute and assistance from the National Water Well Association. Data from 400 field sites across the country were obtained from ground-water professionals and incorporated into a database.

The database was structured using the concept of hydrogeologic settings developed for the EPA's DRASTIC system, an aquifer vulnerability index using hydrogeologic settings. The database is used by determining the hydrogeologic setting that best matches a site or an area of interest. The hydrogeologic setting is selected by determining the ground-water region, aquifer media, and then the setting which best describes the site in question. The setting is used to access the database; the database statistics can then be used for ground-water modeling or for general site characterization purposes.

General Chemical Database

The general chemical database contains 117 chemicals with one card of information per chemical and was taken from the ROKEY database. Chemical information can be accessed in four ways: by category, by name, by EPA number, or by CAS number (Chemical Abstract Service number). The general chemical database contains a Notebook button which enters data from the card into the notebook (for more information on the notebook see the previous discussion).

Specific Chemical Database

The specific chemical databas contains 18 chemicals with 25 cards (information per chemical. The first car of the database has buttons which acces information related to Identificatior Physical Properties, Fire Hazard Dat Chemical Reactions, and Toxicology These terms are defined as they ar used to describe the chemicals in th database.

Darcy's Law

The Darcy's law stack calculates th ground-water velocity in a system wher hydraulic conductivity, gradient, an porosity are known. The help buttor (question mark icon) gives information fo each of the parameters needed in th calculation.

Analytical Models

Currently, only one analytical model is contained in this stack. ODAST is a one-dimensional solute transport model that considers advection, dispersion, solute decay, source decay, and adsorption. Output from the model is provided as a two-way table of dimensionless concentration versus time and distance. The ODAST model is a useful tool for providing preliminary estimates of solute transport in a ground-water system.

BIOPLUME II Model

BIOPLUME II is a two-dimensional computer model that simulates the transport of dissolved hydrocarbons under the influence of oxygen-limited biodegradation. BIOPLUME II also simulates reaeration and anaerobic biodegradation as a first-order decay in hydrocarbon concentrations. The model is based on the USGS solute transport two-dimensional code. It computes the changes in concentration over time due to advection, dispersion, mixing, and biodegradation. BIOPLUME II solves the solute transport equation twice: once for hydrocarbon and once for oxygen. As a result, two plumes are computed at every time step. The model assumes an instantaneous reaction between oxygen and hydrocarbon to simulate biodegradation processes. The two plumes are combined using the principle of superposition.

The model is extremely versatile in that it can be used to simulate natural biodegradation processes, retarded plumes, and in-situ biorestoration schemes. BIOPLUME II allows injection wells to be specified as oxygen sources into a contaminated aquifer, and the

model can be used to evaluate alternate methods for aquifer reclamation. A graphical preprocessor for the BIOPLUME II model has been developed to facilitate data entry.

OASIS Example

As an example of the way in which OASIS can be used as a support tool for the BIOPLUME II model, consider a gasoline leak at a service station located in the western mountain ranges. The following steps might occur when using the system.

First, the user might consult one of the two chemical databases contained in OASIS. The user could refer to the specific chemical database to examine physical data on benzene (Figure 1). If the user is unfamiliar with the hydrogeology of the area, he or she can enter the hydrogeologic database. The correct ground water region is selected first, then the aquifer media, and then the hydrogeologic setting, as pictured in Figure 2. Once the setting is known, the user can examine data from sites with a similar hydrogeologic setting. The hydrogeologic data is designed to be used as a general educational tool and not as a substitute for field work.

At this point, the user can run the analytical model to help set up the problem or enter directly into the BIOPLUME II preprocessor. The preprocessor was designed to do three things: structure the data entry process, give immediate access to ground water and data entry help, and provide a graphical method for entering and viewing the spatial information used by the model.

Once the user finishes entering the data, the preprocessor makes a text file corresponding to the format required by BIOPLUME II. The model is run and the graphical postprocessor, BioGraph, displays the output from the model (contaminant concentrations over the area of the aquifer) in the form of patterns. Darker patterns correspond to higher concentrations. The development of the plume over time can be seen with an animation option in BioGraph. Concentration profiles over time or over distance can be examined also. The preprocessor and the postprocessor for BIOPLUME II were designed to facilitate model calibration and data evaluation.

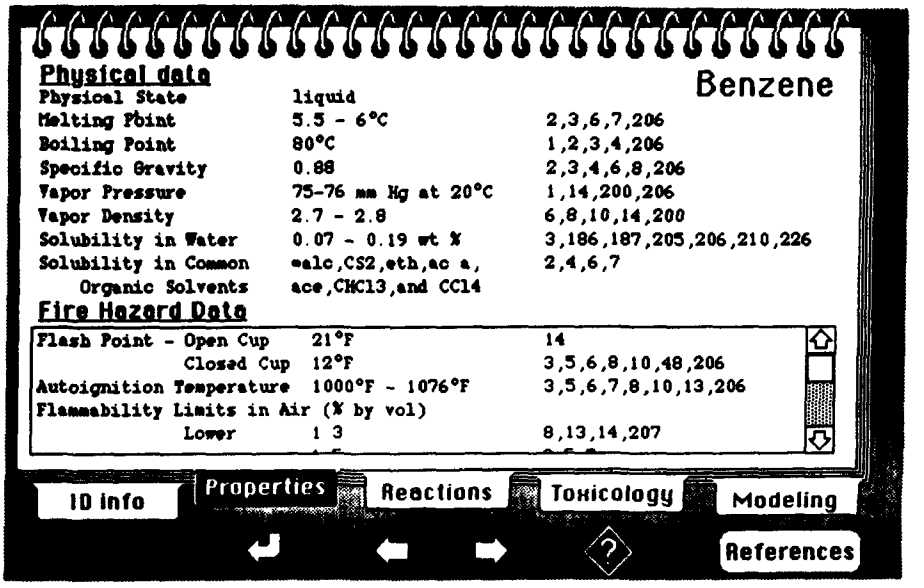

Figure 1. Card from the specific chemical database, benzene.

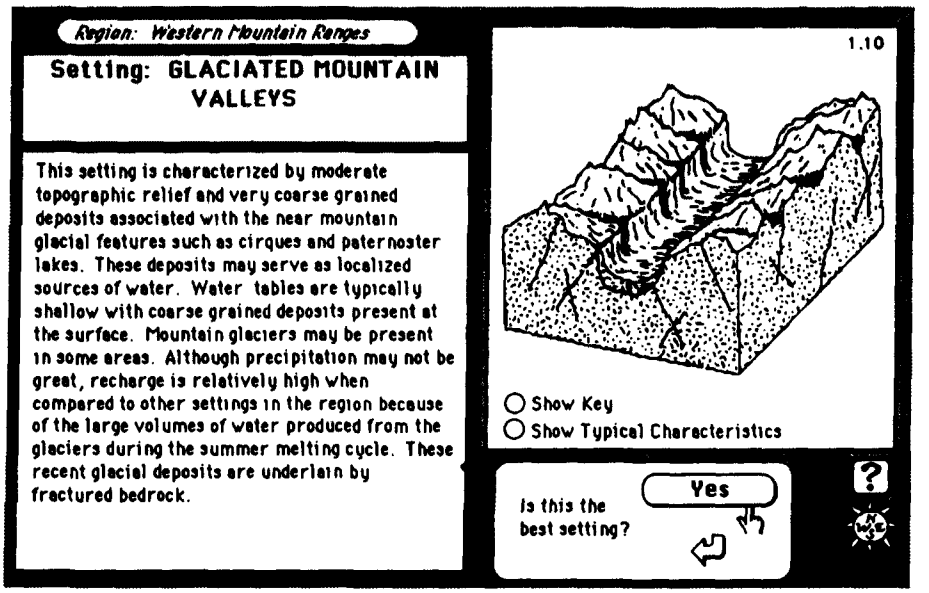

Figure 2. Hydrogeologic setting card.

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***Joe R. Williams** is the EPA Project Officer (see below).*
The complete report, entitled "OASIS: Parameter Estimation System for Aquifer Restoration Models, User's Manual Version 2.0," (Order No. PB 90-181-314AS; Cost: $17.00, subject to change) will be available only from:
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