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A MODULAR GROUND WATER MODELING SYSTEM (GWZOOM)

1. Concept and System

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A MODULAR GROUND WATER MODELING SYSTEM (GWZOOM): 1. Concept and System

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ABSTRACT: To support water resources evaluation, planning, and regulation, the South Florida Water Management District (SFWMD) develops and maintains a ground water modeling information base. This information base consists of calibrated regional groundwater models and associated data sets. Frequently, new models, typically at smaller scales and with finer grid resolution, need to be created to analyze localized impacts of wellfields, water control structures, and water management alternatives for water supply, flood control, and environmental enhancement. To facilitate the creation of these smaller-scale models, a modular ground water modeling system, called GWZOOM, was created based on a Geographic Information System (GIS). GWZOOM provides an interactive environment in which model grids, spatially referenced to a base map, can be generated on a computer screen. Spatially and temporally distributed data can be interpolated to all grid cells, and automatically assigned to the model coordinates (layer, row, column). The model input is created in the format required by the ground water flow model code (MODFLOW). This modeling system provides the capability for modelers to create, apply, and revise groundwater models quickly and in ways never before possible. It also provides a new system for organizing, processing, and storing data for groundwater models.

KEY TERMS: Ground Water Modeling; Geographic Information System; Water Resources Management; Information Management; Hydrogeology

INTRODUCTION

Traditionally, creation of ground water models is often a lengthy, tedious, and difficult process. The majority of effort in this process has been to transform data in the form of maps and tables into the "layer-row-column" format for each hydrogeologic parameter. It is often not feasible to create new models within a short time frame. However, the ability to quickly "zoom" into a selected area within an existing regional model, to create a new smaller-scale model and to analyze alternatives, is needed at the South Florida Water

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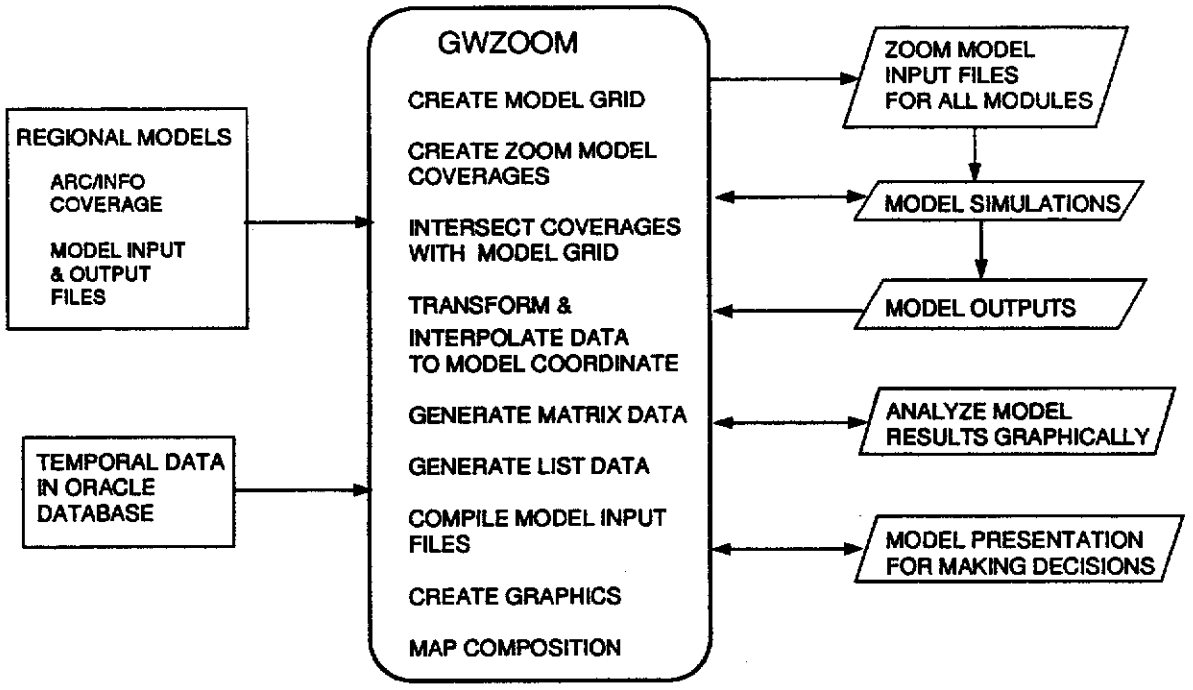

Figure 4. Conceptualized GWZOOM

GWZOOM SYSTEM

The system is operated from within the Arc/Info GIS environment. Once inside Arc/Info, the system can be started by typing "gwzoom" from the Arc Prompt. The GWZOOM main menu will appear on the screen (Figure 5), which provides the following options:

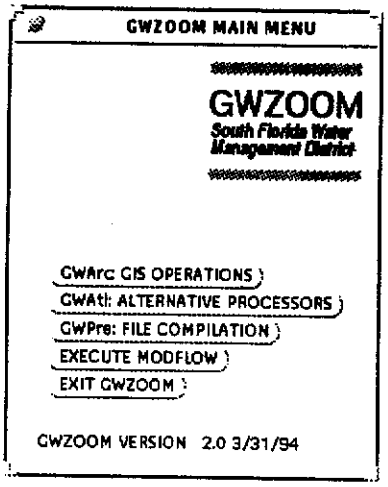

Figure 5. GWZOOM Main Menu

- "GWArc": Performs model-related GIS operations within an Arc/Info workspace.
- "GWAlt": Provides major alternative options for creating model inputs, analyzing model results, and adding new modules.
- "GWPre": Performs model related file compilation and form-driven input for model parameters.
- "Execute": Runs a MODFLOW model for which all input files have been prepared.

- "Exit": Exits GWZOOM, returns to Arc/Info.

Where "GWArc" and "GWPre" were programmed with modular structures and sharing common sub-programs corresponding to all modules of MODFLOW, "GWAlt" was programmed with independent modules for special needs and alternative operations. Additional modules can be easily added to all three options. Due to the limited space in this paper, only the major features in "GWArc" will be discussed.

GWArc

GWArc integrates GIS functionality with model development and application processes. It includes the following GIS based operations:

- Generate a uniform-spaced or variable-spaced finite-difference model grid graphically using base map features as a background.
- Generate matrix data files for model inputs (e.g., recharge, aquifer top, or aquifer hydraulic conductivity values for each cell) from GIS entities such as polygon coverages, three-dimensional surfaces (Arc/Info TIN or LATTICE), or from the input or output files of regional models.
- Generate list data files (e.g. wells, rivers) from GIS entities such as point coverages (wells), arc coverages (rivers), and polygon coverages (lakes).
- Allowing time-varying data (e.g. pumping rates, recharge, canal stages) stored in database tables to be accessed and related to model stress periods, and then processed into the model input data sets.
- Post-process model output into GIS-compatible format files so that simulated heads may be manipulated and analyzed with respect to other GIS data.
- Make displays of model inputs and outputs in maps and profile forms.

The goal of GWArc is to allow modelers to utilize the power of Arc/Info for developing models in a menu-driven, point-and-click environment. The GWArc menu and its sub-menus are illustrated in Figure 6. The various "pull-down" menus are associated with the main menu options delineated with triangles. Figure 6 shows that there are numerous options available to the modeler to facilitate model development and application. "Model Grid" and "Model Data" are the most frequently used operations.

Model Grid

A model grid can be created interactively on a computer screen. This option is designed to generate a uniform or variable-spaced finite-difference model grid graphically with base map features as a background. Once a base map is displayed on the computer screen, the grid can be generated using the steps illustrated in Figure 7. The resulting model grid has the starting row/column block at the top-left corner. This convention is consistent with MODFLOW grids. This process creates a polygon coverage that identifies each cell with a model row and column and a MODFLOW input data file describing the model grid. After model grid creation, options in the "Model Data" menu are typically used to generate the remaining MODFLOW input data files.

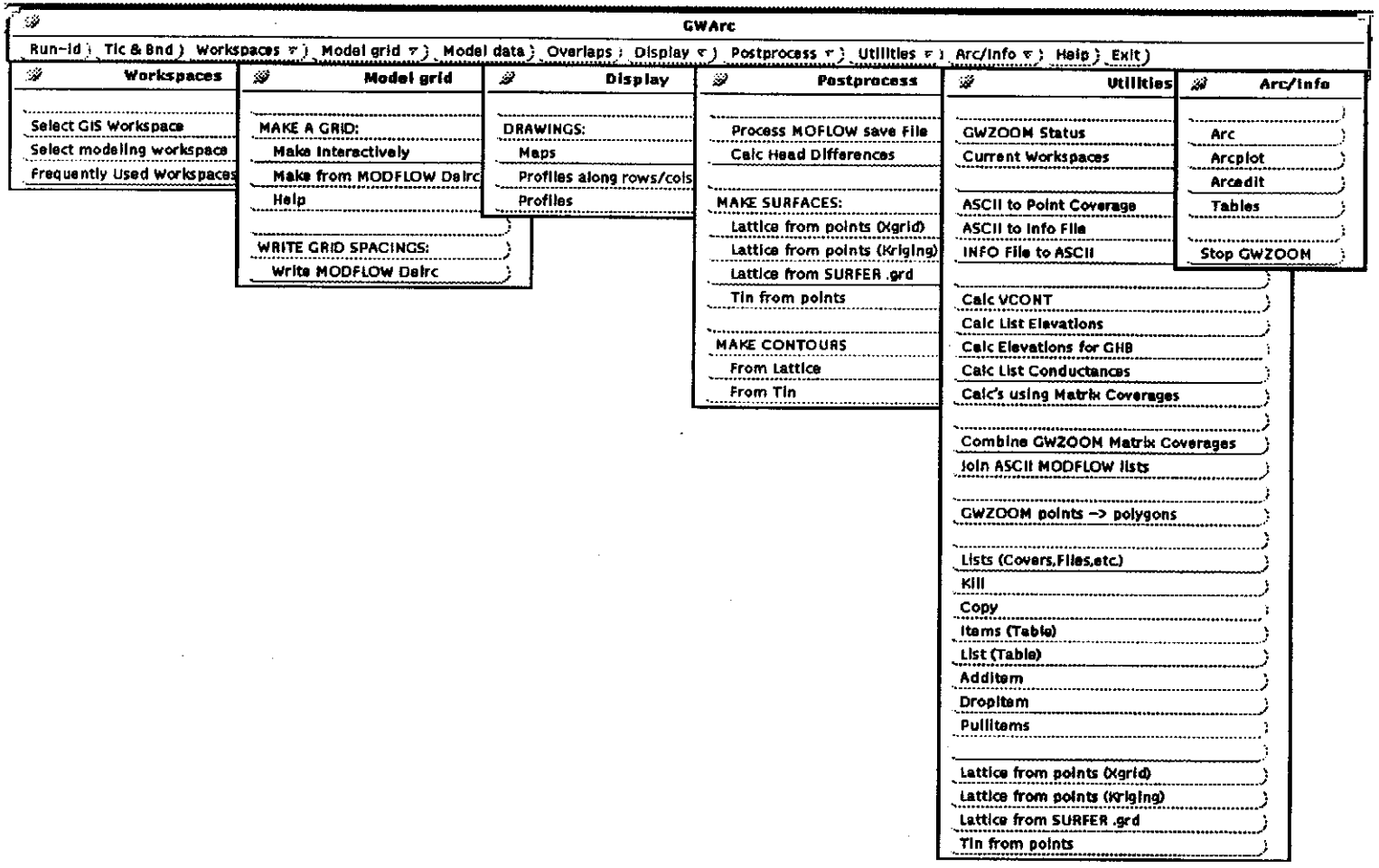

Figure 6. GWArc Menu

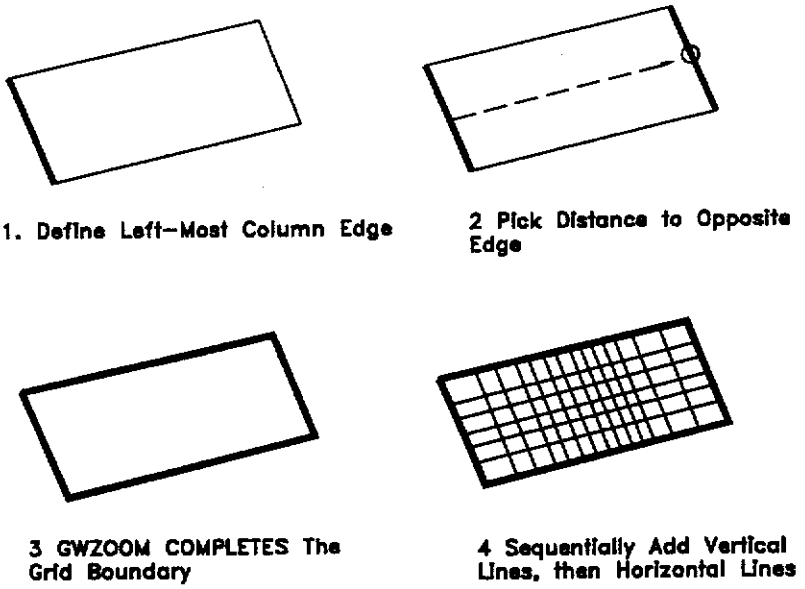

Figure 7. Creation of a Finite-Difference Grid

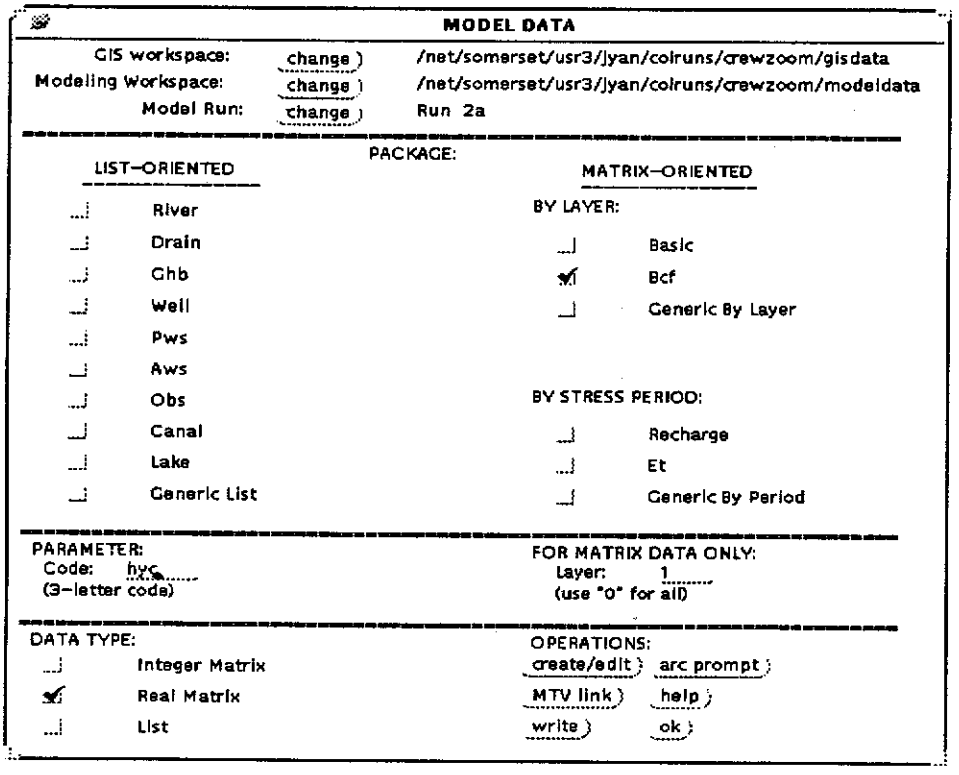

Figure 8. Model Data Menu

Model Data

The "Model Data" menu (Figure 8) provides the options for developing input files for the various MODFLOW modules, classified into two categories: list-oriented and matrix-oriented. The data files for each module for the zoom model can be created interactively in this point-and-click environment. GWZOOM uses embedded procedures to calculate and convert data stored as GIS coverages of the regional model data files into MODFLOW data files for the zoom model.

CONCLUSIONS

The GWZOOM system integrates four major components for developing and applying models: 1) a geo-referenced hydrologic database, 2) a data processing and transformation system for creating scalable ground water models, 3) a ground water simulation program, and 4) a system for graphically displaying and analyzing model input and output. The integration of GIS with ground water modeling provides an effective mechanism for the development and application of ground water models at the South Florida Water Management District.

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