UNIVERSITY OF MARYLAND

SHA

GISHYDRO2000

Performing Automated Hydrologic Analyses in Maryland

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Bridge and highway engineers must consider the frequency, magnitude, and timing of floods and the floods' effects on highway infrastructure. The University of Maryland (UMd) and the Maryland State Highway Administration (MSHA) have developed a software package that removes much of the drudgery associated with standard hydrologic modeling tools. This geographic information system (GIS)-based software allows the engineer more time to consider alternative design scenarios and to examine the sensitivity of the model output to a range of input parameters—that is, how the results will hold under different possible situations.

Problem

Standard hydrologic analysis programs examine flood flows at a given design point—for example, at a highway bridge crossing. However, these programs have been tedious and laborious to apply. First the engineer would assemble data on topography, land use, and soils, then delineate the watershed, and finally with tracing paper and a light table, overlay the information to determine the watershed parameters. A change in the location of the proposed highway structure or an error in the data could negate weeks of work, requiring a repetition of the same tedious and time-consuming procedures.

Solution

GISHydro2000, a program developed at UMd, employs GIS technology to reduce the time to perform hydrologic analyses. The program also improves the integrity and the reproducibility of the results. There are three steps in the analyses: assembling the data, estimating the peak flows, and analyzing and critiquing the model results.

Assembling Data

The first step is to select information from a database on the entire state of Maryland as well as the adjacent areas of Pennsylvania, Delaware, and West Virginia that drain into Maryland (Figure 1). This geographic information allows the user to examine the sensitivity of the model output to changes in land use, topography, and soils.

Estimating Peak Flows

The engineer next indicates the location of key elements such as the overall watershed outlet—that is, the design point—and identifies the location of specific internal features, such as reservoirs or other infrastructure.

GISHydro2000 currently supports two fundamentally different hydrologic analysis programs:

- "TR-20," a rainfall-runoff model developed by the Natural Resources Conservation Service and required by the state of Maryland for all significant hydrologic analyses, and
- The U.S. Geological Survey's peak-flow regression equations.

Analyzing and Critiquing the Results

A bonus of GISHydro2000 is that the time saved in the first two steps can be applied to the analysis of the model results. Several scenarios can be investigated to determine which design is the most cost-effective or environmentally sound. The program also allows the examination of different characterizations of the watershed by variations in land use, soils, and topography, indicating the sensitivity of the model results to the input data.

Application

MSHA has used GISHydro2000 and its earlier versions since 1991. The software has become the standard tool for MSHA watershed analyses. The

Maryland Department of the Environment also has recognized the program's value, and other state, local, and private agencies now are using GISHydro2000 in their analyses.

Benefits

On 83 projects varying in size from 1 to more than 50 square miles, GISHydro 2000 and its earlier versions have trimmed costs by an estimated total of $994,600. This amount is based on approximately 18,000 engineer-hours saved. These savings only account for MSHA engineers and do not include consultants or employees of other government agencies.

With use, the program's efficiency has increased; MSHA estimates that, on hydrologic analyses, GISHydro2000 now saves 75 percent of the costs of the previously used paper methods, and future savings are expected to be greater.

GISHydro2000 has realized savings in construction as well. Before the program and its earlier versions, time constraints had precluded calibration of the model results as well as sensitivity analyses. Today 25 percent of the analysis time is spent on sensitivity studies, resulting in more reasonable discharge estimates; this saves 40 to 70 percent on the costs of construction related to peak-flow magnitudes, such as the size of a waterway opening. These construction savings may total millions of dollars.

Another valuable benefit is that GISHydro2000 standardizes all MSHA hydrologic analyses. The traditional approach required subjective decisions in delineating the watershed and deriving parameters. GISHydro2000 documents all decisions, and different engineers can reproduce the results, giving greater credibility to the analyses. Outside consultants and reviewers involved in the permitting process also have access to this program and can produce analyses that are consistent with those generated by MSHA. Therefore, before the use of this program and its earlier versions, turn around time for review and approval of MSHA studies generally ranged from 12 to 24 months. With the current software, this process now generally requires only 2-4 weeks.

Present and Future: GISHydro Website

The current version of GISHydro2000, including documentation and a user's manual, can be downloaded from the UMd website, http://www.gishydro.umd.edu/.

MSHA and UMd plan to develop a new version that will work directly from the website. The website program would offer all the features of GISHydro2000 but require only a web browser to operate. In this way, agencies can forgo the purchase of several software licenses and can centralize the location of the software and database for ready maintenance, updating, and support.

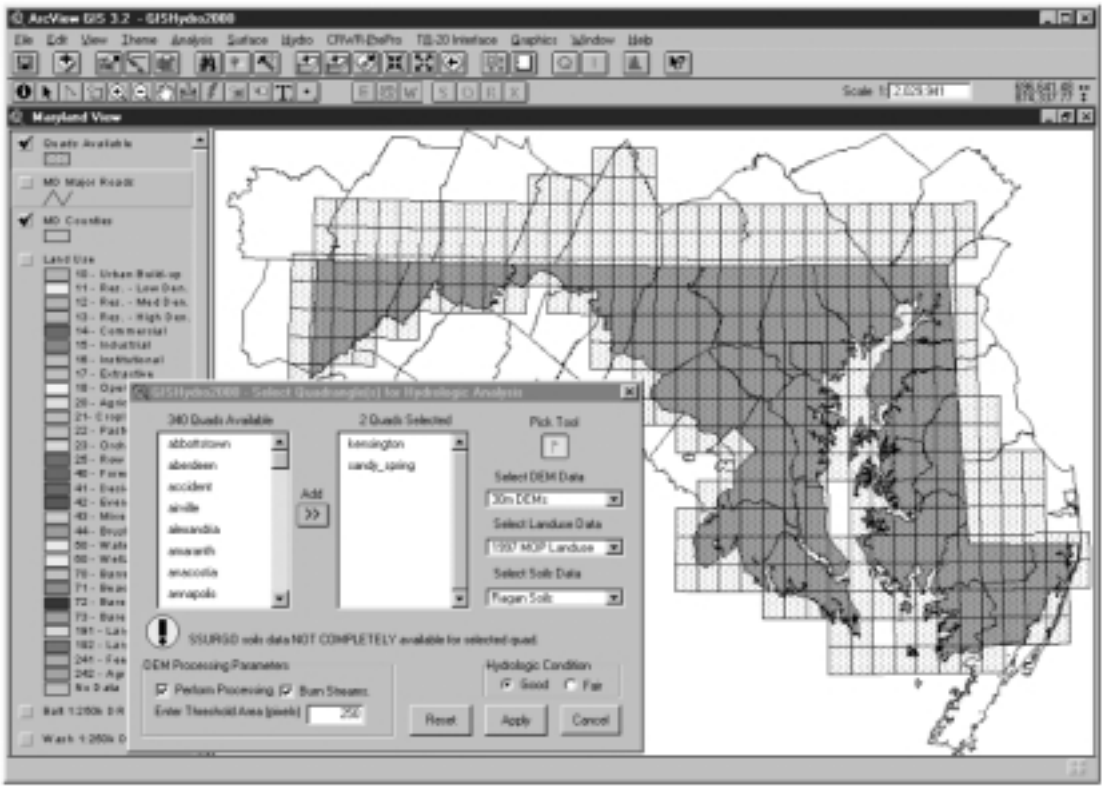

FIGURE 1 GISHydro 2000 "Maryland View" with "Select Quadrangle(s) ..." dialogue box active.

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Suggestions for "Research Pays Off" topics are welcome, Contact G. P. Jayaprakash, Transportation Research Board, 2101 Constitution Avenue, NW, Washington, DC 20418 (telephone 202-334-2952, e-mail gjayapra@nas.edu).