GIS For Water Resources: *NOW* and Into the *FUTURE*

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Geographic information system software is becoming a vital tool for managing resources and better understanding the world. GIS provides a framework for information integration, communication and collaboration, and decision support. It is used today by millions of people in government, business, energy, public safety, education, engineering, health and human services, natural resources, and water resources. Water professionals are increasingly using GIS to help better represent, understand, manage, and communicate hydrologic issues.

As GIS becomes a ubiquitous technology, new breakthroughs will propel the technology even further. A few key areas on the innovation front are interoperability, data models, Web services, Web-based GIS, and temporal and mobile GIS. Each of these areas will help water professionals with their work and provide a foundation for continued success.

Interoperability

Interoperability is the capacity for different computers, databases, and technologies running on different software and hardware platforms to work together in an integrated fashion. Open, standards-based technology will help infuse computer mapping and analysis into core IT environments, eliminating the need for isolated information data stores and for data conversion, translation, and importing and exporting. In addition, GIS will be used as an enterprise platform—a linked technology network of software, hardware, and data—that fully integrates into an organization's overall information system to improve data sharing and communication. Interoperability will help agencies utilize a common GIS infrastructure that fully integrates with other hydrological applications and databases. For instance, predictive floodplain analysis can be performed with greater speed because GIS can more easily interoperate and transfer data with near-real-time rainfall measurement applications and watershed flood models. What once required significant data management is now optimized.

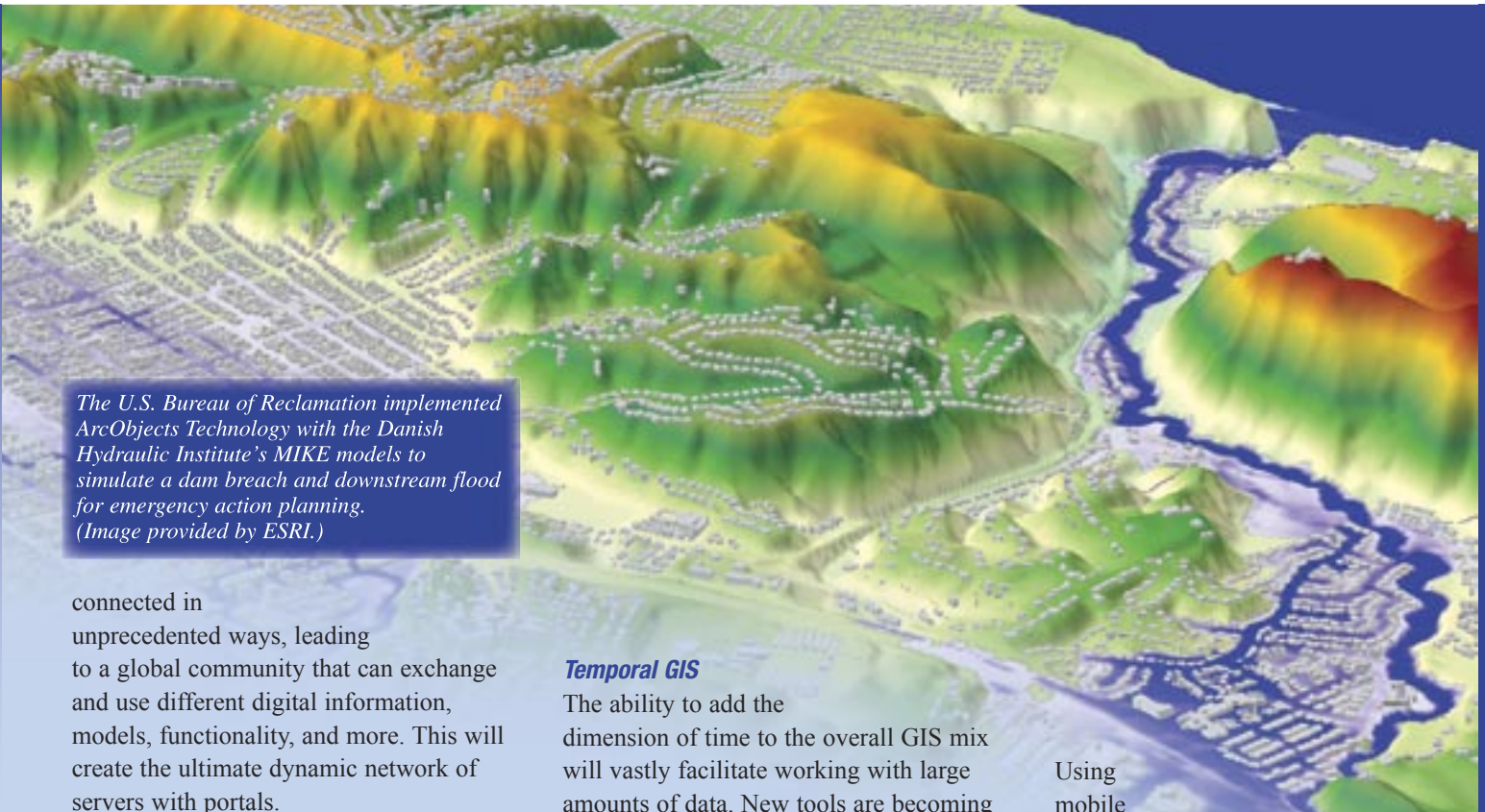
Data Models

Industry-specific data models simplify the implementation of projects and promote standards. Academic agencies, government organizations, businesses, and industry leaders are joining forces to create and design data models that can be used within a single GIS platform. The result will be tailor-made, industry-specific data models that meet the needs of specific industries, such as water resources.

Specifically for the water industry, and with input from key state, national, and international contributors, ESRI developed the Water Resources data model, Arc Hydro (see page 18). ESRI also developed the geodatabase, a physical store of geographic information inside a database management system. The geodatabase uses data models to define and organize datasets with schema, definitions, and topological rules. Data models organize the information and metadata that make up complex maps, allowing applications to visualize and use data in the geodatabase.

Web GIS

Web GIS, such as ArcIMS, provides methods for linking users and servers with portals, or Web gateways to many other Internet resources. Through portals, multiple distributed services can be dynamically integrated, allowing data to be overlaid and analyzed. As a result, people and organizations are becoming



The U.S. Bureau of Reclamation implemented ArcObjects Technology with the Danish Hydraulic Institute's MIKE models to simulate a dam breach and downstream flood for emergency action planning. (Image provided by ESRI.)

connected in unprecedented ways, leading to a global community that can exchange and use different digital information, models, functionality, and more. This will create the ultimate dynamic network of servers with portals.

One example of such a Web service is the U.S. Office of Management and Budget's Geospatial One-Stop (geodata.gov), a portal that references spatial data from many federal, state, and local government agencies. Another example is the StreamStats project, a Web service currently in development that will allow streamflow statistics to be calculated via the Internet for any point in the United States or Puerto Rico, using existing regression equations. The U.S. Geological Survey Office of Surface Water contracted with ESRI for the design and implementation of this system, which is currently being prototyped.

Finally, several years ago, ESRI launched the Geography Network (www.geographynetwork.com), a global network of spatial data users and providers. It provides the Internet infrastructure to support sharing of geographic information among data providers, service providers, and users around the world. Through the Geography Network, a user can access many types of geographic content, including dynamic maps, downloadable data, and more advanced Web services.

Temporal GIS

The ability to add the dimension of time to the overall GIS mix will vastly facilitate working with large amounts of data. New tools are becoming available to represent, display, and manage time-series data for watersheds, land cover, soils, climatic variables, and more. Users can visualize and analyze temporal data by defining events, including time, location, and attribute information. These tools can display vector data such as points, lines, polygons, and tracks, for historical or real-time data analysis. Monitoring actions are also available, and existing temporal data can be set with future and/or past time windows. This type of analysis can, for example, help hydrologists understand and possibly predict landscape water flow using both time and space variants. Hydrologists also can use GIS with time data to visually identify patterns such as river bacteria over years or rainfall runoff over minutes.

Mobile GIS

For water professionals, the ability to perform data capture and analysis in the field is tremendously valuable. Professionals are now turning to mobile GIS in their fieldwork, gaining database access and global positioning system (GPS) integration through handheld and mobile devices. Data collection is fast, easy, and significantly improved, with immediate data validation and availability. Using mobile GIS, professionals can use existing data remotely. They also can add data from the wireless Internet, as well as query data; measure distance, area, and bearings; navigate a GPS; and perform data editing. For ecologists, environmentalists, and others who conduct field surveys of rivers, lakes, urban water systems, and more, this provides an efficient means for gathering digital information that then can be quickly and easily uploaded and linked to other digital datasets, applications, and databases.

What the Future Holds

GIS has been used for decades to develop solutions to water resource problems and find innovative ways to better sustain natural resources. Today's technological innovations and the future of GIS will provide even greater ease of use and advanced geoprocessing. Hydrologists won't have to become GIS experts to solve problems. They will simply be able to use and benefit from GIS tools that are fully integrated into an overall information system.

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