GIS Applications in Water Recourse Engineering

Term Paper

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For

CRP 514: Introduction to GIS
Term 081 – 14th Offer

Course Instructor:
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Date: Feb. 4, 2009

Contents:

Abstract

This term paper discuss the relationship between GIS and water resources engineering. Some application of GIS in Water Engineering are presented such as Watershed Delineation, Hydrologic Modeling, Floodplain Management, and other applications. Advantages and some of the recent obstacles in using GIS in water recourses engineering are discussed. Overall using GIS have helped hydrologists in understanding nature but additional studies on GIS has to be performed to eliminate and reduce errors on this applications compared to other applications not using GIS.

1- Introduction

A hydrologic simulation model is, in general, composed of three basic elements, which are (1) equations that govern the hydrologic processes, (2) maps that define the study area and (3) database tables that numerically describe the study area and model parameters. When a model is constructed using a procedural programming language, such as FORTRAN, these three elements are usually processed separately and then assembled at runtime to form a model. Because of this separation, the modification on a model map will not automatically update its related databases and programs. Therefore, each time the model study area is changed or additional data are obtained, the procedure and efforts of the data collection and preparation used to construct the original model are repeated to construct a new model. The situation can be improved if all three elements of a simulation model can be integrated and if standard map bases can be built for extensive regions.

In addition, when looking back into the history of the numerical modeling in the area of water resources, it can be seen that the general trend of the modeling approach is moving from the periods of (1) 'function-centric' where numerical models were self-contained and supported by their own data sets, through (2) 'data-centric', where models were supported by some general database management systems, and towards (3) 'map-centric' where models would be supported by or written in GIS.

On the other hand, hydrologic or hydraulic models are designed to
simulate the processes of surface or subsurface water flow. The effects of land cover, vegetation, soil type, topography, geology, water quality, and other factors must be considered in order to make sound management decisions. The data are available from a variety of public agencies, but often in different coordinate systems, at different scales,

and from different time periods. How is it possible to synthesize all these data to form a holistic view of the watershed?

Also,

Hydrologic analysis is vital to the design of drainage facilities in highway engineering. The cost of drainage facilities, such as storm drains, highway culverts, bridges, and water quality and quantity control structures, accounts for twenty five to fifty percent of the total cost of highway projects. The importance of drainage structures covers the range from transportation facilities to security against natural disaster, life safety and economics. Hydrologic analysis has always been an important component in highway engineering design and directly affects the success of whole projects. Accurate hydrologic analysis is desired. But accurate analysis depends not only on advanced and reasonable hydrologic models, but also the availability and the processing of wide range of spatial data. Substantial efforts are required to manually establish and manipulate spatial data. The traditional approach usually balances accuracy with simplicity. In general, simplicity limits the choice of hydrologic models and so limits the degree of accuracy.

From this introduction, we can see easily that performing hydrological modeling has three basic requirements:

1- The ability to be updated(in maps, equations and database) easily when new data arrive or changes occur with no need of redoing modeling again.
2- The ability of adding data from various sources, coordinate systems, scales, time periods,….etc.
3- The ability of producing an accurate model taking in consideration any spatial data needed.

Due to the development of computer and hydrologic computation techniques, GIS-based hydrologic systems are improving the situation by improving accuracy, reducing the effort of data establishment and manipulation and all the above requirements.

Why GIS is the best choice?

A geographic information system (GIS) is designed to visualize, store and analyze the information about the locations, topology, and attributes of spatial features. In most GIS programs, data are stored and managed in a relational database embedded in the system. A GIS program can perform regular database management tasks in addition to its spatial analysis capabilities. For this reason, GIS can be considered as a relational database management system with a map interface for data presentation. In GIS, locational data and their map representations are dynamically linked so that any changes made in the databases are reflected immediately on its map presentation. The linkage between the map and databases makes GIS an ideal and strong tool for spatial data visualization and analysis (Bao J. , Maidment D., Olivera F., 1997).

2- Objectives

GIS is a new technology which can be used as an effective tool at any science. As a civil engineer (water resources), I am interested to know how GIS can be used in my field. In addition to that I am willing to use GIS in future applications in water resources. So, to reach my goal in using GIS, first I have to perform a search on applications of GIS in my field of interest.

3- Limitations and Constraints

Actually there are some limitations and obstacles faced me when preparing this term paper such as:-

1-Applications of GIS in Water resources are relatively new (since 90s), and they are still being studied by scientist. Different scientist – sometimes- have various opinions on GIS applications in water resources.

2- Papers published are not accessible, a searcher must pay money to get the papers.

3- The field is really complicated and sometimes I faced difficulties of understanding some GIS technical terms because of my recent knowledge of GIS.

4- Literature review and Case Studies

I will present here a short summary for the major sources and case studies (3 out of 4 master thesis From Center for research in water resources , Bureau of Engineering Research, The University of Texas at Auston, http://www.ce.utexas.edu/centers/crwr/) I used in my term paper:

1- Source: W. D. Rosenthal, R. Srinivasan, J.G. Arnold, Alternative River Management Using Linked GIS-Hydrology Model

In this paper the scholars tried to study the accuracy of using GIS-Hydrologic model to aid in forming input files for the hydrologic model SWAT (Soil and Water Assessment Tool). The area of study was the lower Colorado river basin of Texas. They have concluded that GIS can be used to collect and manage input into SWAT. And they noticed that the model closely simulate (R=0.75) monthly stream-flow volume from 1980 to 1989 with observed values.

2 – Wolfgand-Albert Flugel, 1997, Combining GIS with regional hydrological modelling using hydrological response units (HRUs).

Dr. Albert Flugel has performed an application and delineation of hydrological response units (HRUs) in Germany-Brol catchment. HRU are usually the heterogeneous hydrological characteristics of drainage basin such as recharge, runoff, precipitation, topography, land-use….etc. This study showed that GIS method used for their delineation is applicable in basins of different climate and topography, which was usually a problem for hydrologists.

3- David R. Maidment , 1993,Developing a spatially distributed unit hydrograph by using GIS.

The goal of this paper was to develop a spatial unit hydrograph that helps scientists to determine internal distribution flow through watershed. Additional benefit was describing the connectivity of the links in the watershed flow network. The researcher divided watersheds into a grid of elevations using GIS. Each square in the grid will allow water to flow to one of the eight neibor squares which has the lowest elevation.

4- **Master Thesis :** Kwabena Asante and David Maidment, 1997 ,GIS Based Reservoir Planning for the Souss Basin, Morocco.

This research was done to develop a map-based surface water simulation model of Souss River in Morocco and the three major located within the basin. The goal was to simulate the effects of reservoirs on flow in the basin. The researcher used a program developed from GIS software ArcView. Data used by Mr. Kwabena were collected for about 60 years. The study of the reservoir planning activities in the Souss basin provided insight into the use of a map based surface water simulation model in water resource planning.

5-**Master Thesis :** David James Anderson, 2000 ,GIS-Based hydrological and hydraulic modeling for Floodplain delineation at highway river crossing.

Mr. David James named his thesis GIS-Based hydrological and hydraulic modeling for Floodplain delineation at highway river crossing. This research investigates the synthesis of previously developed hydrologic and hydraulic modeling tools for digital floodplain analysis at two locations - Castleman Creek (McClennan County, TX) and Pecan Bayou (Brown County, TX). GIS was used to prevent manual plotting of extent floodplain. Mr. David James concluded that GIS framework can effectively define a hierologically correct terrain model, similarly watersheds can be delineated accurately

6- F. De Smedt, L. Yongbo and S. Gebremeskel, 2000, Hydrologic modelling on a catchment scale using GIS and remote sensed land use information.

This is a research that presents a physically based distributed hydrological model that uses detailed basin characteristics to predict hydrological processes. The researchers focused on the simulation of runoff. The model is validated for a small watershed in Belgium by comparing calculated and observed hourly discharges for a 6 months period. The utility of the model is demonstrated by forecasting peak discharges resulting from an observed 100 year precipitation series. Actually their conclusion was amazing, the resulting calculated hydrograph compared favorably with measurements, without any need to model optimization.

7- Source: Dao Huy Giap Yang Yi , Nguyen Xuan Cuong and Le Thanh Luu , James S. Diana, C. Kwei Lin , Application of GIS and Remote Sensing for Assessing Watershed Ponds for Aquaculture development in Thai Nguyen, Vietnam.

This is a project conducted by the Vietnamese government. The government has initiated aquaculture development in those areas as a means to increase protein availability.

Therefore, the development of aquaculture in Thai Nguyen may also serve as a model for watersheds in other provinces. The project proposes to develop a GIS database of watershed ponds. The study showed the modeling power of GIS to evaluate land for development of watershed ponds.

8- Source: David L. Jordan, An Introduction to GIS Applications in Hydrology , Southwest Hydrology.

In this article, the writer showed why GIS is important tool in Hydrology. Mr. David implied that to make a sound management decisions, the effects of land cover, vegetation, soil type, topography, geology, water quality, and other factors must be considered. GIS is the tool for combining, using and analyzing these factors.

9- Paul Amos, Desktop GIS Software for Hydrological Applications, Southwest Hydrology.

This paper presents different GIS software used in hydrological applications. Some of these softwares are free and some cost thousands of dollars. In addition, some programs have much more powerful tools then others. The writer chose to present:

- Autodesk – Envision 8 ,
- Bentley Systems PowerMap ,
- Clark Labs – IDRISI: The Kilimanjaro Edition
- Earth Resource Mapping – ER Mapper 6.4 ,
- ESRI – ArcView ,
- Geographic Resources Analysis Support System 5.0.3 (GRASS) ,
- Intergraph – GeoMedia 5.1 ,
- Keigan Systems - MFWorks 3.0 and
- Manifold System 5.5 Professional Edition.

10- Source: David R. Maidment, Arc Hydro Data Model: A Hydrologic Data Integration Tool, SouthWest Hydrology.

First of all I have to mention here that Dr. David is one of the leading professionals in GIS-Hydrologic Modeling. He is the chairman of Center for Research in Water Resources, University of Texas , and he is working with ESRI to improve its products. I have seen a lot of his publications and they were useful.

In this article Dr. David tells us a new reason for using GIS. How to get benefit of all data available to improve our understanding of water resources. He showed " what can Arc Hydro do". Data modeling was compared to hydrological modeling which can be better understood if we imagine that our goal is to describe the hydrologic environment within which the hydrologic processes function– Data Modeling , instead of describing how they function- Hydrological Modeling.

11- Source: Steve Kopp,GIS For Water Resources:NOW and Into the FUTURE, SouthWest Hydrology.

Mr. Steve presented – as a member of ESRI team – the vital role of GIS for better understanding of the world. The paper showed beifly the new abilities for hydrologists because of the improvement of GIS science in present and a prediction on what will be new in the future such as making GIS applications easy and usable even to non-GIS specialists.

12- Source: Roberto Anaya and Robert E. Mace – Texas Water Development Board Behind Every Successful GAM, There is a Good GIS, Southwest Hydrology.

In this paper the writer presented the importance of GAM (Groundwater Availability Model) for assessing the possible effects of drought and pumping on water levels and spring flows. The writer admitted that behind every successful GAM is a good geographic information system (GIS) since developing a GAM requires immense quantities of spatial and temporal data, including geology, soils, census, aquifer properties, hydrography, and land use.

13- **Master Thesis** :Eric Tate, 1999, Floodplain Mapping Using HEC-RAS and ArcView GIS.

This research – thesis-presents a straightforward approach for processing output of the HEC-RAS hydraulic model, to enable two- and three-dimensional floodplain mapping and analysis in the ArcView geographic information system. The methodology is applied to a reach of Waller Creek, located in Austin, Texas. A planimetric floodplain view is developed using digital orthophotography as a base map. Overall, the results of the research indicate that GIS is an effective environment for floodplain mapping and analysis.

14. Source: University of North Dakota, 2007, Water Resources and GIS Integrating Water and Hydrology.

This is a study conducted by University of North Dakota. The aim was to study factors causing the rise and fall of water level at Devils Lake in northeastern North Dakota. The research issues involved in the hydrology of the Devils Lake basin are an ideal representation of how GIS can be used to integrate different scientific disciplines as well as differing scales to study complex natural systems.

5- Applications of GIS in Water Resources

The management of water resources requires a wide range of spatial data, from hydrography and water distribution and collection systems, representing the status of water resources, to phenomena influencing the quality and movement of water such as terrain, climate, soils, and land use.

5-1 Hydrologic and Water Quality Data

The new rising GIS-Hydro science has enabled governments, agencies and organizations related to water resources to change numerical tables' data to maps of spatial data that support any spatial search for relevant data. There are a lot of examples that show this jump in water management. Environmental Protection Agency is a good example, which allows the user to obtain water quality data in the form of maps and tables (http://www.epa.gov/surf/).

It is obvious that these spatial data can be used beyond research, management or assessment (such as the values of real estate or decisions on business locations) because of its huge capabilities (Wilson J.P., Mitasova H., Wright D.J., 2000).

5-2 Spatial Interpolation

One of the most powerful aids GIS provided Hydrology is the new tools for creating spatial and spatiotemporal models of land surfaces, climatic phenomena (e.g., precipitation and temperature), soil properties, and water quality from measured data.

"The inclusion of the ANUDEM elevation gridding procedure in ArcInfo (Versions 7.0 and higher) illustrates these new capabilities. ANUDEM and TOPOGRID (as it is called in ArcInfo) take irregular point or contour data and create square-grid DEMs. The procedure automatically removes spurious pits within user-defined tolerances, calculates stream and ridgelines from points of locally maximum curvature on contour lines, and (most importantly) incorporates a drainage enforcement algorithm to maintain fidelity with a catchment's drainage network."(Wilson J.P., Mitasova H., Wright D.J., 2000).

5-3 Watershed Delineation

Over the last decade a number of algorithms for the delineation of watershed and extraction of stream networks from DEMs (Digital Elevation Models) have been developed and implemented in GIS.

This development in calculating topographic attributes (such as, slope, aspect or curvature) has provided the basic required parameters for hydraulic modeling. Tracing flow allowed the simulation of :

- Water movement,
- Sedimentation movement, and
- Pollutants movement,

which improved our understanding and identification of potential sources of non-point source pollution.

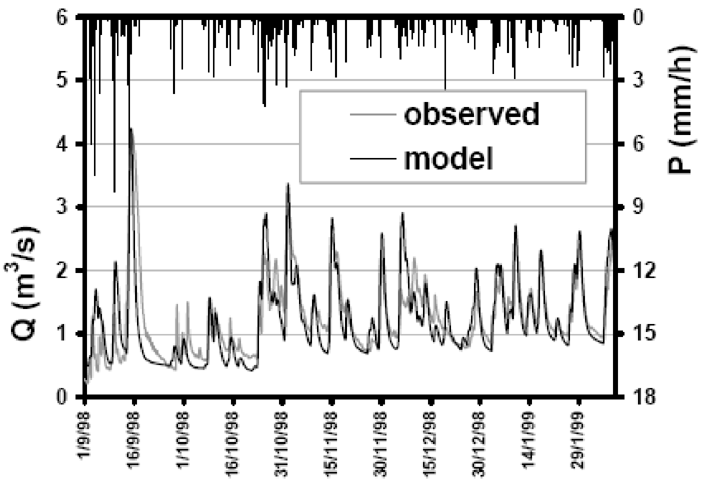
5-4 Hydrologic Modeling

Usually as hydrologists we present watersheds a homogeneous units with terrain, soil, and cover conditions. Also we present these parameters with their average since considering its actual values and characteristics will consume a lot of time, money and effort.

This was from the past, now GIS has provided the tools to compute these average values more efficiently and to include some level of spatial effects by partitioning entire watersheds into smaller sub-watersheds. There are a lot of examples showing this efficiency of using GIS such as:

- Djokic and Maidment (1991) used ArcInfo to simulate the drainage system and assess whether the existing drainage system in a portion of the City of Asheville, North Carolina can accommodate 10- and 25-year return period design flows. Their approach used the rational method to examine contributions from surface terrain (i.e., overland flow), man-made structures (i.e., pipes and channels), and storm water intakes.

- The accomplishments of the Danish Hydraulic Institute are particularly noteworthy in this regard. They have implemented numerous modeling systems for river basins, urban drainage, sewer systems, rivers and channels, estuaries, and coastal waters during the past decade and since 1998 have embarked on an ambitious program to link their models with the ESRI (Environmental Systems Research Institute) family of GIS products. Many of their modeling systems now support GIS data transfer and one runs inside the ArcView GIS.



F. DE SMEDT, L. YONGBO and S. GEBERMESKEL , 2000. [1]

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[1]- F. DE SMEDT, L. YONGBO and S. GEBERMESKEL , 2000, Hydrologic modeling on a catchment scale using GIS and remote sensed land use information, Department of Hydrology and Hydraulic Engineering, Free University Brussels, Belgium..

- It was always difficult for civil engineers (specially water engineers) to divide rainfall into infiltration, runoff and internal distribution flow through watershed. Some models and techniques were made to split total runoff from infiltration, but it was really very difficult and time consuming to split usual runoff from internal runoff flow through watershed.

The usage of GIS has changed this difficulty and opened new doors for sciences we usually thought that it wouldn't be opened soon. Using GIS helped to develop a spatial distribution unit hydrograph which is a revolutionary step allowing engineers and scientists to determine the internal distribution flow through watershed and describes the connectivity of the links in the watershed flow network (Maidment D.R. , 1993)

5-5 Floodplain Management

Computer models play a pivotal role in hydrologic analyses by aiding in the determination of water surface profiles associated with different flow conditions. Unfortunately, a consistent deficiency of these programs has been their inability to connect the information describing the water profiles with their physical locations on the land surface. Often the computed water surface elevations are manually plotted on paper maps in order to delineate floodplains. Automating this manual plotting would result in significant savings of both time and resources. Geographic information systems (GIS) offer the ideal environment for this type of work to help improve hydraulic design capabilities.

The connection between the HEC-RAS hydraulic model and ArcView GIS, allowing for improved visualization and analysis of floodplain data. It also permits GIS to function as an effective planning tool by making hydraulic data easily transferable to floodplain management, flood insurance rate determination, economic impact analysis, and flood warning systems. Another important application is automating floodplain mapping to aid in the design of drainage facilities (Eric Tate, 1999)

In addition to that, before using GIS evaluating extreme storm events and the resulting floodplain has been accomplished by manually plotting the extent of the floodplain on paper maps. As GIS entered to the scene the process was automated and a significant saving of time and resources in the design process. It was an effective tool for representing the spatial variability of the watershed characteristics, integrating hydrologic and hydraulic modeling processes with GIS, and displaying an accurate floodplain map of the project site (Anderson D. J., 2000).

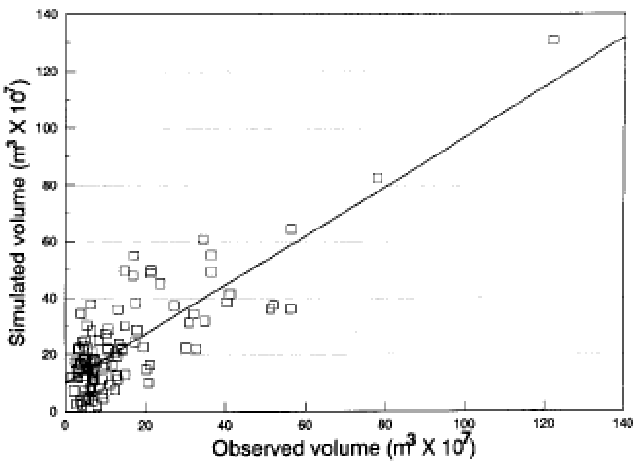
5-6 Closed Basin Hydrology

Closed basins are a product of a delicate balance between inputs—precipitation over the lake and runoff from surrounding land—and outputs, such as evaporation and seepage outflows. This dynamic balance makes a closed-basin system extremely sensitive to climate variation. A disturbed balance causes fluctuations in lake levels. So fall of water level will cause the closed basin's salinity to rise, which affects
the lake's ecosystem, and rise will cause flood over new areas.

Because of their capability to integrate and analyze data from many sources, geospatial tools such as geographic information systems (GIS) are ideal for unraveling the complex mysteries of closed-basin systems. The versatility of GIS allows researchers to integrate diverse data from many scales—from micro-climate to regional climate variations.

5-7 Water Quality Assessments and Planning

One of the most important subjects in water resources is water quality assessments of river systems. It covers the entire river basin and an evaluation of best management practices to minimize nonpoint source pollution. To do this engineers must manage to monitor water quality continuously, which is expensive and not currently conducted. Hydrologists decided to simulate hydrologic balance and water quality parameters to help assess the effects of proposed changes in land use and land management. Hydrologists have linked GIS hydrologic models to facilitate model execution (Vieux, 1991). GIS was preferred because it can store, manipulate, provide spatial data for a variety of display and analytical tools, and to collect and manage input into the SWAT (Soil and Water Assessment Tool) hydrologic model. At one of the papers I read the relationship between simulated data using GIS and observed data was really close (R=0.75)



Source: W. D. Rosenthal, R. Srinivasan, J.G. Arnold. [2]

Reservoir planning and management can be undertaken by developing a map-based surface water simulation model of any watershed, which may include rivers, lakes or both of them. There is a need for inexpensive tools that enable planners to accurately quantify the available water supply and its ability to meet the competing demands of projects. There are now some models build using GIS (ArcView) that helped to plan and simulate a model for a watershed and its reservoirs (Asante K., Maidment D., 1997).

[2] - Rosenthal, W. D., R. Srinivasan, and J. G. Arnold. 1995. Alternative river management using a linked GIS hydrology model. *Transactions of the* ASAE. 38(3): 783-790.

5-8 Constructing a Groundwater Simulation Model under GIS

Because most groundwater simulation models are self-contained and require a specific input data format, it is not easy to integrate an external groundwater model with a GIS. However, because GIS has the ability to manage and display spatially-referenced data, it is desirable to use GIS to support groundwater simulation models. To achieve this goal, a map-based groundwater model is constructed within the GIS environment using the concepts of spatial database management and OOP. The user interface and data processing capability of this map-based model are enhanced by the spatial data display and analysis capabilities of the GIS.

It is now said that bbuilding a regional groundwater flow model without the foundation of a good GIS is unthinkable. GIS has helped to organize and analyze enormous amounts of information, making the models more accurate and useful. Although GIS may not get its deserved attention or credit, a Groundwater Availability Models, or GAMs would be nothing without it (Anaya R.,Mace R.E.,2004).

These GAMs are used to assist in making management and policy decisions concerning groundwater. They are useful tools for assessing the possible effects of drought and pumping on water levels and spring flows.

5-9 Connecting the Spatially-Referenced Time-Series Data with GIS

Because most hydrologic processes are time dependent, spatially referenced time-series data are frequently encountered in simulating hydrologic events. Therefore, it is important to have an efficient data structure and data management system to handle spatially-referenced time-series data. Data structures designed during this research can be either embedded in or connected to a GIS map to manage the spatially-referenced time-series data efficiently and effectively, (Anaya R.,Mace R.E.,2004).

6- Discussion

It is the way life goes on, there must be advantages and disadvantages for any new application. The way engineering or even scientific community accept new applications is when its benefits exceeds its disadvantages. GIS is a new application in water resources engineering, it has a lot of benefits but also it needs a lot of work and additional researches to remove any obstacles. I will present here some of the advantages and disadvantages of using GIS in water resources.

6-1 Advantages

Overall, the computer-generated climate surfaces represent a major advance over their hand-drawn predecessors. They cost less and can be produced more quickly, they are repeatable, and they can be used with the visualization tools commonly found in GIS to develop customized maps and tables (Custer et al. 1996, Daly and Taylor 1996).

GIScience has changed the communication of water resource data by increasing their availability in the form of maps generated efficiently by cartographic tools available within many GIS softwares. It has also provided tools for new ways to visualize the movement of water through landscapes using dynamic visualization in three-dimensional space. (Mitas et al. 1997)

The averaged values of landscape characteristics used in the watershed models have been replaced by their distributed representation in these new models using GIS. In addition to simulating impact-specific land use practices, these new models simulate the spatial pattern and location within the watershed.

Really the use of GIS will make like life easier for hydrologic engineers and will increase their abilities to perform complex analysis easily such as:

- Effective and efficient delineation of watersheds and streams.
- Quick extraction of watershed and stream parameters.
- Digital Elevation Models (DEM) can define the drainage basin boundaries.

A key advantage of using GIS in water applications is its ability to integrate, manage and analyze large volumes of data, particularly over very large areas ,(John P. Wilson, Helena Mitasova, Dawn J. Wright, 2000).

6-2 Disadvantages

Although using GIS as a hydrologic/hydraulic model's pre-processor and post-processor has the benefits of reducing the amount of data preparation work, enhancing spatial data display and revealing some hidden spatial relations, the effort and cost of developing a GIS interface can also be significant and sometimes, outweigh the benefits of using it (DeVantier, 1993). One of the reasons for this high development cost is that both GIS databases and simulation models are usually self-contained and have different data structures. As a result of this difference, a great number of programs and procedures need to be constructed simply for data conversion purposes.

This problem can be mitigated if a simulation model is constructed with all three of its elements integrated, because in such a model, the programs and maps would share the same databases and the problems of data inconsistency would be eliminated. High set-up and operating cost can also be improved if a GIS interface developed for one model can be shared by other models.

Unfortunately, making programs and maps share the same database and making one main model to be shared with other models needs a wide use and understanding of GIS benefits worldwide, but this will take long time since GIS applications in water recourses is a relatively new science (from early 90s).

Cost of using GIS applications in water recourses still slows the acceptance of this new technology. Many case studies and detailed discussions with the experts of the subject have proves that the cost of development can be brought down when Remote Sensing has been used along with conventional methods

Another obstacle hydrologists have to become GIS experts to solve problems. It's a hope that they will simply (without going deep into GIS Technology) be able to use and benefit from GIS tools that are fully integrated into an overall information system, (Steve Kopp,2004).

7- Conclusion

Water resource assessment and management are inherently geographical activities requiring the handling of multiple forms of spatial data. GISs and simulation models have contributed to the identification and evaluation of potential solutions to water resource problems during the past decade. GISs have expanded the number of ways information can be presented and thereby extended their accessibility, and many of the most popular spatially distributed data sets can now be accessed via the Internet. Similarly, there has been a steady increase in the number and variety of functions incorporated in GISs that are suited to water resource applications. GIScience has also influenced the development and implementation of hydrologic models at several different levels. For example, GISs have provided tools to compute averaged values more efficiently and to include at least some level of spatial effects by partitioning entire watersheds into sub-watersheds in both site-specific and lumped parameter models. Similarly, geographic information technologies have played a major role in the development of distributed hydrologic models. These models offer the best chance for improving our understanding of spatial processes and patterns affecting the distribution and movement of water in landscapes as well as the impact of land use on water resources over the long term.

There are a lot of advantages for using GIS in water recourse engineering such as the ability to produced more quickly, repeatable, they can be used with the visualization tools commonly found in GIS to develop customized maps and tables and effective delineation of watersheds and streams. Also the ability of modeling systems for river basins, urban drainage, sewer systems, rivers and channels, estuaries, and coastal waters.

As anything in life, GIS has some obstacles such as, high development cost is that both GIS databases and simulation models and obstacle hydrologists have to become GIS experts to solve problems.

I believe that these obstacles will be reduced as soon as more scholars understand deeply this new rising technology. Also additional technical experiments must be done to test hydrological models built using GIS to reduces errors and to show the promising benefits of this technology to scientists doubting its advantages.

8- Acknowledgments

I have to thank Dr. Baqer Al-Ramadan for being very helpful, and for opening new horizons for me it his course (CRP 514: Introduction to GIS). Also I want to thank Dr. Mohammad Al-Zahrani for his guidance. And finally to Mr. Basheer Al-Gohi (Lecturer-B) for his precious help.

9- Reference

1- Center for research in water resources , Bureau of Engineering Research, The University of Texas at Auston, http://www.ce.utexas.edu/centers/crwr/

2- KWABENA ASANTE and DAVID MAIDMENT, 1997 ,GIS Based Reservoir Planning for the Souss Basin, Morocco, **MS Thesis**, Bureau of Engineering Research ,The University of Texas at Austin.

3- DAVID MAIDMENT, 1993,Developing a spatially distributed unit hydrograph by using GIS, Dept of Civil Engineering, University of Austin, USA.

4- DAVID JAMES ANDERSON, 2000 ,GIS-Based hydrological and hydraulic modeling for Floodplain delineation at highway river crossing, **MS Thesis**, Dept of Civil Engineering, University of Austin, USA.

5- F. DE SMEDT, L. YONGBO and S. GEBERMESKEL , 2000, Hydrologic modeling on a catchment scale using GIS and remote sensed land use information, Department of Hydrology and Hydraulic Engineering, Free University Brussels, Belgium.

6- Dao Huy Giap Yang Yi , Nguyen Xuan Cuong and Le Thanh Luu , James S. Diana, C. Kwei Lin,2003 , Application of GIS and Remote Sensing for Assessing Watershed Ponds for Aquaculture development in Thai Nguyen, Vietnam, Map Asia Conference, 2003 - gisdevelopment.net.

7- David L. Jordan,2004, An Introduction to GIS Applications in Hydrology , Southwest Hydrology, A publication of SAHRA on Science and Technology Center, The University of Arizona.

8- Paul Amos, 2004, Desktop GIS Software for Hydrological Applications, Southwest Hydrology, A publication of SAHRA on Science and Technology Center, The University of Arizona.

9- David R. Maidment, 2004, Arc Hydro Data Model: A Hydrologic Data Integration Tool, SouthWest Hydrology, A publication of SAHRA on Science and Technology Center, The University of Arizona.

10-Roberto Anaya and Robert E. Mace, 2004, Every Successful GAM, There is a Good GIS, Southwest Hydrology, A publication of SAHRA on Science and Technology Center, The University of Arizona.

11- Wolfgand-Albert Flugel, 1997, Combining GIS with regional hydrological modelling using hydrological response units (HRUs), Geographisches Institut, Universitat Jena, Germany.

12- Eric Tate, 1999, Floodplain Mapping Using HEC-RAS and ArcView GIS, Bureau of Engineering Research , **MS Thesis**, Dept of Civil Engineering, University of Austin, USA.

13- Rural Geospatial Innovations, 2007, Water Resources and GIS Integrating Water and Hydrology, University of North Dakota.

14- Steve Kopp, 2004, GIS For Water Resources:NOW and Into the FUTURE, SouthWest Hydrology, A publication of SAHRA on Science and Technology Center, The University of Arizona.

15- Rosenthal, W. D., R. Srinivasan, and J. G. Arnold. 1995. Alternative river management using a linked GIS hydrology model. *Transactions of the* ASAE. 38(3): 783-790.

16- Juling Bao , M.S., David Maidment, Francisco Olivera,, 1997, Using GIS for Hydrologic Data-Processing and Modeling in Texas , **MS Thesis**, Dept of Civil Engineering, University of Austin, USA.

17- John P. Wilson, Helena Mitasova, Dawn J. Wright, 2000, Water Resource Applications of Geographic Information Systems, URISA Journal, 2000.

18- Er. S. C. Gupta, Er. R. S. Goel , Er. Sanjay Sharma , Application of GIS and Remote Sensing techniques in water resources development, GIS Development, http://www.gisdevelopment.net/application/nrm/water/overview/wato0009.htm.