Review on Application of GIS in Water Distribution System Planning and Designing

Miss D.J.Surani[1] Prof.G.V.Dihora[2]
[1]M.E. Scholar (Water Resources Management) [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Shantilal shah Engineering College, Bhavnagar, Gujarat

Abstract— Water distribution systems constitute a vital part of civil infrastructure. The purpose of a water distribution system is to ensure the supply of water to the users at specified demand." Water distribution system is a complex system that integrates several spatial features. Therefore, it is needed to use multi- support geographical information system which has capability of storing; managing and analyzing the large data set. The implementation of GIS can not only reduce the time needed for analyzing information but also can ensure a more efficient use of the resource with high flexibility in time and scale. In the field of water distribution system (WDS) analysis, the problems occurs that, survey of area, lying of a pipe lines and location of ESR. So the solution is that with the use of GIS tools. After the use of GIS tools we can get results like node elevation, length of pipes, location of ESR, and also create "inp" files for hydraulic simulation models. The current paper describes the study of various literatures on such a strategy of combining the use of GIS and various hydraulic simulation models like EPANET, WaterCAD etc.

Key words: GIS tools, hydraulic simulation models, pipe Network, Water supply

I. INTRODUCTION

Water is one of the fundamental necessities for sustaining life on the earth for all living entities. Man needs water for many of his activities in day to day life. Initially Man used to live nearby water bodies such as rivers, lakes etc. This led to the development of water supply engineering, as a part of civil engineering, to develop a system for supplying protected water to all the people to meet their demands. The water distribution system consists of several components such as intake, pumping, transmission, treatment, storage, distribution network etc. Water is the most important renewable natural resources. It is required for agriculture, industry and domestic purposes. Rainfall is the main source of water. This is, however, unequally distributed spatially and temporally and is also limited. Lots of money is spent every year around the world for providing or upgrading drinking water facilities 80-85% of the cost of a water supply project is used in the distribution system. Unheard-of increase in population, urbanization, agricultural expansion and industrialization lead to higher levels of human activities. As water demand increases, issues on water availability become critical. Water supply system (WSS) is a complex system that integrates several spatial features. Therefore, it is needed to use multi- support information system to have capability of storing; managing and analyzing the large data set. GIS technology has reached maturity. The world has a long history of GIS application in planning and resource management dating back to the mid-1960s. This is because GIS manage large spatial and non-spatial data with a unique valuable application for policy makers in area of urban planners. The application of GIS in spatial planning support tools have an important advantage through changing the valuation standards to visually illustrate and depict where the implications of different spatial decisions and alternatives are convenient. The capabilities needed for decision making readily available in a single system make GIS a great tool for integrating in planning processes. GIS provides functions for development and preparation of accurate spatial information for input to network design optimization models. It also facilitates post optimization spatial analysis and graphical output display for evaluating results. Given the time and spatial variability of parameters such as water-distribution network layout, street layout, pipe characteristics and cost, pressure requirements, and demand patterns, the GIS can perform cost analysis, network routing, and allocation, and provide effective color graphic display of results. And main function of GIS in Water distribution system is to collect without any survey we can take an elevation data from area topography using (Digital Elevation Model-DEM), measure a length of pipes and population data with GIS tools and create a "inp" files for designing a network in hydraulic simulation models.

A. History of GIS:

Canadian GIS is an example of one of the earliest GIS developments. Civilian GIS in the U.S. got a jump start from the military and intelligence imagery programs of the 1960s. The Internet was started in the 1970s by the U.S. Department of Defense to enable computers and researchers at universities to work together. GIS technology was conceived even before the birth of the Internet. The mid-1990s witnessed the inception of a new generation of user-friendly desktop GIS software packages that transferred the power of GIS technology to the average personal computer (PC) user with entry level computing skills. There were only a few dozen GIS software vendors before 1988, the number had grown to more than 500. GIS technology was conceived in the 1960s as a digital layering system for co-registered overlays. Currently GIS technology has evolved and grown its objectives are expanding. Generally GIS can be considered as an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, socio-economic, utility, facility, image and other resource data that is geographically referenced. Its objective is to improve overall decision making by visualizing data and seeing new patterns. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. So, GIS has become to symbolize a technology, an industry, a way of doing spatial work. It has come to promise a new world of disciplinary and professional integration. GIS allows

mapping, modeling, and displaying large quantities of diverse data, all held together within a single database.

B. Application of GIS:

1) Application of GIS in Water Resources Management:
- Application in Water Distribution System,
- Development of Hydraulic Models

2) Hydrologic and Water Quality Data
3) Spatial Interpolation
4) Watershed Delineation
5) Floodplain Management
6) Closed Basin Hydrology
7) Constructing a Groundwater Simulation Model under GIS
8) Connecting the Spatially-Referenced Time-Series Data with GIS

II. LITERATURE REVIEW

A. Dr. H. Ramesh ET al.[1]

Paper represented by Dr. H. RAMESH et al describes "a Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS"; a case study in the Alnavar is a Taluka panchayat (sub-district) of Dharwad district, Karnataka state, India.

For modeling of water distribution system Methodology used for study is as described in below:
- Ortho rectified Cartosat-1 images, rectified LISS IV images and topo sheets are masked and extracted for the required area using ArcGIS software.
- Population forecasting by 3-methods (Census data)
  - Arithmetic Increase Method: Pn= [P0+n. x*]
  - Geometric Increase Method: Pn= P0 (1+r/100) n
  - Incremental Increase Method: Pn= {P0 + n. x*+ [n (n+1)/2] y*}
- Hulikere Lake is selected as potential water source for drinking situated at a distance of 6.5 Km.
- Main pipe lines are designed based on the required discharge and the velocity of flow using discharge and Manning's hydraulic equations. Discharge Q = A* V m3/s, velocity V= (1/n) R2/3S1/2.
- The network is simulated for both present demand scenarios and future demand scenarios using GIS and EPANET. And finally network designed by EPANET.

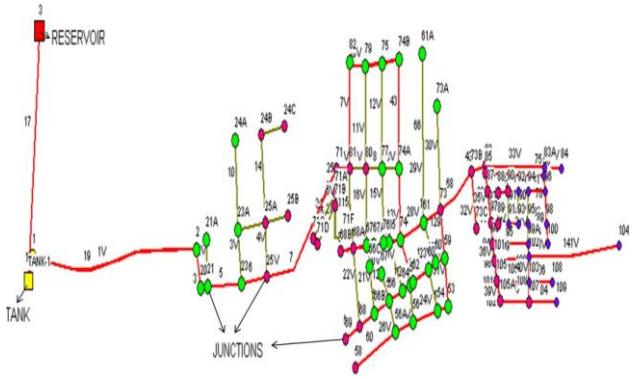

Fig. 1: Components of the network model for the ward

It is concluded that this research has demonstrated an application of stochastic simulation for reliability analysis of water distribution systems using EPANET 2.0, taking into account the hydraulic considerations such as pressure, head, velocity etc. Also the satellite image and DEM have shown in effectively in selection of alternate alignment and quantity of earth work estimation.

B. Juned Laiq Syed ET al.[2]

Paper represented by Juned Laiq Syed describes an "Application of GIS in the Hydraulic Analysis of Water Distribution System"; a case study in hypothetical area belongs to a small town of Unites States of America (USA) with a lake.

For modeling of water distribution system Methodology used for study is as described in below:
- Collection of required data for designing of water distribution system.
- WaterCAD drawing of the hypothetical water distribution system is exported to AutoCAD 2000 to see the details of the drawing. The results of the hydraulic analysis produced by WaterCAD such as pressures at the junctions, water flows in the pipes, reservoir water levels are exported and converted into database files using MS Excel2000. Graphics (dxf) files and database files are exported from WaterCAD and MS Excel 2000 into software ArcView GIS 3.2a.
- The output data of modeling is converted into tabular and graphical form by using GIS package ArcView GIS. Also Making Themes and Theme Tables in ArcView GIS.

It is concluded that hydraulic simulation software WaterCAD is the only commercially available software which can be incorporated with ArcView GIS. It is recommended to carry out more modifications in WaterCAD regarding the export of data from WaterCAD into ArcView GIS as it is observed that ArcView GIS was unable to import generated data directly from WaterCAD, but it has to be first transferred to MS Excel for converting data into database files and then exported to ArcView GIS.

C. Abolghasem akbari.[4]

Paper represented by Abolghasem akbari describes an Application of GIS and RS(Remote sensing) in rural water supply systems, A case study in Study site is located in north-east of Iran. The water supply system is designed to distribute the fresh water from the source of water in 2 to 18 villages with total population of 10500 (based on year 2005). The system has developed for the planning period of 25 years.

For modeling of water distribution system Methodology used for study is as described in below:
- Data collection is an important part of the GIS projects.
- After Data collection Topographic maps at scale 1:50000 are used for in primary phase of study. Also aerial photographs or satellite images are used to distinguish the best path of water supply network.
- Branch layout is the distribution system and operation system is gravity and pumping system. Land sat image (ETM+) were used collect some ground update data such as service roads, settlement boundaries. Also, Satellite image and

digital elevation model (DEM) are used for train visualization.

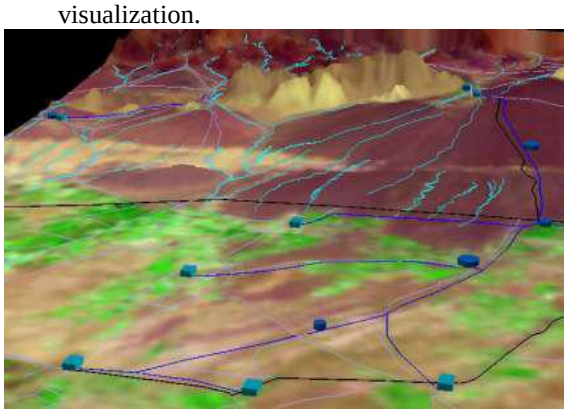

Fig. 2: A typical 3D scene of Bardaskan's WDS

It is concluded that the GIS and RS is powerful tool in developing WDS and facilitates to use the following process:

- Data collection and monitoring
- Site selection for source of water
- Network analysis and design of pipe line path.
- site selection for reservoirs and pumping stations
- site selection for surge tank and control valves
- routing optimization and visualization

D. Rola Ahmead Abeaid et al.[5]

Paper represented by Rola Ahmead Abeaid et al describes an "A GIS-Based DSS for Management of Water Distribution Networks," A case studies in Study area Rafah City (Gaza Strip).

1) Methodology:

- Select study area.
- Select the proposed systems to be included in the DSS system were ArcView GIS datasets and Water CAD/Water GEMS.
- The hydraulic analyses characteristics are summarized as follow: Analyses Extended period simulation, Friction method, Hazen-William formula, Accuracy: 0.001, Trials: 40, Starting time: 6.00 AM, Duration: 48 hours, Hydraulic time step: 1 hour.
- The four stages include use GIS & hydraulic modeling based on DSS for proposed O&M systems for Rafah area.

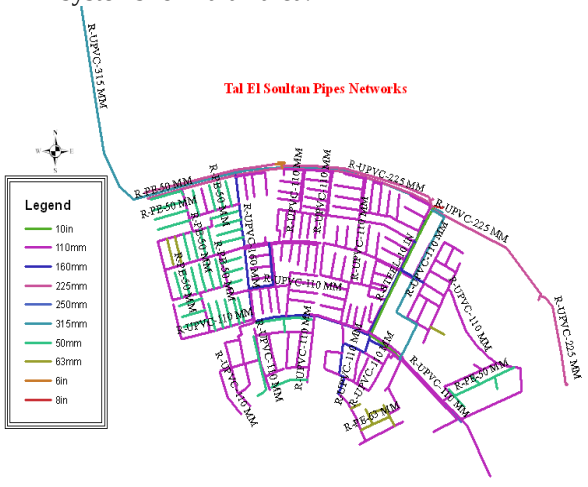

Fig. 3: Water distribution networks for Talsultan zone.

It is concluded that the proposed O&M system depends on the use of the integration between GIS and hydraulic modeling based on DSS for management O&M water networks to take the best decision at the needed time for all daily works. Clarify water networks pipes and diameters.

III. CONCLUSION

From study of these various literatures related to application of GIS-software for water distribution system planning and designing by hydraulic simulation models. It is concluded that this type of study with the use of GIS, Its give accurate result, visualization of water supply network is much better for understanding. This study also helps in water supply engineering for saving the time. This process works fastly and less tedious and easy to incorporate the changes. If we have huge amount of data GIS can performed and solved that type of problems easily.

REFERENCES

[1] Dr. H. Ramesh,L. Santhosh and C. J. Jagadeesh (2012). "Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS" International Conference on Ecological, Environmental and Biological Sciences (ICEEBS'2012) Jan. 7-8, 2012 Dubai

[2] Juned Laiq Syed (2003). "Application of GIS in the Hydraulic Analysis of Water Distribution System" King Fahd University of Petroleum & Minerals Civil Engineering Department

[3] Rossman L.A., 2000, EPANET 2 User's manual. Report EPA/600/R-00/057, Cincinnati: USEPA, Water Supply and Water Resources Division, National Risk Management Research Laboratory.

[4] Abolghasem akbari (2007). "Application of GIS and RS in rural water supply systems" ACRS (Asian Conference on Remote Sensing) Malaya.

[5] Rola Ahmead Abeaid (2013). "A GIS-Based DSS for Management of Water Distribution Networks (Rafah City as Case Study)" Journal of Geographic Information System, 2013, 5, 281-291.

[6] ESRI, 1999, ArcView GIS 3.2 help, Environmental Systems Research Institute Inc., Redlands, California.

[7] ESRI International User Conference proceeding, 2006

