A Review on paradigm shift of Water Distribution Infrastructure

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Abstract: The primary element of an urban water distribution system is to satisfy water supply demand with desired standard quality. Due to rapid urbanization and water scarcity, maintaining a stable and safe water supply has become a challenge to many cities. The problems like inadequate supply of water with low pressure, pipe burst, excessive leakage and non revenue water are increasing exponentially. To overcome these challenges, Smart water system is needed which provides fast and accurate methods and technology to manage water distribution infrastructure efficiently. In this paper efforts are made to review various software to manage water distribution infrastructure and some modernized water supply system which are using advance technology and software to handle large amount of data, mapping of water distribution network, improve efficiency of system, reducing maintenance-operation cost and prioritizing repair or rehabilitation by decision supportive system.

Key words: Water distribution infrastructure, GIS

Introduction:

The drinking water is one of the essential elements required for all biotic components to carry out their different fundamental activities of life. Water required for drinking purpose is further stressed by continuously increasing population and in order to fulfill this ever increasing demand at urban as well as rural level, there is a need to replace the traditional and obsolete methods of designing, operating and maintaining water distribution networks with accurate, speedy and computer based software and methods (1) . The Management of water distribution system includes different aspects starting from source selection to designing network for providing enough pressure at each pipe and node in the network, maintaining quality of water, analyzing large amount of data by mapping the network and maintaining the system by avoiding leakage and other problems are done by coupling GIS with water distribution system.

The Geographic information systems (GIS) play a distinguished role in water utility management like the asset creation and management, infrastructure capital improvement, planning and analysis, Optimizing field operations, water conservation etc. The Geographic Information Systems (GIS) is an effective tool for storing, managing, and displaying spatial data typically encountered in water resources management (2).

The advancements in the field of water supply and the usage of computers in it has urged field experts, scientists, research scholars, developers and programmers to develop number of software for the design and modeling of water distribution networks including public domain software like EPANET, Branch, and LOOP as well as commercial softwares like Aquis, H2O map, KYPipe, WaterCAD, WaterGEMS, etc (1). The available software for designing and modeling of the water distribution networks (WDN) developed over the period of time and advancements in water distribution system is reviewed in this paper. This paper is divided into two group viz., Review of modernized water distribution system and Classification of modeling software based on use in water supply.

(A) REVIEW OF MODERNIZED WATER DISTRIBUTION SYSTEM

This paper covers three key aspects of modernization and application of software in relation to water distribution system . 1. Asset management 2. Leak management 3. Quality monitoring

1.Asset management

1.1 Dr. Prashant P.Bhave and Kalpna S.Dumbre have studied in their paper entitled **"GIS Application for water supply system management"** In order to make infrastructure improvement, a water supply system has to handle a large amount of diverse information on a continuing basis. The necessary information includes the data about pipelines, valves, ESRs, pumps, consumers, billing data, data regarding expenditure and revenue collected etc. The first step of water supply infrastructure improvement is the development of an information system. The objective of this work is to study the use of GIS for determining the optimal infrastructure improvement strategies. GIS is used for (i) lowering operation and maintenance cost by adopting preventive maintenance practice (ii)increasing revenue (iii)improving quality of service to customers (iv) development of hydraulic models. Methodology adopted: After collection and validation of data, its conversion is done for GIS layer formation by using software like Arc GIS and EPANET. This paper concluded that GIS is useful in operation and maintenance of water distribution infrastructure. (3)

1.2 Che´rifa Abdelbaki, Mohamed,Mouaˆ dBenchaib at.al have observed in their paper entitled "**Management of a water distribution network by coupling GIS and hydraulic modeling: a case study of Chetouane in Algeria"** For more effective management of water distribution network in an arid region, Mapinfo GIS (8.0) software was coupled with a hydraulic model (EPANET 2.0) and applied to a case study region, Chetouane, situated in the north-west of Algeria. The area is characterized not only by water scarcity but also by poor water management practices. The results showed that a combination of GIS and modeling permits network operators to better analyze malfunctions with a resulting more rapid response as well as facilitating in an improved understanding of the work performed on the network. The grouping of GIS and modeling as an operating tool allows managers to diagnosis a network, to study solutions of problems and to predict future situations. The later can assist them in making informed decisions to ensure an acceptable performance level for optimal network operation.

Methodology adopted: Network modeling was employed to analyze and to simulate the Chetouane network using GIS (MapInfo 8.0). Specifically, problems were diagnosed, such as supply discontinuity, leakages and worn out pipes. EPANET was chosen for the simulation of the distribution of velocities and pressures. In EPANET, supply networks are defined by elements, such as nodes, pipes, valves and tanks.

Furthermore, it concluded that the grouping of GIS and EPANET modeling as an operating tool allows managers to diagnosis the network, to study the solutions of problems and to predict future situations(fig-1). The later can assist them in making more informed decisions to ensure an acceptable performance level for optimal network operation.(4)

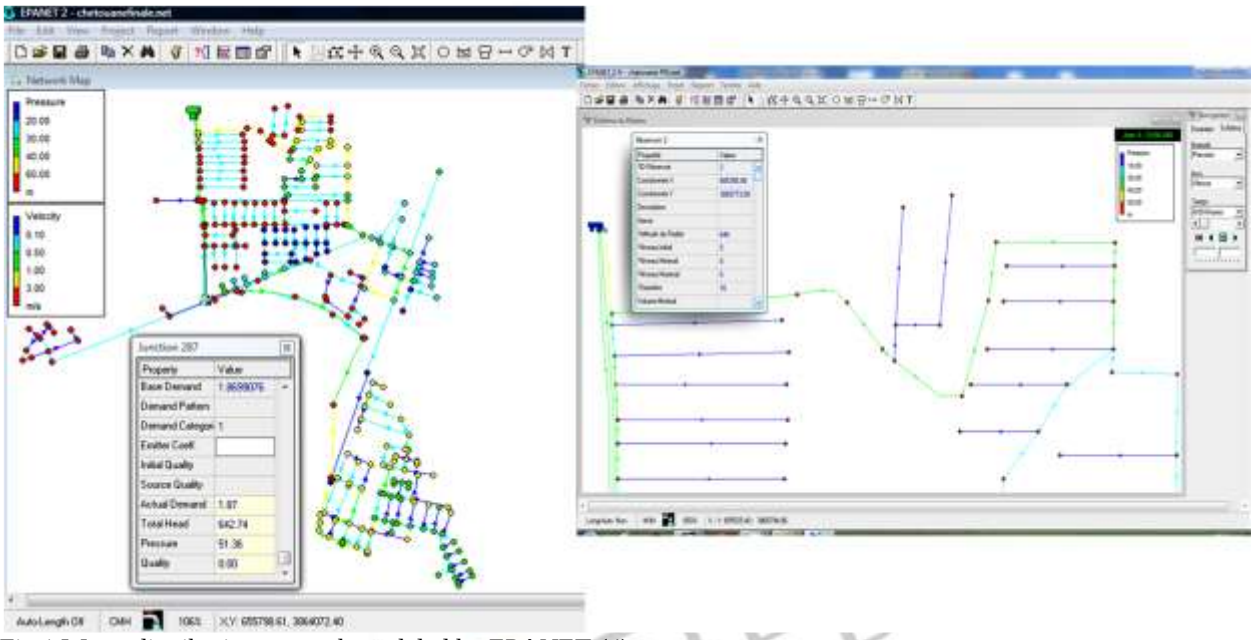


Fig.1 Water distribution network modeled by EPANET (4)

2. Non revenue water and Leak management

2.1 A report of "**Leakage ManagementTechnologies, U.S. Environmental Protection Agency"** Washington D.C. give information that leakage management technologies and practices are constantly improved along with the software supporting the practitioner. In this publication, a newly developed software for leakage management is explained along with its use. The primary purpose of these leakage management software solutions is to rapidly collect all the data necessary to carry out leakage level calculations and then to report on the results of those calculations in a useable manner for the water utility. They allow the normally time-consuming data collection and analysis work to be done quickly and efficiently in a consistent manner. The software solutions therefore have the aim of reducing awareness time and facilitating a lower overall leakage level. Recently developed proprietary software called "AdviseIT Water Loss Management" (WLM) can be incorporated into a water utility's SCADA system. The WLM software automatically performs water loss calculations based on the data acquired from field devices such as flow meters and pressure transmitters.(8)

2.2 Dr. Reena D Popawala(2012) studied in her paper entitled **BENCHLEAK: "An Innovative Water Balance Software for Non-Revenue Water Calculation from Urban Water Supply Network"** There is an increasing awareness around the world regarding sustainability of water resources as it is limited. The active water loss management is one of the primary interests of water utilities in the world. In the last decade a comprehensive set of analytical tools and water loss reduction strategies has been developed. The IWA methodology of determining and comparing leakage in water distribution system is now accepted as best practice in many countries of world. In this research paper, BENCHLEAK software developed by WRC is used and effort is put forwarded to evaluate Infrastructure leakage Index (ILI) as well as non- revenue water generated from the water distribution system of Surat city.

This paper concluded by calculating amount of non revenue water which can be utilized by people of Surat.(9)

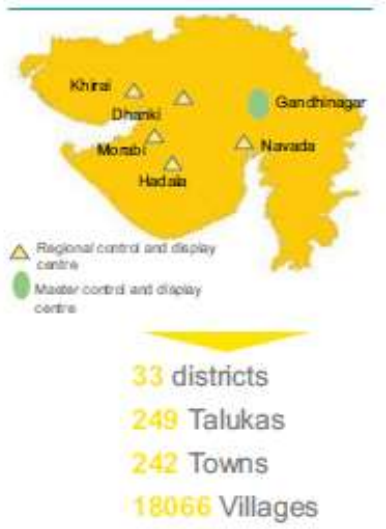
3. Quality monitoring

3.1 A report (2017) on "Establishment of real time monitoring system (SCADA) for bulk water supply network in Gujarat" by water supply-Gujarat shows some fact that Gujarat, one of the leading states in terms of economic growth & industrialization, falls under the water-stressed category 70% of Gujarat's fresh water resources are located only in 30% of its geographical area. At present, there is disparity in water availability across different regions as South and Central Gujarat has more than 50% of the total water availability.

Low quality standards

85% of the available water has high pollution level Of 26 districts in the state, 20 are affected by salinity, 18 are affected by fluoride, 17 are affected by chloride Increasing water networks To counter the dependency of regions such as Saurashtra and Kutch on rain water, the Gujarat government is expanding the Narmada canal network as work on 5,000km of the 12,000km network is under progress Rising focus on the sustainable and effective water technologies due to decrease in per capita availability of water and deteriorating water quality, presents an attractive business opportunity and need for installation of water distribution network monitoring by Supervisory Control and Data Acquisition System. (11) Following image gives detail of the project presently going on.

Project Information



Project Name

Supervisory Control And Data Acquisition System, SCADA phase- 1 for GWIL & GWSSB

location

- Gandhinagar, master control and display centre
- Five regional control and display centre:- Khirai, Dhanki, Morabi, Hadala, Navada

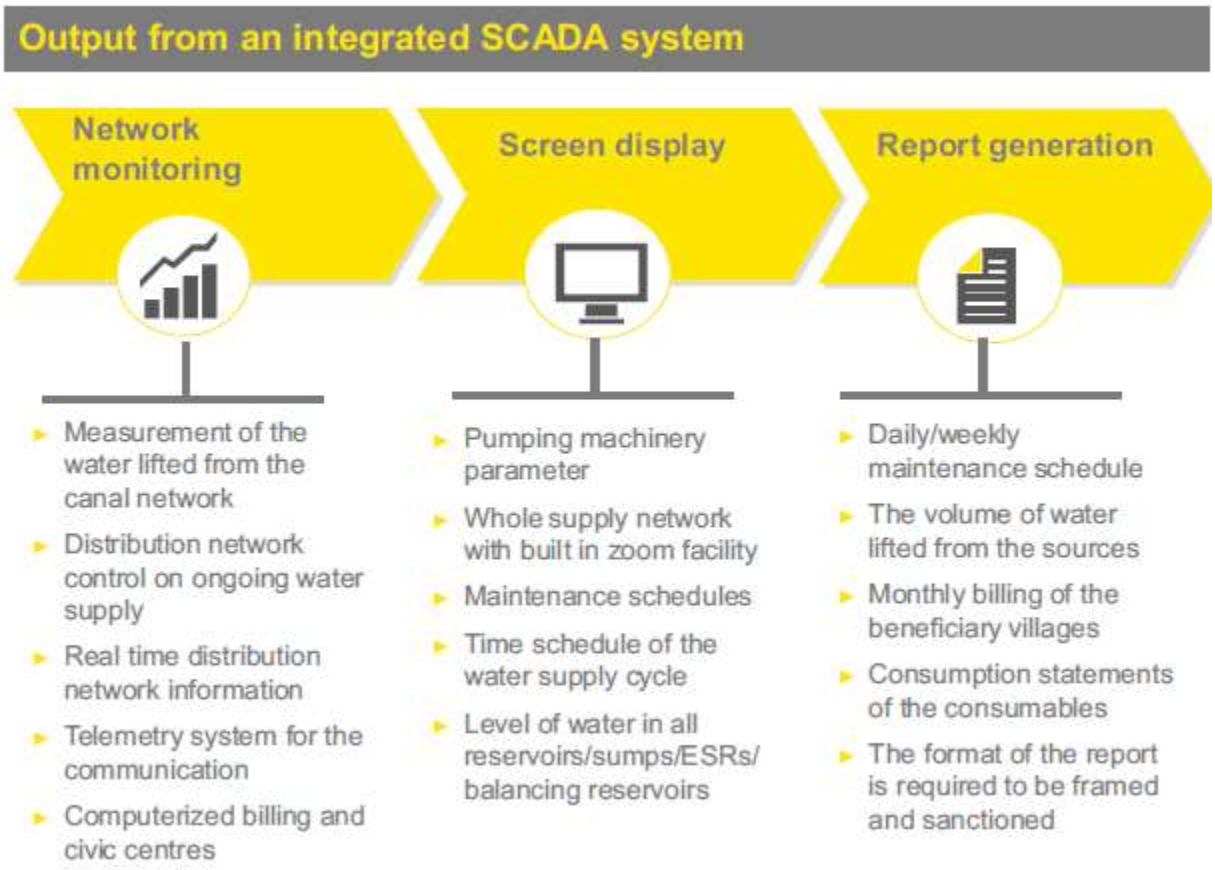


Fig.1 SCADA Project detail of Gujarat (11)

(B) Classification of modeling software based on application in water supply

At present many software available which are used for different purpose and ultimately improving efficiency of network. Adopting suitable software plays very important role in success of water distribution system. To ease in selection of software for different uses in WDS this paper has classified software as per their application.

1.Planning, Mapping and Modeling software:

(1.1) EPANET: It is software that models water distribution piping systems. EPANET's Windows user interface provides a visual network editor that simplifies the process of building piping network models and editing their properties and data.

(1.2) ARC GIS: It Maintain information about water network assets, plan capital projects, respond to leaks, reduce water loss, optimize field work, communicate with customers, and more. ArcGIS for Water Utilities includes these workflows: maintaining and viewing asset information, designing and planning for capital improvement projects, optimizing field operations, understanding the status of operations, and connecting with customers.

(1.3) Water GEM: It provides a comprehensive yet easy-to-use decision-support tool for water distribution networks. The software helps to improve knowledge how infrastructure behaves as a system, how it reacts to operational strategies, and how it should grow as population and demands increase.

(1.4) WATER CAD: Utilities and engineering firms around the world trust WaterCAD as a reliable decision-support tool for their infrastructure. Design new water systems and manage existing water networks effectively to reduce disruption risks and energy use.

2.Non revenue water and Leak Detection Software

(2.1)Bench leak: The BENCHLEAK model, developed by the Water Research Commission, aimed to facilitate the evaluation of leakage levels and, in particular, of the Non Revenue Water (NRW) in water delivery systems. The model is simple, user-friendly, based on an excel spreadsheet and is free.

(2.2) The AQUALITE: The Aqualite (2007 version) was developed to replace BENCHLEAK and is free too. It can be used to evaluate the IWA WB and assess the Real Losses and NRW levels of a system. Confidence limits are provided to assess the ranges of the variables. It calculates the UARL and the ILI levels. It is designed to assess the real losses level based on the traditional IWA top down water balance.

(2.3) AQUIS: The Aquis is a hydraulic modeling tool which simulates the flow and pressure in your distribution network. Unlike other tools, Aquis uses real-time data to analyze and track the current situation enabling operators to make better and smarter decisions and to optimize production and enhance your bottom line.

3.Water quality Analyzer software

(3.1) SCADA: The Supervisory Control and Data Acquisition (SCADA) is a technique for quickly and accurately identifying the operational status of water supply. Automatic control enables smooth and smart operation of the facilities, making it easy to achieve the target water quality and conserve energy. In addition, SCADA allows a management center to keep track of facilities such as purification across a wide area via external communication lines. Therefore, SCADA can be adapted to various applications in a flexible manner such as wide-area management of plants and unattended operations.

(3.2) Infowater: It is the Most Comprehensive ArcGIS-Integrated Water Distribution Modeling and Management Solution. InfoWater offers all the capabilities with a state-of-the-art hydraulic network solver. Command real-time simulations, optimize hydraulic performance, analyze water quality conditions, determine fire fighting capabilities, perform online calibration, evaluate energy cost savings, and design sound unidirectional flushing programs, with astounding speed and accuracy.

Conclusion: Managing water supply infrastructure using GIS and other software is very appropriate approach in solving water supply issues. This paper provides municipalities and decision makers an over view of the major technical features of software can be used. Review of other modernized system give importance and requirements of advancing and digitizing the water supply system. By software application in the water supply infrastructure, get advantages in terms of saving time, increase system efficiency, leakage management, accurate water quality analysis and reduce cost of operation & maintenance.

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