EXPERIMENTAL INVESTIGATION BY WATER GEMS SOFTWARE FOR REDESIGN OF WATER DISTRIBUTION SYSTEM

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Abstract : The paper is about to find out the water distribution analysis did by the various researcher in various areas, techniques that they have implemented and result that they have got. From this research paper I going to implement the best techniques in study area. This paper gives the final technique of implementation, by reviews of the researchers. Water is an essential element required for the sustenance of life. Demand for drinking water is increasing on continual basis with corresponding increase in population. This ever increasing demand can be fulfilled by designing efficient water distribution networks based on advance computing systems include modern hydraulic modelling and designing softwares. Decision variables involves are pipe diameter, reservoir elevations and reservoir capacity etc. with flow as primary variable. A design is obtained duly considering minimum and maximum head and velocity criteria in order to determine the actual supply form each node to all consumers. In this paper a part of Chalisgaon city is designed by WaterGEMS software. In this paper design of water supply network duly considering optimization in addition to the cost minimization, minimum head requirement is presented. WaterGEMS software algorithm is based on gives optimal solution for the design of new as well as expansion of existing water supply network.

IndexTerms - QGIS, Google earth, WaterGEMS Software, Water Supply Network, USGS.

1. INTRODUCTION

Water Distribution Networks (WDNs) serve many purposes in addition to the provision of water for human consumption, which often accounts for less than 2% of the total volume supplied. Piped water is used for washing, sanitation, irrigation and firefighting. Networks are designed to meet peak demands. The purpose of a system of pipes is to supply water at adequate pressure and flow. However, pressure is lost by the action of friction at the pipe wall. The pressure loss is also dependent on the water demand, pipe length, gradient and diameter. Several established empirical equations describe the pressure–flow relationship these have been incorporated into network modeling software packages to facilitate their solution and use. There is still not a convenient evaluation for the reliability of water distribution systems. Traditionally, a water distribution network design is based on the proposed street plan and the topography. Using commercial software, the modeler simulates flows and pressures in the network and flows in and out to/from the tank for essential loadings. Water distribution networks play an important role in modern societies being its proper operation directly related to the population's well-being. However, water supply activities tend to be natural monopolies, so to guarantee good service levels in a sustainable way the water supply systems performance must be evaluated.

1.2 Significance of the Study:

The incorporation of performance assessment methodologies in the management practices creates competitiveness mechanisms that lead to the culture of efficiency and the pursuit of continuous improvement. The primary task for water utilities is to deliver water of the required quantity to individual customers under sufficient pressure through a distribution network. The distribution of drinking water in distribution networks is technical challenge both in quantitative and qualitative terms. It is essential that each point of the distribution network be supplied without an invariable flow of water complying with all the qualitative and quantitative parameters. The water supply in most Indian cities is only available for a few hours per day, pressure is irregular, and the water is of questionable quality. Intermittent water supply, insufficient pressure and unpredictable service impose both financial and health costs on Indian households. Leakage hotspots are assumed to exist at the model nodes identified. For this study area Chalisgaon has been identified and the network model for the area under consideration will be prepared and studied for water losses.

1.4 Objectives

- To evaluate water demand of Chalisgaon.
- Convert intermittent water supply to continuous water supply .
- Zoning of city area on the basis of elevation and population density.

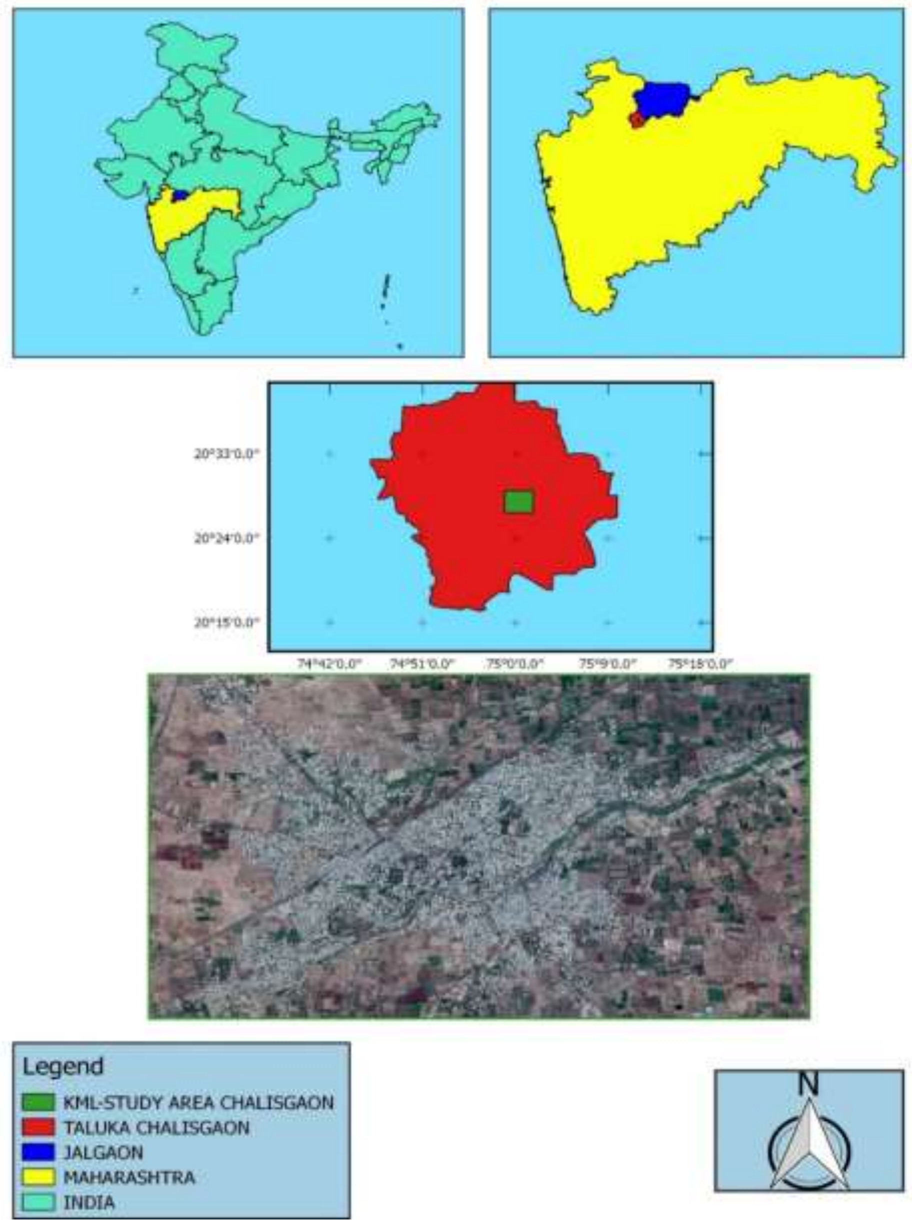

Fig.1 : Study area

Selection of study area : Study area: Chalisgon, Jalgaon, Maharashtra, India

Latitude and longitude: 19.9975° N, 73.7898° E

average altitude 344 m (1129 ft.) from M.S.L Jalgaon the district headquarter is at distance of about 93 Kms. from Chalisgaon. Chalisgaon town is also connected with Aurangabad, Dhule, Malegaon district other tehsil headquarters Pachora, Bhadgaon by state highway. Dhule-Chalisgaon-Aurangabad National Highway No.211 passes through Chalisgaon. It is situated on the Bombay-Itarci and Dhule-Chalisgaon section of the central railway. Famous Ellora Caves are situated at about 45 km to the south-west of Chalisgaon. Maharashtra region of the Maharashtra State itself has related to Khandesh area through one of the most difficult Autram Ghats in Ajanta ranges via Chalisgaon. Bhaskaracharya the great mathematician of ancient India has established ashram near Patnadevi temple. The Government of Maharashtra had declared reserved forest near Patnadevi the town has potential for developing as tourist center for visitors to Patnadevi. Jalgaon district is one of five districts in Nashik division and situated on the North of Maharashtra state. The district is divided into 16 Tehsils. Chalisgaon town is one of the Tehsils in Jalgaon district. Chalisgaon town is the head quarter of Chalisgaon Tehsil.

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1.5 Reviews from Researcher

Gholizade et al in this study of optimal design of water distribution network stated an approach to select an optimal design between three pre-specified scenarios that accounts for both economic and technical issues to supply the required water demand to customers and also satisfy decision maker's criteria and meet the design. Node elevations were estimated using grid point data of the study area. The grid point file contains elevations and GPS data. TRex tool in WaterGEMS were used to estimate node elevations through elevation data of closest grid points. Three sets of mechanical and hydraulic conditions were introduced and imported in WaterGEMS as independent projects and results were compared to field data measurements to perform model calibration. As a result, suggesting an optimal design for water distribution network requires considering both technical and economic criteria, a course that was the main goal of this research.

Abdelbaki et al in this paper author put light on the scope of GIS in water distribution system and modeling as an operating tool allows managers to analyze the network, study solutions to problems and predict future conditions. Network modeling was employed to analyze and simulate networks using GIS. Problems were analyzed, such as supply disruption, leakage and worn pipe. The area was chosen for simulation of velocity and pressure distribution. In EPANET, supply network elements are defined by nodes, pipes, valves and tanks. Various available options in GIS allow for the acquisition of network maps and their collaborative features. Each layer or level can be related to a specific topic with related alphanumeric information. Therefore, these GIS systems are mainly hopeful for the sketch of drinking water supply systems. The creation of GIS for water distribution network was enthused by the fact that it allows for the spatial examination by adding layers of information where galvanized steel pipes are less than 80 mm in diameter. In tallying, the water distribution network provides the agreement of data base to study user and get the answer.

Wu et.al in this paper deals with distribution modeling requires for not only topological and geometrical information but also junction demand data. Maintaining accurate up-to-date demand data is essential to keeping a model calibrated and thus it ensures an informed hydraulic and water quality simulation. However, deriving junction demands can require a variety of data from different data sources. This process is often conducted by retrieving data from various databases e.g. customer billing data from customer information system, land use data from geographical information system and then manipulating the data to calculate demand for current and future conditions on a node-by-node basis. To facilitate loading a water distribution model, this paper has developed a general framework and fully GIS integrated tool that enables hydraulic and GIS modeler to flexibly calculate, allocate, distribute and project demand by using water consumption data and a variety of GIS-based information.

Hooda and Damani et al in this water distribution network model studied rural water network is usually the branch network, with the same water source rising. The main design decision for such a network is choice of pipe diameter from a separate set of commercially available pipe diameter. Its purpose is to come up with a formulation that solves general formulation while still maintaining optimality. Using standard design, we have implemented a water network design system, called Jalantra. There is also a GIS integration in ease of adding network details. The overall goal of the hydroelectric has been wide reach and will try to solve many network design barriers such as source selection, storage space, capacity, pipe diameter choices, water supply scheduling, cost allocation etc. Nodes in the network have water demand and minimum pressure requirements should be maintained. Input are source node, height of nodes, water demand, minimum pressure requirement, link length, commercial pipe diameter i.e. cost per unit length, roughness and for purpose of reducing total pipe cost, output of pipe segment as per length and diameter of each link. To optimize cost of piped water network, we have presented a general design which is optimal compared to previous designs for specific problem of one pipe segment per link also, they have completed a solution in the water network design system Jaltantra. There is also GIS integration for ease of adding network details to optimization engine in the Jaltantra.

Ray and Court et al according to most recent Drinking Water Needs Infrastructure Survey (DWNIS) conducted by the United States (US) Environmental Protection Agency (EPA), the US will need to invest $83 billion over the next 20 years to repair or replace deteriorating water distribution infrastructure. There is almost 1 million miles of distribution piping in the United States, the majority of which will be reaching the end of their life spans in the next 30 years. Network reliability has become a major issue. Determining the location of these critical elements e.g. aged valves, old pipes, etc. and what would happen if they failed is an important part of replacing or refurbishing strategies of any water utility. There are different methodologies and technologies used for identifying the location of these critical elements and rating the impact of their failure. There are also some new advances in hydraulic modeling and GIS software that allow municipalities/utilities to use their hydraulic models along with their GIS as a cost-effective tool for analyzing pipe/valve failures and replacement strategies in their water distribution system.

Thomas M. Walskiet al using a hydraulic model with pressure dependent demands (PDD), the PDD function relating demand vs. pressure must represent a collection of orifices e.g. sinks, toilets, showers, etc. with a wide variety of orifice coefficients located at different elevations operating at different times. Modeling every orifice for every user is impractical, but some type of effective PDD function relating pressure and water use must be provided. This paper presents several approaches for creating functions that represent water use at the model node and reasonably approximate actual water consumption. When the elevation of the water using orifices differs from the elevation of the model node, the function that represents water use tends to vary from the expected exponent of 0.5, especially at low pressures. This paper explains those findings using both manual calculations and a hydraulic model.

Wu et al in this paper, author studied conventional water distribution models are formulated under assumption that water consumption or demand defined at nodes is a known value so that nodal hydraulic head and pipe flows can be determined by solving a set of quasi-linear equations. This formulation is well developed and valid for scenarios that hydraulic pressures throughout a system are adequate for delivery required nodal demand. However, there are some scenarios where nodal pressure is not sufficient for supplying the required demand. These cases may include planned system maintenances, unplanned pipe outages, power failure at pump stations and insufficient water supply from water sources. In addition, some water consumptions like leakages are pressure dependent. In this paper, a robust and efficient approach for pressure dependent demand analysis is developed for simulating a variety of low pressure scenarios. A set of element criticality evaluation criteria is also proposed for quantifying the relative importance of elements that may be out of service. The results are presented for applications of approach to trivial systems and to a large water system.

1.5.1 Interference from Review

Development in the field of water distribution network has been extended up to great level. GIS integrated software and tool are giving better alternative to conventional mapping techniques, analysis etc. It is time saving, conventional and efficient. Also, for the continues supply of the water with sufficient pressure and velocity to consumer end regulation of those distribution network is one of the tedious tasks to manage. Many researchers work on the design of water distribution network and they conducted field survey method to input background data like elevation and pipe line lengths but the problem with field survey is there we cannot give assurance of data accuracy. Also, the inputting and obtaining data is tedious task along with wastage of time, money, efforts and skilled workers require. To overcome the above problems, we propose a methodology which is more feasible and accurate to work in WaterGEMS. By keeping all this in view, the following study has been performed.

1.6 Methodology of Research work

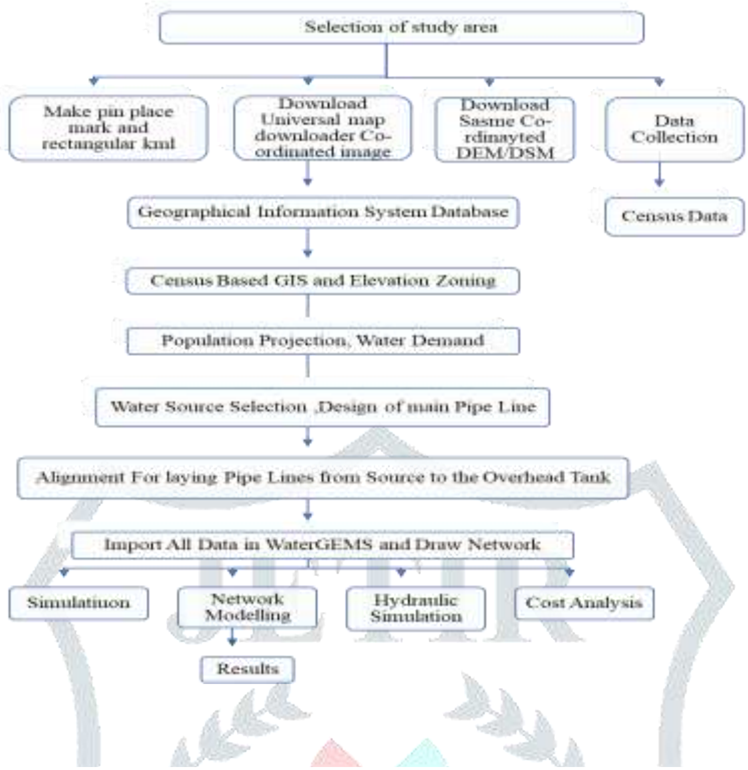

Figure 2 : Methodology of Research work

In this study ,we did work on water distribution supply as per the study we followed following steps.

1. We collected data from Chalisgaon municipal council
2. Census based GIS and elevation Zoning
3. We calculate demand method.
4. We draw area by using Google earth.
5. Extracting and reprojected DEM in QGIS.
6. We import all data in WaterGEMS.
7. By using Darwin Designer design optimized water distribution network.
8. We did simulation from WaterGEMS Software and as per the simulation we got solution of optimum pipe distribution network.

1.7 CONCLUSION

From the above review of research paper can conclude that,

1. It is seen that from the census report the water demand is not sufficient to provide water to present population.
2. For the converting intermittent supply to continuous supply it requires some more additional ESR in new Zones.
3. Zoning is done for the Chalisgaon whole city and it divided in to the 8 zones on the basis of Elevation, population Forecast Density.
4. For the converting continuous water supply requires to replace old area pipe on the basis of the Demand depend upon population growth.

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