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Assessment of Water Supply System of Deodar Taluka, Banaskantha, Gujarat, India using Geo-informatics Technology and EPANET

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Abstract:- *Water supply system is a system of engineered hydrologic and hydraulic components which provide water supply. This study explains the water distributions supply system of Deodar taluka, Banaskantha district, Gujarat. In the present study, the Indian Remote Sensing (IRS) LISS-IV data covering study area analyzed for understanding the road transport network, study area and various infrastructure in the city. The population forecast for next three decades was carried out using three methods namely, Arithmetic increase method, Geometric increase method and Incremental increase method. The water demand for next three decades for the estimated population was also carried out. The Google Earth Image was downloaded and the elevation of nodes, length of pipe was recorded. These data was used in EPANET Software for analysis of pressure, head loss and elevation. Ultimately the pressure at various nodes and head loss in various pipes will get as result. This study would help the water supply engineers in saving time as this process is fast and less tedious.*

Keywords:-Water Supply System, EPANET 2.0, Remote Sensing and Geographical Information System

I. INTRODUCTION

Water Supply System (WSS) is a structure of collection, storage, and distribution of the water for homes, commercial establishments, industry, and irrigation and for other purposes. It is a complex system that integrates several spatial features. In all cases, the water must fulfil both quality and quantity requirements. Design of the water supply system is related with the location and storage capacity of tank.

The layout of water distribution system can be divided into four types

i) Dead End System
ii) Grid Iron System
iii) Ring System
iv) Radial System

Geographical Information System (GIS) has been used to prepare and visualize the entire water supply network from source to household. It is an effective tool not only for collection, storage, management and retrieval of a multitude of spatial and non-spatial data, but also for spatial analysis and integration of these data to derive useful outputs and modelling.

The planning of the water supply network is mainly depending on the development of the area and population growth. In the present study adequacy of the existing water supply system has been assessed and evaluated and suggestions have been given to improve and modify the water supply system based on the GIS study.

II. STUDY AREA

The Gujarat state is located on western part of India between 20°01' N to 24°01' N latitude and 68°04' E to 74°04' E longitude. The study area Deodar is a taluka in Banaskantha district of Gujarat. Deodar taluka is covered by Kankrej taluka in East, Bhabhar taluka in West, Radhanpur taluka in South, Tharad taluka in North.

From March onwards the temperature starts rising maximum up to 42° C. The temperature during the summer season is remaining in between 30° C to 42° C. January is the coldest month of the year. The average

rainfall in Deodar is 840 mm. In history, the maximum rainfall was occur in 1977 and that was the 1189 mm. And, the minimum rainfall was occur in 1987 and that was the 18 mm.

In this region, the soil is mainly coarse loamy and fine loamy. Here, major area falls into 'very deep' soil. The depth of soil is too deep about 35 to75 cm. The soil fertility is medium with low phosphorus and potash. This region is containing the moderate salinity of the soil.

In Deodar area, the main source of water is Narmada Main Canal. It is divided into four zones. There are five villages in Golva zone, thirteen villages in Jada zone, sixteen villages in Lavana zone and thirty-six villages in Jasali zone. The water is supplied to these zones by making the off take from Narmada Main Canal. The intake well is constructed near the canal. The water from intake well is supplied to the water treatment plant for remove the impurities. Then this filtered water is stored in sump. At last, this water is supplied to the main four storage tank.

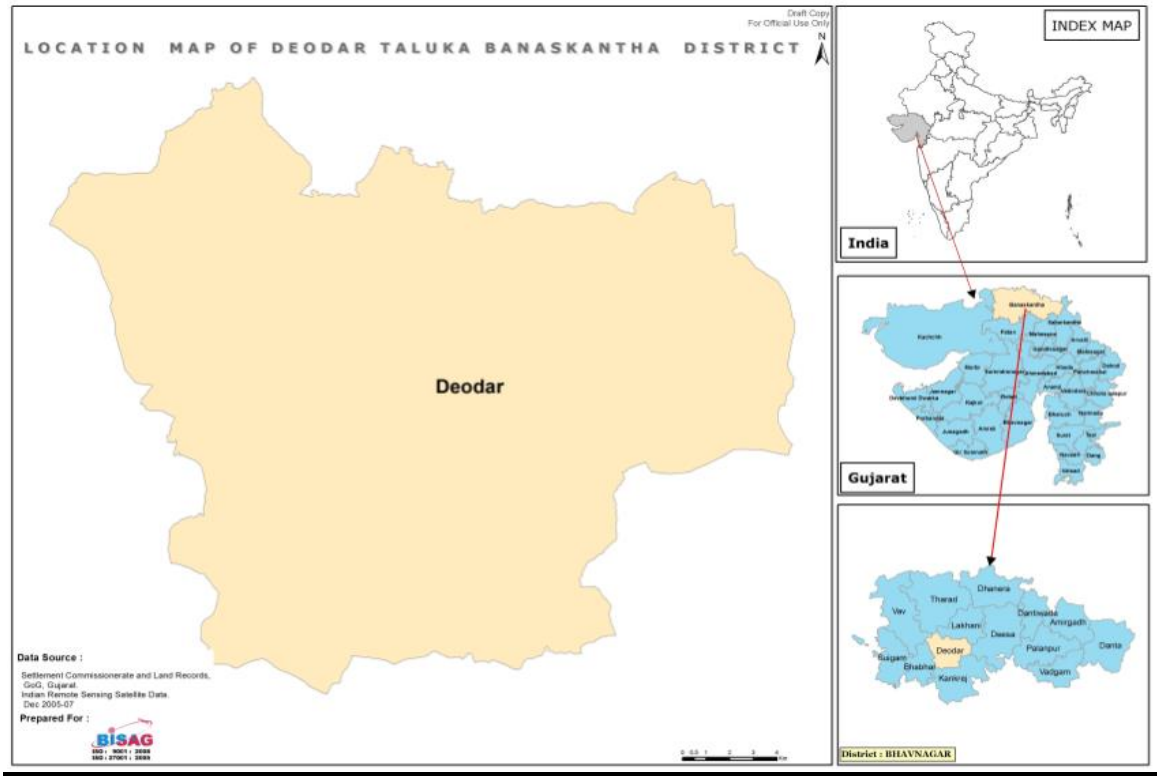

Fig. 1 Location map of study area

III. METHODOLOGY

Various thematic maps such as road network, land use, soil and slope have been prepared using remote sensing and GIS technology. The stepwise method for assessment of Water Supply System is presented through flowchart.

3.1 Georeferencing

Georeference means to associate something with locations in physical space. This is commonly used in the GIS to describe the process of associating a physical map with spatial locations. Georeferencing may be applied to any kind of object or structure that can be related to a geographical location, such as roads, places, bridges, or buildings.

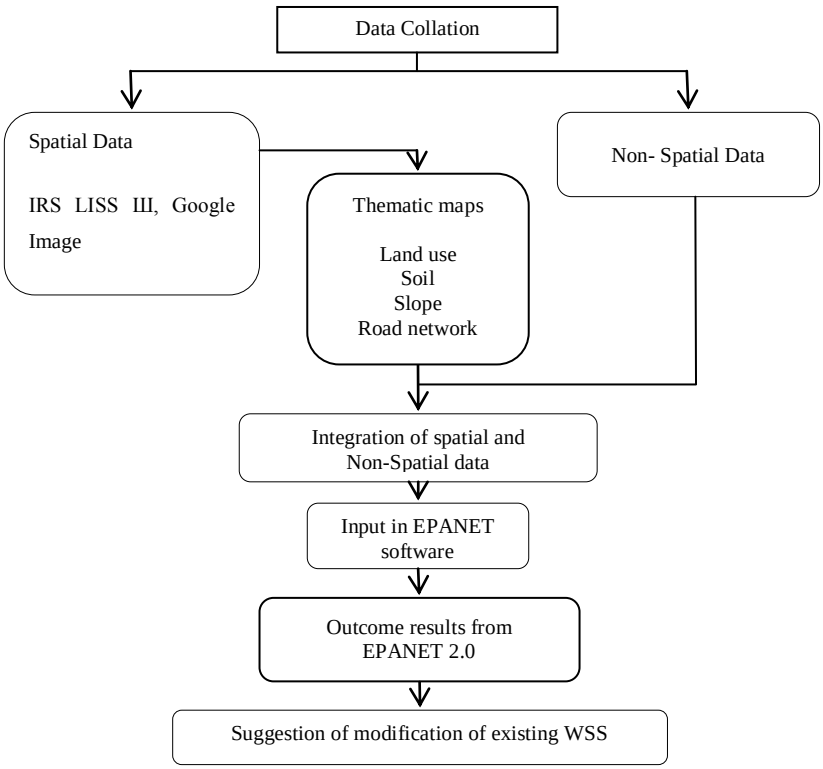

Fig. 2 The flow chart of methodology adopted for Study**.**

3.2 Population and water demand forecast

The population was forecasted using three methods as shown below:-
Arithmetic Increase Method: $P_n = P_\circ + n.\bar{x}$
Geometric Increase Method: $P_n = P_0[1 + r/100]^n$
Incremental Increase Method: $P_n = P_0 + n.\bar{x} + (n(n+1))/2.\bar{y}$

Where:
P_n = Prospective or forecasted population after n decades from the present, P_0= Population at present, n = No. of decades between now and future, $\bar{x}$=Average (arithmetic mean) of population increases in the known decades, r = Assumed growth rate (%),
$\bar{y}$= Average of incremental increase of the known decades.
The population and water demand is forecasted up to the year of 2045.

3.3 EPANET SOFTWARE

EPANET is developed by the US environmental protection agency. It is a computer program that performs extended period simulation of hydraulic and water quality behaviour within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, etc. The result is get using this software based on Hazen-Williams hydraulic equations.

3.3.1 Elevation and base demand of nodes

Depending upon the level of the source of water and that of the city, topography of the area, and other local conditions and considerations, the water may be forced into distribution system by gravitational system, by pumping system and by combined gravity and pumping system.
The elevation at various junction locations is found out using Google Earth. And the length between all nodes is recorded from the Google Earth image. Every intersection for the pipe network of water distribution system is known as a node. The base demand of each node is calculated according to the forecasted population.

Node ID	Elevation (m)	Base Demand (Mld)	Pipe ID	Length (m)
2	62.8	0	2	406
3	59.95	0	3	4648
4	55.19	0.18	4	2174
5	54.83	0.33	5	3870
6	47.52	0.61	6	2040

Now, the network diagram for the Golva zone is draw in EPANET 2.0 as shown below:

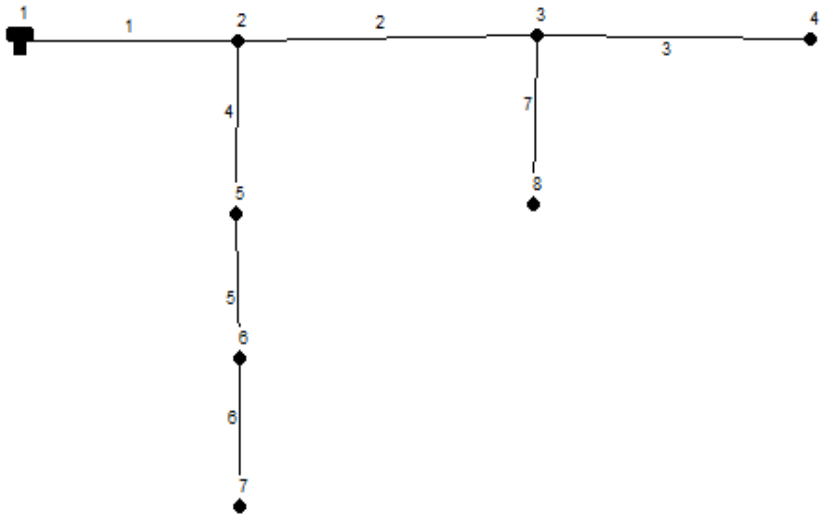

Fig 3 Network diagram

IV. RESULT AND CONCLUSIONS

With the help of GIS study various thematic maps such as land use, road network, soil and slope have been prepared and integrated with the water demand and supply data. These data has been assessed and evaluated for planning of the water supply system using EPANET software. Results for the velocity, head loss and pressure have been obtained and evaluated as shown in the Figures (Fig. 4 and 5). These results are of Golva zone area of Deodar Taluka. Similar results have been obtained for other zones.

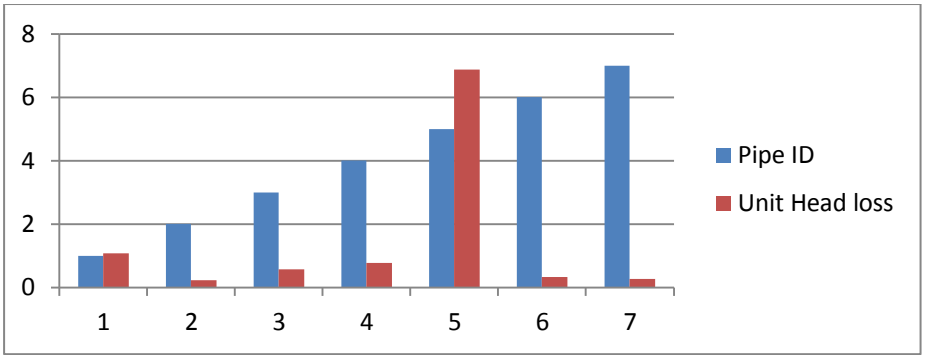

Fig 4 Unit Head Loss for Golva zone

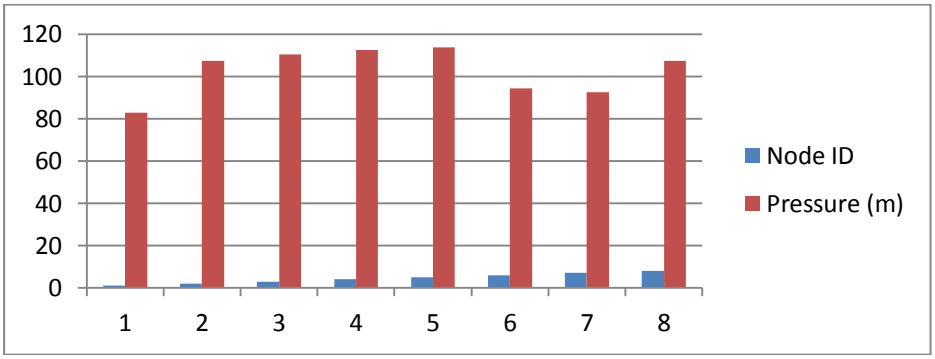

Fig 5 Pressure for Golva zone

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