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Study on Water Distribution Network using GIS for 81 Villages at Yamcha, Telangana State

B. Vinod[1], G. Anitha[2], T. Rakesh Reddy[3] and Pritanjali Shende[4]

[1,2,3,4]RGUKT Basar
E-mail: [1]iitbvinod@gmail.com, [2]anitha111243@gmail.com,
[3]rakesht.iitb@gmail.com, [4]spritanjali@gmail.com

Abstract—*Water plays a crucial role as the availability of water is not uniform throughout the geography. The need of water distribution to areas where there is scarcity of water; which may not meet the demand due to various reasons such as availability of insufficient water, shortage of power supply, efficiency of pumps and the proper network system etc. The distribution can be done by gravity to some extend and/or by boosters which pumps the water to the elevated areas. The network data associated with each village is stored and analyzed manually, which is cumbersome and hence the solution for this problem of network system can be done with the application of GIS. In this paper GIS is used to digitize the water distribution network data collected from the governmental records and a more efficient network is proposed.*

The water distribution network data from Yamcha village, which supplies drinking water to 81 villages, is studied. The total areal supply to these 81 villages is divided into five different networks with the help of boosters for efficient water distribution. The five individual boosters are located at Yamcha, Abbapur, Amrad, Navipet and Metpally.

All the network data is stored in paper format and hence it is difficult to maintain the old records for future research. GIS was used to study and analyze the water distribution network through these five boosters among 81 villages. It was observed that the present water scenario in these villages was not able to meet the required water demand with the existing water distribution system. Through the survey it came into notice that the quality of water was not maintained up to the mark. As a result a proper treatment system along with systematic water distribution network is required for these 81 villages.

1. INTRODUCTION

Water plays a crucial role as the availability of water is not uniform throughout the geography. The need of water distribution to areas where there is scarcity of water; which may not meet the demand due to various reasons such as availability of insufficient water, shortage of power supply, efficiency of pumps and the proper network system etc. Hence a set of data are required inorder to optimize the Water distribution system (WDS). However, the WDS data are crucial for research tasks and are often not available or of poor quality. Water supply pipeline network is a system which has a large of spatial attribute data.Contrary to practical applications where the aim is to describe a specific system sufficiently and very accurately, for research purposes it is often more important to gather information on many different water distribution systems with different characteristics in order to obtain case unspecific results from evaluations[1]. Therefore, recently researchers started to create few virtual water distribution systems manually [2] or even automatically in great number [3-7]. All these approaches are capable to create different kinds of water distribution systems. But a lack of all these approaches is that the generated network layouts are only a simplified representation of real systems. In order to improve the manage and work efficiency, reducing the workload of workers, the best way is that designing a water supply network based on GIS, the system based on Arc GIS platform [8].

The present paper aims in studying and improving the existing water distribution networks for 81 villages in Yamcha area.

2. STUDY AREA

Yamcha is a village panchayat located in the Nizamabad district of Telangana state, India. The latitude **18° 51' 14"**and longitude **77° 58' 2"**are the geo-coordinate of the Yamcha. The groundwater in this region is rich in fluoride (1.8 ppm to 4.5 ppm) and salts. Hence a Yamcha water scheme was proposed. The Yamcha drinking water scheme built on Godavari river to supply safe drinking water to as many as 81 fluoride- affected villages in Navipet, Makloor, Renjal and Yedapally mandals is beset with several problems resulting in drinking water scarcity in these villages. As of now, as against the 81 villages under the scheme only 37 are being given water, leaving the rest in the lurch. The Yamcha Projects schemes are located in the 15 mandals of the Nizamabad Districts.

This Scheme comes under the fluoride project of Rajiv Gandhi National Drinking water Mission (RGNDWM) in Nizambad area since 1994 as per Govt. of India, Ministry of Rural Development. The original project proposal covered 188 villages of which 164 depended on bore wells/open wells water for drinking. The remaining 24 villages depended on rivers, streams, canals.The perennial Godavari, Manjeera

Rivers, local streams, vaghus, irrigation canals were selected as the sources of the project. The treatment system of the schemes along the river consists of Summer Storage (SS) Tank followed by slow/rapid sand filtration (SSF or RSF). The head works for major schemes consist of a SS Tank followed by a RSF/SSF. The total project cost escalated from an initial Rs. 2147.85 Lakhs to a final Rs. 3050.00 lakhs. The total design population is 1,80,340.

3. OVERALL DESIGN

The scheme is spread in six mandals of Nizamabad district viz, Navipet, Renjal, Yedpally, Makloor, Nizamabad, and Dichpalli covering 78 habitations serving a population of 1.30 Lakhs as per 1991 census and designed for and ultimate population of 1.80 Lakhs. The enroute PWS scheme at Madav Nagar, Ananthagiri, Srinagar and Ashokform are connected to the Yamcha scheme, which are sanctioned in the fluoride project Nizamabad as individual schemes.

The principal and only source is River Godavari, which is a semi perennial source and the water being available for 10 months in a year. The summer storage tank is conveniently constructed at Yamcha encompassed by natural hillocks. The bunds are formed for about 680m length with height from 6 to 10m and the storage capacity is about 6,35,000 m^3 of water. Due to utilization of natural hillocks the RWS Department has saved Rs.2.00 crores (approx.) when compared to construction of S.S. Tank in plain areas.

The transmission lines runs for about 205 km length. Out of which 152 km. are gravity main and 53 kms are pumping main. The diameter of pipes range is from 80mm to 500mm dia. All the safety valves/control valves are provided in the transmission lines. Water is supplied to the villagers through Over Head Storage Reservoirs (OHSRs, design population > 1500 capita) and Ground Level Storage Reservoirs (GLSRs, design population < 1500). The following Boosters are constructed to boost the head of water so as to flow the water by gravity further. The population Fig. s, based on the 1991 census are the follows.

Table 1: Population data of 81 villages

Year of Census	Population
1991	134483
2006	161380
2021	188276

4. METHODLOGY

The objective of this study is to understand & analyze the existing water distribution network for 81 villages. The data about the network and the villages associated with it were in printed documents and the storage and retrieval of the data in digital format, was needed to be made manually which made it a tedious process. One of the solution to this problem is GIS which is a an integrated tool, capable of mapping, analyzing, manipulating and storing geographical data in order to provide solutions to real world problems and help in planning for the future.

By preparing the present network or digitizing the existing network data using GIS, the supply from the booster is meeting the demand of the villages or is there a need for increasing the supply, was estimated. The map in Fig. 1 shows Godavari river, Intake well for the Yamcha water treatment plant, the location of Yamcha water distribution network ,the boosters and some of the major villages which comes under this distribution network.

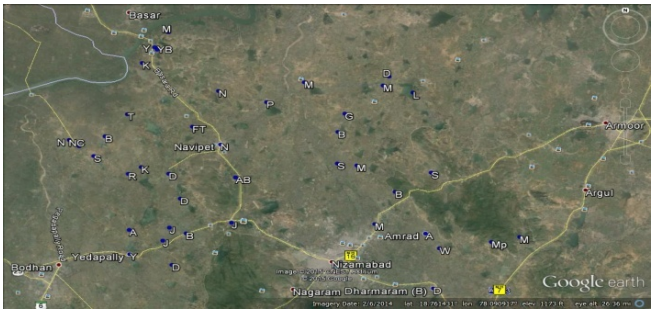

Fig. 1: Map of Google Earth, showing some major villages of network

A digitized image of present water distribution system (WDS) was obtained using GIS as shown in Fig. 2.

Fig. 2: Water Distribution network of Yamcha

A systematic network of the water distribution system, which comes under this network, connecting all the villages was observed from the digitized map.

The total areal supply to these 81 villages is divided into five different networks with the help of boosters for efficient water distribution. The five individual boosters are located at Yamcha, Abbapur, Amrad, Navipet and Metpally.

4.1 Yamcha Booster

Yamcha has the Godavari river intake well from which the water is distributed throughout the network of villages. It also has the filtration system which filters the water by rapid sand filtration method. After the filtration the water is pumped to the overhead tank located on the hill using motors. From this overhead tank the water is distributed by gravity for some

extent and pumps are used to distribute them to other villages of the network. Fig. 3 shows the map explaining the distributary network from the Yamcha Booster.

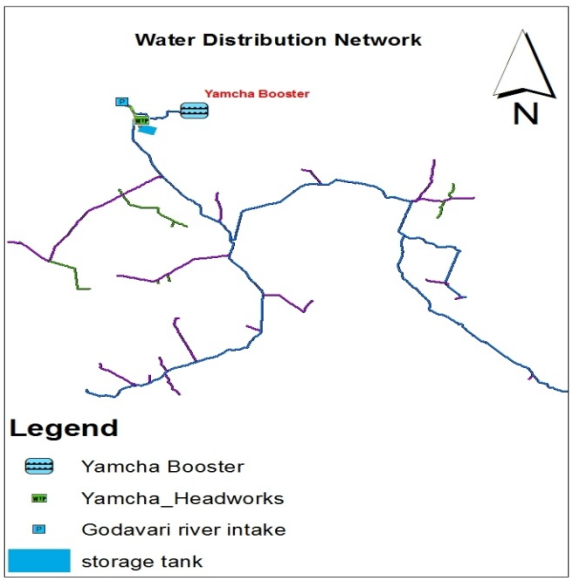

Fig. 3: Layout of Yamcha Booster

A detailed table showing the various input data interms of sensus data having the perspective population and the ultimate population values is shown in table1.

Total water for all the distribution systems is through Yamcha headworks. Yamcha also has its own booster to serve nearby villages. The type of distributary network is OHBR. It is serving 16 villages by using the **3** No. 90HP submersible pumps. It has 2.50 Lakhs Liters capacity OHBR with 6m staging. It has pumping main diameter 450mm and Gravity main diameter is 500mm.

4.2 Abbapur booster

Fig. 3 shows the details of the distribution of water from the Abbapur booster. From this network water is being distributed to 26 villages. Abbapur booster is located nearly 6.3km away from the Yamcha project. The type of distributary network of Abbapur booster is GLBR.

Table 1: Report of Yamcha Booster

Name of the Habitation	Present population as per 2011 census	Present daily supply demand @ 40 LPCD	PP	UP	SRC
Yamcha	1232	49296	1232	1438	40000
Mittapur	570	22800	570	665	10000
Fakeerabad	883	35328	883	1030	20000
Kosli	1967	78672	1967	2295	40000
Nagepur	1937	77472	1937	2260	40000
Matta form	720	28800	720	840	10000
Pothangal	2500	99984	2500	2916	60000
Fathenagar	1034	41376	1034	1207	20000
L.K. Form	605	24192	605	706	20000
Rampur	1088	43536	1088	1270	20000
Ananthagiri	1147	45888	1147	1338	60000
Tadbiloli (T)	374	14976	374	437	10000
Tadbiloli	3000	120000	3000	3500	60000
Borgoan	2311	92448	2311	2696	40000
Neela camp	2400	96000	2400	2800	40000
Neela	4949	197952	4949	5774	90000
PP: Perspective Population, UP: Ultimate Population, SRC: Service Reservoir Capacity					

GLBR has 1.06 Lakhs liters capacity with 7m diameter and 4m depth. Pumping main 350mm diameter pipes and Gravity main 300mm diameter pipes are being used for supply of water. The submersible pumps of 60HP are been used for the pumping and supply. A detailed report for Abbapur area was generated with the help of GIS is shown in table 2.

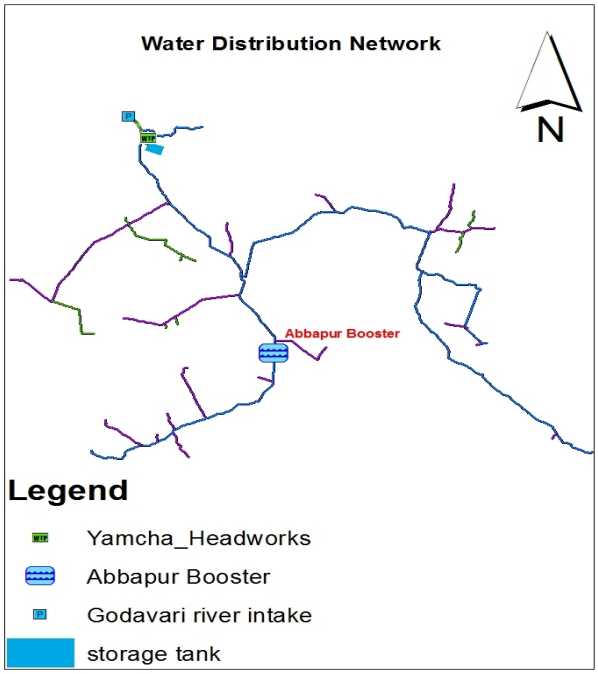

Fig. 4: Layout of Abbapur Booster Using GIS

Table 2: Report of Abbapur Booster from GIS

Name of the Habitation	Present population as per 2011 census	Present daily supply demand @ 40 LPCD	PP	UP	SRC
ARP camp	2688	107520	2688	3136	60000
Dubba Tanda	438	17520	438	511	10000
Shatapur Gate	258	10320	258	301	10000
Yedpalli	9752	390096	9752	11378	200000
Jamlam	1043	41712	1043	1217	10000
Waddepalli	954	38160	954	1113	10000
Dharmora	960	38400	960	1120	10000

MSC form	780	31200	780	910	5000
Jaitapur	1567	62688	1567	1828	60000
Bapunagar	972	38880	972	1134	10000
Doopalli	4039	161568	4039	4712	150000

4.3 Metpally Booster

Fig. 5 explains the Metpally booster's distribution network which covers 22 habitations. The type of distributary network is OHBR. It has 60,000 liters capacity OHBR with 9m staging. It has pumping main of 200mm diameter and Gravity main of 250mm diameter pipe. The 3 Submersible pumps are used having 20HP power.

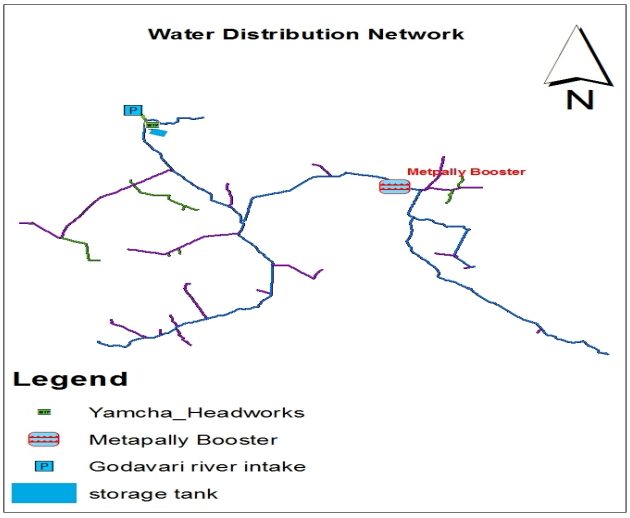

Fig. 5: Layout of Metpally booster Using GIS

Table 3: Report of Metapally Booster

Name of the Habitation	Present population as per 2011 census	Present daily supply demand @ 40 LPCD	PP	UP	SRC
Krishna nagar	720	28800	720	840	10000
Singampalli	389	15552	389	454	10000
Singampalli(T)	70	2784	70	81	10000
Durga nagar	85	3408	85	99	5000
Durga nagar Ca	180	7200	180	210	10000
Durga nagar Kin	720	28800	720	840	20000
Elinaik (T)	240	9600	240	280	15000
Madapur	3120	124800	3120	3640	60000
Bonkanpalli	1438	57504	1438	1677	60000
PP: Perspective Population, UP: Ultimate Population, SRC: Service Reservoir Capacity					

A detailed data regarding the major villages in Metapally area are shown in the table 3 which is generated from the ArcGIS.

4.4 Navipet Booster

The central point of the Distribution network is Navipet Booster. The Fig. 6 shows the distribution network of Navipet booster which serves 5 villages of its mandal. The distribution of water for other boosters is through the Navipet booster. The report generated by the GIS software is shown in table 4.

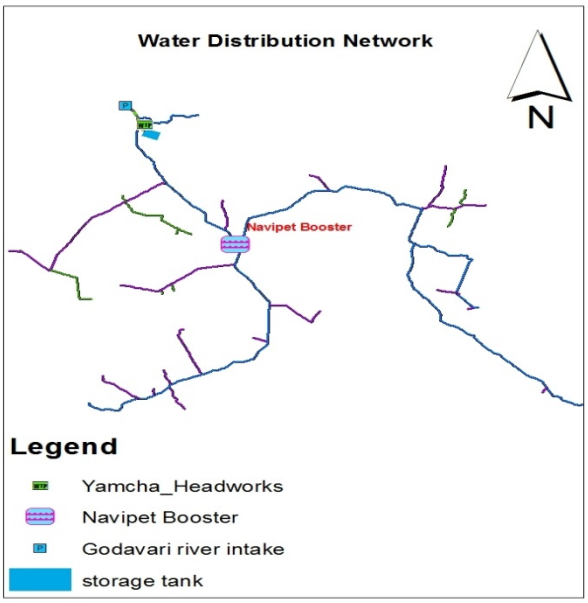

Fig. 6: Layout of Navipet Booster

Table 4: Report of Navipet Booster

Name of the Habitation	Present population as per 2011 census	Present daily supply demand @ 40 LPCD	PP	UP	SRC
Pothangal	2500	99984	2500	2916	60000
V.Gutta	622	24864	622	725	10000
Dandigutta	790	31584	790	921	10000
Kalyapur	1680	67200	1680	1960	80000
PP: Perspective Population, UP: Ultimate Population, SRC: Service Reservoir Capacity					

4.5 Amrad Booster

The map in Fig. 7 shows the distribution network of Amrad booster. It serves 8 villages/habitations by using 2 No. 10HP submersible pumps. Table 5 shows the detailed report obtained from GIS for Amrad booster.

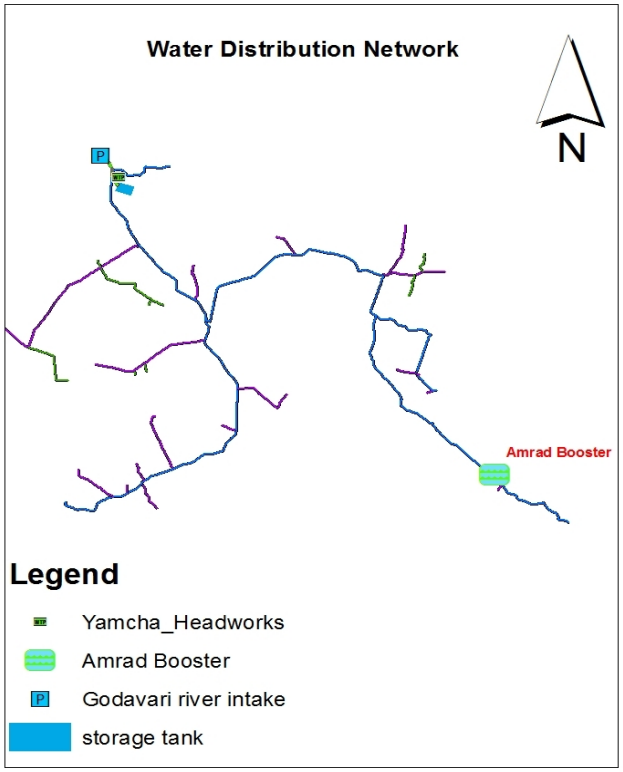

Fig. 7: Layout of Amrad Booster

Table 5: Report of Amrad Booster

Name of the Habitation	Present population as per 2011 census	Present daily supply demand @ 40 LPCD	PP	UP	SRC
Waddiatpalli	1694	67776	1694	1977	80000
Amrad	3468	138720	3468	4046	150000
Amrad(T)	768	30720	768	896	10000
Muthyampalli	743	29712	743	867	40000
Manikbandar	3780	151200	3780	4410	60000
Borgoan	2916	116640	2916	3402	90000
Madanpalli	3496	139824	3496	4078	90000
Madanpalli(T)	360	14400	360	420	17500
Madanpalli Ca	300	12000	300	350	17500
PP: Perspective Population, UP: Ultimate Population, SRC: Service Reservoir Capacity					

4.6 Yamcha Water Distribution system

Fig. 8 shows the complete water distribution network in Yamcha region for 81 villages.

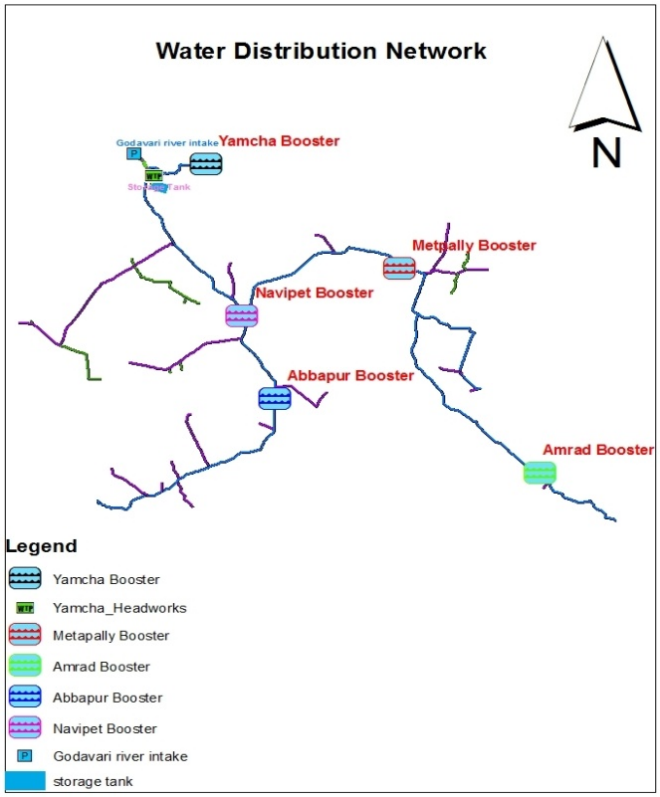

Fig. 8: Layout of Yamcha water distribution network of 81 villages

5. CONCLUSION

As the existing plant is unable to meet the demand of present population we need to take some measures to improve the efficiency of the distribution network. As the population growth of our country is very high it is clear that we cannot meet the future demand. So, the possible solution to this problem is to provide another treatment plant which increases the rate of filtration & also allows us to continuously distribute the water throughout the network.

The improvement in the Existing network can be made by extending it to every household in the village and can also meet the required water demand by improving the efficiency of the network. Thus it can be said that by the data stored in the GIS database has a large scope for future improvement in maintaining the efficiency of the water distribution network. Another problem which arises during the distribution is the power shortage at Yamcha & also at other boosters of the network. To curb this problem we can arrange solar panels at each booster which uses the solar energy & produces some amount of power in addition to the existing power supply.

6. ACKNOWLEDGEMENTS

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