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Analysis of Storm Water Drainage Network for Nagala Village, Tharad Taluka, Banaskantha Using Geo-Informatics Technology

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Abstract-As India is agriculture based country, the problem of metrological change act major as globally. It may lead to increase temperature day by day, which causes unpredictable heavy rain in short duration. Due to short period heavy rain water logging become a serious problem. This problem badly affects People, crop production, Infrastructure Facility, socio-economic growth of country. In month of July, 2015 heavy rain occurs of 48 inch in 3 days in Banaskantha. Due to this many of area is submerged and act like a lake up to several month particularly in Nagala village, Banaskantha district. Main focus is on removing that water easily and effectively. This study mainly comprises removal of excess water and provides effective and efficient drainage system in western part of Banaskantha by designing of storm water drainage for Nagala village using Geo-Informatics Technology.

Keywords: Water logging, Drainage, Runoff, Storm water,GIS,DEM

I. INTRODUCTION

Water-logging is emerging as a pressing concern at the backdrop of climate change in recent years in Gujarat also. A global report on climate change has projected 0.5-1.20 ^{0}C rise in temperatures by 2020, resulting in unpredictable and excessive rains. Globally, more than 40 m ha area is estimated to be affected by water-logging. In India about 8.53 m ha area is affected by water-logging with an estimated crop loss of greater than 2 m tons each year.

Due to this heavy and unpredictable rain in India, now a day's water logging becomes one of serious problem. Banaskantha is suffering from Heavy rainfall during 24/7/2015 to 27/7/2015which causes problem of water logging in low laying areas. Nagala village is suffered more than three to four month. Analysis of Nagala village is carried out using Geo-Informatics technology to design Storm water Network as a better solution.

II. BANASKANTHA AT A GLANCE

Banaskantha is one among the thirty-three districts of the Gujarat state of India. The administrative headquarters of the district is at Palanpur which is also its largest city. Banaskantha District situated between latitude 24.1731° north and longitude 72.4314° east. The district is located in the Northeast of Gujarat and is presumably named after the West Banas River which runs through the valley between Mount Abu and Aravalli Range, flowing to the plains of Gujarat in this region and towards the Rann of Kutch. The geographic area of Banaskantha District is 10,400 sq.km. It contributes to agriculture Product of states and Ranks No. 1 in Production of Potatoes in India.

2.1 Location of Study area

The study area falls in Banaskantha district, Nagala Village of Tharad taluka. Total area of Tharad is 1358 km^2

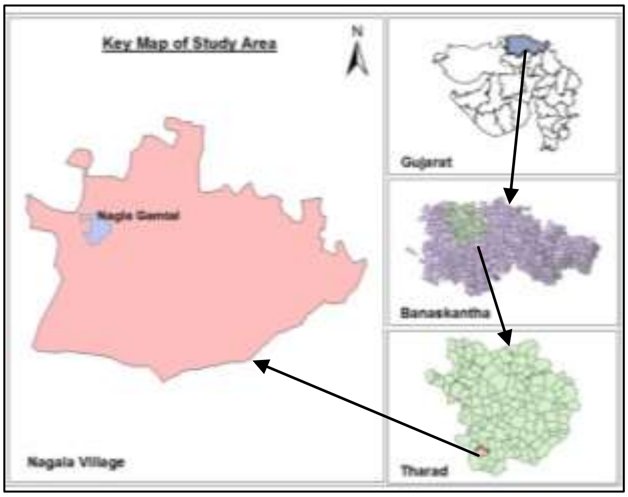


Figure 1. Key Map of Nagala Village

2.2 Geographic Profile of Study Area

Table 1 Geographic Profile Data

Taluka/Village Name	Population			Household
	Total	Male	Female	
Tharad	3,27,289	173732	153557	39,314
Nagala	2276	1325	951	233

2.3 Climate

It is too hot in summer. In summer highest day temperature is in between 30 ° C to 43°C. Average temperatures of January is 21 ° C , February is 23 ° C , March is 28 ° C , April is 32 ° C , May is 35 ° C.

III. NEED OF STUDY AREA

Recently major part of Banaskantha district experienced heavy rain in the month of July, 2015 of dated from 26 to 30 resulting in water logging most of the area. It is disturbing day to day activity of the human being and causing lot of damage to the property, agriculture and animals needing detail study of the area to prevent and manage such type of disaster in future.

IV. AIM OF STUDY AREA

The main aim of the study is to analyse suitable storm water drainage system for prevention of water logging in future. Solving problem of waterlogged are will lead to a significant increase in quality of life, maintain hygienic condition and regional development take place. Geo-informatics techniques are used for identification of depression area as well as generation of maps become easy. Different Thematic Maps are generated for Analysis of Nagala Village.

V. FIELD SURVEY

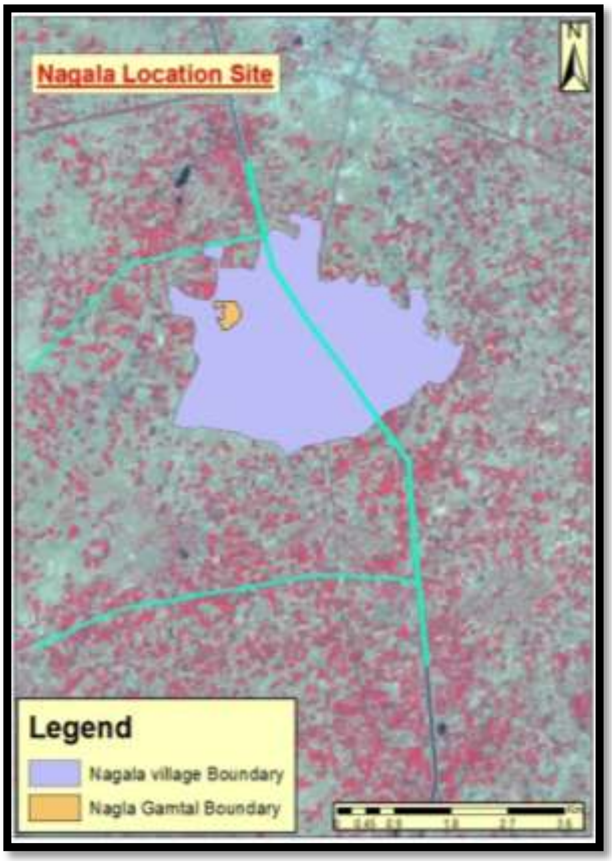


Figure 2. Location Site of Nagala Village

As shown in Fig.3 Nagala village is surrounded by three side canal network namely Narmada Main canal, Madaka canal, Malsan canal. Due to such site conditions it is clear that elevation of canal structure is comparatively higher than the village site location, which is one of reason to accumulate water over that area.

Initially removal of water is carried out by making cut in Madaka canal, but water not removed completely. Afterwards 3 No. of Fighter pumps are provided on Malsan canal but situation is almost same. Finally 24 No. of Submersible pumps are used and water is pumped out from village site only.

Figure 3. Accumulated water in Nagala village

Figure 4. After Pumped out water in Nagala Village

VI. DATA COLLECTION

6.1 Population Data

Tharad population has grown from 1,90, 058 in 1971 to 3,27,289 in 2011. For design purpose only Nagala village is considered as pilot project. Population growth of Nagala Village is 937 in 1971 to 2276 in 2011.

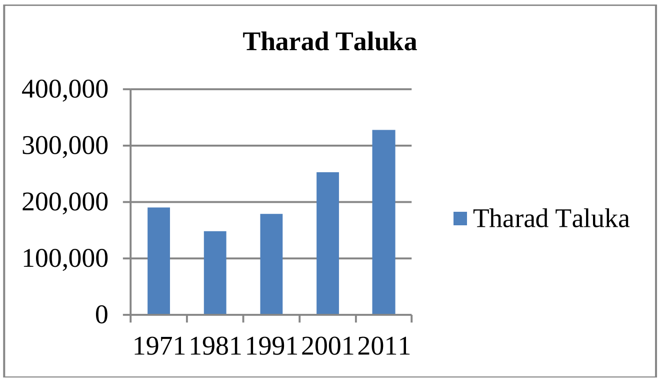


Figure 5. Population of Tharad Taluka

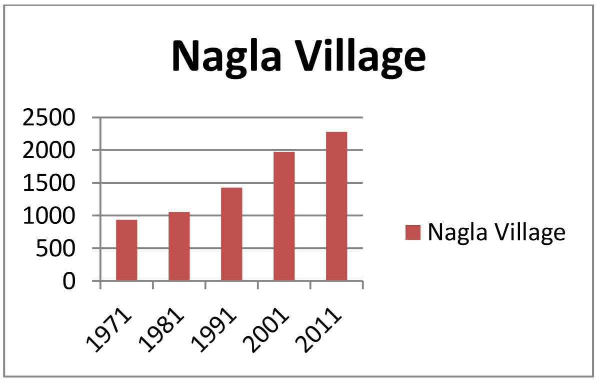


Figure 6. Population of Tharad Taluka

6.2 Rainfall Data

Heavy Intensity of rain the main reason of water logging, Tharad village has maximum rainfall on 27th July, 2015.

Table 2. Rainfall Data

Rainfall in mm				
Sr No.	**Taluka**	**25/07/2015**	**26/07/2015**	**27/07/2015**
1	Tharad	2	105	112

6.3 Topographic Data

3-D Surface Relief Map shows contours and slope direction of Nagala Village.

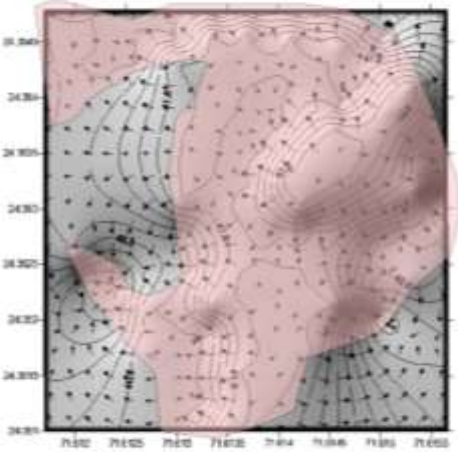


Figure. 7 3D Surface Relief Map of Nagala Gamtal showing contours (m) and slope directions

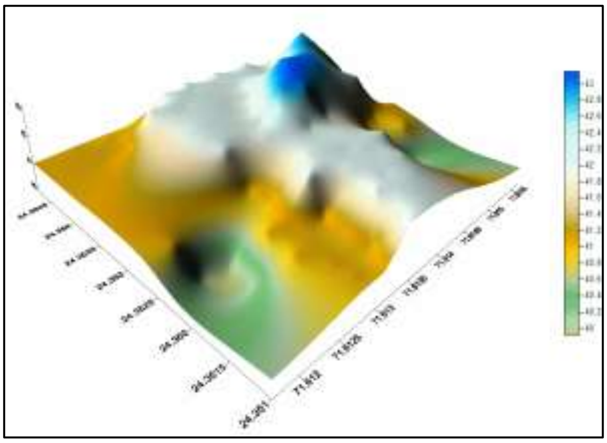


Figure 8 3-D surface relief Map of Nagala

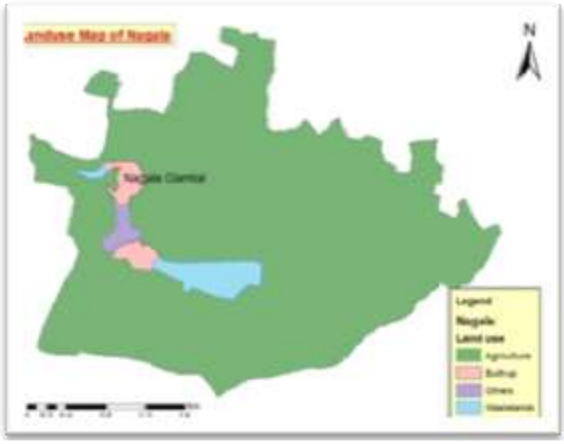


Figure 9 Land Use Map of Nagala

Land use can be defined as the use of land by humans, usually with emphasis on the functional role of land in economic activities. Land cover designates only vegetation either natural or man maid on the earth's surface. Land use depends on the natural and anthropogenic activities. These maps have been developed using Envy and Arc GIS software. In the Nagala Village Agricultural, Built-up area, Wasteland and other purpose use land is identified and delineated the Land use/land cover maps as shown in Figure 9.

6.4 Lithological Map

Groundwater (or ground water) is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands.

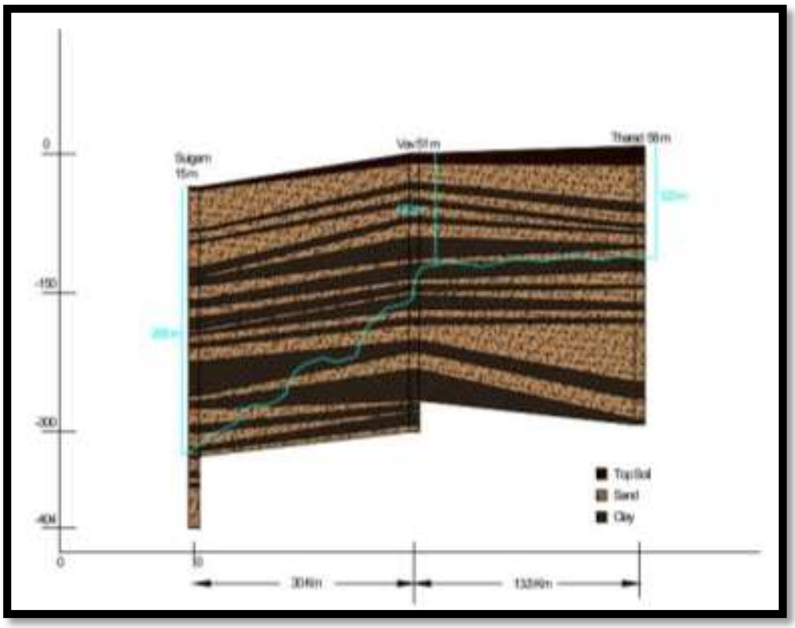


Figure 10 Land Use Map of Nagala

VII. DESIGN OF STORM WATER DRAINAGE FOR NAGALA VILLAGE

8.1 Estimation of Storm Runoff

For estimating the flow to be carried in the storm sewer, the intensity of rainfall which lasts for the period of time of concentration is the one to be considered contributing to the flow of storm water in the sewer. Of the different methods, the rational method is more commonly used.

$$Q=10\,CiA$$

Where,

Q : Runoff in m^3/hr

C : Dimensionless runoff coefficient

i : Intensity of rainfall in mm/hr

A : Area of drainage district in hectares

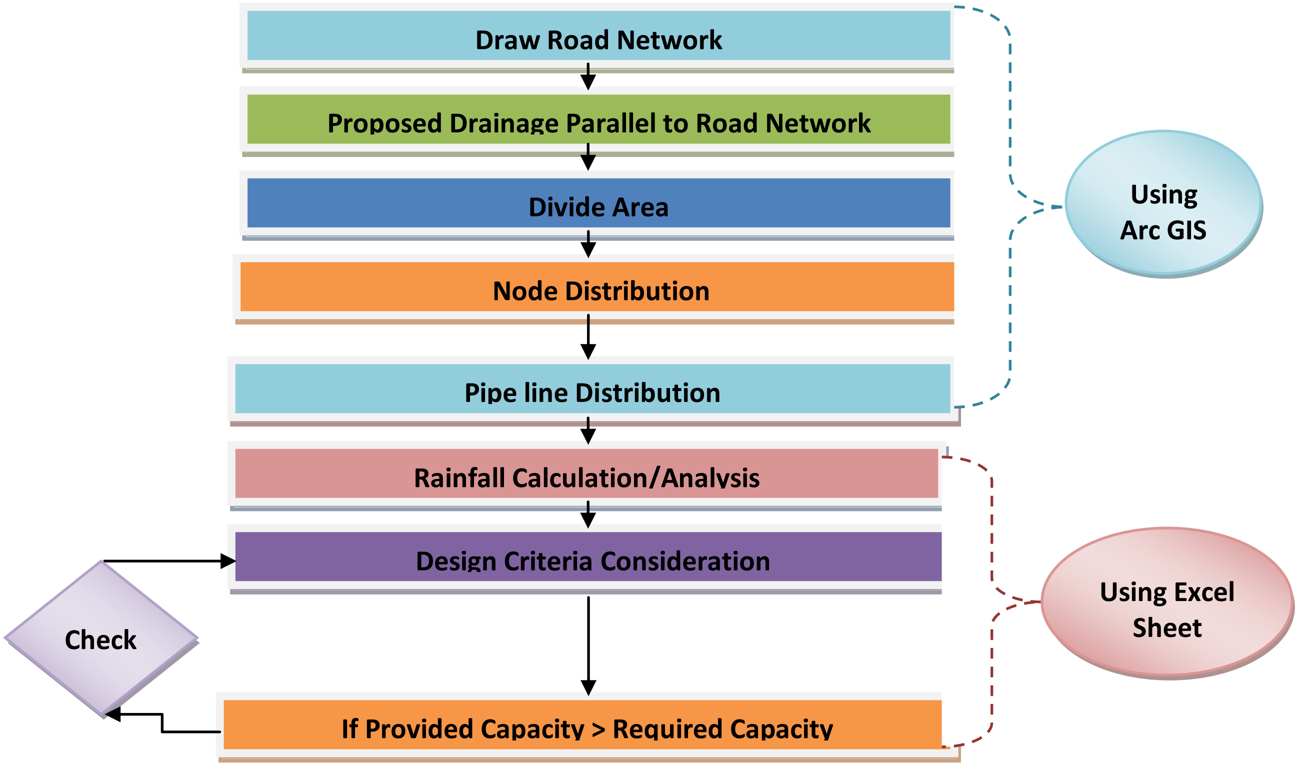
8.2 Factor of Imperviousness:

It may be reiterated that Q represents only the maximum discharge caused by a particular storm. The portion of rainfall, which finds its way to the sewer, is dependent on the imperviousness and the shape of the drainage area apart from the duration of storm. The percent imperviousness of the drainage area can be obtained from the records of a particular district. In the absence of such data, Table .4 below may serve as a guide.

Table 3. Runoff coefficients for stated surfaces

Sr. No.	Type of Area	Percentage of Imperviousness
1	Commercial and Industrial Area	70-90
2	Residential Area - High Density - Low Density	 61-75 35-60
3	Parks and undeveloped areas	10-20

8.3 Design Steps:



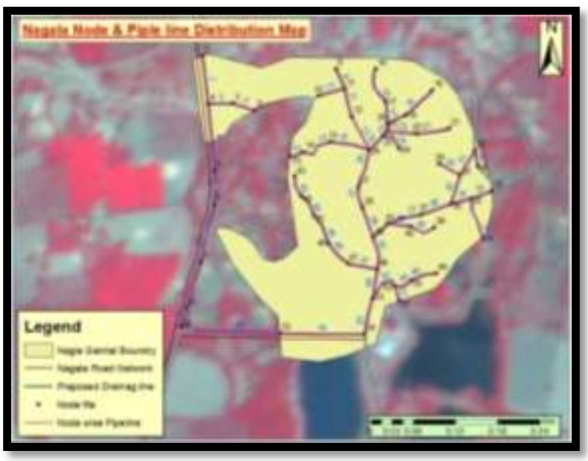


Figure 11 Proposed Drainage Pipe network

Figure 12 Detailed Drainage network

A schematic drawing is one in which pipe lengths are entered manually. Nagala Village, Tharad Taluka has designed for the network of 2389 meters, in that 279 meters of storm water network can be shown Fig.10 and the design is tabulated in table 4.

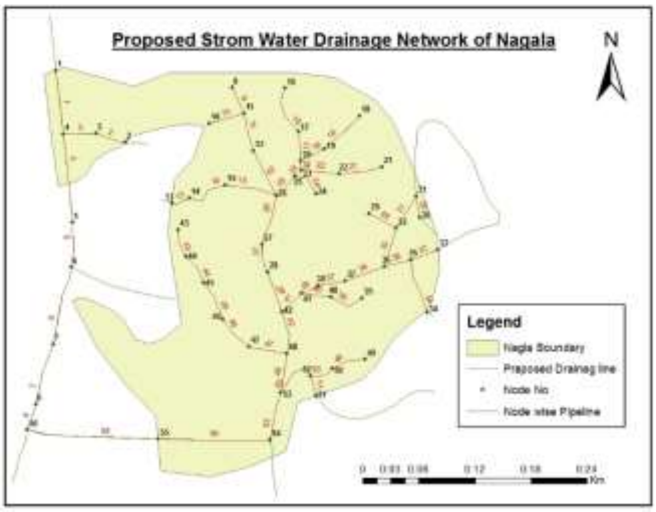


Figure. 13 Design Area with Detail Networking

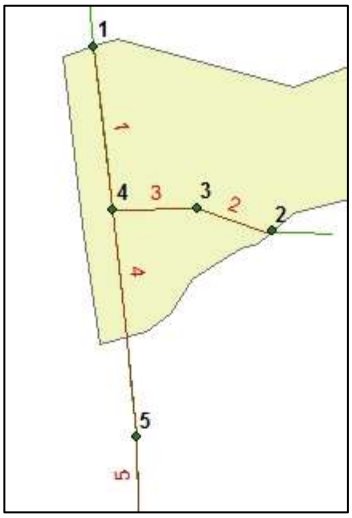


Figure. 14 Focus for Design on Node 1 to 5

Table. 4 Analyses and Final Strom Water Design Sheet for Node 1 to 5

Location of drain		Total cummulative area	Time of Concentrate -Tc			Runoff		Flow	Design										Profile	
From Node	To Node		inlet time- ti	Travel time - tt	Tc	Runoff 10ci	Total Runoff	Total Flow Q	Section		Hydraulic parameter			Slope	Manning's coeeficient -"n"	Capacity of the Drain- Qd	Velocity-V	Length	Existing Ground level	
									Section Width - b	Water Depth - d	Wetted area - "A"	Wetted perimeter -"P"	Hydraulic radius -"R"	I in L					From node	To node
		ha	Minutes			m3/hr/ ha	m3/hr	lps	m	m	m2	m	m			lps	mps	m	m	m
1	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		24
1	2	0.0628	10	4.07	10.00	1892.41	118.79	33.00	4.00	0.150	0.60	4.30	0.14	2000	0.0200	54.85	0.28	68.29	33.00	33.00
2	3	0.1806	10	1.73	14.07	1731.85	312.73	86.87	4.00	0.150	0.60	4.30	0.14	2000	0.0200	89.20	0.32	32.79	33.00	33.00
3	4	0.2496	10	1.66	10.00	1892.41	472.40	131.22	4.00	0.150	0.60	4.30	0.14	2000	0.0200	134.55	0.35	34.85	32.00	32.00
4	5	0.3574	10	4.14	11.66	1826.94	652.95	181.38	4.00	0.150	0.60	4.30	0.14	2000	0.0200	192.10	0.38	95.07	32.00	32.00
5	6	0.3802	10	2.10	15.80	1678.29	638.04	177.23	4.00	0.150	0.60	4.30	0.14	2000	0.0200	192.10	0.38	48.16	34.00	34.00

Figure.15 Detailed Pipe Network for Storm water drainage

VIII. CONCLUSION

Following conclusion are made from the above study-

1. Meteorological changes are unpredictable but as once such heavy rain is occurred we have to prepare for future situations, so suitable storm water network is better solution.
2. Nagala village is identified as most affected village. In this village water was remained accumulated for more than 3 to 4 month. Therefore, this area has been taken as pilot study area for planning and designing of storm water network.
3. The Indian Remote Sensing (IRS) LISS-IV data covering Western part of Banaskantha was analyzed for understanding the affected villages, study area and various damaged infrastructure in the city. CARTOSAT Digital Elevation Model (DEM) data and LISS-IV data were used to generate 3-D visualization image of LISS-IV image of Study area.
4. Run off the area has been calculated based on the Rainfall data by rational method as per CPHEO Manual, accordingly design of storm water drainage has been finalized.
5. Different Road network, Node details, Pipe line details, Node wise Area detail and final designed Pipe line detail network of storm water is visualised using Arc-GIS.

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