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Construction of Digital Elevation Model and Contour Map for 2006 Flood at Surat (India)

Prasit G. Agnihotri and J.N. Patel

Department of Civil Engineering, S.V. National Institute of Technology, Surat, India

Abstract: Floods affect Surat city situated on river Tapi in India many times, which creates damage to the people and properties. In this paper the study of floods at Surat city in general and the study of flood occurred at Surat during 2006 in particular has been made. The Digital Elevation Model (DEM) for the flood water depth has been prepared and presented in this paper. The contour map of the study area has also been prepared and presented. The useful ness of the prepared DEM and contour map of the study area is also discussed.

Key words: Surat . river tapi . flood . submergence . flood level . DEM . contour map

INTRODUCTION

Surat city is situated at the delta region of river Tapi (India). The river Tapi is originating from a mountain Satpuda and flowing through three states Maharastra, Madhya Pradesh and Gujarat. The river Tapi is merging to the Arabian Sea at about 15 kms away from Surat city. The map of Tapi river basin is shown in Fig. 1. Ukai dam controls the flow of water and water level in the river Tapi, which is 100 kms away from Surat city. The dam is constructed at Ukai, Tal: Songadh, Dist: Surat. It is constructed for irrigation purpose mainly and also served the purpose of flood control, generation of hydropower and supply of industrial and drinking water. The average rainfall in the catchment area is about 785 mm and average yearly run off is 17,226 MCM. The salient features of Ukai Reservoir are shown in Table 1. Total seventeen rain gauge stations are available at different places and twenty two wireless stations are linked with the dam site, which gives the information about rainfall to the Central Water Commission. The Indian Meteorology department predicts the probability of rainfall in the catchment area during next 24 to 48 hours and same information is transferred to Central Water Commission and media.

Flood occurs at Surat city frequently due to sudden release of water from Ukai dam in river Tapi. At the time of floods in river Tapi, Surat city and surrounding region are most affected. History of floods at Surat city, Flood submergence map of the city and preparation of DEM for flood depth of Surat city are included in the subsequent topics. The contour map of the study area is also prepared and presented in this paper.

Table 1: Salient features of ukai reservoir

Sr. No.	Item	Description
1	Location	Songadh (District Surat)
2	River	Tapi
3	Catchment Area	62 225 sq km
4	Design Flood Discharge	49 490 cumecs (1.75 million cusecs)
5	Year of Completion	1972
6	Gross Storage Capacity	8.511 BCM
7	Live Storage Capacity	7.092 BCM
8	FRL	105.22 m (345 ft)
9	HFL	107 m (351 ft.)
10	MDDL	82.3 m (270 ft)
11	Riverbed level	47.87 m (157.05 ft)
12	Installed Power Generation Capacity	305 MW (4 X 75 MW +2 X 2.5 MW – this was added at a latter date)
13	Hydraulic Head	34-57 m
14	Maximum Discharge	213 cumecs (7522 cusecs)

The prepared of DEM and contour map for the flood water depth are useful for suggesting the flood control measures.

HISTORY OF FLOODS AT SURAT CITY

The Surat city has faced many floods since 1883. The history of the floods is given in Table 2.

SCENARIO OF FLOOD DURING AUGUST 2006

The flood occurred in the year 2006 was devastating. The level of water started rising in the river

Corresponding Author: Dr. Prasit G. Agnihotri, Department of Civil Engineering, S.V. National Institute of Technology, Surat, India

Table 2: Flood History at Surat

Sr. No.	Flood event	Discha-rge (Lac Cusecs)	Water level at Hop bridge (m)	Period
1	1883	10.05	11.05	July
2	1884	8.46	10.05	September
3	1894	8.01	10.33	July
4	1942	8.60	10.56	August
5	1944	11.84	11.32	August
6	1945	10.24	11.09	August
7	1949	8.42	10.49	September
8	1959	12.94	11.55	September
9	1968	15.5	12.08	August
10	1994	5.25	10.10	Aug.-Sep.
11	1998	7.0	11.40	September
12	2006	9.09	12.40	August

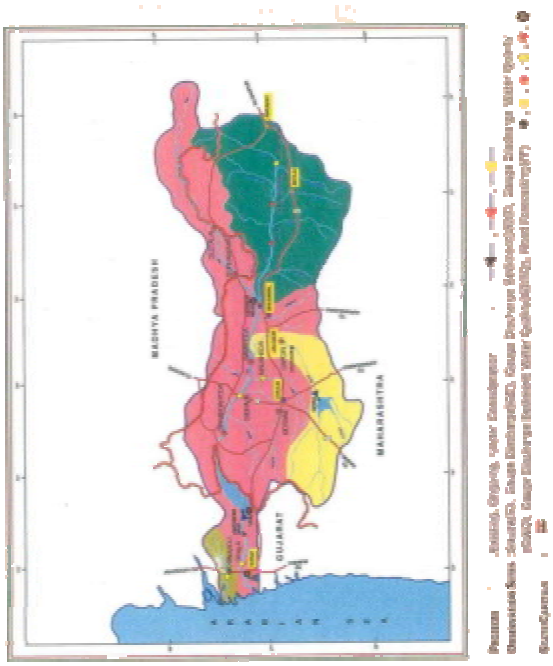

Fig. 1: Map of tapi river basin

Tapi from 1st August 2006 and started spreading in the nearby area of city. By 5th to 9th August 2006, almost 90% area of the city was flooded and the depth of flood water observed in the different areas was varying according to the topography of the City. The map of Surat city (Fig. 2) is showing the variation in the depth of submergence in different colours. The information and warning about flood must be reached to the people timely so that the people can take their own measures of safety and precautions. From the figure, it is evident that about 43% of people did not receive any warning from the Surat Municipal Corporation (SMC) or any other state agency. They learnt about the approaching

Fig. 2: Flood submergence map of Surat City (Source: S.M.C.)

Fig. 3: A rescue work

flood only when they saw the water rising. This proportion was highest (64%) in areas like citylight, umra and piplod, all of which are considered Surat's

Fig. 4: Overflowing bridges during flood

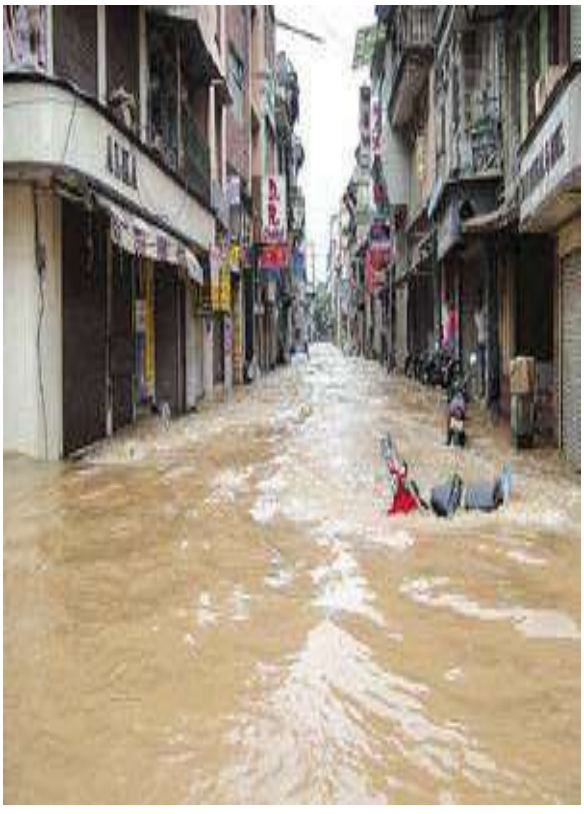

Fig. 5: Flooded area of Surat city

Fig. 6: Submerged residential area of Surat city

posh or upcoming localities. Only around 7% of respondents said that they had received some warning from the administration through vans or Short Service Messages (SMS) on mobile phones. As many as 30.7% of respondents said that they first learnt about the flood through the media. Friends, relatives and neighbours were of big help in warning people. A significant share making up for 20% of respondents said that they got information about the flood either through their friends, relatives or neighbours. The authenticity of message received other than local authority and the media is to be checked. It may cause unnecessary fear and disorder among the community. It is necessary to develop control techniques for flood as well as better warning system if flood occurs. Photographs of a rescue work, flooded river Tapi and area of city are shown in Fig. 4-6.

DATA COLLECTION

The data related to depth of flood during flood 2006 is acquired by conducting the survey of the affected area. By using Google Earth software, the map of the study area was downloaded making the grid of 0.5 km. in X and Y direction. For each point of the grid the latitude and the longitude are evaluated from the Google Earth software. The value of depth of flood water at each grid point was assigned.

Table 3: Details of inflow, outflow and water level of 2006 flood

Date	Time	Inflow (cusecs)	Outflow (cusecs)	Water Level (m)
Aug 5	8:00 am	85 958	26 664	102.20
	8:00 pm	48554	23640	102.26
Aug 6	8:00 am	75087	124920	102.14
	8:00 pm	330216	254780	102.57
Aug 7	8:00 am	853679	409004	103.46
	8:00 pm	1072680	816036	104.22
Aug 8	8:00 am	1053133	844092	104.97
	8:00 pm	961466	907316	105.33
Aug 9	8:00 am	856000	850000	105.34
	8:00 pm	711757	650000	105.38

Table 4: Depth of flood water in the study area

Point	Latitude (N)	Longitude (E)	Avg. flood depth (m)
H1V1	21° 15' 36"	72° 41' 24"	0
H1V2	21° 15' 36"	72° 42' 00"	0
H1V3	21° 15' 36"	72° 42' 36"	0
H1V4	21° 15' 36"	72°43' 12"	0
H1V5	21° 15' 36"	72° 43' 48"	0
H1V6	21° 15' 36"	72° 44' 24"	0
H1V7	21° 15' 36"	72° 45' 00"	0
H1V8	21° 15' 36"	72° 45' 36"	0
H1V9	21° 15' 36"	72° 46' 12"	0
H1V10	21° 15' 36"	72° 46' 48"	0
H1V11	21° 15' 36"	72° 47' 24"	0
H1V12	21° 15' 36"	72° 48' 00"	0.90
H1V13	21° 15' 36"	72° 48' 36"	2.75
H1V14	21° 15' 36"	72° 49' 12"	3.25
H1V15	21° 15' 36"	72° 49' 48"	3.00
H1V16	21° 15' 36"	72° 50' 24"	2.50
H1V17	21° 15' 36"	72° 51' 00"	2.00
H1V18	21° 15' 36"	72° 51' 36"	0.90
H1V19	21° 15' 36"	72° 52' 12"	0.50
H1V20	21° 15' 36"	72° 52' 48"	0.50
H1V21	21° 15' 36"	72° 53' 24"	0.50
H1V22	21° 15' 36"	72° 54' 00"	0.90
H1V23	21° 15' 36"	72° 54' 36"	River bed
H1V24	21° 15' 36"	72° 55' 12"	0.90

The flood water depth collected from field by measuring the markings of the flood height by local authority. In some area the heights are not marked. In such area flood water depth is acquired by local enquiry to the residing people in that area. The study area is shown in the Fig. 6. The Table 4 shows the sample data.

Fig. 7: Study area

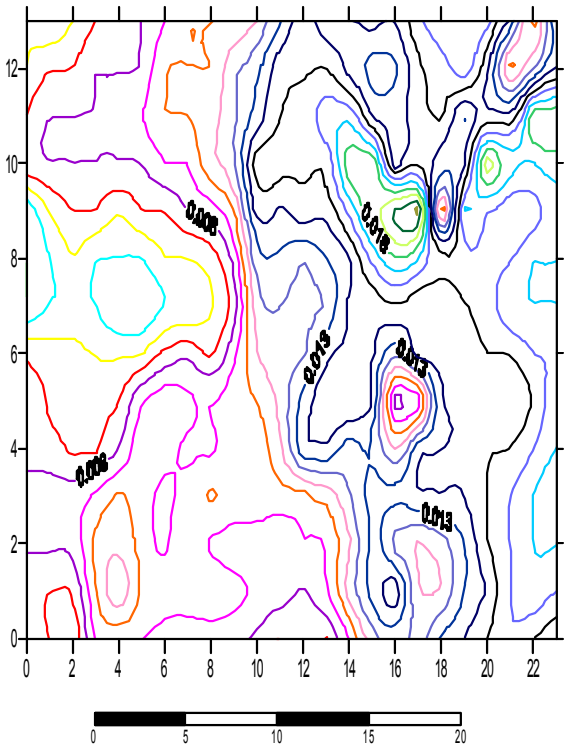

Fig. 8: Contour map with flood depth (all dimension in Km)

PREPARATION OF DEM AND CONTOUR MAP

For the preparation of DEM following software were used.

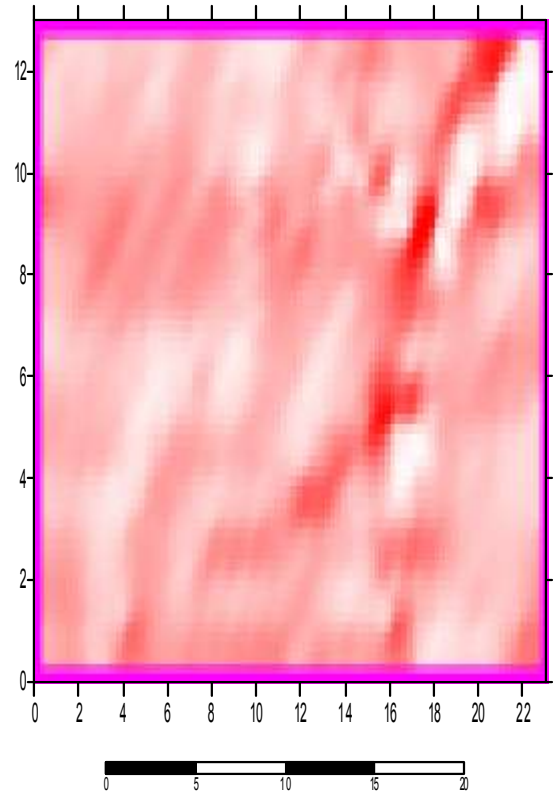

Fig. 9: Shaded relief map of study area with flood depth

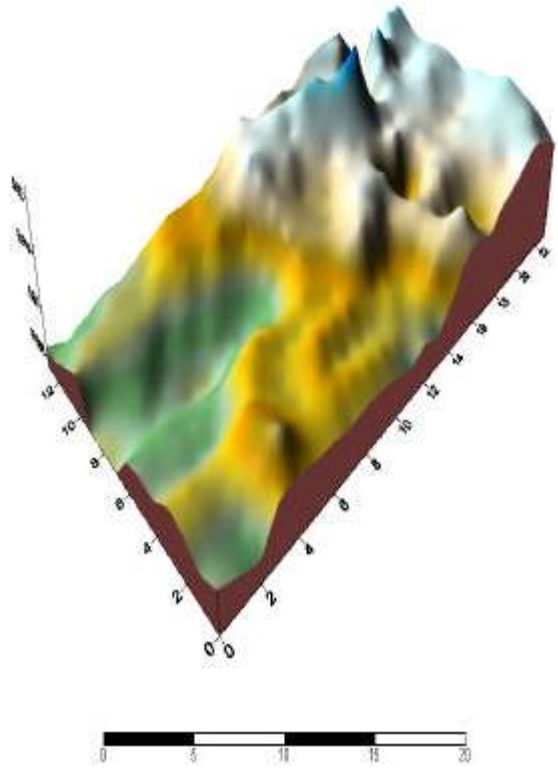

Fig. 10: Surface map of study area with flood depth

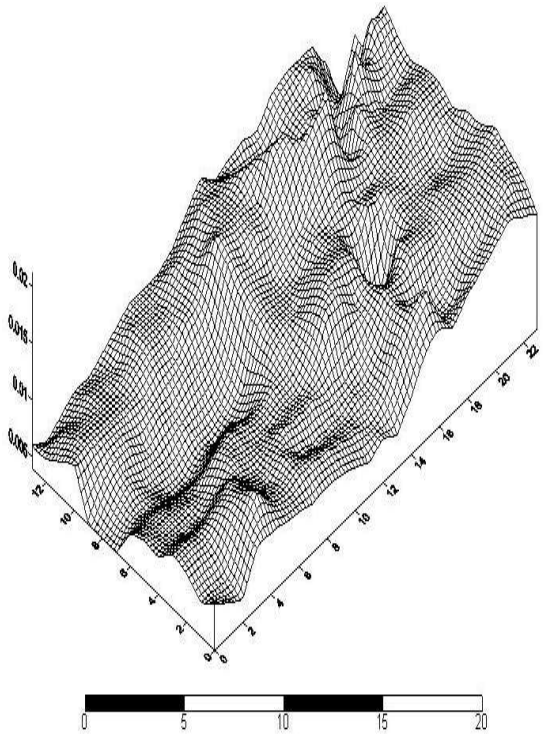

Fig. 11: Wire frame map of study area with flood depth

- Microsoft Excel
- Surfer 8.0

The DEM is prepared using software surfer 8.0. This software requires datasheet in the Microsoft Excel which contains X-coordinate, Y-coordinate and height of the point of the area concerned. This is the input data. Using software surfer 8.0, image map, shaded relief map, wireframe and surface (DEM) can be prepared.

The sample data given in the Table 4 is used for the preparation of DEM. The data is converted in to the grid file. From the grid file, using software Surfer 8.0, image map, shaded relief map, wireframe and surface (DEM) of study area has been prepared and shown in the Fig. 8-11.

CONCLUSION

The study area is highly affected by the flood and it is necessary to develop flood reduction plan for the study area which helps to minimize the effect of such a devastating disaster in future. The preparation of DEM and contour map of the study area for the depth of flood water is very useful for the flood control measures which include construction of enhancing the drainage capacity, diversion of river water to other rivers or drains, determination of location points for ground

water recharge as well as for carrying out calculations for increasing the carrying capacity of river Tapi.

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