An Overview of Flood Resilience: A case of Surat City

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ABSTRACT

Resilience *is the ability of individuals, communities, organizations and states to adapt and recover from hazards, shocks or stresses without compromising long-term prospects for development. Disaster resilience programming aims to save lives, protecting infrastructure, livelihoods, social systems and the environment (**Cabot Venton et al., 2013**; **Turnbull et al., 2013**). River Tapi is originating from a Multai Hills (Gavilgadh hill ranges of Satpura) and flowing through three states Maharastra, Madya Pradesh and Gujarat having length of 725 Kms. The flow of water and water level in the river Tapi is controlled at Ukai am which is 100 kms away from Surat city. The major purposes of the dam being essentially irrigation, power generation and partial flood control. Major floods occur in the year of 1968 and 2006. floods of August 2006 remained devastating for Surat in terms of the extent of damage, during which nearly 75% of the city was inundated. Surat city faced huge amount of life ,property loss also infrastructure that cost crores of rupees. Hence, some preventive measures are crucially required or we can say there must be need of improving resilience of the city to withstand or reduce the diverse effects of flooding. This paper address some possible and suggestive measures to overcome this issues and challengesthat can be very crucial for improvement of resilience of the surat city against floods.*

Keywords-*Resilience, Flooding,River Tapi, Preventive measures.*

1. Introduction

The combination of climate change and increasing urbanization brings great challenges to planning and managing cities for sustainability. Recent studies show that climate change is very likely to alter the hydrological cycle in many regions, causing a higher probability of extreme weather events such as droughts and floods (Bates *et al.*, 2008). In a recent report on natural disasters (UNISDR, CRED, 2015), the United Nations pointed out that 43% of them, in the period between 1995 and 2015 were related to floods. These event affected more than half (56%) of all people who suffered from any type of natural disaster, kill ing about a quarter of them (26%).

In many parts of the world, the intense urbanization process and rapid growth of the cities has led to the emergence of so-called mega cities, which are especially sensitive due to major land use changes and resource consumption. Mega cities, especially in late urbanization countries, tend to be densely populated, with many areas that have grown fast, often with insufficient infrastructure, resulting in environmental degradation and greater flooding. Mostly in river flood is problem from which economy and culture of city to be distracted so it is necessary to analyze the flood on river and forecast the flooding condition on river. Flood inundation is the process in which we have to inundate or analyze flood in particular region of river so it is easy to prevent future flood condition and also precaution against hazardous condition.

Flood Resilience

Resilience is the ability of individuals, communities, organizations and states to adapt and recover from hazards, shocks or stresses without compromising long-term prospects for development. **Resilience** is the capacity of individuals, communities, businesses, and systems within a city to survive, adapt, and grow, no matter what kinds of chronic stresses and acute shocks they experience.(Surat Resilience Strategy,April 2017)

Benefits of Disaster Resilience

Disaster resilience programming aims to save lives, protecting infrastructure, livelihoods, social systems and the environment (**Cabot Venton et al., 2013**; **Turnbull et al., 2013**).

Potential contribution of Disaster resilience can be,

- Saving lives
- Protecting infrastructure and livelihoods
- Protecting social systems
- Protecting the environment
- Supporting broader resilience in contexts of violent conflicts or fragile states.

2. Study Area

River Tapi is originating from a Multai Hills (Gavilgadh hill ranges of Satpura) and flowing through three states Maharastra, Madya Pradesh and Gujarat having length of 725 Kms. The flow of water and water level in the river Tapi is controlled at Ukai am which is 100 kms away from Surat city. The foundation of dam is resting on Dolerite dykes (Basalt). 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 area of Surat city situated at delta stage of the river is 326.51 sq.km. and population is about 40 lacs. The city is having 60,000 Shops & Establishment in trading activity. The city is also famous for diamond industry. The Major industries like Essar Steel, Reliance, ONGC, L & T, Gail, Kribhco, Shell, NTPC, GSPC, Torrent Power etc. are situated in the city. The study area is shown in Fig. No.1. Floods are occurring in river Tapi time to time, due to which major portion of the city is submerged creating lot of damage in residential as well as industrial areas. There is a need of reducing the effect of flood. In this paper the aspects of river channel modification are considered for enhancing the carrying capacity and reducing the effect of flood in the city.

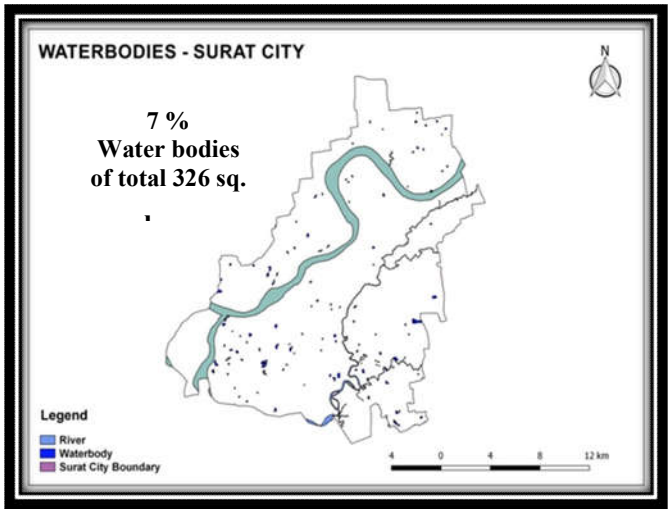

Figure 1 Tapi River within Surat City (Source-BISAG,Gandhinaga

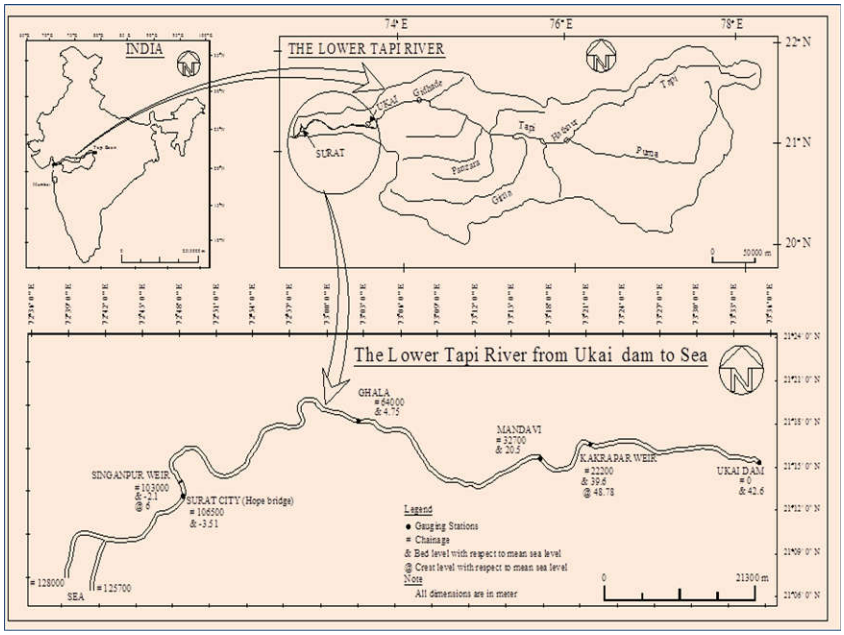

Figure 2 Tapi Basin (Source-SMC)

Surat, previously known as Suryapur, is a city in the Indian state of Gujarat. Surat - the modern port city of today boasts of a great historical and cultural heritage. Surat of today has earned the reputation of an important industrial hub and commercial center of the country **Diamond City":** Surat is well known for its Diamond business. **"Silk City" :** Surat is also known as "Textile city".

Demographic Profile

Table 1Democratic Profile Table of Surat City

Sr. No.	Name of Zone	Area (km^2)	Totalpopulation		Total house hold
			2001	2011	
1	Central Zone	08.18	413641	408760	74679
2	North Zone	36.363	416370	705163	82775
3	East Zone	37.525	711516	1137138	143574
4	South East Zone	19.492	397257	748304	81999
5	South zone	61.764	407980	695028	94582
6	South-west zone	111.912	242466	347447	50236

7	West Zone	51.29	287144	424986	57687
Total		**326.515**	**2876374**	**4466826**	**585532**

(Source-SMC)

History of Flooding in Surat and the Reasons

Since 1869 up to 1884, on an average, the city was flooded every two and half years followed by a fall in its frequency by 1914. During 1949 to 1979, the average natural flood occurrence was once in every four years. With this in mind, the Ukai dam, located about 100 km upstream of Surat, was completed in 1972. The major purposes of the dam being essentially irrigation, power generation and partial flood control. However, heavy Rainfall in the catchment area of Ukai Dam in the upstream (mainly in Maharashtra) which leads to heavy inflow in the Ukai Dam has often resulted in heavy discharge of water from the Ukai Dam, responsible for flooding in Surat in the past 20 years. This is largely caused by the competing objectives of the Ukai dam, which designed mainly for irrigation and power generation with partial flood control. To meet the first two objectives, the dam has to be able to hold as much water as possible leaving a limited cushion for flood control, especially during the later parts of the monsoon.

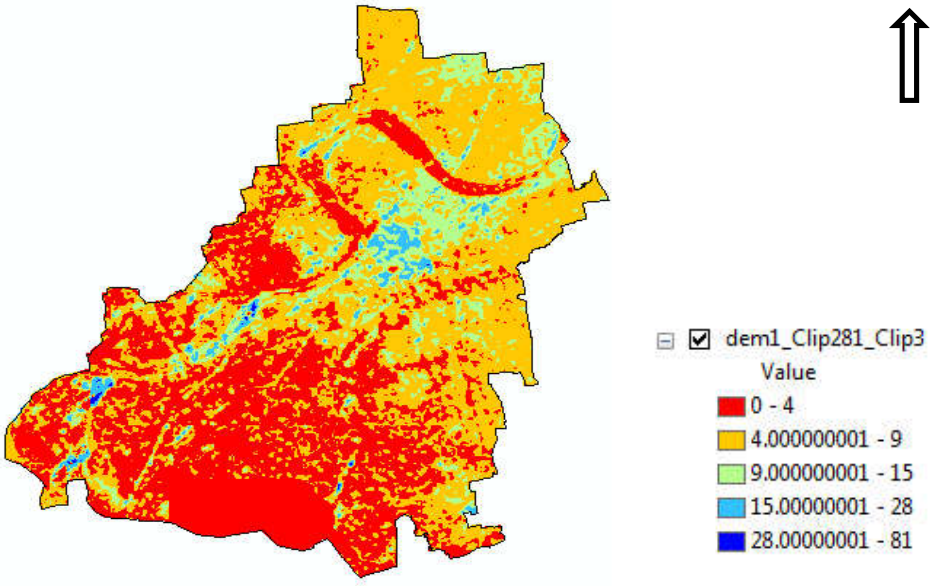

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Figure 3 Digital elevation modelling image showing low lying area of surat city

The floods of **1998, 2004** and **2006** occurred following emergency discharges from Ukai dam. Out of these years, floods of August 2006 remained devastating for Surat in terms of the extent of damage, during which nearly 75% of the city was inundated. Anthropogenic changes including building of bridges, embankments and the Singanpore weir have reportedly increased the siltation and reduced the carrying capacity of the river channel, as evident from the increasing flood levels for the similar amount of the discharge over last few decades (Flood Risk Management Study, Centre for Social Studies. 2009).

Types of Floods in Surat- floods due to the Ukai dam & the Khadi

Flooding due to Ukai Dam:

The floods in August 2006 were primarily due to the discharge of water from the Ukai dam in a very short span. The Tapi River within embankments can safely discharge about 8,495 cubic meter per sec (0.3 million cusecs).

Khadi Floods- The second type of flood is caused by the two streams passing through the city. These floods are more frequent but cause comparatively less damage. While not causing severe impacts now, the Khadi floods can be expected to impact significant sections of population living on the stream banks. With the change in future tidal conditions and increased population growth along (especially poorer sections of the population) along the tidal creaks will be at a high risk.

Table 2 Flood Events at Surat city

Sr no.	Flood Event	Discharge (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.-Sept.
11	1998	7.0	11.40	September
12	2006	9.09	12.40	August

(Source-Flood Cell,Surat)

Scenario of Flood during August 2006

The flood occurred in the year 2006 was devastating. The level of water started rising in the river 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 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. Figure 2 shows the status of warning in Surat during flood 2006. 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 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 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.

Figure 4 Flood water level at area of Surat city

Figure 5 Flooded Area of Surat City

3. Recommendations

Below listed some flood prevention measures that can reduce the flooding effects as well as improves the resilience of the city.

- Construction of artificial Reservoirs
- Land use control
    - Spatial Planning Flood risk adapted land use
    - Building regulations
    - Building codes
    - zoning ordinances
- Construction of Embankments/ protection wall
- Channel Improvement
- Drainage Improvement
- Diversion of Flood Waters
- Watershed Management
- Increasing the carrying capacity of river
- Channel Dredging

4. Conclusion

Surat city (India) situated at the tail end of river Tapi is subjected to moderate to heavy floods frequently due to heavy rainfall in the catchment area. Study of floods at Surat city has been made in this paper. To minimize the effect of flood at Surat city, certain preventative measures have been suggested.

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