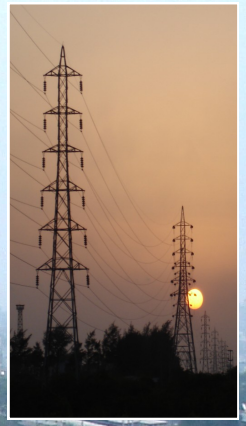
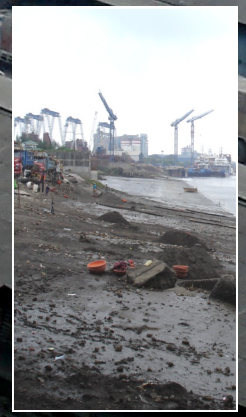
Surat City Resilience Strategy





April 2011

Surat City Resilience Strategy

April 2011

MESSAGE

FOREWORD

It is with the great pleasure of reaching a milestone in an important program that I introduce to you the context and the process that has resulted in the "City Resilience Strategy' document for Surat.

As we know, cities have been the centres of major civilizations all through the history of mankind, whether in the Mohenjo-daro towns, in Mesopotamian citadels, in the Aztec city palaces or in Classical Roman and Greek republics. In the modern era too, cities have been the cradles of economic, political and cultural evolution of human society in many ways.

As cities become recognised as the engines of economic growth, their significance for the peace and progress of every nation has become more and more evident. While in many western nations, almost 60 to 80% of the population lives in cities and towns, India too, has seen a rapid growth in urbanization fuelled by growth in the industrial and service sectors along with large scale migration across and within states. At the same time, Indian cities face urgent challenges to meet the growing needs of infrastructure and services that would ensure an acceptable (and in some cases desirable) standard of living and quality of life. The challenges are not only confined to providing quality and equitable accessibility of municipal services, but also relate to the resources required for ensuring sustained availability of these services that are critical to ensure safe, healthy and viable urban life. Apart from finance, manpower, technology and managerial ability, cities would be well advised to appreciate the importance, nay, criticality of access to vital natural resources, namely land, water and energy sources for their continued well-being.

In Surat, the 9th largest city in India, and blessed with an exceptionally high level of civic commitment, Surat Municipal Corporation has been pursuing sustainable technology, practices and programs for more than a decade to maintain and enhance the quality and availability of the civic services that are dependent on access to these critical natural resources. Being located in a flood prone zone, over the past five years, the city has also made considerable efforts to address flood risk management issues through structural and non-structural interventions. Over the last decade, several initiatives for environment protection and conservation have been taken to reduce energy consumption and manage natural resources effectively. The city of Surat is well known today for implementing innovative ideas and for being in the forefront of leading initiatives aimed towards enhancing the quality of life of its citizens.

Continued...

सूरत महानगर पालिका
बहुजनहिताय बहुजनसुखाय

It is in this context, that the Asian Cities Climate Change Resilience Network, an initiative of the Rockefeller Foundation, has provided a framework and a platform for the city of Surat to create a formal and consultative approach to mapping its own resilience in the face of the growing impacts of climate change.

Recognizing the keen interest of the citizens of Surat to retain the pre-eminent position of Surat as one of the most dynamic and progressive cities in India, Surat Municipal Corporation has been promoting responsive and participatory city governance. It is thus that, under the ACCCRN, the City Advisory Committee (CAC) was established to study the impacts of climate change in the context of Surat, and to recommend strategies that would create a higher level of resilience for its citizens. It is a matter of pride for the city that the CAC incorporates the views, wisdom and commitment of members of all sections of urban life, from academia, industry, trade, local government and civil society.

The CAC initiated the process of (i) assessing the likely impacts of processes of climate change on the socio-economic life of Surat ; (ii)identifying the probable challenges in future and (iii) initiating the formulation of viable and thoughtful strategies to address the same. This process included analysis of some of the critical sectors of the socio-economic life of Surat, such as water, energy, environment, transportation, flood risk management and health. More significantly, for perhaps the first time, an assessment was made of the vulnerability of different sections of the population to the changing weather patterns that may result in, increased precipitation, frequent flooding, changes in disease patterns, sea level rise, increasing energy demand etc.

The work under the Asian Cities Climate Change Resilience Network (ACCCRN) initiative in Surat over the past three years establishes the nexus between urban systems, poverty related challenges, underlying city vulnerabilities and the overriding phenomena of climate change and the risks posed thereby. Vulnerability of the city, if not recognized and addressed, will only exacerbate with accelerated incidence of extreme weather events and rising sea levels.

Therefore, the process of formulation of a city resilience strategy was initiated in Surat during 2009-2010. Realizing the cross-sectoral nature of the impacts, the City Advisory Committee adopted an interactive and holistic approach entailing engagement with a wide array of stakeholders. A number of Risk to Resilience workshops were held.

The City Resilience Strategy (CRS) is an attempt to assess the key city vulnerabilities, the risks and challenges likely to be posed to the city of Surat by the processes associated with climate change, the likely impacts on crucial sectors of city's socio-economic life and the kind of adaptation interventions which can be taken to address the same.

Continued...

The City Resilience Strategy (CRS) is the product of consistent and sincere efforts by a wide array of enlightened and committed citizenry and stakeholders of Surat. It is gratifying to note that all stakeholders actively and passionately contributed to the process to ensure that the document becomes a live and vibrant strategy which is owned and acted upon by all through a convergence of approaches and action. The City Resilience Strategy (CRS) highlights innovative methods such as GEOPSY and Scenario Exercises which can also serve as effective urban planning tools for cities on the move.

The work under the ACCCRN has been a successful shared experience and has provided relevant learning on climate change and adaptation issues to city stakeholders. It has promoted climate literacy, learning and sharing of knowledge on urban climate change resilience. The two years of efforts have indicated the growing appetite and ambition among the Surat citizens and stakeholders to develop high level interventions to tackle climate change and contribute to development of Surat metropolitan region.

I welcome the timely publication of Surat City Resilience Strategy, developed under Phase II of the Asian Cities Climate Change Resilience Network (ACCCRN) initiative. I take this opportunity to acknowledge the support and guidance of the Government of Gujarat (with its own Climate Change Department), the General Board and Standing Committee of SMC, Gujarat State Disaster Management Authority (GSDMA), TARU and local organizations namely the Southern Gujarat Chamber of Commerce and Industry (SGCCI), Sardar Vallabhbhai National Institute of Technology (SVNIT), Centre for Social studies, various departments of Surat Municipal Corporation and individual experts in contributing to the preparation of this document.

I commend the CRS, Surat to all those interested in climate change issues, promoting urban climate change resilience and to cities across the world as part of the learning process for building a culture of sustainable and resilient urban landscape. I would also like to mention that the document would serve as a living and dynamic guide to Surat, being reviewed and revised periodically, as we learn more from one another as global citizens, about this phenomenon that we call climate change.

(S. Aparna, IAS)
Municipal Commissioner
Surat Municipal Corporation

MESSAGE

It is heartening to note that the city of Surat has embarked on a mission to take pre-emptive adaptation measures to mitigate the impacts of processes associated with climate change and variability at city level. The process of building resilience to the impacts of climate change is being spearheaded by the Surat Municipal Corporation under the Asian Cities Climate Change Resilience Network (ACCCRN) initiative of the Rockefeller Foundation with technical support from TARU Leading Edge.

The fact that the city of Surat and its enlightened stakeholders have been focusing their attention on the key issues and challenges associated with climate change for the past three years indicates the pro-active approach and latent dynamism and entrepreneurial spirit of the people.

I am glad to learn that adopting a multi-stakeholder approach, the Surat Municipal Corporation (SMC) has began the process of assessing the key city vulnerabilities, impacts on critical sectors of socio-economic life and initiating concerted efforts through focused adaptation and mitigation measures to address the same.
The process has led to formulation of the City Resilience Strategy (CRS) outlining the main challenges the city of Surat is likely to face and identifying relevant intervention measures to address the same.

I am sure the city of Surat, its enlightened citizenry and stakeholders will be able to offset the adverse impacts of climate change through convergence of approach and synergies of action. Surat has earlier on too displayed its inherent resilience by overcoming the scourge of plague to become the cleanest city in India as also the worst flood in a century. I am confident that Surat and its citizens will once again charter a new course and set an example by achieving the ability to remain resilient in the face of processes of climate change for other cities to emulate.

I hope the City Resilience Strategy will guide all of us to take requisite measures in this direction.

(Rajendra A. Desai)
Mayor
Surat Municipal Corporation

सूरत महानगर पालिका
बहुजनहिताय बहुजनसुखाय

MESSAGE

Climate change is one of the most pressing challenges of the 21st century. Though it's a global problem, actions need to be taken locally to help communities prepare for and weather climate-related impacts. The stakes for cities such as Surat are particularly high given its strong economic base and rapid growth. Cities now house more than half of the global population, including hundreds of millions of poor and marginalized households, making it essential that steps are taken to increase the resilience of cities and the communities within them to withstand the shocks and stresses spurred by climate change. The Rockefeller Foundation is delighted to see the launch of the Surat city climate change resilience strategy. This strategy reflects a tremendous amount of leadership, effort and dedication shown on the part of the city and wide range of institutions and individuals within it, from government, business, academia, technical centres and civil society. The Rockefeller Foundation is proud that Surat is one of ten cities in the Asian Cities Climate Change Resilience Network (ACCCRN) and looks forward to seeing the city continue to serve as a globally recognized leader in strengthening urban resilience to climate change.

THE ROCKEFELLER FOUNDATION

(Ashvin Dayal)
Managing Director, Asia Office
The Rockefeller Foundation

ACKNOWLEDGEMENT

This is a result of dedicated efforts by TARU and ACCCRN team over two years which includes inputs from wide range of stakeholders, urban researchers, practioners and citizens of Surat city.

We appreciate the important contributions made by Surat Municipal Corporation, Southern Gujarat Chamber of Commerce and Industries, Gujarat State Disaster Management Authority, Institute for Social and Environmental Transition (ISET), Urban and Social Health Advocacy & Alliance, Sardar Vallabhbhai National Institute of Technology, Centre for Social Studies, Micro Information Pvt. Ltd, Enviro Control Associates (I) Pvt. Ltd. and TIFAC-CORE in Environmental Engineering for their contribution towards the sector studies and preparation of Climate Resilience Strategy.

We would like to thank all the stakeholders and citizens of Surat who have actively participated in the meetings, workshops, discussions and surveys.

The 20th century has been a period of greatest warming in at least a thousand years. Such climate variability and change is likely to have an impact on the metabolism of the cities. The IPCC Working Group found evidence that recent regional climate changes, particularly temperature increase, have already affected many physical and biological systems and have found preliminary evidence of effects in human systems. The ability to manage hazard risk, especially climate variability and change risks, depends on a number of critical factors – this includes the city's baseline infrastructure and quality of services, resource linkages especially water and energy, economic growth, poverty and employment opportunities, social safety nets, effective governance, investment made towards hazard mitigation and vulnerability reduction, access to risk information, collective responsibility of stakeholders in implementation of social welfare schemes, and public awareness. Several attempts are underway to minimize the effects of climate change within priority sectors and vulnerable section of the society through building adaptation mechanisms.

The city resilience strategy (CRS) development has been spearheaded by Surat City Advisory Committee (CAC) and key stake- holders including the Surat Municipal Corporation (SMC) and Southern Gujarat Chamber of Commerce and Industries (SGCCI), Industry groups, academic institutions and individual experts. CRS development and action planning is an ongoing effort to be undertaken with the active engagement of the stakeholders and the community. The strategy aims to reduce the impacts of climate change by identifying sectors and communities most vulnerable to the risks. The strategy provides an overarching framework with a clear vision and direction for improved delivery of the services by the stakeholders and action to be undertaken by the communities, thereby promoting economic development of the city and the Surat Metropolitan Region.

Key initiatives are proposed to be undertaken through the support of the Rockefeller Foundation to inform this strategy and the CAC will coordinate in its efforts toward the implementation thereof with all relevant stakeholders.

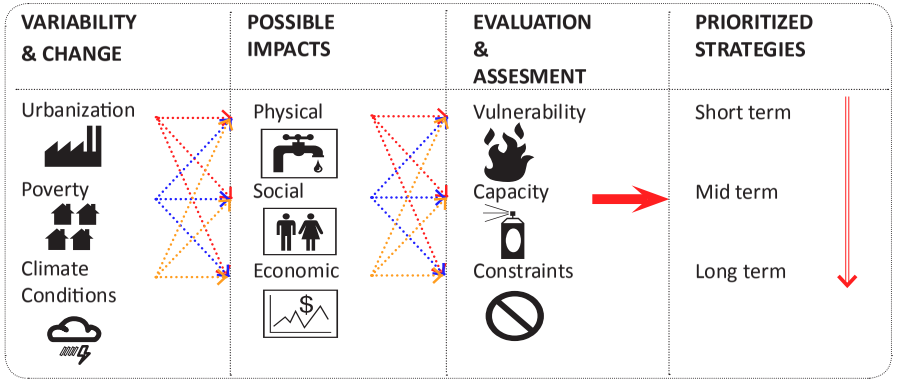
Purpose of this document:
This document is prepared with the aim of providing a framework for the development of a Climate resilience strategy for the city of Surat. It has been developed through continued interactions with city stakeholders, sector studies conducted to understand different dimensions of current situation and information from secondary literature. Moreover, to gain a more analytical understanding, detailed Vulnerability Assessment studies and a series of Risk to Resilience Workshops were conducted.

This document is aimed at city managers, while also providing information that can be understood by people at large. Lastly, this document is based on the current situation. We would like to highlight the need of the same being updated at regular intervals to reflect emerging trends over time. The resilience strategies with therefore evolve over time with better understanding of climate change phenomena as well as emerging city level issues. Structure of the Document

Structure of the Document
The document has been divided into 4 parts

1. Part 1- Variability and Change collates the predicted changes that would affect the city.
2. Part 2- Possible Impacts- analyzes the impacts of these changes on the city fabric.
3. Part 3- In Evaluations & Assessments, the cities vulnerabilities and capacities are assessed.
4. Part 4- Strategies are discussed to counter or mitigate the negative impacts of climate change, poverty and urbanization

DOCUMENT STRUCTURE



1. VARIABILITY & CHANGE

Urbanization	Poverty/Informal settlements	Climate Conditions
Population	Living (environment)	Temperature
Industrial & Economic Growth	Livelihood (earning)	Precipitation
Landuse-landchange LULC/Environmental transition	Lifestyle (migration/ social status, access to resources)	Sea level rise

CONTENTS

1. GROWTH & PRESENT POPULATION

Surat is the 9th largest city in India. As per 2001 Census, the population of Surat was 2.89 million. This includes a total of 1.09 million workers, driven by pull migration induced by the growth of textile and diamond industries especially since the 1970's.
The city has seen an unprecedented growth in last four decades, recording one of the highest growth rates in the country and a 10-fold population rise over four decades. Coupled with this, the spillover of population into the periphery has also been observed especially towards the coast and Hazira in the west and the National highway towards East.
The city area has expanded with time (major expansion being in 2006) and presently covers 326.515 sq.km. The estimated population of the city in 2011 is about 4.5 million.

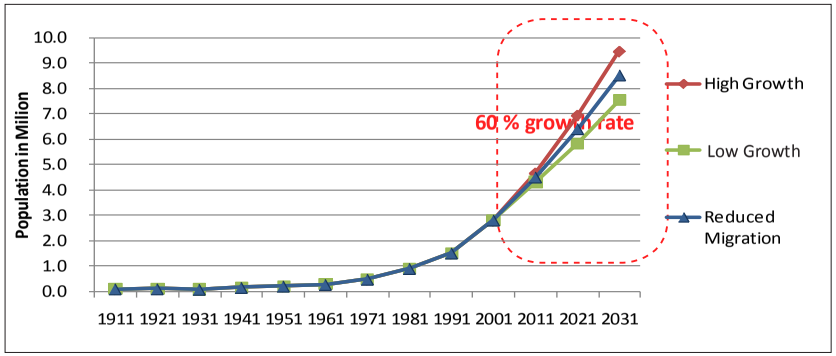
Surat Municipal Growth Statistics (Area and Population)

Sr. No.	Description	1951	1961	1971	1981	1991	2001
1	Area (Sq. km)	8.2	8.2	33.9	55.6	111.2	112.3
2	Population (Million)	0.2	0.3	0.5	0.8	1.5	2.4
3	Growth Rate (%)	-	29.1	63.8	64.7	93.0	62.4
4	Density (Person/Sq. km)	27,284	35,211	13,934	13,977	13,489	21,677
Source: CDP, Surat							

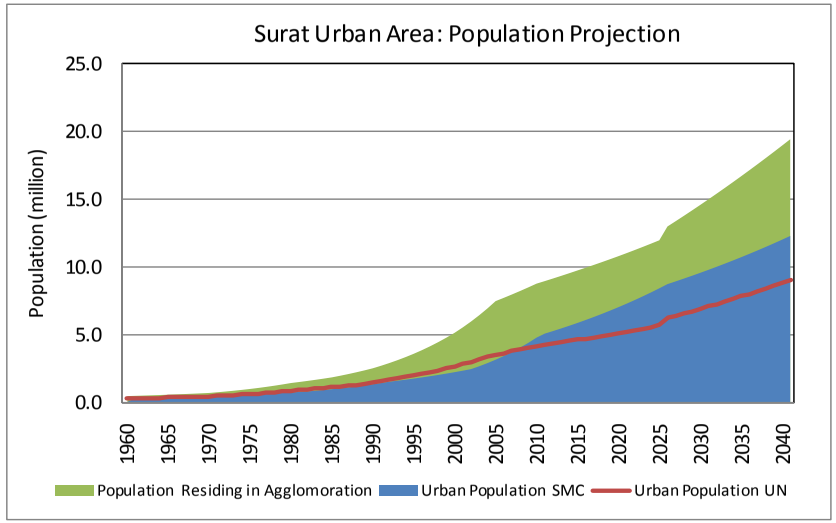
2. FUTURE PROJECTIONS

The population of Surat is expected to grow from 2.89 million (2001) to 4.5, 6.4 & 8.5 million by 2011, 2021 & 2031
Presently, the Surat Municipal Corporation (SMC) provides the essential services such as safe drinking water, sanitation, roads and bridges, streetlights and primary health and education services to all residents. With the increase in population, addressing these urban services and other societal needs will become a challenge

POPULATION & DECADAL GROWTH



Source: Surat City Development Plan (2006-2012)



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1. PRESENT INDUSTRIAL BASE

The evolution of the power loom and handloom sectors led to gradual growth of textile industries. Surat was historically a textile and trading city since the early Mughal period. The near simultaneous collapse of Mughal, Persian and Ottoman empires as well as the birth of the deep water port in Mumbai(Bombay then) with the rise of British Empire resulted in Surat's decline. (for more see: http://www.thefreelibrary.com/The+Mughal+port+cities+of+Surat+and+Hugli.a0192801347). Another important addition since the 1950's is the diamond cutting and polishing industry. In the last three decades, especially during the eighties, large-scale industries have come up in Surat and its peripheries.

The economic base of Surat, thus, consists of Textile manufacturing, trade, diamond cutting and polishing industries, intricate Zari works, chemical industries and the petrochemical and natural gas based industries at Hazira established by leading industry houses such as ONGC, Reliance, ESSAR, and Shell. The medium and large-scale industries are mostly located at the five industrial estates in and around the city, while a significant proportion of the small industries are located within the city limits.

2. TEXTILES, DIAMONDS, HEAVY ENGINEERING

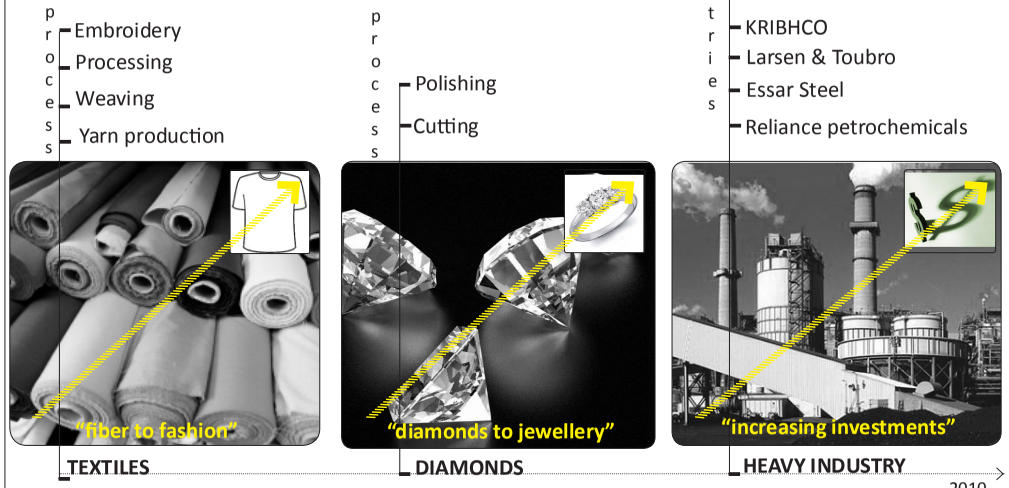
Textiles- Nearly 30 million meters of raw fabric and 25 million meters of processed fabric are produced in Surat daily. It is estimated that about 10 percent of the synthetic Sarees manufactured in India are from Surat and around 90 percent of polyester used in India comes from Surat.
There are 0.7 million looms and 150 multi-storied textile markets and trade is routed through 50,000 merchant manufacturers (traders). About 1.2 million textile workers are reported from the city and neighborhood. The main market for Surat's textile products are India, Middle East and other Asian countries.

Diamond cutting-Surat introduced diamond cutting and polishing industry at the turn of 20th century. The diamond industry is one of the most labor-intensive industries in India. There are about 6,500 diamond polishing units in Gujarat, employing about 0.7 million people. Out of these, 38% of the units and 57% of the workforce are located in Surat (RBI, 2009: Report of the Taskforce for Diamond Sector, Reserve Bank of India, Ahmedabad). Over 1.5 million people are directly or indirectly dependent on the diamond cutting and polishing industry of Surat.

Large Industries: The Hazira Industrial area and port is located in the northern banks of Tapi River and is adjacent to the Surat urban area. It is home to several major processing facilities/manufacturing centers for Reliance Petrochemicals, Essar Steel, Larsen & Toubro, KRIBHCO, ONGC, Shell, ABG Shipyard, Torrent Power.
In general, Surat's industrial system is a complex blend of home-based, small scale and medium scale industries largely dependent on semi-skilled and unskilled labor.

PRESENT INDUSTRIAL BASE

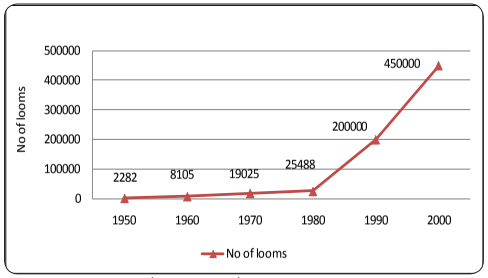
- 2006: It is ranked as the 131st richest cities of the world with a GDP of 22 billion USD
- 2020: Expected to rise to 119th rank with a GDP of about 57 Billion USD and a growth rate of 6.5 percent annually.
- In India, Surat current holds the status of city with one of the highest per capita income. (Source: www.citymayors.com, 2010)

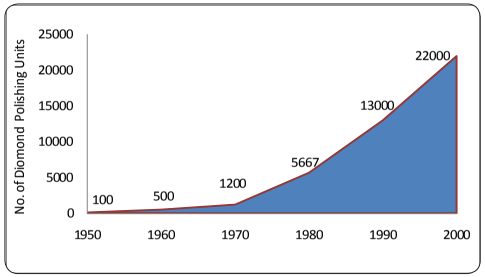


EMPLOYING: 1.2 MILLION WORKERS
ANNUAL TRANSACTION- Rs. 30-35 BILLION

EMPLOYING: 0.7 MILLION WORKERS

Image Source: Google Images





Source: SURAT CDP (2006-2012)

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FACTS

- 42 % of the world's total rough diamond cutting and polishing,
- 70 % of the nation's total rough diamond cutting and polishing,
- 80 % of the nation's total diamond exports (` 70 Billion)
- 40 % of the nation's total man-made fabric production,
- 28 % of the nation's total man-made fiber production
- 18 % of the nation's total man-made fiber export, and
- 12 % of the nation's total fabric production.

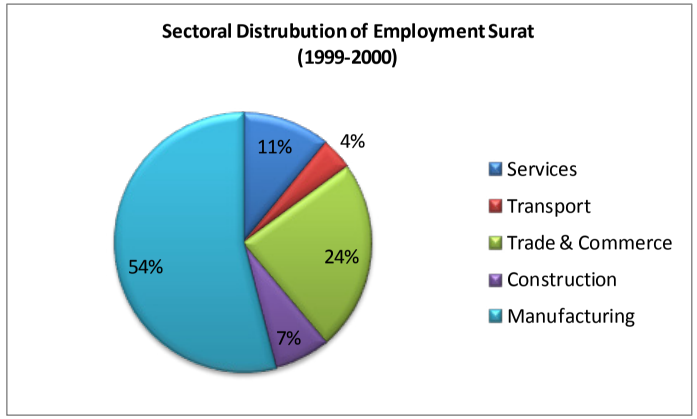
(Source: Environment Study of Surat City, Enviro Control Associates (I) Pvt Ltd, p.6)

According to CMIE 2002, the Surat City region has a proposed investment of about Rs. 11,817 Crores. In addition projects worth Rs. 2,022 Crores are under implementation. Hazira and SEZs (located on the side of Hazira)are major focal points for growth.

3. EXPECTED GROWTH

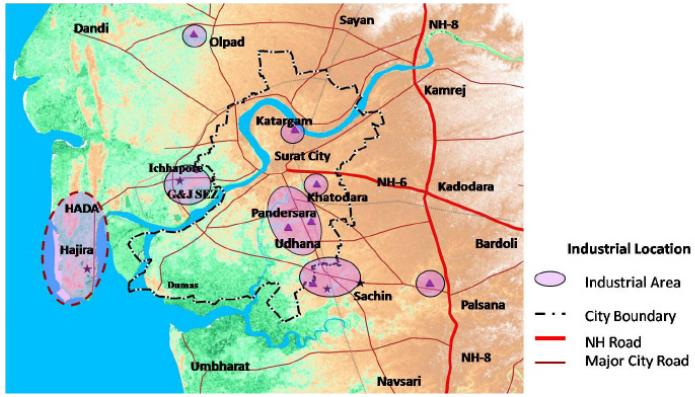
Given India's growing population and lifestyles, the Surat textile industry is poised to grow to meet the internal as well as exports demands. The technical advantages, vocational skill development and research facilities for textiles, within the city, provide a unique opportunity for the economic growth of Surat. The diamond industry too, has similar advan tages and thus, is slowly shifting from diamond cutting to the manufacturing of Jewellery. SGCCI has already started focusing on expansion of textiles from "Fiber to Fashion" and "Diamond to Jewellery" through exhibitions, research etc. It has also set up a convention and exhibition center and special economic zones for diamonds as well as garments are coming up.

On the western front of Surat is Hazira. This industrial area has been able to attract several large petrochemical, steel and shipbuilding and related industries over the last three decades, since its establishment. With scope for new investments, this industrial area is expected to grow as one of the major petroleum and energy hub. Considering the unique mix of economy, considering the present conditions with niche products i.e. synthetic textiles/diamonds and due to the growing role of Hazira Industrial area, the economic growth of Surat is expected to sustain or increase over next two decades



Source: Environment Sector Study of Surat City, Enviro Control Associates (I) Pvt Ltd

Existing industrial zones



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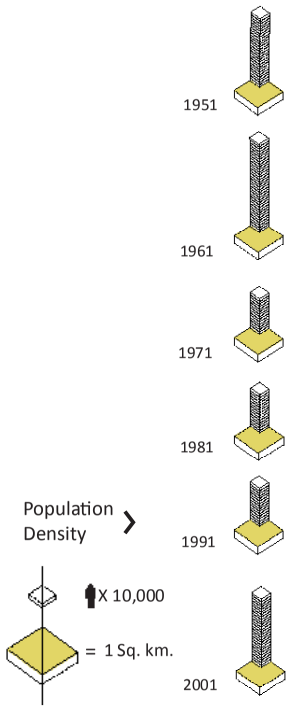
1. CITY GROWTH

Prior to 1961, Surat's area was only 8.12 sq. km., while in 2009 it had expanded to 326.5 sq. km.
The city was originally established on the southern bank of the River Tapi with a castle on the eastern bank of the river.
The activities were concentrated within the inner wall, construction of which was started in the year 1664 as a flood protection structure with gates that were closed in the event of a flood. The area of the city at this time within the wall was 178 hectares. The construction of the entire wall was completed in the year 1707 enclosing an area of 736 hectares.
In subsequent years, the oldest part of the city developed in the area between the train station and the area known as Athwa lines. Since the 1990s, most of the new development including the most desirable locations for the city's burgeoning middle and upper class has been the land between the Athwa lines and Arabian Sea. Since the establishment of Surat Urban Development Authority (SUDA) in the late 70s, the city has been growing at a rapid pace; though the development in the peripheral areas was not that rapid until 2001. Due

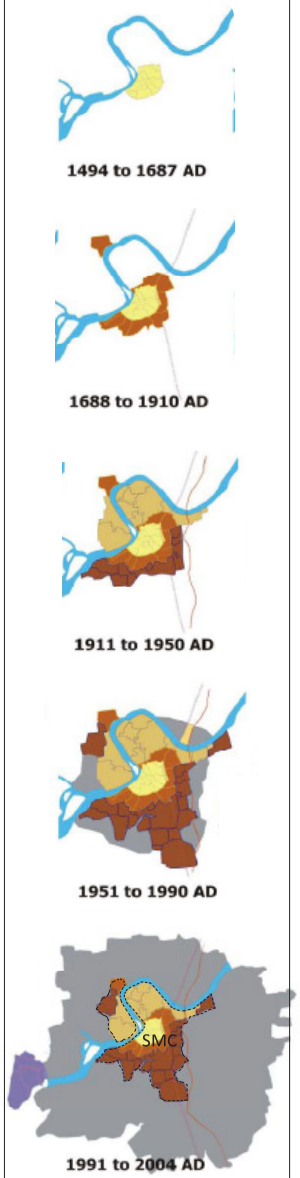
2. LANDUSE PATTERNS & CHANGES

With the establishment of the Surat Urban Development Authority (SUDA), the development plan for its entire area (including SMC's area) was prepared under the Gujarat Town Planning and Urban Development Act, 1976. The planning area includes SMC and 148 villages of Choryasi, Kamrej, Palsana and Olpad Talukas. The urban sprawl had already started growing outside of Surat city limits, along the radial roads and different corridors such as Udhana corridor, Dindoli corridor, Rander – Adajan – Olpad corridor, Nana – Varachha –Kamrej corridor etc (CDP 2006).

Area	1951	1961	1971	1981	1991	2001
Surat Municipal Area						
Area (Sq.km)	8.18	8.18	33.85	55.56	111.16	112.27
Population	223,182	288,026	471,656	776,583		
Decadal Growth Rate (%)	-	29.05	63.75	64.65	93	62.38
Prop. Density (per sq.km)	27,284	35211	13,934	13,977	13,489	21,677
Sex ration	916	915	887	857	839	774
Surat Urban Agglomeration						
Population						
Decadal Growth Rate (%)	-	-	-	85.36	66.22	85.09
Source : Surat City Development Plan 2006-2012						

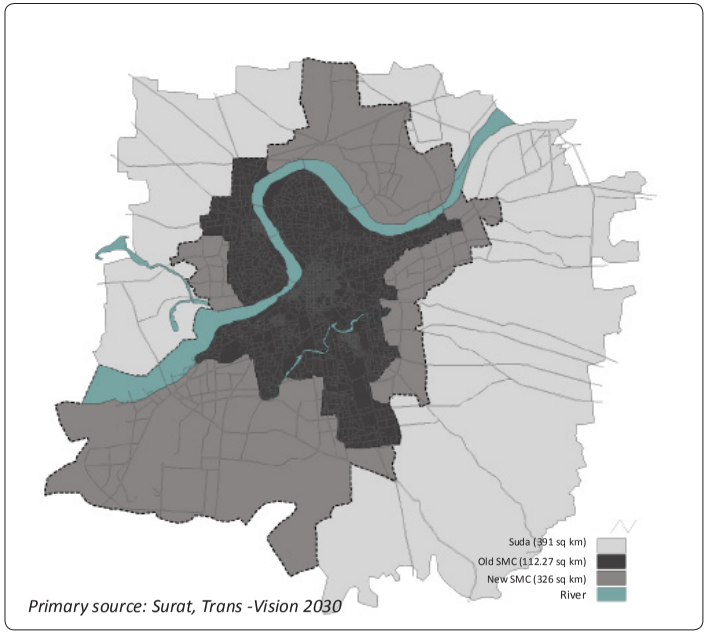


SURAT CITY GROWTH



Source: Surat, Trans -Vision 2030

Road Network: SURAT city



Primary source: Surat, Trans -Vision 2030

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The recent population growth (55% of total population are migrants) of the city is mainly due to the two main labor demanding industries i.e. textiles and diamond cutting & polishing. The population growth is due to the combination of natural growth and in-migration. Surat claims to be a zero unemployment city, this has attracted rural migrants from within state (Saurashtra, arid northern parts) and other states (especially Maharashtra, Uttar Pradesh and Orissa). About 80 percent of the slum households in Surat are migrants from rural areas of Gujarat as well as from other states of the country. Moreover, with the large dependence on semi-skilled migrant workers to support the industrial labor demand, this trend is likely to continue.

1. LIVING (ENVIRONMENT)

Similar to other cities in India, Surat has its own share of slums. The slums have mostly a migrant population who are unable to afford formal housing. As per 2001 Census, about 20% of the Surat's population (0.49 million) lived in 307 slums. With the recent expansion of the city in 2006, this number has increased to 406 slums.

In 'Slum Dwellers in Indian Cities: The case of Surat in Western India' Biswaroop Das, writes (largely based on the data collected in a survey conducted in 1992), about the living challenges faced, which provides a snapshot of the city's slums during early 1990's as against the current situation (described later).

- As high as 60 per cent of the slum localities is devoid of any kind of drainage or gutter arrangements.
- A serious lack of rain water drainage makes the conditions of many of these localities filthy, muddy and hazardous in terms of health especially during heavy rains. Slums located on lower slopes remain water-logged for long and this leads to high incidence of mosquito breeding and tend to contaminate drinking water passing through pipes.
- Variously used spaces by the slum households for bathing include (i) spaces inside the dwellings, (ii) spaces outside the dwellings; (iii) spaces around the public water posts and (iv) spaces like river and canal banks, wells etc.
- Available toilet facilities are enough only for about 22 per cent of the slum population in the city; conditions of a substantial proportion of public toilets are appalling and hence underutilized for the purpose meant for; spaces used most frequently for defecation are nearby open plots or grounds, followed by strips along the canals and river banks.
- In case of 28 per cent of slum localities in the city, services like dispensaries/health centres are located within a radius of 3 kms. As high as 68 per cent of the households have not used institutional facilities like hospitals, dispensaries, health centres etc.*

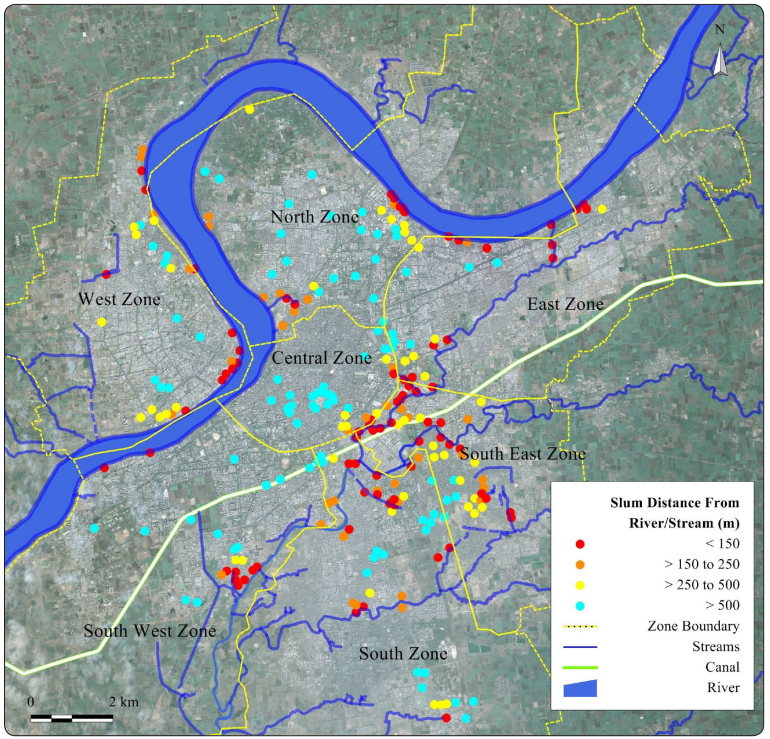
Since the late nineties, Surat Municipal Corporation followed the policy of providing free water and sewage connections to households living in the slums. Almost all slums including most on private lands have been provided safe drinking water and access to drainage. In addition paving of internal streets, streetlights, public toilets, individual toilets have also been provided. Primary health, child care and primary school services are made available to poor families in the slums.

Moreover, many of these slums are located along the tidal creeks, along the river, between the embankments and other drainage lines. These slums face higher risk of flooding (pluvial, fluvial and tidal). Having recognized this, efforts to relocate the slums were initiated by the government under various schemes (mainly during the last decade under various national projects including JNNURM) and more than 22,000 permanent houses at safer location have already been provided to the slum dwellers and more are under construction. (For more data on slum rehabilitation & housing see: Surat Development Plan 2006- 2012, SMC, SUDA)

The Urban community development department (SMC) is active and monitors delivery of essential service in slums. In comparison to rest of India, slums in Surat have better access to water supply, drainage and sewerage facilities. But, very high in-migration of semi-skilled workers from across the country poses a continuous challenge to the efforts of SMC.

* Das, Biswaroop. Slum Dwellers in Indian Cities: The Case of Surat in Western India. Working Paper, Surat: Centre for Social Studies, p.11-13, for more see: http://www3.qeh.ox.ac.uk/pdf/qehwp/qehwps07.pdf

SLUM LOCATIONS



Source: Surat City Development Plan (2006-2012)

Zone Wise Slum Settlement (2005)					
Zone	No. of Slums	No. of slum Households	Slum Population	Percentage to zone population (%)	Percentage to total population (%)
Central	25	9,189	45,618	11.0	1.9
North	40	9,603	45,596	13.6	1.9
South*	128	58,213	233,658	35.8	9.6
East	53	19,364	79,009	13.6	3.2
West	38	11,333	51,712	20.7	2.1
South West	23	8,961	34,712	17.2	1.4
SMC	307	116,663	490,305	20.1	20.1
* south zone was bifurcated in the year 2004.					
Source : Surat City Development Plan (2006-2012)					

CONTENTS

2. LIVELIHOOD (EARNING)

As shown in the Table P1, most migrants are pulled to cities in search of employment opportunities. Almost 30% of the migrants come in search of jobs. The city presents a wide range of activities in various industrial and commercial sectors. Growth in such activities, possibilities of absorptions in its industrial, allied as well as service sectors, scope of employment in petty trade and business activities, hawking, vending, carting etc. have attracted rural poor people to the city. Accordingly, there has been a shift in the monthly income range of slum households between 1994 and 2001. The households in the income range below Rs 1,000 per month have improved their status marginally while the new households that were added after 1995 remain in the lower income ranges (Surat CDP 2006).

The population residing in slums can be classified into twelve broad categories as shown in Tables P2.

3. LIFESTYLE (SOCIAL STATUS, ASPIRATION)

There has been a considerable investment by the SMC in upgrading slum settlements. The Sites & Services Programmes, the Built house programme and provision of LIG and EWS housing projects are all steps towards providing better living environments and a chance towards social and economic mobility.

The problem lies in the rate of the 'pull factor' with slums increasing at a rate that is beyond the SMC capacity. Moreover, the lack of information on services availability in slums and limited availability of land within the Corporation area for slum relocation, all pose problems in dealing with this complex urban phenomenon.

Also, the regional difference between migrants poses social issues, creating a more fragmented social landscape. Despite continued investments by SMC to provide infrastructure and services to the slums, the continued pull migration is likely to challenge the efforts and resources of the Corporation.

P1: Variations in % of migrants with purpose of migration

A	% Migrants to Total Population	55.85
B	Purpose of Migration	% to Total Migrants
1	Work/employment	29.19
2	Business	8.90
3	Education	0.46
4	Marriage	12.84
5	Move after birth	8.03
6	Moved with h/h	29.96
7	Others	10.62
8	Total	100
Source: Census of India, 2001.		

P3: Distribution of Slum Households by Income

Income Range (Rs.)	% Slum Households	
	1994	2001
<700	8	6
701-1000	27	12
1001-2000	42	36
2001-3000	12	31
>3000	11	15
Source: Surat City Development Plan (2006-2012)		

P4: Male (%) by State of Origin

State of origin	Persons	Male (%)
Maharashtra	2,65,593	53
Uttar Pradesh	1,61,994	73
Orissa	90,135	84
Rajasthan	84,757	63
Bihar	53,549	79
Madhya Pradesh	25,963	63
Other States	69,978	62
Outside India	5,062	60
Total	7,57,031	65
Source: Slum Dwellers in Indian Cities: The Case of Surat in Western India, Biswaroop Das (1992)		

P2: Type of Occupation and Household

Occupation Type	Households (%)
White Collar	3.7
Blue Collar	13.7
Construction	4.2
Textiles	30.7
Agriculture and Allied (Higher Level)	1.7
Self-Employed (LL) (Repairs)	1.6
Self-Employed (LL) (Services)	13.4
Self-Employed	0.2
Self-Employed (LL) (Sales)	12.1
Self-Employed (LL) (Production)	4.7
Self-Employed (LL) (Processing)	6.9
Other Occupations	7.1
Total	100
*Note: Excludes 6714 household heads or 7 per cent, for they belong to categories like unemployed, disabled, invalid, retired, `house wives' and those who are living on land and house rent inherited wealth or property etc.	
Source: Slum Dwellers in Indian Cities: The Case of Surat in Western India, Biswaroop Das	

The problem in the global domain

Source: Google images, http://archithoughts.wordpress.com/2010/11/

CONTENTS

1. OBSERVED CLIMATE

Located near the coast, Surat experiences moderate but humid climate. The summers are hot with extreme day temperatures ranging from 37.8°C to 44.4°C . The climate is mostly pleasant during the monsoon. The winters are pleasant with night temperatures in January dropping to around 15.5°C. The average annual rainfall of the city is around 1,222 mm (IMD). Most of the rainfall occurs between June and September.

2. TEMPERATURE CHANGE PROGNOSIS

The monthly average maximum temperatures are likely to increase by about 0.5°C per decade. According to the regional models, by 2070-2100 the average maximum temperature may increase by around 4°C. This inference is not expected to be different with change in the selected model or scenario and neither is it specific to a single season. The upward changes in maximum and minimum temperatures combined with high humidity and the urban heat island effect will have major impacts on human comfort, especially during the summers and the monsoon seasons.

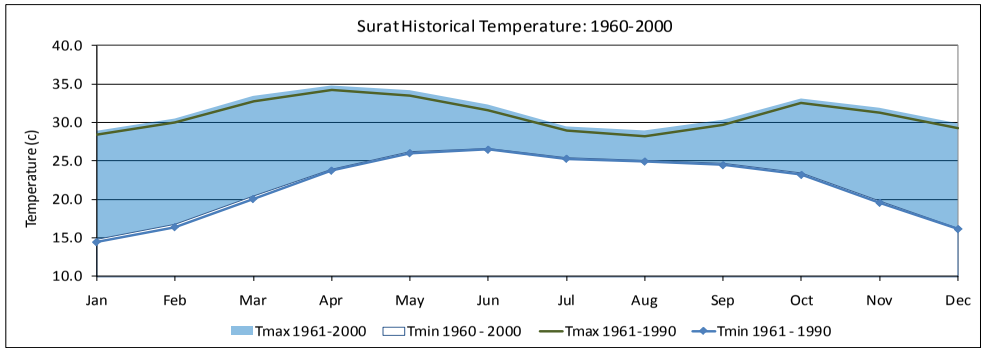
Data Source:

DOWNSCALED CLIMATE VARIABILITY AND CHANGE ANALYSIS

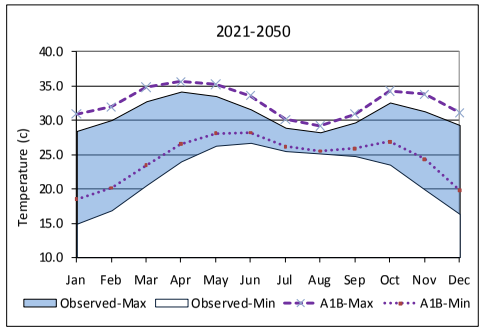
The climate data (past and future) from Climate Systems Analysis Group (CSAG), Indian Institute of Tropical Meteorology (IITM), Indian Meteorological Department (IMD) and Global Historical Climate Network (GHCN) were analyzed and their results discussed within this report. The CSAG data was downloaded from University of Cape Town web site accessed between December 2009 and March 2010. CSAG has taken data from nine large-scale general circulation models and downscaled the scenario results to a scale more

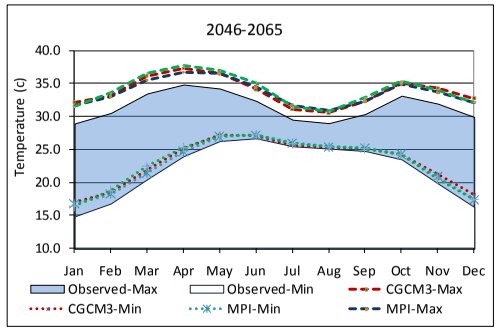
Name of Research Institute	Abbreviation
Canadian Centre for Climate Modelling Analysis (CCCMa)	CGCM3
Centre National de Recherches Meteorologiques, Meteo France, France	CNRM-CM3
Indian Institute of Tropical Meteorology, Pune and Hadely Research Center UK	PRECIS

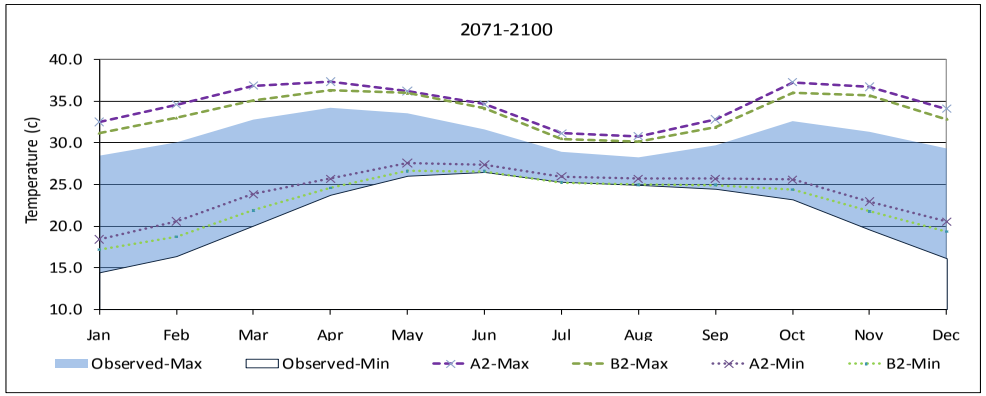
OBSERVED CLIMATE



Estimated Monthly Average Maximum Temperature- 2021-2100







PRECIPITATION

CONTENTS

1. PECIPITATION CHANGE PROGNOSIS

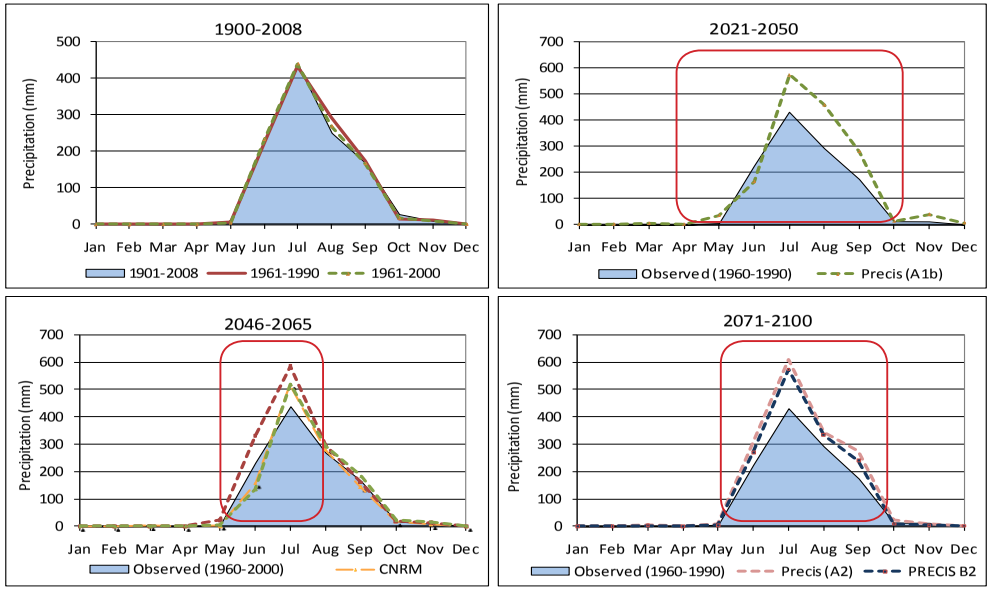
Surat receives an annual rainfall ranging between 950-1200 mm. About 90% of the rainfall occurs in period between June to September. The GCM and RCM results indicate a high probability of increased precipitation in the future. This predicted increase, from different models and scenarios, ranges from 200 mm to 450 mm annually (by 2070). Similar changes are expected in the upper catchment areas of Tapi basin also.

Analysis of the Indian monsoon over past century indicates decrease in number of rainy days as well as more intense precipitation events across the country (Goswami & Ramesh, 2007: Extreme Rainfall Events: Vulnerability Analysis for Disaster Management and Observation System Design, Centre for Mathematical modeling and Computer Simulation, Bangalore).

The instances of extreme point rainfall events (EPRE) have mainly affected the regions on NW, NE, central India, the coastal zones and the hill stations (Extreme Rainfall Events: Vulnerability Analysis for Disaster Management and Observation System Design, Centre for Mathematical modeling and Computer Simulation, Bangalore).

Considering the physiographic setting of Surat, the increase in rainfall with increasing EPREs may add on to the existing risks of pluvial fooding.

Precipitation Historical and Future Estimates:



SEA LEVEL RISE

CONTENTS

1. RIVER FLOW & PEAK DISCHARGES

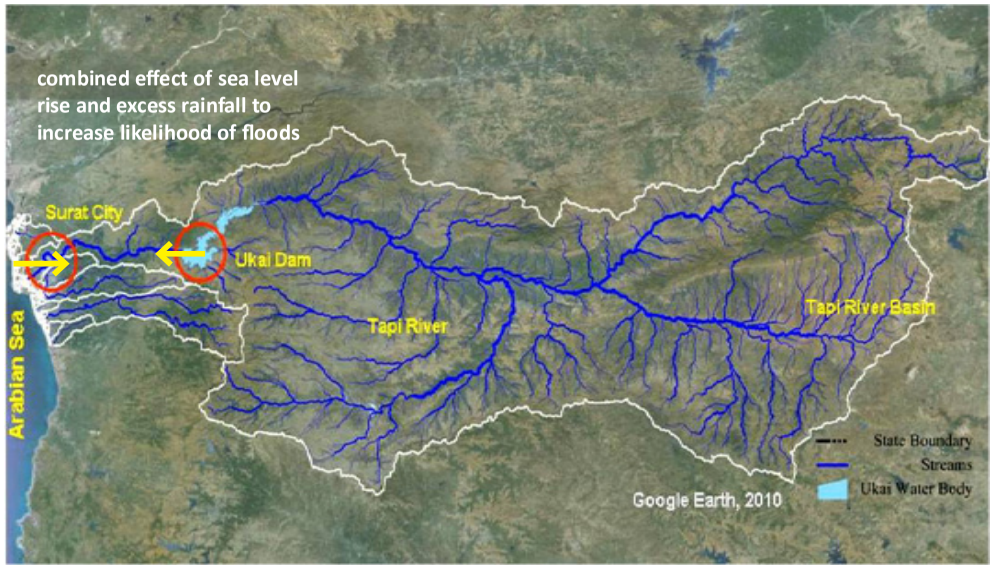
The analysis of the Tapi River basin based on the RCM future scenarios indicates an increase in water yields. This predicted increase is 29% under A2 scenario and 22% under B2 Scenario for 2071-2100 periods (INRM &TARU 2010: Climate change and Climate variability Scoping study for Gujarat-Final report, prepared for GSDMA, Gandhinagar,unpublished). During this same period, the 30 year peak discharges are also expected to increase by 50% under B2 and 85% under A2 scenarios indication dominations of EPREs.

2. SEA LEVEL RISE

Surat is a coastal city and lies near the estuary of Tapi River. Several tidal creeks cut across the city. Tidal range of Surat is about 5.8 m. During rainy months, the high tides (the highest during the year) often cause the sea water to inundate the slums located along the creeks. During last five years, the slums have been periodically evacuated during the mid-July period due to the above tidal inundation, according to the recent study of the sea level changes in Arabian Sea by Unnikrishnan*, during the last one century, there has been an increase in sea level along the Gulf of Cambay by around 0.67 m. If such increase prolongs into the future, it could have a major impact on the city.

* Unnikrishnan 2007. Observed Sea level rise in the North Indian Ocean coasts in the past Century, Physical Science 91-92

FUTURE MEAN TEMPERATURE RANGES- 2021-2100



2. POSSIBLE IMPACTS

PHYSICAL/ ENVIRONMENTAL	SOCIAL	ECONOMIC
Water- Water supply/ sanitation/ floods Landuse & planning Solid Waste Transport	Public Health Social Cohesion/ Equity Institutional	Energy Domestic (lifestyle)/ Industry Loss Estimation- - Gross value added - Capital

CONTENTS

1. PRESENT SOURCES

The water needs of Surat are being managed by The Surat Municipal Corporation. The major source of water supply is the perennial river Tapi. The water supply network was commissioned in the year 1898 in Surat. Over the decades, the city has invested in the water supply, and now has a well-managed system.

The River Tapi originates from Madhya Pradesh and passes through Surat City via the Ukai Dam. This dam was constructed in 1972 in the upstream of Surat City (at about 100 Km from Surat). The purpose of this dam includes irrigation, Hydro-power and partial flood control.

The flow of the river, down-stream of Ukai dam and Kakrapar weir, is now being controlled by Gujarat Electricity Board/Water Resources Development authorities. There has been a drastic reduction in the river flows. The river currently flows as a small stream on the opposite side of the old water works of Surat City due to the reduction in flow. In addition, the silt deposition around the infiltration wells and radial collecting wells, which has been increasing year after year, reduces the percolation of water and well yields. This phenomena is affecting the water supply to the Surat City.

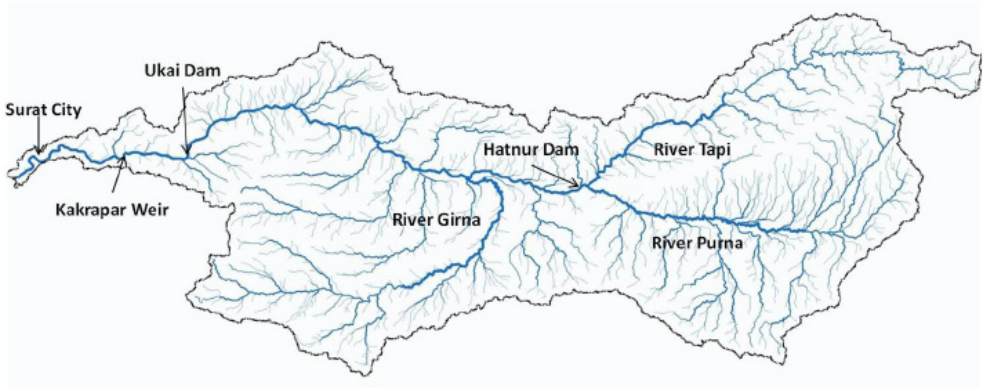
As stop gap arrangement, temporary bund of sandbags were being constructed every year after monsoon. However, during monsoon, the bunds would get washed away creating water crisis in Surat City. To overcome these problems and to rejuvenate the existing sources at Head Works at Varachha and Sarthana (SMC), in association with the major industrial establishments, constructed a Weir cum Causeway across the Tapi River near Singanpore. This weir has improved the water supply for Surat City by providing a standing pool of freshwater. It has also prevented the ingress of tidal water and drifting silt entering infiltration well area during high tides. The Singanpore weir is owned and operated by the SMC. The minimum flow of 2,446mld (1,000 cusecs) is being made available by state water resources department, except in the months of May & June. During these months only about 1,712 mld (700 cusecs) is available (Water Security – A Sector Study Report, SMC 2009). However, this water is being allocated to Industries of Hazira, in addition to of the allocation to SMC (725 mld).

2. PRESENT NEED VS. SUPPLY

Present population of Surat City is approximately 4.5 million (Year 2011). About 700 MLD of treated drinking water is being generated from four water works. Water demand includes domestic, industrial, commercial, institutional etc. Out of the total generation, an average of about 55 MLD of water is being supplied to industrial users (who also use ground water), 6-7 MLD is being supplied to commercial and institutional users and rest is supplied to domestic consumers. Connections for industrial, large commercial and residential apartments are metered.

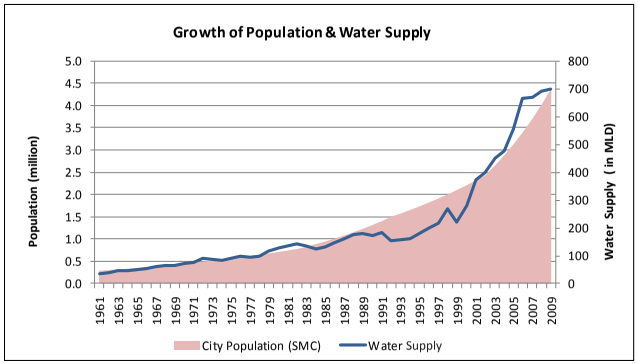
In absence of water audit and scientific loss measurement study, 20% loss has been assumed.

Sources of Water



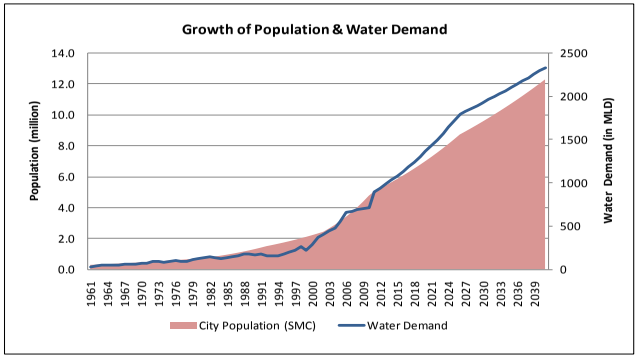
Source: Water Security – A Sector Study Report, SMC 2009,

Surat City Water Supply trend (1961-2009)



Source: SMC, 2009

Population projection in 2010-2026-2041 with water needed



Source: Water Security – A Sector Study Report, SMC 2009 SMC 2009

CONTENTS

3. POSSIBLE IMPACTS

Impact of urbanization

Surat city depends on Tapi for meeting most of its water demand. At present, it is drawing about 700 MLD which is close to the available riparian rights. Droughts and late onset of monsoon are already creating stress on Surat's water supply system during peak summers. Under the high economic growth scenarios, the population growth is expected to grow significantly. For meeting the demand of future population-8 million plus in 2020, at least 1,200 to 1,500 MLD water is required to cater to the population. Apart from domestic use, additional water will be needed for industries in Hazira. This situation may increase the competition over limited resources currently allocated for irrigation and power generation. The water scarcity is likely to become an issue, unless major change in allocating Ukai dam water takes place, or alternative sources are explored.

The estimated water demand for domestic and industrial purposes in the year 2011, 2026 and 2041 within SMC, against availability of water from Tapi River is presented in the following Table. (Water Security – A Sector Study Report, SMC 2009)

Tapi River being the only reliable source of water, it can be interpreted from graph, that the available water, although adequate for immediate future, falls short of the requirement from around year 2015 onwards, during the summers. If one considers the storage capacity of 31 MCM of Singanpore weir, availability of water is sufficient to meet the water shortfall up to the year 2026 but not much longer thereafter.

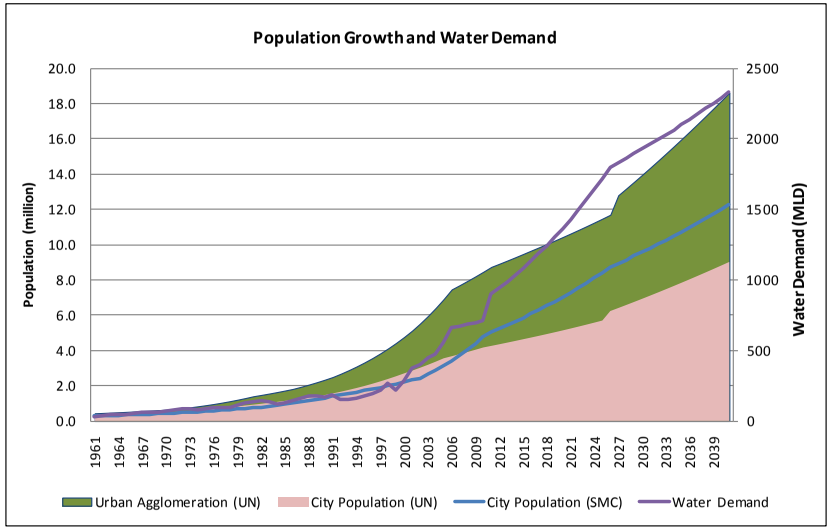
Impacts of Poverty, Migration & Aspiration -

Surat has remained a major focus of immigrants from arid regions of the state and also far off states like Orissa and Bihar due to the employment opportunities it offers, resulting in a 10-fold population rise in four decades, unmatched by any other city in the country. With increasing population, there is an increasing load on the water supply. Also, as income levels increase so will the pressure on resources (with more affordability per capita resource consumption goes up), creating an additional load on the water supply.

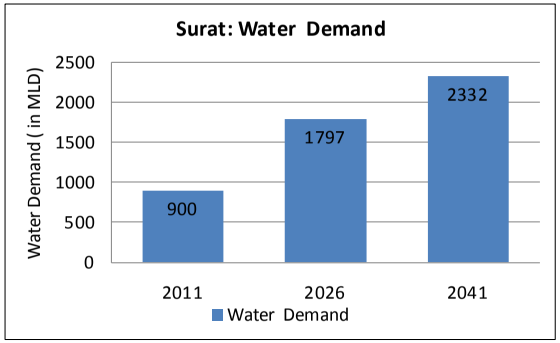
Impacts of Climate change:

- Increasing droughts and floods- Climate change is expected to increase the frequency of extreme events, which includes floods and droughts.. The advent of droughts will cause problems in the supply of water, whilst heavy precipitation could cause floods.
- High Tide effect in the Arabian Sea- which could result in the tide entering the city via river Tapi upto the Weir cum Causeway. With the sea level rise, high intensity tides from the Arabian sea may result in the carryover of saline water over the existing weir structure. As a result, the intake well very near the weir cum causeway may get contaminated with saline water and can hamper the water supply system in the western part of city.
- River Dynamics: Water Quality trend in River Tapi- There will be deterioration in river water quality due to less dilution effect imposed by droughts. Algal blooms will be tremendous. Sequential years of drought will render the river water untreatable through conventional process.
- Changes in distribution and survival of aquatic species & Algal Blooms- Temperatures are expected to increase pathogens, nutrients and invasive species. Algal blooms can also be expected especially during summers. There is also likelihood of loss of aquatic species whose survival and breeding are temperature dependent, as well as change in the abundance and distribution of coastal and marine species. Increased rates of evapotranspiration can result in shrinking of water-bodies. (Water Security – A Sector Study Report, SMC 2009)

Surat City Water demand: 1961-2041



Surat City Water Demand Projection 2011, 2026, 2041



Source: Water Security Report, SMC 2009, "Water Demand: 180 LPCD at generation station (water works) with loss of 15% in network. As per CPHEEO norms at ULB level, drinking water supply should be provided at the rate of 135 LPCD at consumer end. How ever, 100 LPCD at consumer level is also permitted. But by no means, consumer should get drinking water less than 70 LPCD. However, As per WHO Guideline (2005) for Minimum Water Quantity needed for domestic use in emergencies - Technical note no. 5, 20 LPCD can be considered as lifeline water supply quantity / short term survival quantity.

CONTENTS

1. PRESENT CONDITION

Surat lies in an almost flat terrain which poses a challenge to sewarage and storm water drainage. The SMC over the years has laid more than 1150 km of sewerage network with more than 38,500 manholes and has a total of 8 sewage treatment plant (total capacity = 642.50 MLD) and 32 sewage pumping stations (total capacity = 1163 MLD). Earlier, 97% of the city area was covered by piped networks (108.91 sq.km area of old city) for water supply and sewerage. However, with the expansion (2006) the total area of the city increased to 326sq. km, only about 86% of the present population is served with sewerage network. This has led to the remaining domestic grey water and sewage generated from peri-urban areas discharged into the Tapi River. This pollution has led to algae blooms, proliferation of underwater Hydrilla and surface variety of water Hyacinth. SMC is currently investing heavily in expanding the sewage network in the newly urbanised areas and has already upgraded existing sewage treatment plants to provide for secondary treatment process.

2. POSSIBLE IMPACTS

Impacts of Urbanization-

- Increasing urbanization will mean more discharge of sewage, necessitating the need for additional sewage infrastructure. Moreover, if the present trend of discharging sewage and domestic water from the peri-urban areas continues, there will be additional pollution loads on the Tapi River. This combined with the pollution from the industries could lead to further loss of aquatic habitats and more instances of disease and water treatment costs.

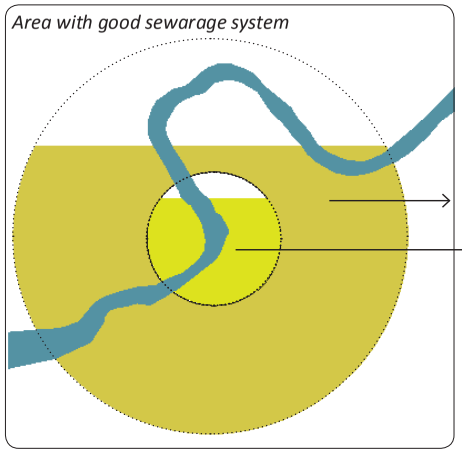
Impacts of Climate change

- In the event of floods, the storm water runoff mixes with sewage and is released into the river, leading to river pollution. Moreover, stagnant water could lead to potential vector borne and water borne diseases like malaria, dengue and gastro-enteritis. An extensive and independent storm water drainage system could prevent this eventuality.

3. PROJECTED WASTE WATER GENERATED- POTENTIAL

The estimated water demand for domestic and industrial purposes in the year 2011, 2026 and 2041 within SMC, against availability (different from allocation) of water from Tapi River is presented in the table alongside. Tapi River being the only reliable source of water, the available water, is likely to be inadequate for meeting the summer demands from around year 2015 onwards.

Recycling of domestic wastewater, along with demand management and water conservation, is likely to be an important strategy in water management. It is noteworthy that estimates of climate change impacts and population growth indicate that the rainfall in this region is likely to show higher variability; combined effects of climate change and population growth, this is likely to reduce per capita water availability. Recycling of domestic wastewater, especially for cities like Surat, with limited ground water recharge potential (due to proximity to sea and saline aquifers),can be an important and desirable element of water management. (Water Security Plan , Surat Municipal Corporation). Essentially the exploration of water supply hierarchies is required to create clear networks of fresh and grey water for domestic or industrial use.



Quick facts

- 59.7% of residential area & 85.6% of the population is covered.
- 1150 kms of sewage network laid by SMC.
- -38500 manholes
- -8 sewage plants with capacity 642.5 MLD capacity
- -32 sewage pumping stations with 1163 MLD capacity .

ADDITIONAL TREATMENT

Estimated Water Demand and Availability in River Tapi near Surat City			
Year of Estimate	Water Demand (in MLD)	Water Availability (in MLD)	
		Normal Months	Peak Summer
2011	900	2445	1712
2026	1797	2445	1712
2041	2332	2445	1712

Source:Water Security Plan , SMC

Source:Environment Study of Surat City, Enviro Control Associates (I) Pvt Ltd.

CONTENTS

1. WHEN & WHY? - 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. The 1968 flood had been the biggest flood witnessed so far and had a highest flow of about 42,475 cumecs (1.5 million cusecs). Water level at Hope Bridge, Surat reached 12.01 m.

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.

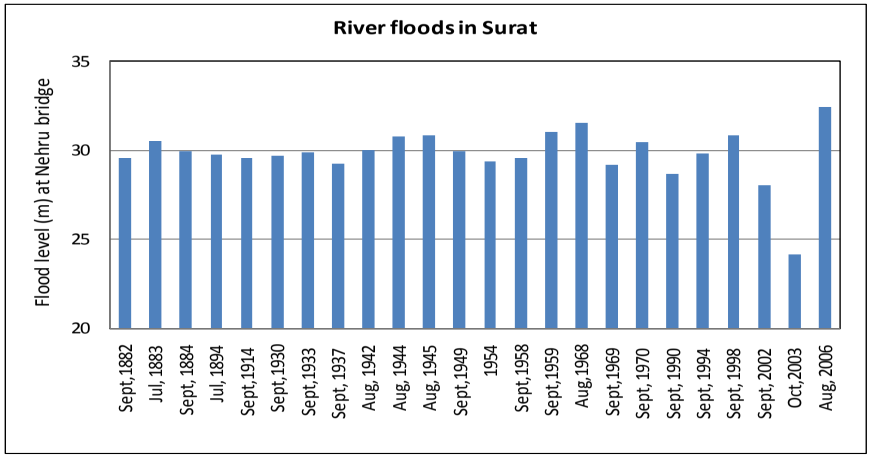
The floods of 1998, 2004 and 2006 occurred following emergency discharges from Ukai dam. Out of these years, floods of August 2006 remained devastating for Surat in terms of the extent of damage, during which nearly 75% of the city was inundated. Anthropogenic changes including building of bridges, embankments 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)

2. 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). Due to the uncertainty of the monsoon and competing and increasing water demands, the dam managers try store as much as they could in the reservoir for the forthcoming seasons (winter and summer). These conflicting objectives of the Ukai dam often proves to be disastrous to Surat.

During the end of the monsoons, when the dam is near to its capacity, depending on the level of the dam, unexpected rains for 3 to 5 days in the catchment can create situation in Ukai dam to force discharges of up to 36,811 cumecs (1.3 million cusecs) leading to floods in Surat. Since the city is located near the mouth of the river, with the high tides reaching the western part of the city, the tides prevents smooth outflow of flood discharges resulting in higher flood levels and increase damages.

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.



Source: Disaster management plan, SMC 2009

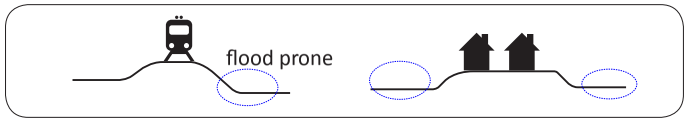
Source:Google Images

CONTENTS

3. OBSERVED & POSSIBLE IMPACTS

Impacts of Urbanization-

- Hazira landfill- The land occupancy led to large scale filling floodplains to raise original ground at RL (+) 3.0 to (+) 6.0 m in Hazira and many places in city, resulting in the reduction of the floodplain area in the downstream of Surat city. Moreover, the Hazira complex has grown by reclaiming sections of the flood plain.
- Coastal erosion-According to the work*, there are two types of coasts – one where sand is depositing and the other where the sand gets eroded. South Gujarat coast falls in the latter type. According to him, the coastal erosion rate has increased during the past decade. Though 10 m erosion is an average annual rate, the sea has encroached up to about 80 m at places in some parts of South Gujarat coast . The tidal levels are also likely to increase the City's vulnerability to floods by raising the submergence levels.
- Rail embankments, roads , canals- cut off flow and restrict water to enclosed areas and induce flooding in areas that in the past did not have this problem or not to the same intensity. (Flood Risk Management Study, Centre for Social Studies. 2009).

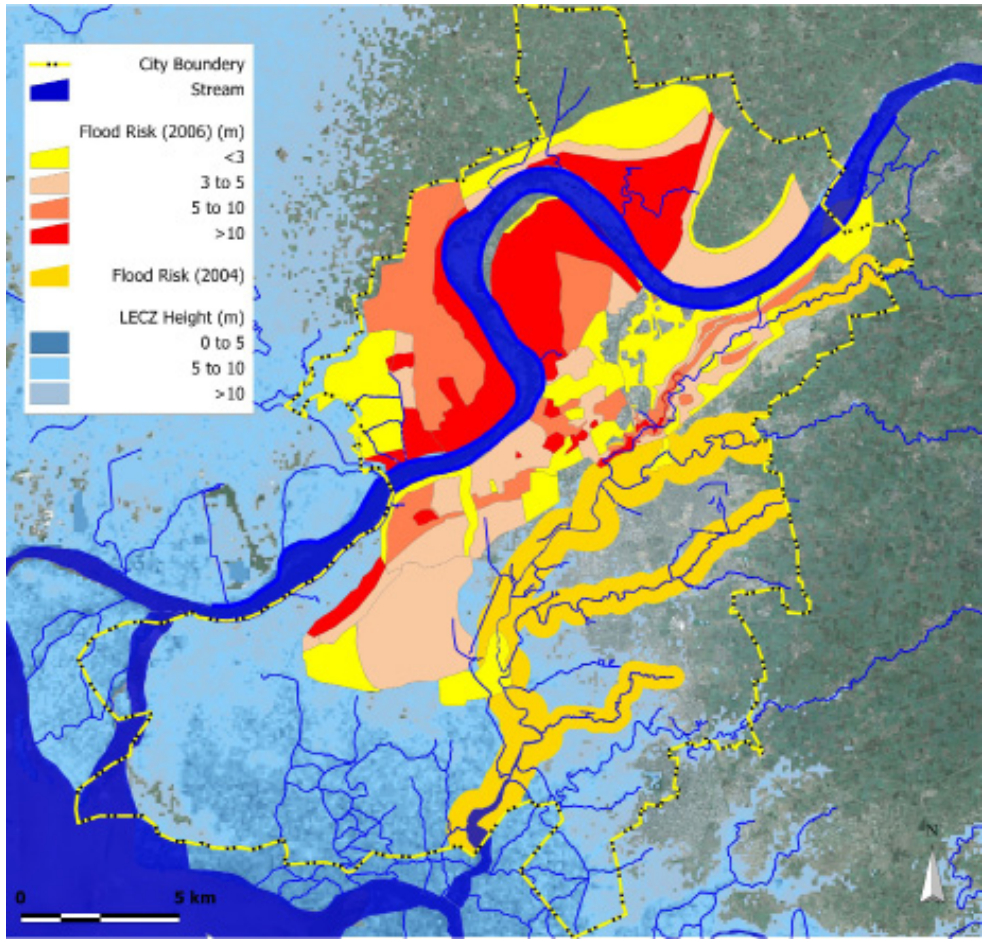


If unchecked, unregulated urbanization and human induced topographic changes is expected to lead to larger losses due to flooding in the future. Topographic assessment and modeling of flood prone areas will reveal the most vulnerable zones and is of utmost priority in the development agenda. It is imperative to formulate an understanding of the terrain and hydrological context in order to develop the city. In order to mitigate the impacts of floods, it is necessary that the urban planning and infrastructure development is informed by knowledge of the terrain, hydrology, as well as climate change impacts. Moreover, future urbanization, especially industrialization in Hazira needs to be informed by the flood risk studies to allow the natural drainage pattern to function.

Impacts of Poverty, informal settlements-

The informal settlements have mostly migrant population who are unable to afford formal housing. As per 2001 Census, about 20% of the Surat's population (0.49 million) lived in slums. Many of these slums are located along the tidal creeks, along the river, between the embankments and other drainage channels. These slums face higher risk of flooding (pluvial, fluvial and tidal). Having recognized this, efforts to relocate the slums were initiated by the government under various schemes (mainly during the last decade under various national projects including JNNURM) and more than 22,000 permanent houses at safer location were provided to the slum dwellers. However, with migrants coming to the city every day for work opportunities, the regulatory framework needs to ensure that flood prone areas are not encroached.

Flood map 2006



* Desai et al. (2008) of Department of Geography, M.S. University, Baroda

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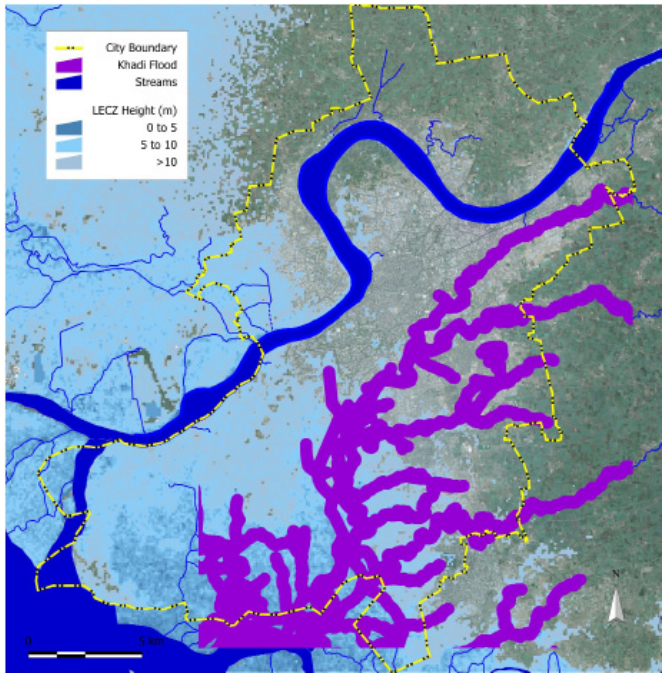


Areas Prone due to Khadi floods

3. OBSERVED & POSSIBLE IMPACTS

Impact of Climate Change

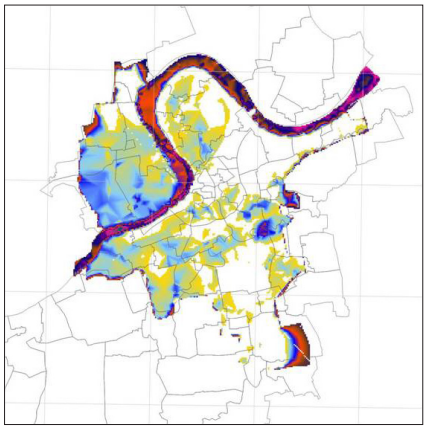
The natural causes of floods:

- Heavy precipitation in the catchment of the Tapi or even in the localized catchments of one or more of its tributaries.
- Cyclonic storms caused by depressions in the Bay of Bengal, moving north and north-west wards coming in contact with the south west monsoon in the Tapi basin results in heavy downpours.
- Silting: Large quantities of silt brought by the Tapi leading to siltation at the mouth of the Gulf of Cambay causes the flood water to rise higher and extend inundation into higher reaches. Moreover, human induced changes in river hydrology have led to increased siltation.
- Effect of Tides: During times of high tides the draining of Tapi waters into the sea is affected and leads to flooding in higher reaches and along the creeks.
- Low bank-ful capacity of the Tapi in some stretches means that in times of heavy water flow, the river spills its banks and floods certain areas.

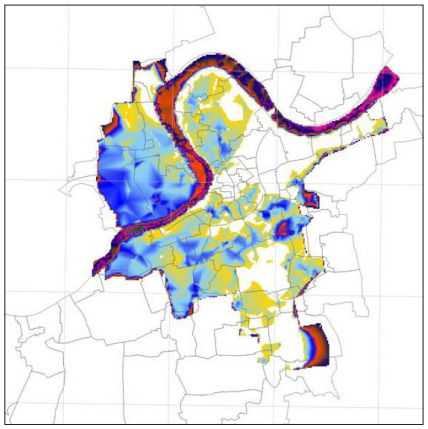
The case of the 2006 floods indicate the lack of coping strategies. (Even this height will not suffice: Coping Mechanisms of Surat to its Recurrent Floods (Draft), Peeyush Sekhsaria for TARU Leading Edge).The future likelihood of extreme events due to climate change is likely to exert additional stress on the city's infrastructure, increasing the impact of floods.

Areas Prone due to Ukai induced floods

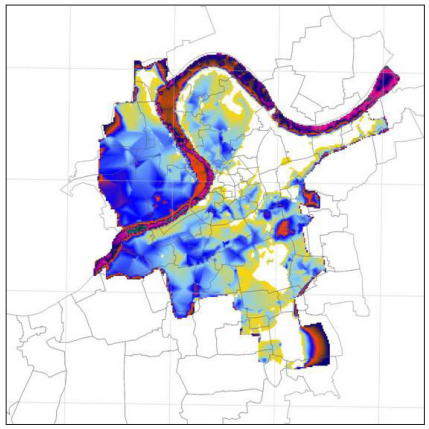
due to 0.4million cusecs discharge



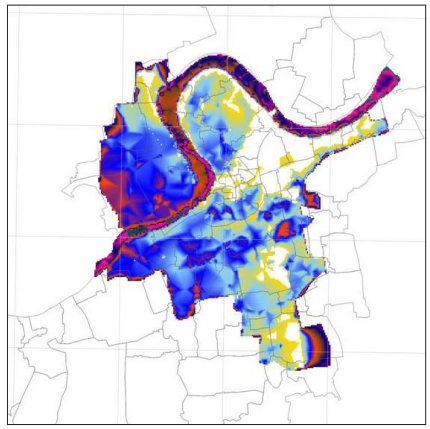
due to 0.5million cusecs discharge

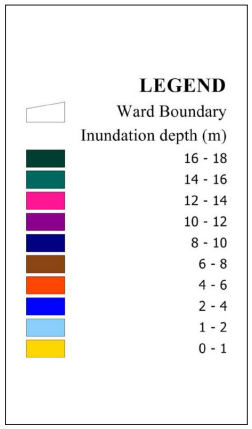


due to 0.6million cusecs discharge



due to 0.7million cusecs discharge





Source: ACCCRN Sector Study: Flood Risk Management

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1. INCREASING RATE OF URBANIZATION

As shown in the diagram alongside, the rate of urbanization from 1978 to 2004 has steadily increased. Urbanization indicates the loss of open agricultural land to city infrastructure and activities associated with industrialized, urbanized economies. This trend is likely to continue given the attractiveness of Surat for pull migrants from across the country.

2. DENSITY, PRESENT LANDUSE & GREEN SPACE

As shown in the density diagram alongside, the population density of the old city (old SMC) is the highest followed by the extended areas. The caveat is that the old city also has old infrastructure but the highest density. Over the years, multi-storeyed buildings within the core area have increased along with the population density. This has resulted in increased traffic density and traffic jams, despite the additional flyovers constructed over the years.

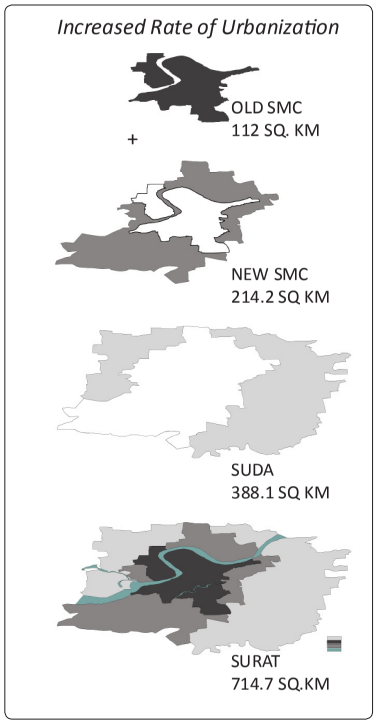
The present land use indicates that majority of the land is devoted to residential usage. However, only 0.63% of the land is devoted to soft-scapes. The green networks within the city mitigate pollution, help in recharging water and improve the overall health and livability of the city.

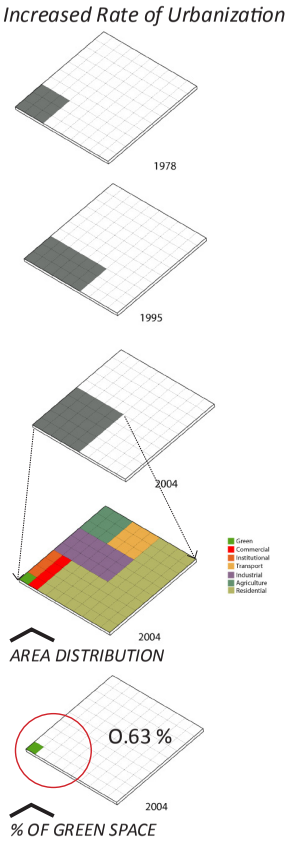
3. INTEGRATION OF URBANIZATION, POVERTY AND CLIMATE CHANGE IN PLANNING

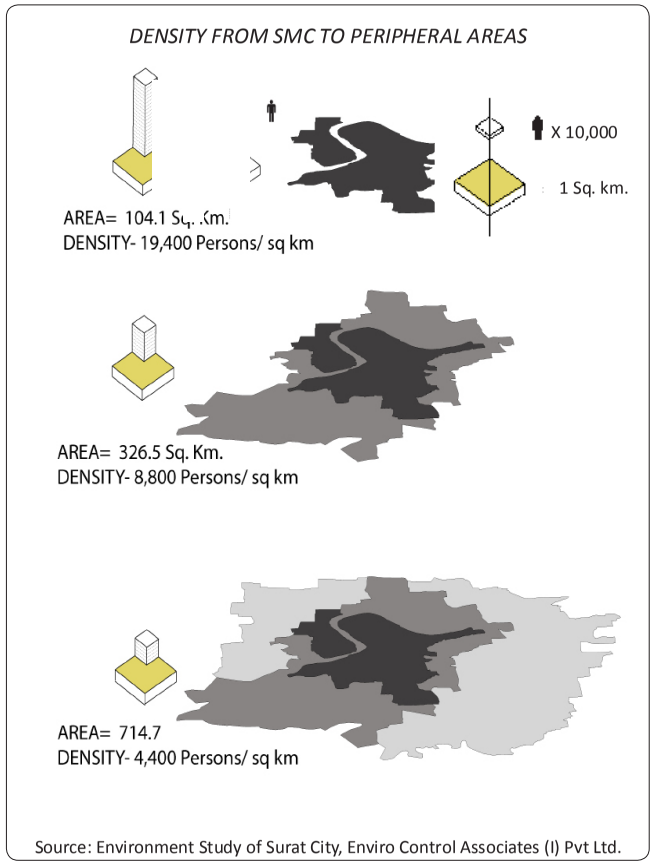
Increasing industrialization and migration will increase the rate of population growth. Demand for the urban infrastructure and services is also likely to grow with improved lifestyles and expectations. There is a need to understand the interlinkage between likely growth scenarios and demands on resources that can influence the pace of urbanization during coming decades to develop plans to improve livability of the city over coming decades.

The in-migrants include low skill labor to support the industrial base of the city. Due to shortage of land and housing, a poorer section of migrants are forced to settle in the underutilized spaces (generally flood plains and low-lying areas) of the city, in slums or informal settlements and succumb to exploitation by informal landlords. The city planners need to make provisions for affordable housing for the poor to keep pace with the industrialization, which will be a major challenge for the city administration. The present town planning schemes adopted by the Gujarat municipalities does allocate land for housing the poor.

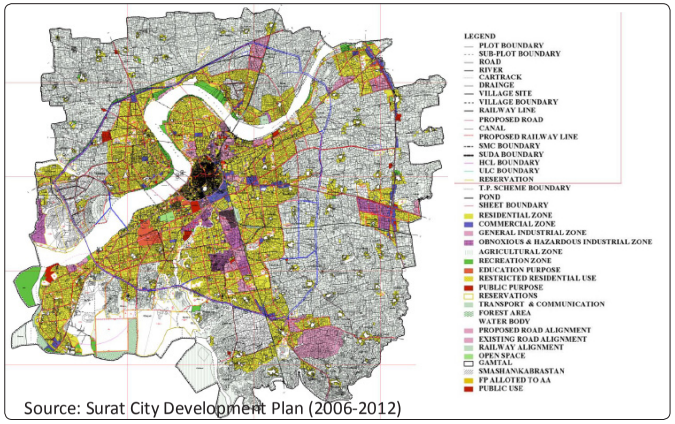
Climate change is likely to increase the temperature and change the precipitation patterns in the city. Planners need to make provisions for improving micro-climatic conditions that increase thermal comfort and create thermally efficient buildings with the provision of sufficient ventilation to ward off the combined effects of climate change and urban heat island effects. Moreover, with increasing residential growth, planning needs to take into account issues of equitable distribution of services and infrastructure. The 2006 floods have highlighted the vulnerability of the city to floods. Detailed flood modeling needs to be done to identify flood-prone areas to develop better planning strategies.



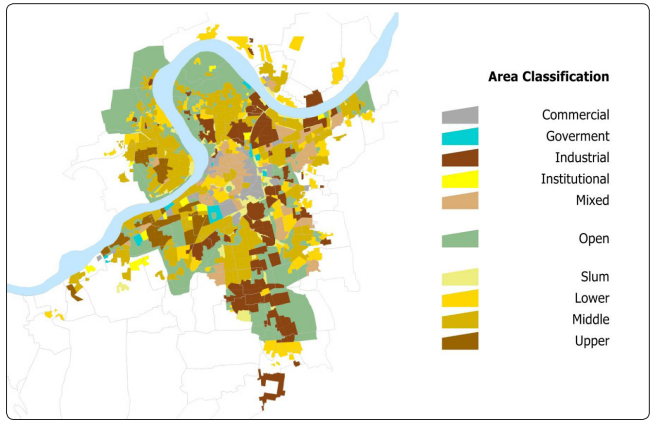




Source: Environment Study of Surat City, Enviro Control Associates (I) Pvt Ltd.



Source: Surat City Development Plan (2006-2012)



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1. PRESENT STATUS

According to the Surat City Development Plan, Surat generates 400gms /capita/ day of solid waste amounting to roughly 1000 metric tons.

Since 2004, Surat privatized contracting and participation of solid waste management. For efficiency, it is divided into 7 zones; the waste collected is then dumped at the Khajod disposal site (200ha).

Solid waste statistics:

- 40% of the total solid waste quantity generated is from the Varachha and Katargam Zone.
- About 700 MT/day. i.e. 60% of total waste produced is collected by a door-to-door garbage collection system. The remaining waste is collected during cleaning of roads and from restaurants.
- With increase in population, about 7% increase in generation of solid waste is observed every year.
- 98% of total solid waste generated is collected and disposed.
- Of the 1000 MT of waste generated, only 30% is recyclable
- 70% of the total waste generated every day is contributed by households, shops and other commercial establishments.
- At present there are 4,503 sweepers engaged in the collection of waste across the seven zones of the city.
- Sanitary Land Filling practice is well established
- Centralized Bio-medical waste collection , transportation, treatment & final disposal facility is available.
- Present solid waste disposal system has been strengthening in compliance with MSW Rules-2000.
- Hanjer Biotech Pvt. Ltd., processes about 400MT of the waste per day to produce green fuel, which is about 40% of the load at disposal site.

Zone Wise Generation details of waste

Zone	Waste MT/Day	%	Population (Approx.) (In Lacs)
Varachha	275	23.91	9.25
Katargam	225	19.56	5.50
Central Zone	175	15.21	5.25
Limbayat	125	10.86	5.25
Udhna	125	10.86	6.00
Rander	125	10.86	4.75
Athwa	100	11.50	3.75
Total	1150		37.75 Lacs PE

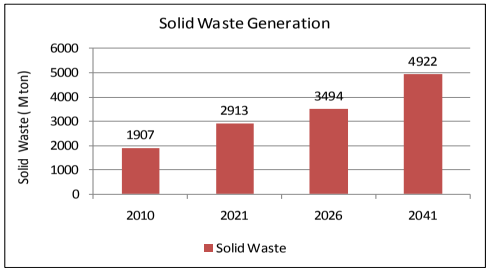
(Environment Study of Surat City, Enviro Control Associates (I) Pvt Ltd.)

FUTURE PROJECTIONS:

Per capita waste generation in major Indian cities will increase from 0.2 Kg to 0.6 Kg

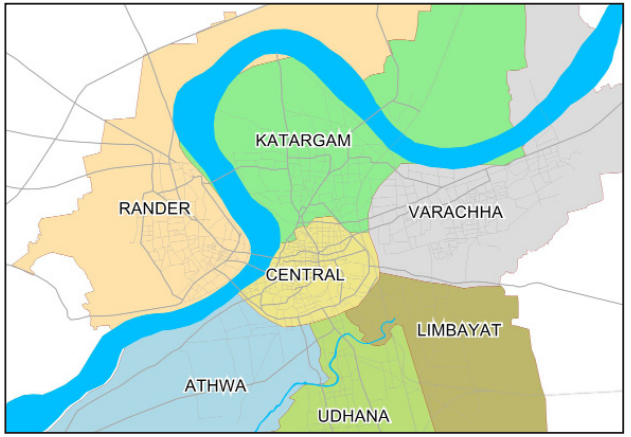
Surat : Solid Waste generation: 400 gm per capita per day. [Source: CDP, SMC (2006-12)]

Current Total waste generation: 1100 M ton per day [Source: Solid Waste Dept, SMC , 2010]

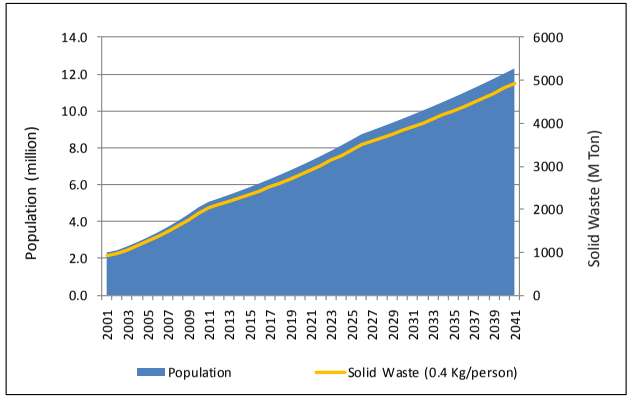


Source: SMC, 2010, TARU Analysis

Zone wise waste generation



Projected Solid Waste generation - till 2041



Solid Waste Management - Existing situation

Head	2005
Refuse garbage collected perday (MT)	950
% Garbage handled by SMC	40
% Garbage handled by contractor	60
Collection per person (urn/day)	390
Generation per person (gin/day)	390
% Efficiency (Collect/ Generate)	98.1
Density of waste (kg. cu.m.)	533
% Moisture content of waste	-42
No, of dustbins (2-3cu.m capacity)	263
No. of dustbins (4.5 cu.m capacity)	1440
Total capacity of dustbins (Cu. M)	

Waste Generation & Collection

Sl No.	Head	Details
1	Generation	
a	Tons Per Day	530 MT
b	Gms/capita/day	403 gm
2	Collection	
a	Corporation (TPD)	980 MT
b	Rag picker (TPD)	25 MT

Quantity of waste generated

Sources	Percentage
Households	53
Shops and Establishments	16
Vegetable/ Fruit/ Meat, Fish market	14
Construction and demolition material	8
Biomedical waste	1
Hotel/Restaurant waste	8

Composition of waste

S. No.	Type of waste	Percentage
1	Combustible Wood	22.45
2	Recycle able	30.28
A	Paper	12.75
B	Plastic	412
C	Metal	2.75
D	Glass	2.05
E	Brick Stone	8.61
3	Earth - Organic	41.97
4	Miscellaneous	5

Solid waste Generation (MetricTons)

Zone	Area (Sq. Km)	Solid Waste Generation (MT/Day)		
		2001	2011	2021
Central	8.18	150.1	139.5	116.2
North	20.54	121.7	179.1	220.6
East	13.86	210.7	295.9	337.7
West	19.63	90.9	166.3	224.5
South	26.01	177.6	291.45	383.1
South East	9.1	59.2	97.15	127.7
South west	14.96	73.2	108.7	139.9
Total	112.28	883.5	1278	1549.7

Source: Surat City Development Plan (2006-2012)

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1. PRESENT CONDITION

Increasing use of private vehicles:

- The vehicles in the city are growing at a fast pace with the changing lifestyle of people. In terms of composition, there has been a shift from non-motorized form to two and three wheelers; and a migration from two wheelers to four wheelers,2 wheelers comprising of nearly 80% of the total number of vehicles while cars constituting about 9.5%.
- The number of vehicles registered in Surat RTO area have increased from 0.4 million in 1994 to 1.3 million in 2007 accounting for a growth rate of 12%. The percentage of personalized vehicles has increased from 70% to 88% within a span of twenty five years.
- The annual rate of growth has remained high at 10 to 11%. In the absence of public transport system in the city, the rate of increase in Auto Rickshaws has been rapid and increment to Motor cars is at 12% per year.

Inadequate Road Infrastructure:

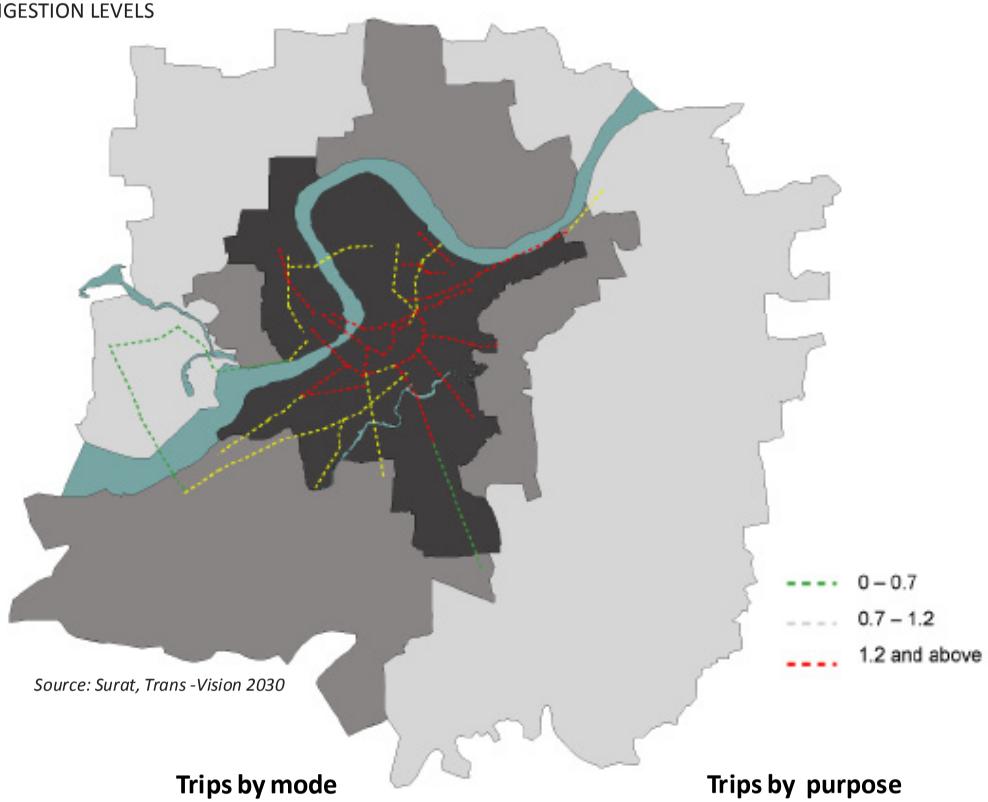
- As per approved development plan, the roadway system of Surat is around 1,150 km.
- Most of the parking is done on the streets reducing the effective width of the roads. At present there are three multi storied parking facilities operating in the city and two more are under construction.
- The total volume of traffic across all the four river bridges has increased by 3.5 times over a period of 15 years. The peak factor vary between 9% to 13%. As expected, in central areas peak traffic is lower while in industrial areas it is higher.
- Recently, SMC has initiated an integrated Road Development Program (IRDP), which includes redesign of three of the major radial roads of the City. The road designs include a segregated carriageway and provision of adequate infrastructure for Non-motorized Vehicles and pedestrians. Other schemes under consideration include Canal Road Redevelopment as part of BRTS corridor and 'Khadi'/Creek Redevelopment with provision of facilities for pedestrians and bicyclists (the redevelopment of creek banks needs to be informed by flooding scenarios).

Public Transport Infrastructure*:

- CRRI has carried out a detailed study of passenger flows. About 0.3 million passengers use the rail and bus terminals every day. Number of rail passengers increased from 0.13 million in 1988 to 0.21 million in 2004 (60% increase).
- Number of bus passengers increased from 69,000 in 1988 to 96,000 in 2004 (40% increase)
- Of the total travellers, 60% are residents of Surat. 47% of the trips are occasional trips and 10% of the trips are monthly trips. Moreover, there are only about 16% daily trips (daily commuters)
- Autorikshaw is the major feeder mode to access ultimate destination/origin and the average length of connecting trips is 6.4 km.

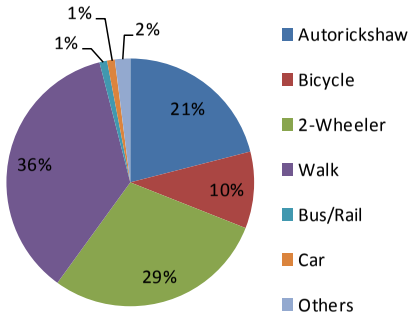
* Environment Study of Surat City, Enviro Control Associates (I) Pvt Ltd.

CONGESTION LEVELS

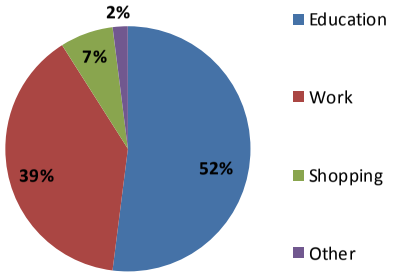


Source: Surat, Trans -Vision 2030

Trips by mode



Trips by purpose



Source: Surat, Trans -Vision 2030

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2. IMPACT OF URBANIZATION & CLIMATE

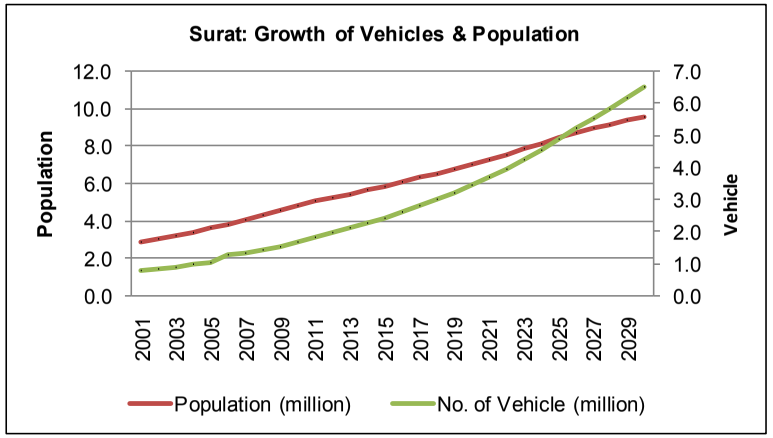
With increasing urbanization and incomes and lack of alternatives, the number of personalized vehicles is likely to increase leading to more traffic on the streets as well as increase in air pollution.
The graph alongside shows the projected number of vehicles using the average growth rate as 3.3% in per capita vehicle ownership (the Per capita vehicle ownership calculated from total no of vehicle (2009-2010)).

Year	Population (Million)	Per capita ownership	Projected Vehicle population
2001	2.9	0.264	7,61,000
2010	4.8	0.352	16,85,386
2020	7.0	0.49	34,41,902
2030	9.6	0.682	65,26,575

Despite continued investments, the present of roads and parking infrastructure, is not sufficient for the escalating number of vehicles. The city planners need to take into explore the feasibility of more robust public transport system to meet the growing challenges of traffic congestions. Moreover, as a long term strategy, scenarios that explore decentralized business districts also needs to be explored. In the event of climate change scenarios such as temperature rise or flooding, there will be an increased challenge of road maintenance costs and reducing lifetimes of infrastructure. The public transport system will have to deal with increase in energy demands, as well as the thermal comfort of passengers. The Surat Municipal Corporation has adopted a City Mobility Plan (CMP) prepared by Centre for Planning and Technology (CEPT), Ahmedabad in 2008. The CMP, which has a perspective for the year 2031, envisages expansion of road network and completion of the gaps in the ring and radial road connectivity, improved connectivity through construction of rail over-bridges, river bridges and flyovers, parking projects and a robust public transport system backed with financial and institutional framework. Building trust on public transport system among the commuters will be critical for ensuring success of this plan.

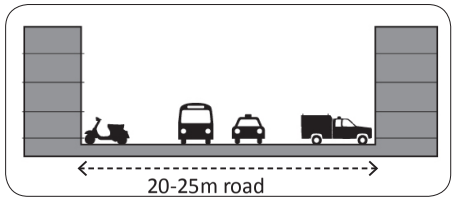
AIR QUALITY

Vehicular pollution accounts for 60-70% of total pollution loads of a city. The main causes are the auto rickshaws and multi axle vehicles. Based on air quality data, Central Pollution Control Board had identified Surat as one of cities which did not satisfy the required standards i.e. more than permissible amount of suspended particulate matter (SPM) recorded within the city (2004-05). Efforts were undertaken by the authorities to convert the auto rickshaws and state transport buses into compressed natural gas (CNG) vehicles. From the recent report of Gujarat Pollution Control Board (GPCB), the move towards CNG has decreased the pollution levels. A quantitative analysis of the same is underway. Even though, the move towards CNG may reduce the SPM, it will not reduce the greenhouse gas contribution.
With increasing vehicles, the air quality is prone to further deterioration (as shown in the Per capita emissions projection for 2040). Combined with increasing temperatures, poor air quality will increase instances of respiratory diseases due to the presence of high suspended particulate matter.



Vehicle growth is projected considering the present growth rate (3.3%) of vehicle wrt to population growth.

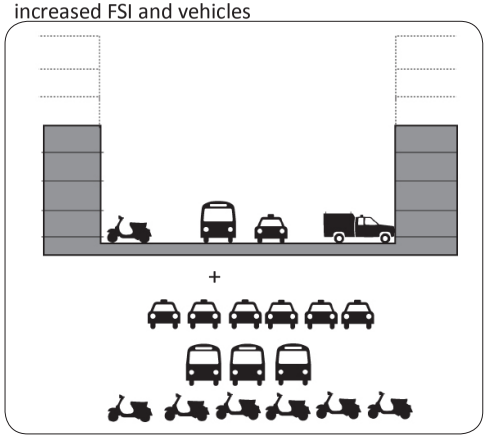
Present condition



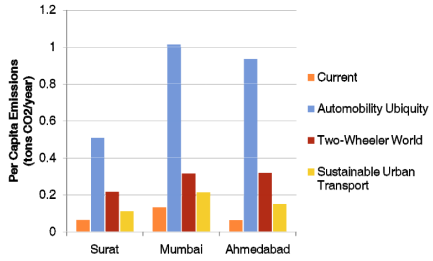
Description	2016	2026
PCTR Excl. Walk	1	1.2
Total Veh. Trips	54 lacs	102 lacs
Public Transport	25%	40%

Source: Surat, Trans -Vision 2030

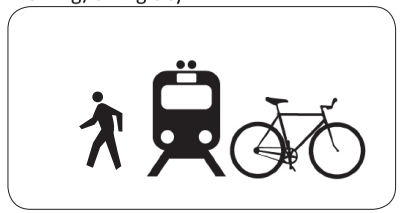
Future Condition- existing infrastructure with increased FSI and vehicles



Per Capita emissions- for 2040



Strategy- Public transportation, walking/biking city



CONTENTS

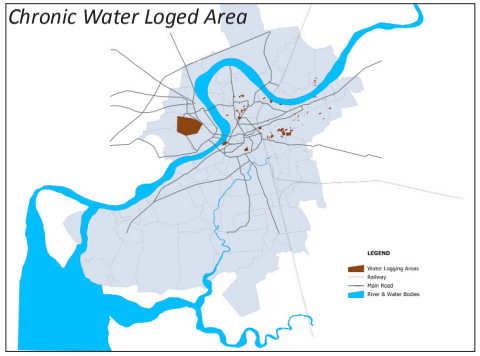
1. PRESENT ISSUES

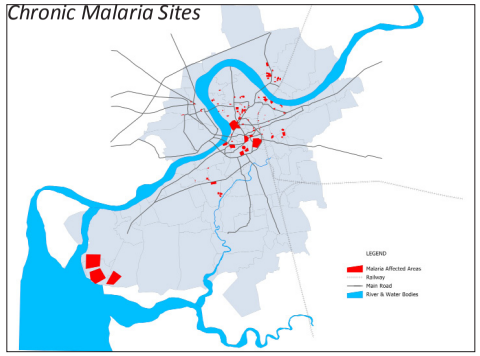
Location, climate, socio demographic structure and developmental activities of Surat city are highly conducive to vector breeding, survival and its efficiency to transmit infections.

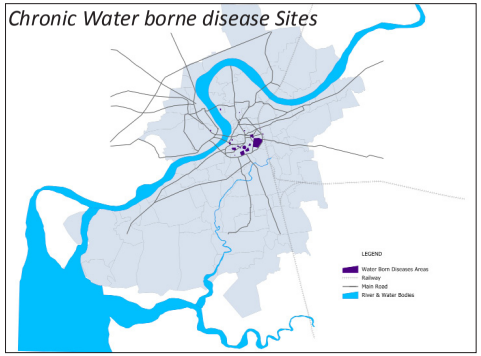
- LOCATION & VECTOR BORNE DISEASES- The position Surat on the river bank and the seashore provides a conducive environment (in terms of temperature and humidity) throughout the year. Moreover, the rise in the number of stagnant water pools has increased the breeding sites available for mosquitoes. Historically, high mosquito infection rate was recorded in sixties. Introduction of underground sewerage system and Multi Drug Therapy (MDT) between 1958-60 brought down the mosquito density as well as infection rate and subsequently city was no more referred to as a Filariasis city. There was a considerable decline in Culex infection rate in 1956 to 1959 as well (from 23% to 5%).
- IMMIGRANT INFECTIONS- The malaria infection rate from 2004-2007 declined from 0.26 to 0.03. A detailed analysis of total infection cases between 1999-2007 reveals that the contribution of cases from Surat city is 9%; the majority who do get infected are migrant workers, especially natives of Orissa (54%) and UP (20%). Thus the infection is imported to the city and mosquitoes prevail with the favorable climate.
- WATER, FLOODS & INFECTIONS- Surat is probably the only city in Gujarat an approximately 90 Km irrigation canal passing through the city, adding to the risk of mosquito breeding. In the last two decades, Anopheles mosquito densities in Surat city have ranged from 0.29 to1.55 per man hour(pmh). The peak of density was observed in 1994 (a flood year). Increase in density was also observed in 1998, 2000, 2002, 2004 and 2006 (all flood years). Even though, Anopheles density in Surat city has remained lower than known critical density (5pmh), the transmission of the disease continues in the city.
- TEMPERATURE, HUMIDITY & INFECTIONS- Since humidity, minimum and maximum temperatures show strong correlation with the slide positivity rate (SPR), the reasons for disease transmission include conducive temperature and humidity, which may aid mosquitoes to efficiently transmit infection at lower density. Further, Dengue cases were identified throughout the years 2007 (a year after flood) and 2008.

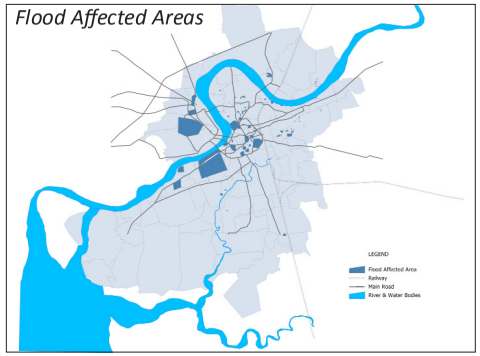
2. POSSIBLE IMPACTS

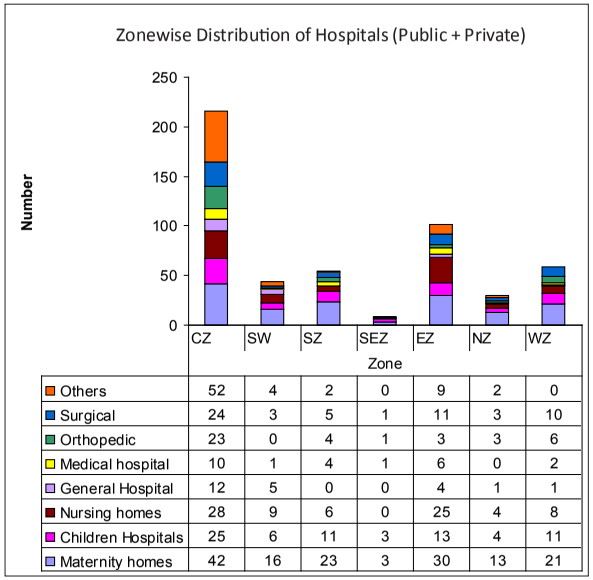
- Impact of Urbanization & Poverty- With increasing urbanization, changing land use, increasing population in combination with inaccessible services such as clean water supply, sewerage and solid waste, there could be an increase in vector borne diseases. It is important for the authorities to continue the work towards providing effective drainage and clean water supply, especially during the monsoons.
- Moreover, since it is the poor immigrants who are most prone to disease, effective treatment facilities as well as infrastructure needs to be provided, to ensure the wellbeing of the residents.
- With increasing urbanization- the trend of increasing instances of diabetes, hypertension, Asthma, could find impetus.
- Impacts of Climate Change- Presently vector borne diseases show a seasonal trend, the understanding of which provides an opportunity of resilient development and preparedness for high disease transmission season. With a changing climatic situation there is a risk of loss of fixed time bound seasonality in addition to impacts on precipitation, temperature and humidity. Such a situation shall lead to unpredictable trend of vector diseases.
- In the event of extreme events such as floods, there is an increasing risk of epidemic outbreaks of communicable disease (proportional to population, density, and degree of displacement). The disruption of pre-existing sanitation services such as piped water and sewage, and the failure to maintain or restore normal public health programs in the immediate post-disaster period further compound the situation. Overcrowding and lack of the basic sanitation increase the threat of outbreaks of gastroenteritis including cholera. Change in climatic condition and overcrowding favor the transmission of Acute Respiratory Infections.
- The delayed threat could include increasing vector borne diseases. Moreover, displacement of Rodents or domesticated animals near human settlements can brings additional risk of zoonotic infections like plague, Leptospirosis. Increase in the possibility of human contact with contaminated slush/mud, water can also increase in the transmission of Leptospirosis. (Health Impact & Adaptation, Urban and Social Health Advocacy and Alliance (USHAA))



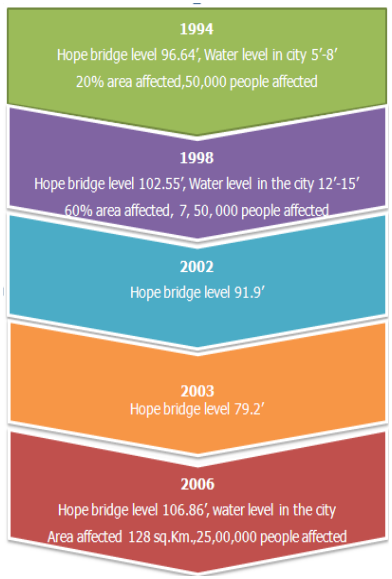








	CZ	SW	SZ	SEZ	EZ	NZ	WZ
Others	52	4	2	0	9	2	0
Surgical	24	3	5	1	11	3	10
Orthopedic	23	0	4	1	3	3	6
Medical hospital	10	1	4	1	6	0	2
General Hospital	12	5	0	0	4	1	1
Nursing homes	28	9	6	0	25	4	8
Children Hospitals	25	6	11	3	13	4	11
Maternity homes	42	16	23	3	30	13	21



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1. CITY GOVERNMENT SETUP

In Surat, there are two main local Governing bodies namely, Surat Municipal Corporation (SMC), Surat Urban Development Authority (SUDA). The Hazira Notified Area Authority, governs the adjoining industrial hub of Hazira. Approximately 326 sq.km of the city comes under the jurisdiction of SMC with an estimated population of 4.5 million (2010). SUDA covers the SMC and an additional peripheral areas totaling 722 sq.km.

The governing structure of SMC consists of both political and administrative wings. The political wing is an elected body of councilors headed by a Mayor. The Commissioner, from the Administrative Services cadre, heads the administrative wing and is responsible for the strategic and operational planning and management of the Corporation. The Elected wing comprises of a general body of elected councilors headed by a Mayor, the Standing Committees and other statutory committees which look after the specialized functions of the SMC.

SUDA is responsible for preparing the Area Development Plan, which includes the area governed by the SMC. Under the development plan, the SMC is responsible for Town Planning schemes within the area under its jurisdiction. SUDA also has the responsibility to control unauthorized developments. Other institutions which have an important stake in the overall development of the city are Gujarat Pollution Control Board (GPCB), Surat Electricity Corporation, Public Works Department (PWD), State Highways Department and State Irrigation Department.

Other City level stakeholders

The South Gujarat Chamber of Commerce and Industry (SGCCI) is among one of the important organizations with a history of almost 67 years. It plays an active role in providing feedback to the state and central governments on policy issues related to trade and industry. It has also taken lead in several city development efforts and has shown its capacity in flood relief and other environmental and social initiatives. Several industrial associations such as the Surat Diamond Association, Surat Textile Trades Association, Pandesra Industrial association are active in management of specific industry related issues. Organizations such as the Surat Citizens Council contribute to building public opinion, while the University, Sardar Vallabhbhai National Institute of technology and Centre of Social studies have taken up valuable studies on different aspects of the city's development.

IMPORTANT INSTITUTIONS IN SURAT

-Surat Municipal Corporation (SMC)
-Surat Urban Development Authority (SUDA)

-The Southern Gujarat Chamber of Commerce and Industries (SGCCI)

-Servajanik Education Society, (SES)
-Center of Social Studies, (CSS)
-Sardar Vallabhbhai, National Institute of Technology (SVNIT)

-Narmada Water Resources Water Supply & Kalpsar Department, (Irrigation Department)

-Torrent Power and DGVCL

2. POSSIBLE IMPACTS

Increase in urbanization will create additional demand on the services of the Municipal Corporation. Sectors that can be mentioned are Water supply, Solid waste, Fire and emergency services, Urban Community development, Slum development etc. The management capacity and the availability of resources will be the critical issue in urban governance. Moreover, the pressure on services will be magnified with the impact of climate change and poverty. The current growth rate in Surat is contributed majorly by the migrant population who come in search of job opportunities, which will add further stress on the demand for housing and other basic services. With the floods risk situation of Surat, the management of flood risk measures will be magnified. Lastly, the impact on the health sector, and the characteristics of vector Borne disease and seasonality will be a critical area which need attention

FUTURE SCENARIOS

The current manpower capacity of SMC is 16,126 staff. With the current population (city area of 326 sq.km.), there are 3.4 SMC staff members per 1000 people.

Scenario 1- represents the SMC staff being constant and the growing population, where the ratio of SMC staff per 1000 population will become 1.8 and 1.3 in 2026 and 2041. In such cases, the development of SMC staff capacity with support of new technology will be of great importance, necessitating a new innovative business model for urban services. The possibility of Public Private Partnerships and the community support services should be explored.

Scenario 2- represents the increase in the SMC strength as well as capacity development. Along with the population growth, the expected growth of the SMC staff from the current strength is of 83% and 158% for the year 2026 and 2041 respectively. However the possibility of expanding the System at this rate and making it sustainable in terms of finance and resources is an area needs to be explored.

FUTURE SCENARIOS

Future Scenarios for SMC strength and Population						
Year	Population (Million)	Scenario 1 (No change)		Scenario 2 (Same ratio as 2010)		
		SMC current staff strength (Nos.)	SMC Staff per 1,000 population	Expected growth in SMC Staff, with currentratio 3.4 per 1000 population	SMC Staff per 1000 population	Expected growth of staff in SMC
2010	4.7	16,126	3.4	16,126	3.4	-
2026	8.7	16,126	1.8	29,540	3.4	0.83
2041	12.3	16,126	1.3	41,615	3.4	1.58

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1. CRITICAL UNCERTAINTIES

As of part of this project and with support from TARU, a series of workshops were conducted to understand the critical uncertainties and possible future Scenarios for Surat. After several deliberations, the city stakeholders identified the economy and social cohesion as the two critical uncertainties that are likely to shape the future of Surat.

Economy: Despite the current strength of Surat's economy, the city stakeholders identified Economic growth as a critical uncertainty. The investments, infrastructure and human capital that is available in Surat could pave way for economic growth in the next two to three decades. But, the city stakeholders strongly felt that the global level processes, economic changes and the rate of inflow of migrant workers required to support the labor intensive industries will influence the city's economic growth trajectory significantly. The results of the discussion led to the conclusion that the globalization of trade including manufacturing, outsourcing of goods and services network has made the economy highly dependent on global factors for growth and stability. External shocks, for example the global downturn like the one in 2008-2009, will have an impact on Surat's economy and growth. The frequency and magnitude of such external shocks is likely to grow with integration of the world. It has to be noted that Surat, over its 8-9 Centuries of history has felt several such shocks and some of them had taken several centuries to recover from. The stakeholders felt that Surat currently has several advantages, which can be eroded by shifting of production centers for textiles and diamonds due to labor and technology changes in other parts of the country/ world. Competition from China, though not strong now, is a matter of concern for some of these industries. (these issues have been brought up in the section on industry).

Social Cohesion: Surat is known for its community spirit, despite a large migrant population. This has been tested time and again, especially during the several disasters for instance during the plague (1996), floods (2002, 2006), bomb attacks (2008) and other challenges faced by the city in last few decades. The SMC, civil society and local industries have worked together to address these issues. The city after each challenge, diligently discusses the issues and explores options to reduce the risks and vulnerabilities. This includes cleaning and widening of roads post-plague situation of 1994, change in rule levels of Ukai dam post- flood 2006, are some of the examples. However, the city stakeholders feel that very high growth of population and in-migration of people with different cultures from across the country is changing the social fabric. Further, the emerging social and cultural differences within the city are reportedly leading to reduction in social cohesion. These are however intangible predictions- further explored in the scenarios explained below.

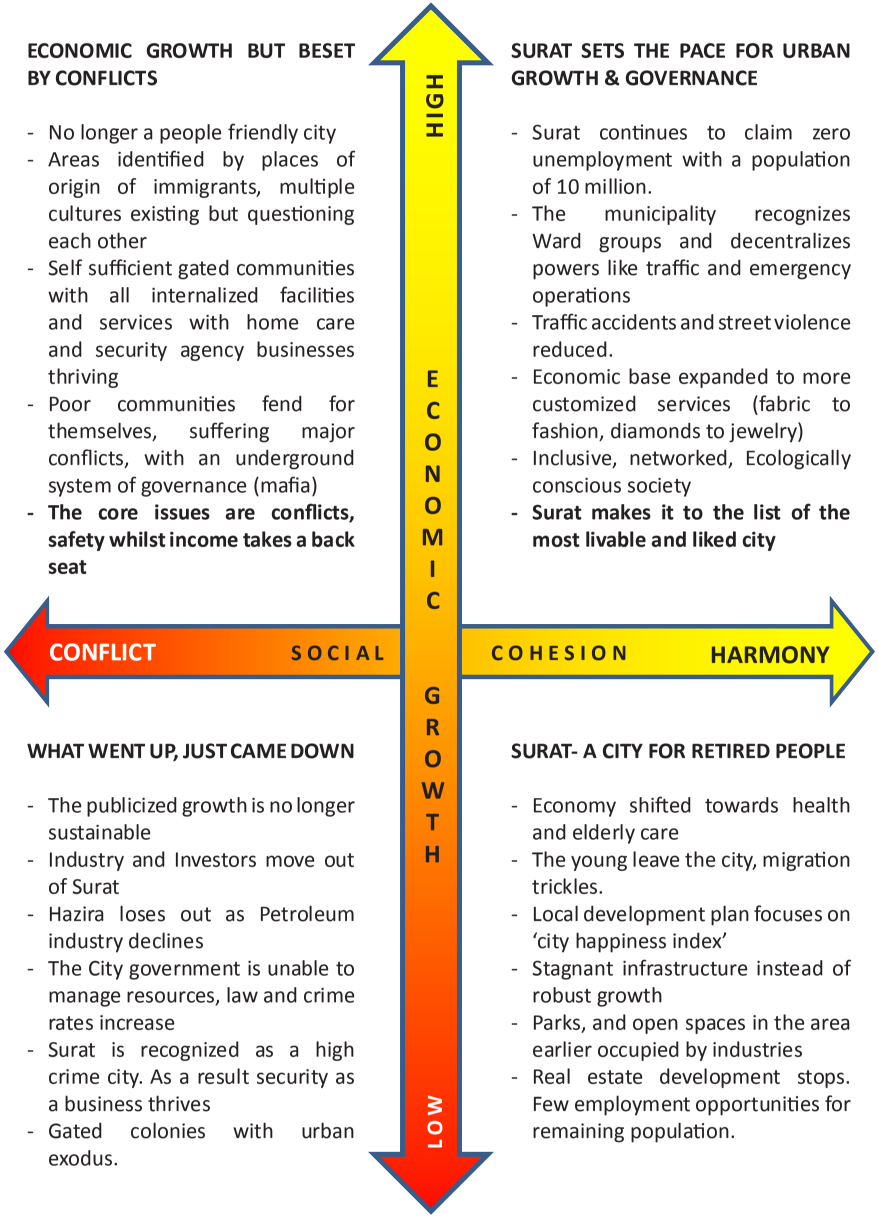
2. SCENARIOS

Based on two critical uncertainties identified by the city stakeholders, four sets of future socio-economic scenarios were developed. These provide a combination of improvement or decay of Social cohesion (X axis) and economy (Y axis). These scenarios reflect 2030-2040 period and are based on the set of certainties and uncertainties identified.

3. IMPACTS OF URBANIZATION, POVERTY AND CLIMATE CHANGE

Each scenario explores changes in the ability of society to deal with the impacts of urbanization, poverty or the extreme events due to climate change. Thus, although with urbanization, migration, the influx of different communities and natural disasters can lead to tears within the social fabric, social cohesion can also be an effective tool, albeit an intangible one, to deal with the more tangible and physical impacts

To ensure that the social system of the city is an asset rather than a problem in extreme events, it is necessary to create a more equitable and harmonious social milieu.



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1. PRESENT ISSUES

The two tables below show the annual electricity consumption in Surat. Over the years, with the growing population, changing lifestyles and industrialization, the electricity consumed has increased substantially. (by almost 16% in three years). Moreover, a sector study shows the break up and increases of electricity consumption in different sectors. The figures reveal that the major consumers of electricity are the industries, followed by residential.

Energy Consumption in Surat

Energy Source	Company	Total Consumption 2007 - 08	Total Consumption 2008 - 09	Total Consumption 2009 -10
Electricity	DGVCL	1,942	2,198	2,387
Electricity	Torrent	3,025	3,157	3,372

Source: GERC, Tariff Order 2009

Sector wise energy consumption

Sector	Total Consumption 2007-08	Total Consumption 2008-09	Total Consumption 2009-10
Residential	819	908	989
Public Utilities	6	7	8
Commercial	523	566	611
Industrial	3,416	3,609	3,861
Railways	55	67	70
Agriculture	127	175	194
Other	21	23	25
Grand Total	4,967	5,355	5,759

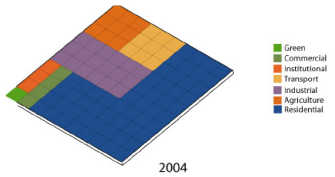
Source: Gujarat Electricity Regulatory Commission, GERC, Tariff Order 2009

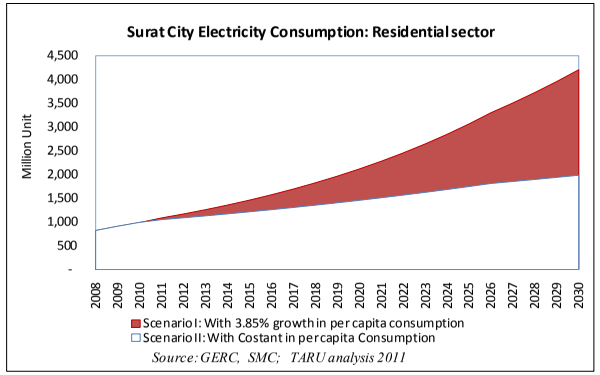
2. POSSIBLE FUTURE SCENARIOS

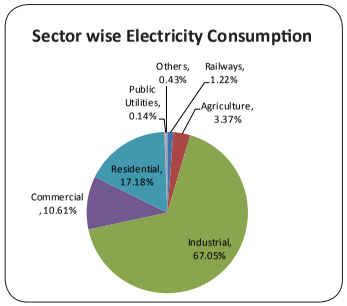
With growing rates of urbanization, industrialization and standards of living, energy requirements will escalate in the years to come. Taking these into consideration- 2 scenarios were created to project future consumption:
Scenario I: Assuming constant Gross per capita consumption (1,203.3 unit) of electricity with projected population.
Scenario II: Assuming growth in Gross per capita consumption (with 1.76%) of electricity with projected population
Surat is the national hub of manufacturing synthetic fabric. It produces more than 40% of the total manmade fabric manufactured in the country. There are around 0.7 million power-looms and 40,000 shops within the city, producing around 25 million meters of processed fabric per day 100,000 m of fabric production requires around 16,000 kwh of electricity, 3500 cum of gas and 1000 KL of water. With the changing climate scenarios, extensive use of resources, especially energy and water, will be a constant challenge. Changing average temperature, precipitation, demographic pattern, lifestyle and role of industries will have an effect not only on the energy demand of Surat but also affect reliability of energy resources i.e. Availability of the city's electricity generation, transmission and distribution infrastructure. Apart from the energy requirement for space cooling, the energy demand will be dominated by the transportation and small scale industrial sector (textiles) and any intervention to increase industrial energy efficiency will necessitate participation of large number of multiple stakeholders.
In Surat, vehicular population has been rising consistently. Recent numbers from Petrol Pump Owners Association (PPOA) suggest that Surat consumes around 25.20 million litres of petrol and 32.40 million litres of diesel annually. As mentioned earlier, with the growth in the number of vehicles at the rate of 10% annually, the demand for fossil fuels is bound to increase. Currently 7% of the vehicles are running in CNG. With the current initiatives and policies, the percentage of CNG vehicles may increase in the future, thereby reducing the Suspended Particulate Matter(SPM), but not the total consumption.

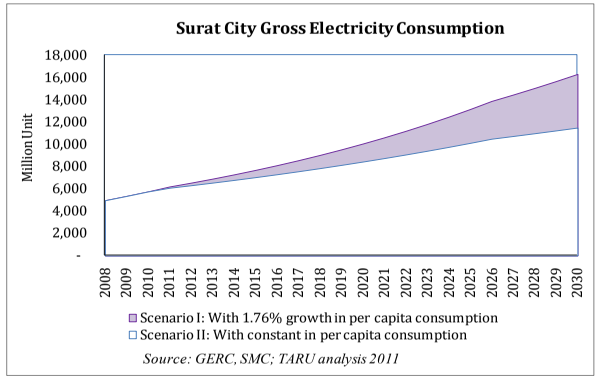
ENERGY TYPE

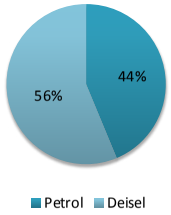
ELECTRICITY	NATURAL GAS	LPG	PETROL	DEISEL	LIGNITE
-Torrent power Ltd -Dakshin Gujrat Vij Company Ltd.	- Gujarat gas Company Ltd	- Indian Oil Corporation Ltd.	-Oil companies	- Oil companies	- Gujarat Mineral development Corporation











Surat City: Gross Electricity consumption

Year	Population (Million)	Scenario I: Gross Electricity Consumption [with constant (1203.3 KWhr) per capita consumption of electricity] MU (MKWhr)	Gross per capita electricity	Scenario II: Gross Electricity Consumption (with 1.76% * annual growth at per capita consumption) MU (MKWhr)
2010	4.8	5,759	1,203	5,759
2020	7.0	8,451	1,433	10,062
2030	9.6	11,515	1,706	16,324

* Observed growht rate in per capita consumption

3. ASSESSMENTS

VULNERABILITIES	CAPACITIES	CONSTRAINTS
Flood	Education Capacity	Regulatory
Drainage & Sewarage	Income Stability	Awareness
Loan & Insurance	Social capacity	

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1. VULNERABILITY ASSESSMENT

City wide Vulnerability was assessed using a GIS assisted vulnerability assessment technique to gain knowledge about current vulnerability of different sections of population across space and socio economic groups. The livelihood Framework developed by DFID was modified for urban context to analyze different aspects of vulnerability. A total of 929 households over 110 settlements across four SECs (this includes mixed settlements with commercial plus middle class) were sampled along with 110 Geopsy samples. The household estimates of GIS based analysis results of main city and immediate neighborhood based on
2004 satellite imagery is provided in the following

1. a. FLOOD VULNERABILITY INDEX (FVI)

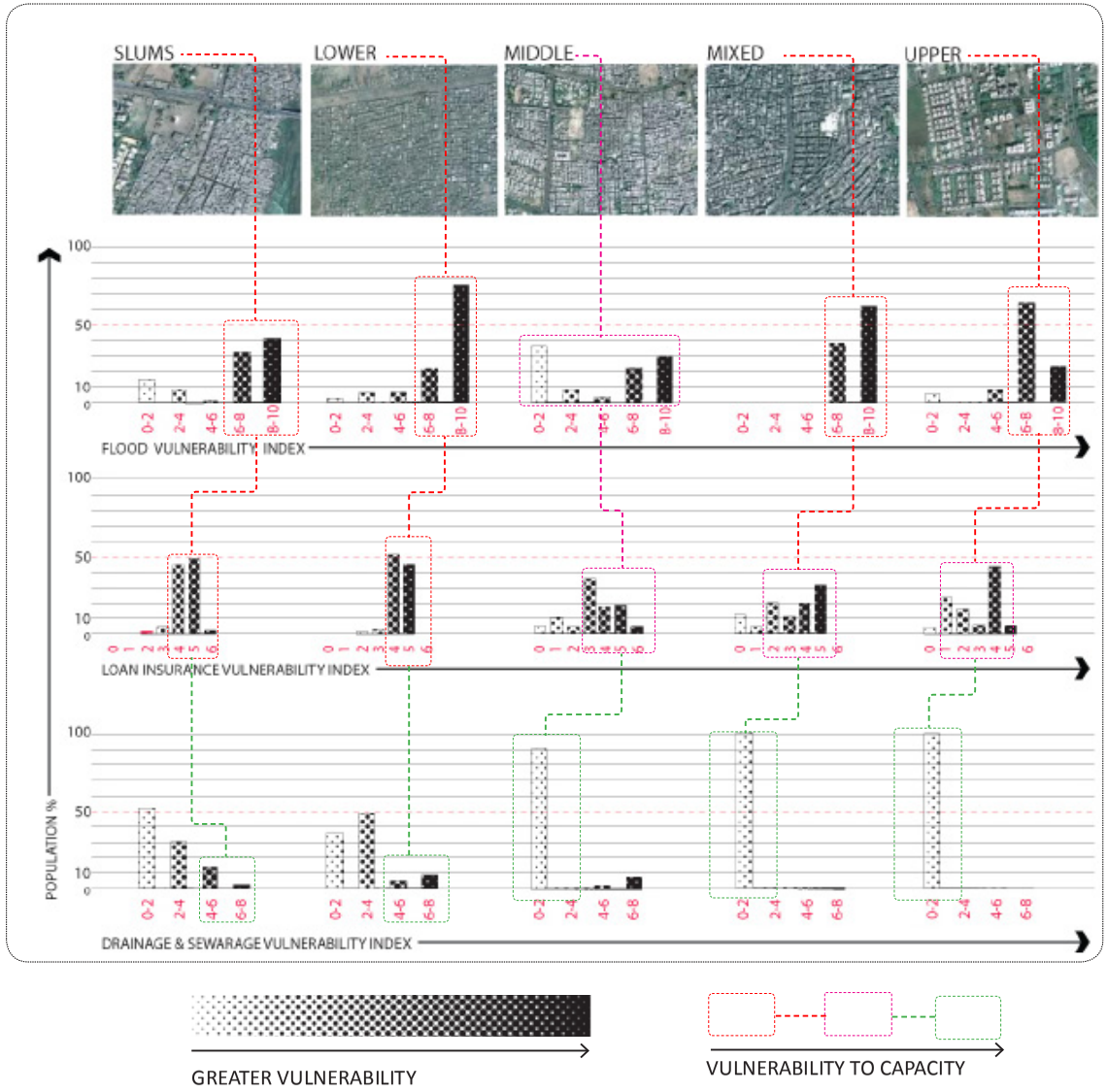
The flood vulnerability index includes damage from floods, depth of inundation and duration of inundation faced by the households. The slums, low income settlements which are located close to the river and middle, upper SEC's (especially ground floor and first floor) residing in the periphery are more vulnerable. The GIS based analysis indicated that about 71,000 households are prone to Khadi flood risks and about 450,000 households are at risk due to emergency release from Ukai dam.

1. b. LOAN & INSURANCE VULNERABILITY INDEX (LVI)

Since Surat is an industrial city dominated by small and medium industries, incidences of loans are expected to be high. The analysis indicates that 68% of the households have loan and insurance vulnerability of less than 5 and the remaining 32 percent lying between 5 and 6. High per capita income and good understanding of risks may be the main reasons for such low vulnerability. Among the poorer SECs, incidence of loan is low but the insurance coverage is also low. Therefore, they still suffer the maximum during disasters and also take longer time to recover.

1.c. DRAINAGE & SEWARAGE VULNERABILITY INDEX DSVI)

Drainage and sewerage networks are extremely important for cities with high population. Surat has nearly 100% coverage of drainage and sewerage, which was, however, reduced due to the recent expansion of the city limits in 2006. The core city has excellent drainage and sewerage system - despite being located in the flood plain in high rainfall environment and the dense pockets of multi-storeyed buildings. The analysis indicates that 85% of the core and 74% of the periphery has a vulnerability index less than 2 indicating very good quality of infrastructure and services.
An efficient solid waste collection was put in place after the plague of 1994, and improved considerably since then, which reduces possibility of clogging of drainage and sewerage network. Monsoon preparations start every year in late April and all drains and sewerage are cleaned to avoid water logging. With the JNNURM projects underway, the sewerage and drainage network are expected to improve further.



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1. CAPACITY ASSESSMENT

Similar to the City wide Vulnerability assessment, a capacity assessment was carried out using GIS. This aimed to showcase the inherent capacities, tangible and intangible that prove to be advantageous during the coping mechanism.

1. a. SOCIAL CAPACITY INDEX (SCI)

The Surat city reflects the pace of Mumbai. In spite of fast paced life, the social cohesion and mutual support is quite high among the Surtis (people of Surat). The social networks are strong among most communities (especially communities from arid and semi-arid zones) from Gujarat. The higher social capacity indices are observed in Middle upper SECs compared to lower and Slum dwellers, which are dominated by diverse immigrant population. The lower SECs show a distinct bimodal distribution (showing two peaks and troughs). This may be due to dominance of Gujarati communities (mainly from Saurashtra), in some of the trades like diamond industries accounting for higher SCI compared to textile workers who are mainly migrants from states as far as Orissa and UP.

Under the continued risks of floods and other hydro-meteorological events, strong social capital is an asset. Therefore strengthening the social capacities especially among migrants will be necessary so that people in lower SECs are able to build resilience through better coordination and mutual support. Unfortunately, the NGO and microfinance coverage is limited in Surat compared to many other cities. Therefore, other avenues to build social capital have to be explored.

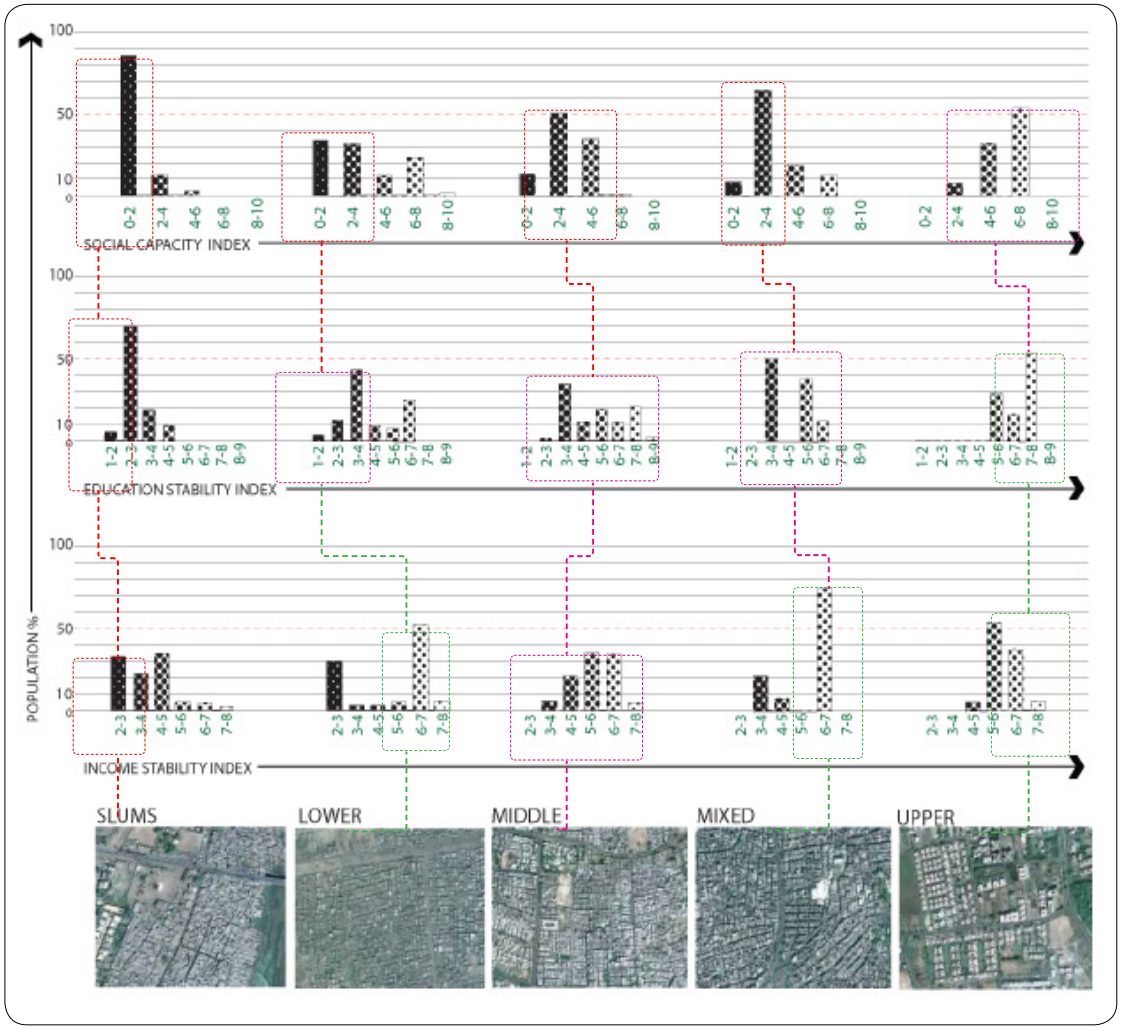
1. b. EDUCATION STABILITY INDEX (ECI)

Low to medium education levels is found to be dominant across the poor and middle class households. The lower income groups and slum dwellers (largely migrant population) show very low education index. The reason being, the types of industries (primarily diamond polishing and textile) in the city demanding medium to high skills, without need for higher education as a pre-requisite. Low education capacity index is one of the major constraints to create awareness and developing effective resilience strategies and their implementation.

1.c. INCOME STABILITY INDEX (ISI)

Surat has one of the highest per capita incomes, and claims to be zero- unemployment city. But, at city level, about one third of the households have income stability index less than 5 indicating need for expansion of skills (to improve the income levels and sense of stability and security). More than three fourths of the poor and slum dwellers are working as semi skilled/ unskilled workers or hawkers/ vendors. The occupational shifts are also common within these people. Among middle class, nearly half are relying on unorganized trade. These people are highly vulnerable to changes in city's economy, disasters or external shocks.

The poor migrants with little job security in organized, unorganized or semi-organized sectors often resort to migration back to their home towns or other cities. This factor can affect the industries. This was evident by the extent of outmigration due the recessions within textile and diamond trade in the recent years. From time to time, the textile industry has been facing labor shortages. The labor availability patterns after the employment guarantee projects (NREGS) in the rural areas across the country also need to be examined. Due to this, in recent years, the industries in Surat were forced to find alternatives for such problems including upgradation in technology and shift to less labor demanding processes. This may lead to relatively jobless growth in the near future and catering to lower income stability index.



GREATER VULNERABILITY

VULNERABILITY TO CAPACITY

DRAINAGE & SEWARAGE I LOAN & INSURANCE I FLOOD VULNERABILITY

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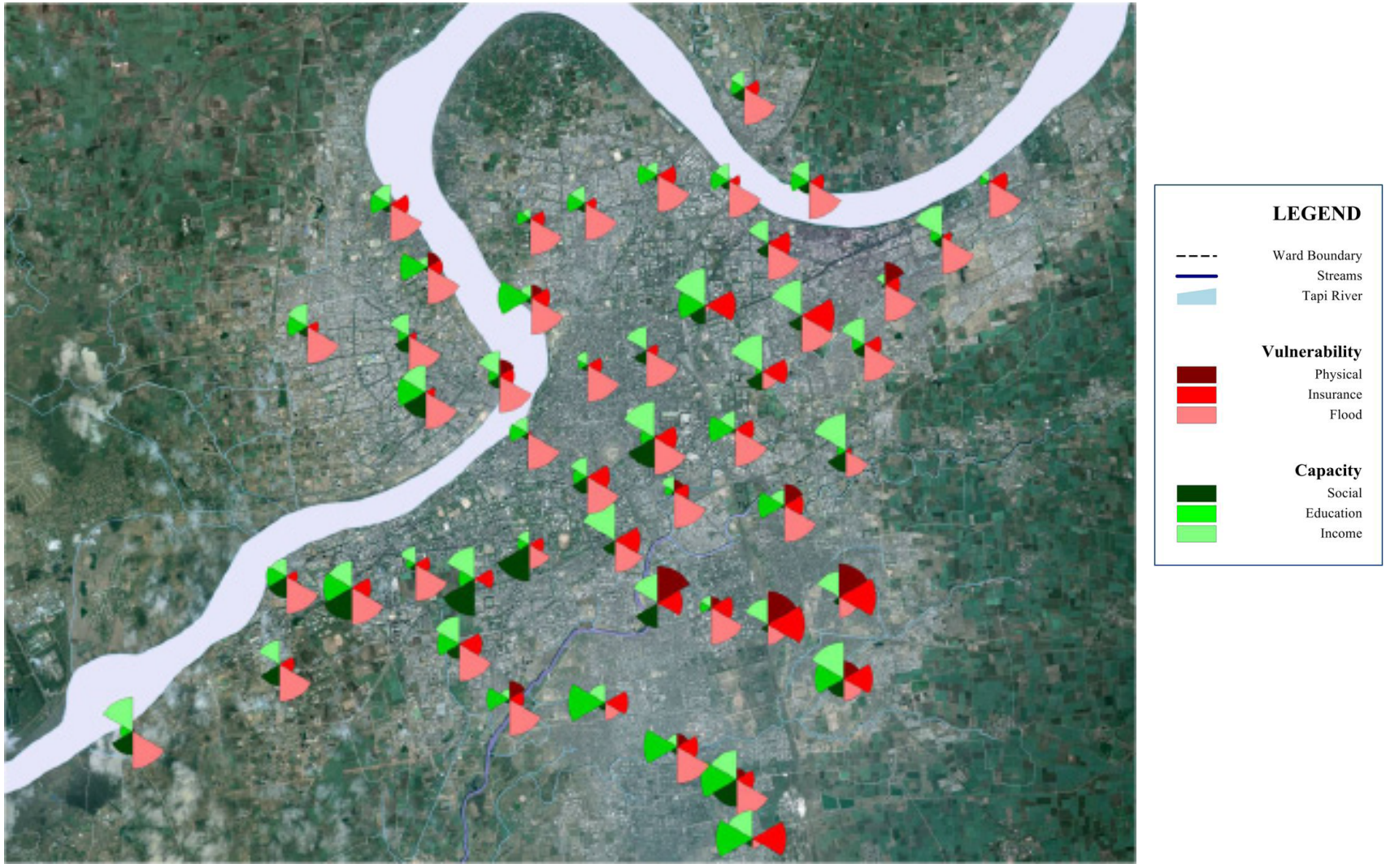
SURAT: Capacity & Vulnerability Index across Sample Settlements



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a. REGULATORY

The city administration is guided by state laws and also the city depends on the state and government funds for most of the infrastructure building. While there is significant devolution of funds, functions and functionaries, the city administration has to depend on resources controlled by the state located beyond its jurisdiction. State government has significant role to play in forming urban development policies and regulations. Also, the city has virtually no control over the river flow, which is managed by State Water resources department (Narmada and water supply and water Resources department). The city also has no control over the city expansion as well as town planning activities beyond its jurisdiction. The urban sprawls along the peripheral areas exerts additional pressure on housing, water supply (through upstream usage, pollution etc.) and transportation networks, these influences are difficult to be regulated by the city administration.

Growth of industrial areas in the neighbourhood, especially Hazira notified area is another constraint. While most of the industries have their own colonies, informal and semiformal labourers depend on Surat City for housing, shopping, recreation and transportation, while it does not contribute towards the city development. Reportedly, the construction and land filling activities in flood plain of the Hazira notified area (HNA) may be the likely cause of increased flood levels due to choking of the Tapi River's mouth. On the other hand, the river water is also allocated for industries in HNA, which constrains the available water for the city residents. The water footprint of the city and HNA overlap and creates competition over limited resources, especially during summers. This is likely to worsen in future and cannot be handled over medium and long term interventions unless regional level planning of water resources, flood control and other services are managed efficiently.

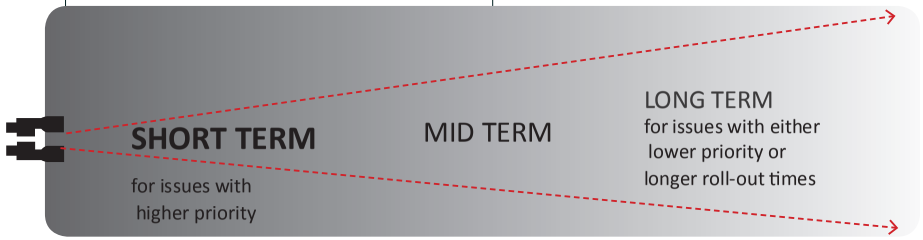
b. AWARENESS

The citizens of Surat are mix of natives called "Surti" who have settled over decades as well as migrants from across the country. More than half the city's population is comprised of migrants with less than 2 deacdes of residence. This mixed population creates a vibrant city with wide range of cultures and habits. A significant section of the recent migrants are from rural background with comparatively less education and skill sets. These also have limited stakes in the city development. Therefore, building awareness about risks and climate change issues is a major challenge.

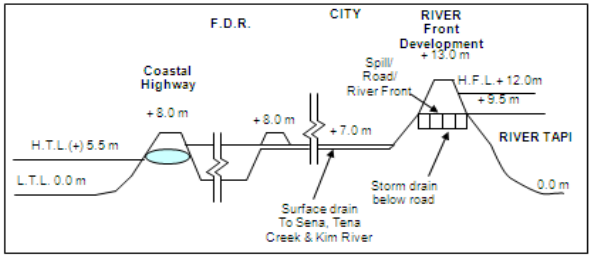
Significant sections of older residents who closely relate to the city are active in its development process. These residents have major stakes in improving the quality of life in the city which are evident by the success of many city level interventions. Surti pride and belongingness is evident from their interest in city's development often accepting sacrifices for the sake of society. Examples include the case of people losing land for road widening and decongestion of the city (post 1994 plague); support for the cleanliness of the city, solid waste management and water supply schemes. On the other hand, traffic congestion across the city shows highly individualistic behaviour driven by competition and pace of the city life.

The Surat's residents are known for prioritising better services over the costs of these services. Changing behaviour patterns will remain a continued challenge with the mix of diverse mind-sets and backgrounds. Concerted efforts are therefore necessary to develop a sense of inclusion and stakes among the population.

4. PRIORITIZED STRATEGIES



IMPACTS	SHORT TERM	MID TERM	LONG TERM
1. WATER 1. A. WATER SUPPLY	**Detailed projections:** Detailed modeling of future demands under various growth scenarios and the assessment of Climate change on resources needs to be carried out **Water Conservation Practices-** -Water Audit Industrial consumers consuming 55 MLD (average) of water are 100% metered. However, domestic consumers are not metered. In the absence of metering, the account of water produced vs. water consumed is not assessed. At the same time, presently, each water works is 100% metered. Thus, water being kept ready for distribution is accounted for entirely. But the quantum of water that reaches the consumer and is being consumed is not known. In order to establish total water account for production and distribution, water audit need to be conducted. Following would be the objectives of water audit: to assess total water produced, to assess water used, losses both physical and non-physical, to identify and priority areas which need immediate attention for control. This water audit will provide sufficiently, accurate area-wise losses to prioritize the area into 3 categories viz. areas that need immediate leak detection and repair, areas that need levels of losses (UFW) to be closely monitored, areas that appear to need no further work now. **-100% metering in water supply** Various consumers like Industrial consumers, institutional, commercial connections are metered. However, domestic consumers are not metered. in order to make these consumers metered, metering policy have been introduced in Year 2008 and it is expected that by the year 2015-16, all consumers shall be metered. **- Save water campaign** This campaign has been introduced in the year 2009 with the intention of sensitizing the citizens of Surat and making them aware of water saving. This will be turned into a continuous exercise. NGOs, Schools, Colleges, and Departments of University shall be engaged / involved for creating awareness, changing attitudes, minimizing wastage at the consumer level and conserving drinking water. **Monitoring Water quality** The health study has pointed out the need for improved linkages between public health surveillance and water quality monitoring. The Hydraulic department has a functioning water quality monitoring system which needs to be linked real-time with the Public health department and its activities. As the city grows, these linkages will be critical. Monitoring of upstream water quality and initiation of a system for real-time remedial actions on to control algal blooms, fish kills and other quality problems. This system will require active participation of Pollution control Board, Irrigation department and SMC. Moreover, a computerized water quality monitoring system covering source to taps including the water utility, citizens and Health department and private medical practitioners is necessary. Different elements of this system exist, but they needs to be integrated in to a single system to provide necessary information to different departments on a near real-time basis.	**Hardening the Water Supply Infrastructure** In order to ensure continuity of water supply in case of eventualities like floods, along with the expansion of the water supply network, the GRID network needs to be strengthened. While dual supply has been provided at all water treatment plant, power supply needs to be enhanced and DG sets installed, to deal with fluctuations or failures. This hardening of infrastructure will be required with climate change and its effects becoming a reality. Waste Water Recycling In Surat, the recycling of tertiary treated domestic waste water project is expected to be commissioned by the Year 2011-12. The project will help in reducing the demand of sweet water in Pandesara Industrial Area, which will be fulfilled through tertiary treated water from Bamroli STP. Likewise, having studied the feasibility of TT water from other STPs, waste water recycling projects shall be implemented. Industrial demand from the existing water supply system will be reduced initially by 40 to 45 Million Liters per Day. Same shall be satisfied through supplying TT water **Review of objective for UKAI Dam** Presently, priority is given to irrigation and electricity generation to the UKAI Dam water discharge. As per National Water policy (MoWR, 2002) the drinking water has highest priority in water allocation followed by irrigation, Hydro Power, Ecology and other uses. This needs to be put into action in later years, if the Tapi continues to be the only source of water.	**Exploring Alternative sources of Water** Tapi being the only reliable source of water, the available water, although adequate for the immediate future, falls short of the required amounts around the year 2015 and onwards, especially during the summer. Alternative sources need to be explored to meet the future needs especially to meet scarcity period demands. Also, during the floods, ground water use is preferred since the sediment load is minimal. Thus, the SMC is investing in the construction of French wells, rain water harvesting to recharge ground water aquifers, distillation, desalination and RO plants, as well as the revival of unused water sources. **Execution of Balloon Barrage** A huge amount of water that is released from the Ukai dam during the monsoon season flows down the river into the Arabian Sea. However, the Surat Municipal Corporation (SMC) has zeroed in on the rubber dam between Singanpore weir and the Magdalla bridge to save this water for generating hydroelectricity, satisfying the water needs of the citizens and the irrigation needs of the farmers. Rubber dam is a new type of hydraulic structure compared with steel sluice gate, and made of rubberized high strength fabric, which forms a rubber bag. The barrage will be filled with air, so that it can be inflated or deflated as per requirement. (Read more: Gujarat's first rubber dam to be built over Tapi – The Times of India http://timesofindia.indiatimes.com/city/surat/Gujarats-first-rubber-dam-to-be-built-over-Tapi/articleshow/6025272. cms#ixzz1BmSOhqmf)



Source: ACCCRN Sector Study: Flood Risk Management, 2010

IMPACTS

1. B. WASTE WATER/ SANITATION

1. C. FLOOD MANAGEMENT

SHORT TERM

Sustaining green networks & industrial use

Hierarchical usage

With the expected growth of population and industries, the city is likely to face water scarcity in the future. Currently the Surface water is the main source of water and there is need for developing strategies for using alternate sources of water including treated waste water. All existing Sewage Treatment Plants are designed and constructed to achieve BOD and S.S of 20 mg/l & 30 mg/l respectively as a final treated sewage quality. Surat city has developed about 101 gardens where the water is required for daily basis. The treated sewage contains high amount of nutrients like Nitrogen & Phosphorus which can be reused for gardening. There is a need for assessing future demand and supply of various qualities of water at city level for developing demand focused end use strategies to meet emerging water scarcity challenges.

End- to- End Early Warning System

Setting up an advance warning system at Ukai dam is an urgent need to protect the people, reduce economic losses and ensure business continuity. This will aid in decision making at the dam site to allow controlled low discharges based on dam capacity and three day forecast of rainfall events in Tapi basin. This will ensure an increased respite time, when faced with high influxes in Ukai dam.

Information & Data management

Meteorological, reservoir management and downstream flood routing models should be regularly updated with the changing environmental parameters including land use, urban development, reservoir conditions, channel profile and exposure.

Intensifying lines of Communication

Surat already has a Ward level disaster management plans in place (City Disaster Management Plan 2010). Efforts have been made to translate this to the community through education, drills and community involvement. However, with the implementation of an early warning system, regular situation and forecast reports will be made available to all decision makers and a multi stakeholder body will take action based on the real-time model results Marking of different levels of floods on service line poles, buildings etc. and linking all advance warning to these levels (E.g. Blue, Yellow, Red levels to indicate low medium and high flood zones can also be explored.

MID TERM

Increasing treatment Capacity

At present, sewage generated is about 545 MLD and the total capacity of sewage treatment plants is 642.5 MLD. The expansions as well as new construction of treatment plants are required to fulfill the treatment capacity of projected value of about 1350 MLD in year 2026.

Separating Combined flows

Storm Water and Sewage should be treated separately which otherwise leads to huge losses in good quality water and an unnecessary load on the treatment units. A program for diversion of sewage from storm drains has been initiated to ensure purity of the river water.

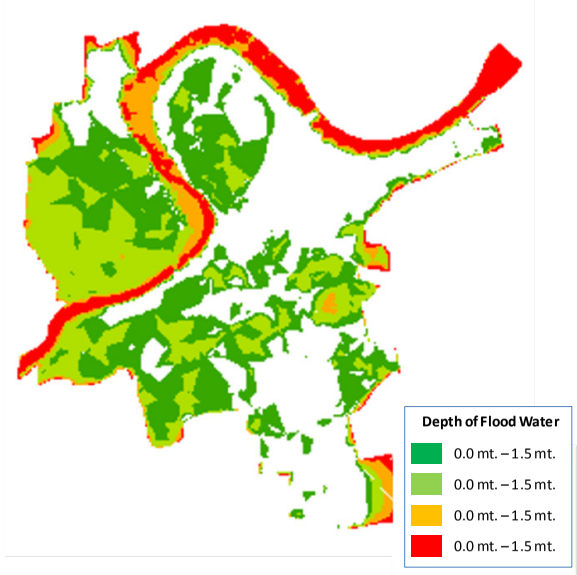
Energy Production

Energy costs of sewage treatment is a major issue in maintenance of STPs. Sewage gas based power production with total capacity of 3.5 MWe has already been commissioned at 4 sewage treatment plants. Energy production by anaerobic degradation of sludge should be

Mapping of flood risk and regulation of construction in flood plains

Detailed flood modeling should aid the identification of flood prone areas. The expansion of the city should be informed by flood risks. Improvements in Land use Policy and building regulations may be necessary to mitigate flood risks.

Flood submergence map of Surat City for flood discharge of 0.4 mc



Source: ACCCRN Sector Study: Flood Risk Management, 2010

LONG TERM

Increasing, Upgrading & Hardening Infrastructure

While the city has a fairly well managed sewerage and solid waste management system, it needs to expand with the growing population. Also the network needs to be hardened to withstand both slow and fast onset changes as well as growing demands on these services. The expected changes in rainfall amount and intensity in Surat is likely to require modifications in design parameters, especially peak flows of storm water drainage. The sea level rise is likely to require changes in outlet levels which are currently above maximum tide levels. The changes in per capita water use may be mostly driven by lifestyle changes, with temperature increase adding on to the increased demands. The capacity of the sewerage system of the inner city needs to be

Diversion of flood water from River Tapi

Provide drains / culverts along the roads, railways, canals so as to spread the depth of flood water to less than 1 m or so in most of the areas wherever drainage is not feasible. The ground water charging can be considered for local low lying areas. An attempt be made to mark and display the predicted flood levels in terms of MSL as 'warning system' and 'no activity zone' of flood plane in display guides for disaster management operations. Planning will include water bodies in district planning and urban planning as well. A Multipurpose detention reservoir be developed for communication, as a source of raw water, as a controller of salinity ingress, as costal wave protection against rising tide, as entertaining centre with water sports etc. with a cost benefit ratio

Balloon Barrage

The proposed balloon barrage project can provide the following benefits:

- Coastal protection against high tide (with Climate Change impact).
- Recharge rainwater to saline GWL of flood plain.
- Provide source of raw water for no-source villages of Choryasi Taluka and Hazira industries
- Provide a water body for recreation, garden along the sea, and to serve the purpose of climate control etc. and
- Spill extra water to sea by Balloon spill way during low tide (HTL 4.5 m low tide 00 at sea).
- The above concept was discussed by Desai and Tailor (2006) and forms part of studies carried out by Agnihotri and Patel (2008a and 2008b).

IMPACTS	SHORT TERM	MID TERM	LONG TERM
2. LANDUSE & PLANNING 	**Green building & inducing sustainable thermal comfort** For the development of areas the bylaws to incorporate measure towards 'green' of ecologically efficient buildings. The drainage lines should have a dual pipe system so that soiled waste water can be reused for flushing, gardening or other reuse purposes with minor treatments at site. Rain Water Harvesting system in all large new buildings are being implemented. An annual review system to maintain effectiveness of such RWH structures needs to be put in place. Also, feasibility of using these storages as a standby before the water crisis period also needs to be explored. **Water bodies and the urban environment** Water bodies improve the general environment and livability of the city. Moreover, they create good micro climatic conditions and make for excellent public spaces. Existing water bodies can be conserved and developed. In addition, SMC should undertake development programs like reclamation of Tapi bank. Water bodies are being developed as eco-zones for entertainment. Eco-education for youth can be made a part of these projects. Since Surat is Malaria endemic area, ecological vector control measures should be should be integrated in design and management of these structures.	**Density & open space, green belts** The heart of the city is very congested and needs some amount of open area. Planners should incorporate green networks within congested neighborhoods, extensive green lungs within intermediate areas and green belts in the peripheral areas of the city. **Residential density** Instead of horizontal spreading of the residential areas, vertical increase should be promoted which can give more movement and green area. However, this would necessitate changes in land use policy and regulations. The planning of such areas should integrate infrastructure and services as well as address concerns of mobility and livability. Essentially, a healthy residential development should be encouraged, so as to avoid extremely congested neighborhoods amidst of gated suburban enclaves.	**Decentralization** New or developing areas can have decentralized treatment units and incentives can be allotted to such units that reduce the load to STP's. Moreover decentralized growth would also allow for better allocation of infrastructures and resources and alleviate traffic conditions. **Slum free city** There are about 406 slums in the city accommodating a population of about 0.6 million for whom up gradation schemes which have been initiated by SMC. These programs can be strengthened & promoted and an action plan activated be made towards slum free city. **Future Development** Appropriate modifications to DCR to encourage transit oriented development are necessary. They would include higher FSI along transit corridors and developing nodes at appropriate locations.
3. SOLID WASTE 	**Continuous Monitoring** The existing network of solid waste management has proved to be extremely efficient. However, continuous monitoring of the facility needs to be continued for sustained success. **Awareness** The solid waste management is currently working satisfactorily, but hygiene practices in handling and disposal need further improvement. With increasing temperatures under climate change scenarios, the decomposition rate of degradable materials is likely to increase and would require timely handling and disposal.	**Waste Segregation** Waste Segregation at source should be promoted which can help in segregating much of reusable and recyclable waste further reducing the load on disposal facilities with increasing shortage in available land. Incentives should be given for those units following the norms and penalties for the ones disobeying them. Awareness generation at household/community level should be undertaken.	**Decentralized Solid Waste** Decentralized Solid Waste processing system can be adopted into the developing areas which can lead to reduction into the municipal solid waste management system. For e.g. large hotels and Canteens can adopt either decentralized composting system or anaerobic degradation and biogas generation system.
4. TRANSPORT 	**Peak hour Traffic management** Traffic management should be made more efficient, especially during peak morning & evening rush hours. A good traffic information system along with staggered timings across industries may be tested and implemented. Promoting car pools Vehicle pooling should be promoted by giving some incentives at work-places reducing fuel usage and air pollution. **Public Transport** Surat is implementing a Bus Rapid transport system. However, parking is an issue along the route stops. The BRTS needs to be integrated with Para-transit system so that origin to destination solutions are available to commuters without having to use private vehicles. Issues like punctuality, comfort and security should be addressed to build trust on public transport system. The current para-transit system will require major revamping and shifting from solely autorikshaw based system to a mix of autorikshaw and small four wheelers running on shared taxi as well as route based system. It will be a major challenge considering the taxi and autorikshaw unions. Awareness generation as well as piloting will be required with active involvement of BRTS and other public transport systems.	**Controlling personal vehicles** The number of cars on the roads can be controlled by introducing a taxation system or other alternatives - as used in cities like London and Singapore. This would require building of trust on public transport system, before introduction of these disincentives. Investing in Public transport Absence of public transport has meant the escalation in Autorikshaws and personal vehicles. These will lead to over- loading of essential infrastructure, pollution and traffic. The Gujarat Infrastructure development board is investing in studies relating to public transport like the 'Integrated Public Transport System (IPTS) Studies'. (for more see: http://www.gidb.org/cms.aspx?content_id=271) **Preventing encroachments** The margins of major roads and the footpaths are encroached upon in several sections for a variety of purposes including informal activities as well as for day parking. Building regulations have to include provision of internal parking in all industrial and commercial buildings. The new regulations should integrate both flood mitigation as well as parking issues for commercial and industrial properties.	

IMPACTS	SHORT TERM	MID TERM	LONG TERM
5. PUBLIC HEALTH 	**Improving Surveillance system** Improving the surveillance system and near-real time Management information systems and improving linkage with Hydraulics and sanitation departments needs urgent attention. Moreover, vector borne diseases are complex issues that need to be understood better with ongoing research and surveillance systems. For instance: The Urban Service Monitoring System (UrSMS) project was developed for improving the monitoring and grievance redressal for health, water supply, sewerage and solid waste services. (for more see: http://surat.ursms.net/cms/home.aspx). All water bodies should integrate ecological/biological vector control systems so that proliferation of mosquitoes is minimized. Surat has one of the largest network of canals passing through the city. These also should be regularly monitored for mosquito breeding in their neighborhoods. Awareness IEC activities to ensure citizens awareness and involvement in disease	**Anticipate problems** Focused research to anticipate possible impacts due to climate change and urban growth. Also all water storage structures(natural and manmade) should incorporate either biological control measures or screening system to prevent breeding of mosquitoes. Increasing the distance between animals and human habitat as well as implementation of city wide rodent control measures will be necessary to reduce the risk of zoonotic infections like plague, Leptospirosis. Improving Sanitation at the wet markets and food stalls will be another issue that needs sustained interventions Given a significant population of households depending on dairying within the city now, it would be a challenge. Systematic efforts towards reduction of domestic animals within the city over medium term can reduce traffic, sewerage and solid waste management to some extent. Education, skill building and alternative employment generation programmes will be necessary over medium term to address these issues. **Infrastructure for weaker sections** Incorporating the ventilation and other passive cooling systems in Weaker section housing programmes. Surat has an efficient Community development department, which can be used to generate awareness about sanitation and health linkages. The current programme of EWS housing is also supported with awareness generation of better sanitation to new residents, which can be further strengthened and extended until the new residents are able to appreciate and maintain healthy surroundings.	**Indoor Thermal comfort** Increased temperature will have an impact on human health and efficiency. While the heat stroke related morbidity and mortality is currently rare in Surat, it may increase and impact vulnerable population including infants, old aged people and poor who live in houses with low ventilation and couldn't afford space cooling costs. Development of options for more affordable thermally comfortable houses with passive cooling and mainstreaming them among the builders, prospective buyers is necessary. The government buildings and schools may be retrofitted with some of the features and a demonstration/support center may be created within Town Planning department to promote these.
6. SOCIAL COHESION/ EQUITY 	**Developing local level agencies** Build, strengthen and empower citizens local level groups in managing their areas and services. **Awareness & community dialogue** Awareness generation, forming issue based groups for community action on managing local assets and address issues.	**Image and Conflict resolution** Managing the Surti social image through local groups and positive action . Preventive action on conflicts.	**Educate** Given the geographic and social context of Surat(nearness to Mumbai, Mumbai- Delhi transport corridor, improving trade links within the country and overseas, increasing wages, competition from emerging textile industrial clusters), it's livelihood profile can potentially change through a shift over long term from industry dominant economy to a service sector base economy. This transformation needs to be managed effectively through improvement of education and maintaining social harmony to face the change along with city growth. Education can create awareness on the advantages of a socially resilient society. Qualities such as equality and openness can be cultivated early on to ensure that the city remains vibrant, in spite of continued pull migration
7. INSTITUTIONAL FRAMEWORK 	**Developing Staff skills** **New technology** New Technologies that can make systems work more efficiently and in cost effective ways should be made an integral part of the SMC's and SUDA's Plans. The potential technologies will include mechanization of maintenance of infrastructure and services, use of IT for governance and also management of lifeline services etc. SMC has already initiated several interventions in this direction including setting up of an IT department, e and m governance initiatives etc. **Active community participation** SMC has built a effective community development department, which caters to many needs of poor and has established trust among them. More proactive measures can be taken to involve other communities in resource conservation and disaster management programs.	**Innovative working model such as PP model, intervention of private sectors** Public Private Partnerships need to be supported for faster turn-over in infrastructural projects. **New policies and governing mechanism** Policies need to be analyzed and refurbished depending on current situations.	

IMPACTS	SHORT TERM	MID TERM	LONG TERM
8. ENERGY 	**Demand Side Management** The Government of India has enacted Energy Conservation Act 2001 to promote energy saving as one of its mission. The energy demand side management is to guide consumers on energy saving with use of energy efficient appliance and guide manufacturers and consumers on appliance quality with improved life cycle operation. Investigation of mechanisms that would help finance demand side management programmes in all sectors by capturing future energy savings. There is a need for programmes to incentivize energy conservation across various scales and activities starting from households to organization levels. These incentives should include issues of energy saving practices indoors as well for mobility and other uses.	Shift to energy efficient appliances in designated sectors through innovative measures and re-engineering to make the products more afford- able. Better technologies in illumination, transportation and conservation of power. New generation of lighting equipment, inverters as well as e-bikes and cars can certainly help in meeting the routine requirements with much less power than what is consumed in the present times.	Management of reactive power in the distribution network has to be initiated. Greater use of renewal sources of energy viz., Wind, Solar, Bio and Sea waves could lead to much needed improvement. Surat has already installed sludge based energy generation as well as on wind power. The share of renewal energy needs to be increased so that the energy demands of essential services can be mostly met by the alternate sources, eventhough technologies are currently priced high.
	Energy Infrastructure Review of safety factors of infrastructure for all installations in the climate risk prone areas is needed and augmented.	‘Climate Proofing’ infrastructure is necessary to ensure supply of energy in times of floods, Higher temperature and Higher Precipitation in Surat. For this purpose, Climate proofing of the off-city installations is also essential. Climate risk screening of of all energy infrastrcture is necessary, which should include risks on inputs (water, wind, actual infrastructure(including generation, transmission and distribution infrastructure), as well as peak demands under extreme weather conditions.	Uses of solar energy and wind energy, which is less than 2% currently, at the Industrial Installation and important building have to be promoted Role of the Gujarat Energy Regulatory Commission (GERC) is very crucial in bringing about policies and changes in regulation, which will further enhance the renewable energy development in the country.
	Future Indicative Energy Measures at Surat Solar energy use should be encouraged for all establishments with floor area of more than 300 sqm. Adoption of Load Management Technique. Tariff restructuring and improved metering arrangement to minimize power thefts/losses Incentivising energy savings and use of energy efficient gadgets. Public awareness, capacity building and training.	ECBC compliant buildings with green building architecture are being encouraged. Though the scheme is voluntary, awareness is being increased through continuous outreach programmes. Solar energy should be encouraged for all establishments with floor area of more than 300 sqm and Solar Panels for public advertising, lighting in open areas, public utilities, streets, etc. Mandatory emergency captive power supply arrangements manage power cuts for medium and large enterprises and multi storied buildings Interim solutions of single point connection in unauthorized colonies and slums. Private Sector Participation in different stages of Power generation, transmission and distribution.	

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About the Rockefeller Foundation

The Rockefeller Foundation was established in 1913 by John D. Rockefeller, Sr., to "promote the well-being" of humanity by addressing the root causes of serious problems. The Foundation supports work around the world to expand opportunities for poor or vulnerable people and to help ensure that globalization's benefits are more widely shared. The Rockefeller Foundation believes that there is a current opportunity to catalyze attention, funding, and action in building climate change resilience globally. The goal of the Climate Change Resilience Initiative is to build resilience to climate change risks for poor and vulnerable people, especially through targeted investments in developing, demonstrating and replicating resilience strategies, and through leveraging policy opportunities to support and fund resilience building measures.

About the Asian Cities Climate Change Resilience Network

The Asia region is the strategic geographic focus for the Foundation's urban climate change resilience work. More than 60 percent of the increase in the world's urban population in the next 30 years will occur in Asia, the continent with the largest urban population, and the largest population at risk to climate related impacts. Decisions made in cities today will either amplify climate change impacts or reduce them, and thus there is a narrowing window of opportunity to ensure that the cities of tomorrow are developed in a climate resilient manner. Addressing urban growth and climate trends in tandem in the Asia region provides the opportunity to create urban resilience strategies that will benefit the largest urban population of the world, and will develop models that can be exported to other regions. Through the development of the Asian Cities Climate Change Resilience Network, the Rockefeller Foundation works with city governments, academic centers, non- profits and the private sector to collectively improve the ability of the cities to withstand, prepare for, and recover from the projected impacts of climate change. Cities will develop a replicable model to assess climate risks, assess vulnerabilities, identify, prioritize and implement resilience building measures. These interventions will span health, infrastructure, water, disaster, urban planning/development issues, and will include leveraging policy incentives and investment funds to improve infrastructure, services, disaster management and preparedness strategies.

Asian Cities Climate Change Resilience Network

Surat Municipal Corporation

The Southern Gujarat Chamber of Commerce & Industry

ISET

TARU Leading Edge