# FLOOD WATER AS SOURCE FOR URBAN WATER: A STUDY FOR SURAT, SOUTH GUJARAT, INDIA.

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**ABSTRACT**

*About one-fifth of the world's population lacks access to safe drinking water and with the present consumption patterns; two out of every three persons on the earth would live in water stressed conditions by 2025. Water scarcity is serious problem throughout the world. Nearly 44 million people in India are affected by water quality problems either due to pollution, prevalence of fluoride, arsenic, and iron deposits in groundwater or saline water intrusion in coastal areas. On the other side the floods are creating damages of thousands of crores and human lives. Surat one of the fastest growing cities in South Gujarat region of India has major sources of water as river Tapti. The same river creates critical condition for city during floods. The city has suffered a lot during the past floods of river Tapti. These flood water can be detained in reservoir and can be utilised as source for drinking or other day to day uses. The city has problems of khar land (saline land on the sea shore) which is increasing due to climate change. These khar land use is proposed for creating flood detestation reservoir combined with multi purpose development – coastal highway, holiday resort, disaster management of gas pipeline based industrial belt and source of water for no source villages etc. It can be economically viable now.*
***Key Words***
*Urban water demand, water scarcity, flood water utilisation, Flood Detention Reservoir*

## 1.0 INTRODUCTION

Life and living objects survive and bloom depending on sustainable supply of good quality water in adequate quantity. All activities from Puja to eternity are linked with water. Puja, hospitality, industry, environment, life, construction and destruction activities are linked with water. Fig. 1 shows the chart for water needs of living beings on earth.

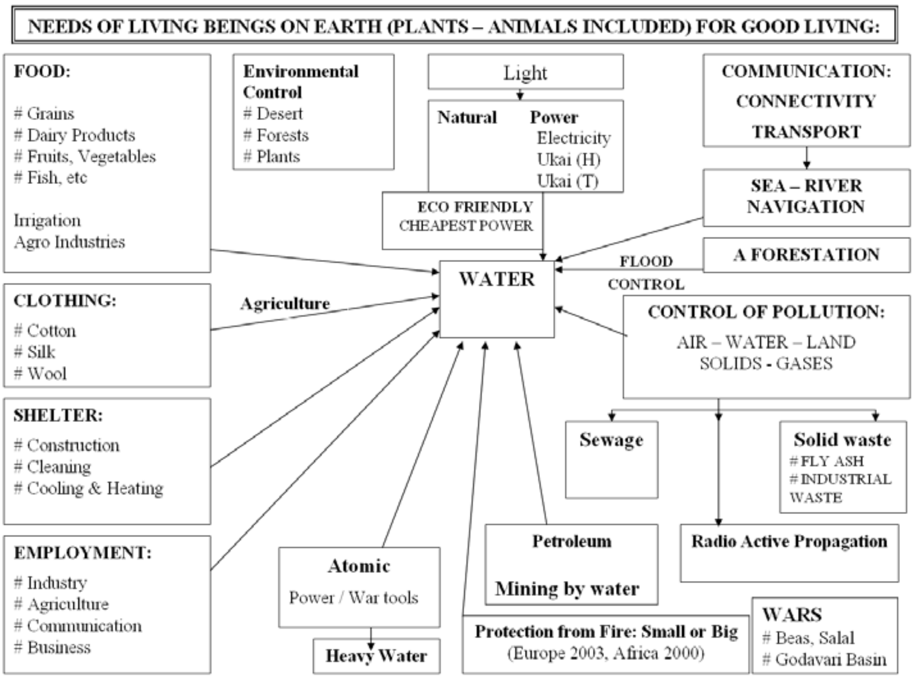


Fig. 1: Chart showing needs of water for good living on earth.

About one-fifth of the world's population lacks access to safe drinking water and with the present consumption patterns; two out of every three persons on the earth would live in water stressed conditions by 2025. [1] Water scarcity is serious problem throughout the world. Nearly 44 million people in India are affected by water quality problems either due to pollution, prevalence of fluoride, arsenic, and iron deposits in groundwater or saline water intrusion in coastal areas. [2]

Every urban growth is directly linked with (a) Water Resources (Quantity), (b) Quality of Water available, (c) Drainage of Storm Water, (d) Management of Water Resources – Conservation, Recycling, Control of Salinity ingress in Coastal Areas. In recent scenario almost all major Urban Centers, Cities have no adequate source. United Nations General Assembly had declared the International Decade for Action: "Water for Life" 2005-2015 as per resolution no: resolution A/RES/58/217 in December 2003. [3] The decade officially started on World Water Day, March 22, 2005. "The primary goal of the UN International Decade for Action: Water for Life 2005-2015 is to promote efforts to fulfill international commitments made on water and water-related issues by 2015. The 10-year period is critical. It is time to intensify advocacy efforts and action on the ground"

The rapid urbanization had played high role in climate change. Impact of climate change manifest in the changed rainfall pattern creating flood all over the world. The floods are creating damages of thousands of crores and human lives. Surat one of the fastest growing cities in South Gujarat region of India has major sources of water as river Tapti. The same river creates critical condition for city during floods. The city has suffered a lot during the past floods of river Tapti. These flood water which is non saline can be stored in reservoir and can be utilized for the drinking or other day to day uses. The city has problems of khar land (saline land on the sea shore) which increasing due to climate change. These unutilized khar land are proposed for creating Flood Detestation Reservoir (FDR). The khar land then will be performed as land for various developments. The integrated proposal planned to utilize the available flood water through flood detention reservoir along with river front development, coastal line protection and other urban infrastructure planning for the city of Surat. Finally the conclusions are derived based on the proposal for water secure urban center.

## 2.0 GLOBAL WATER SOURCE

Good water is essential but scares commodity with zero growth (or decreasing with increasing pollution and intrusion of salinity in ground water over coastal belt) is hardly 2 cubic meter in every 1000 cubic meter of available resources. The cycle of generation of fresh water – Hydrological Cycle on earth is shown in Fig. 2.

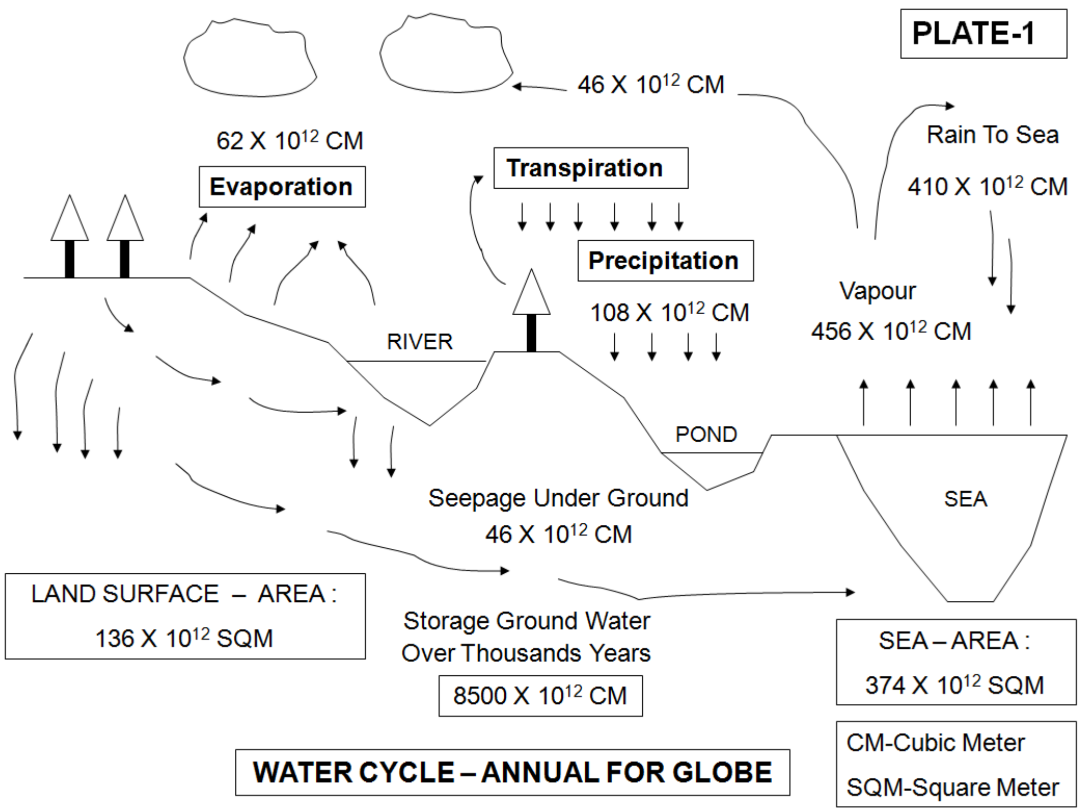


Fig. 2: Plate showing Water Cycle for Globe.

The fresh water on surface is getting polluted by living processes. The millions of years seepage water stored under ground is depleted by use in areas of scarcity. The lowering of ground water by tube wells in coastal belt increases the intrusion of seawater. Thus both surface and ground water are expected to decrease in future. Fig. 3 illustrates the process of sea water intrusion.

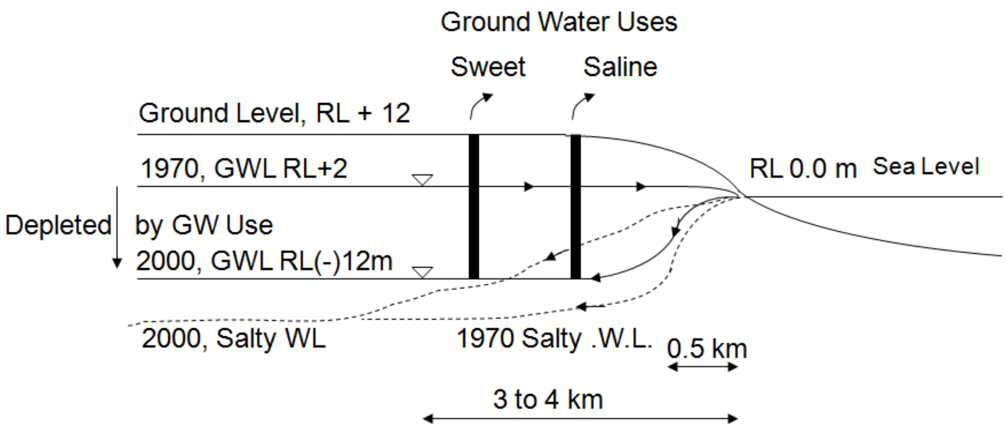


Fig. 3: Sketch showing process of sea water intrusion.

## 2.1 SWEET WATER RESOURCES OF EARTH

Till today no planet with water source has been traced. Huisman (1890) [4] estimated source, which is expected to decrease with years is shown in Table – 1 below.

Table – 1: Water source as estimated by Huisman [4].

| Sl. No. | Source | Quantity in $10^5$ (Lakh)CM | % of Total Water availability |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | Oceans | 1330 | 97.00 |
| 2 | Glaciers Polar Ice | 29 | 2.12 |
| 3 | Ground Water | 8.4 | 0.61 |
| 4 | Surface Water - Ponds, Rivers | 0.13 | 0.01 |
| 5 | Atmosphere Biosphere | - | Negligible |

Available water for drinking is only 6 cubic meter of 1000 cubic meter. Some of this is not assessable by human settlements. Hence the available assessable drinking source could be placed at 2 cubic meters for every 1000 cubic meter.

**2.2 NORMS OF WHO**

Following are the norms for water supply by WHO for overall Global Consideration.

| | **Quantity in CM / Year / Head** |
|---|---|
| Minimum Supply | 2000 |
| Tolerable Supply | 1700 |
| Scarce Supply | 1200 |

These norms will vary from country to country based on climate, growth rate of population, industry, pollution etc. Hence it is used to predict future trends only. The needs for irrigation, pollution control, construction etc per head is included in above quantity.

**2.3 HUMAN NEEDS OF WATER**

On an average, the domestic consumption under normal condition in an Indian city as per IS: 1172-1993 [5] is shown in Table – 2. It shows the activity wise breakup of the standard water requirement as per standard.

Table – 2: Domestic water consumption in an Indian city

| **Activity** | **Quantity in (L / Head / Day)** |
|---|---|
| Drinking & Cooking | 10 |
| Bathing | 55 |
| Washing - Cloths & Urinals | 30 |
| Other Cleaning | 10 |
| Flushing Toilets | 30 |

**2.4 INDUSTRIAL NEEDS**

The water demand by various industries depends on processes. The general breakup for some of the important industries is shown below.

- Textile industry requires 100 Kilo Ltr / tone of textile material handled.
- Paper industry requires 400 - 500 Kilo Ltr of water / tone of product.
- Fertilizer industry – 200 Kilo Ltr / tone

For Industrial Cities, Ultimate per capita water requirement may be as high as 450 L / Head / Day as compared to normal requirement of 50 L / Head / Day.

**3.0 URBANIZATION AND ITS IMPACT ON WATER SOURCES**

The world-bank report 2010 [6] shows that about 51 % of total population living in urban areas and the rapid industrialization boosting the process of urbanization. For the year 2011 the objective of World Water Day [7] is to focus international attention on the impact of rapid urban population growth, industrialization and uncertainties caused by climate change, conflicts and natural disasters on urban water systems. The narrations from documents are “This is the first time in human history that most of the world's population lives in cities: 3.3 billion people and the urban landscape continues to grow. 38% of the growth is represented by expanding slums, while the city populations are increasing faster than city infrastructure can adapt. This year theme, *Water for cities: responding to the urban challenge*, aims to spotlight and encourage governments, organizations, communities, and individuals to actively engage in addressing the challenges of urban water management.”

### 3.1 AVAILABLE WATER RESOURCES IN FUTURE -PROJECTIONS FOR GLOBE

Though fresh water under ground is estimated as $8500 \times 10^{12}$ cubic meter, the renewable source of water is only $46 \times 10^{12}$ cubic meter.

### 3.2 GLOBAL PROJECTIONS OF NEEDS & SUPPLY

Table – 3 shows the water resources scenario for globe. The scarcity supply will grow over years from 2000 and overall reach critical state by 2050. This period will, in each country may vary but trend is definite.

Table – 3: Projections of needs and supply for Globe

| Year | 1950 | 2000 | 2050 |
|---|---|---|---|
| Population x $10^7$ (Crores) | 300 | 600 | 900 |
| Available resources of water (CM / Year / Head) | 3000 | 1650 | 1000 |
| Minimum Desirable WHO (CM / Year / Head) | 2000 | 2000 | 2000 |

### 3.3 CONFIRMATIONS OF WATER SCARCITY FORECASTS

Some recent surveys have shown:

1. About 100 crore (1 billion) people have no drinking water.
2. 280 crore people (2.8 billion) are waiting for water supply for sanitation.
3. 25 crores suffer water born diseases.

Similarly the trend in India confirmed by flowing observations,

1. Increasing repeated scarcity of water in many parts of country.
2. The free drinking water supply is pre 1970 history. The price of litre of water for drinking is average Rs. 15 / litre. The industrial needs of raw water have created new industry of water supply by tankers with cost ranging from Rs 250/- to 400/- for 1000 litre.
3. Water becoming scares and costly, thefts from canals / reservoir and SMC industrial supply have become daily news headlines. Inter state, inter country legal battles have already started in country and will not take long when water may become a political tool for future politicians. Future wars could be for water.
4. Shortage of surface water has led to mass use of ground water lowering G.W.L. by 10 to 50 meters generally. In coastal belts Surat for example, Seawater therefore found entry in 2 – 4 km belt around estuary making G.W. source as polluted.

### 3.4 METHODS FOR MINIMIZING CRISIS

a. **Recycle water** for more than one use. E.g. collect wash & bath domestic water 120 L / Head / day and use for flushing & other cleaning (60 L / Head / day) saving more than half water consumed per capita for domestic use. The sewage water, after tertiary treatment, can be used for gardens, green belts, irrigation and recharging in to ground.
b. **Harvest rainwater** by recharging ground water
c. **Harvest rain water/ Floodwater** by storage check dams, Flood Detention Reservoir etc.

## 4.0 FLOOD WATER AS SOURCE FOR URBAN CENTERS: A CASE OF SURAT

### 4.1 WATER RESOURCES FOR URBAN CENTRE

The direct impact of urbanization and high resource utilization seems in the form of climate change all over the world. The rainfall pattern changes rapidly and the observation shows the high intensity rainfall for shorter period compared to earlier condition. The urban area developed on coast lines are observed with high intensity floods. Along with this unfortunately, planning for water resources in growing urban centers in master plan has been vague or absent for all cities – Surat, Bombay, Delhi, Chennai etc. The urban centers has various planning mechanism, one of this is T.P. Schemes for which even at huge cost, patches of T.P. distribution system cannot effectively avert chaos. Cities without own source of water could face crisis if sources are outside city boundary. Hence there should be strong planning proposals for efficient utilization of all available water like surface water, ground water, flood water etc. for city development.

### 4.2 SURAT AND ITS WATER NEED

The city of Surat located at south Gujarat, India is known for its textile trade, diamond cutting and polishing industries. It is headquarter of Surat district situated in the center of south Gujarat, along a west coast of India almost at equidistance between Mumbai (260 kM) and Ahmedabad (224 Km). Fig. 4 [8] shows the location of Surat city on map of India.

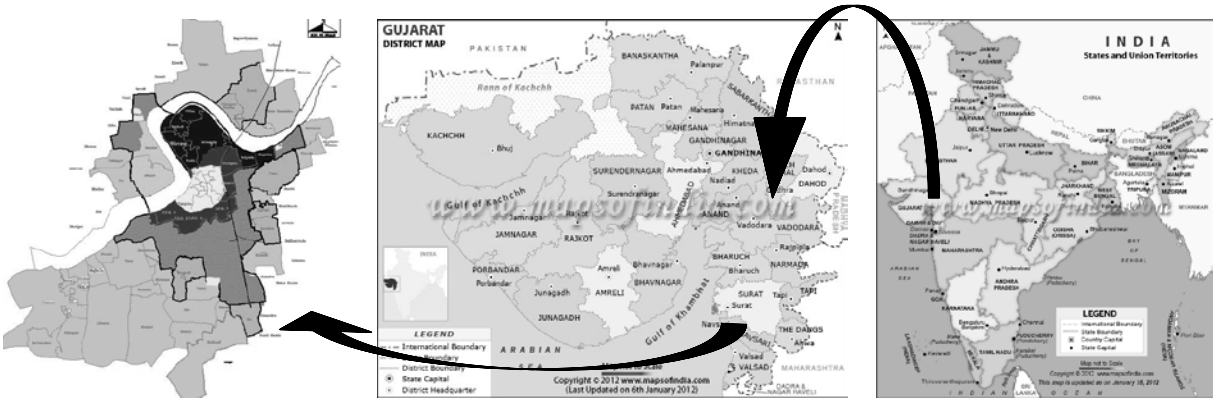


Fig. 4: Location of Surat City on map of India.

It is situated at latitude 21º 12’ N and longitude 72º 52’ E on one of the biggest west flowing rivers in India, river Tapi. River Tapi meanders along the northern limit of Surat City and then slices through the western portion of the Municipal area before joining Arabian Sea at Hazira-Dumas, at a distance of about 16 kM from the center of Surat City [9]. Surat has riparian source from Ukai reservoir to cater average 600 MLD. If downstream of Ukai to Surat is mismanaged by users of villages, industry such as sand mining this source could create crisis. The past few year observations shows that the river Tapi is flowing with controlled outflow after the year 2006 flood disaster. The river / flood water flow can be utilized for sweet water requirements.

The city water supply is mainly depending on river Tapi flow though various intake wells provided at upstream of Singanpore weir. For city of 2020 with projected 45 lakhs census population and 8 - 10 lakhs floating population and surrounding no source villages, needs of 1200 MLD requires extra source. The ground water is saline and sea water may not be so much useful. Rain water harvesting are birds in bush. Even with all water works u/s of weir have perpetual problems every summer and cannot provide economical reliable quality distribution to added areas 30 – 40 kM away from Water works. There is no other source of water for future city.

### 4.3 FLOOD DETENTION RESERVOIR FOR SURAT

Looking to all available water sources it can say that flood will be the major source for sweet water in future. There must be utilization of the sweet water flowing to sea. The study carried shows the probability of the utilization of the flood water through Flood Detention Reservoir. These also help in development at coastline against the costal erosion due to climate change in long term. The project prepared considering the all other problems of development for fastest growing city of Surat. The project is integrated development plan for utilization of flood water club with needs of other industrial and infrastructure development for city. The city is surrounded with huge khar / mud land on coastline and river Mindhola, Kim etc. which are increasing day by day with climate change impacts. Fig. 5 and 6 shows the khar land area for Surat City and sites for water bodies.

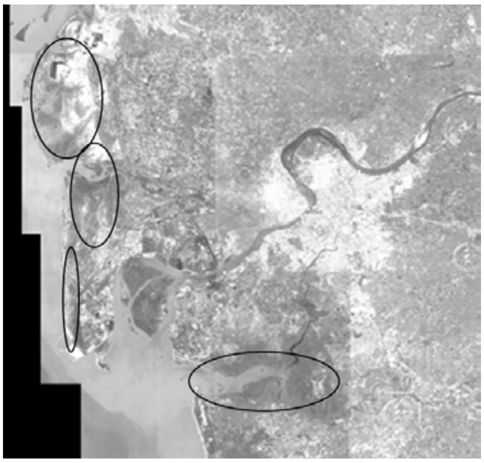

Fig. 5: Map showing the khar land area for Surat City.

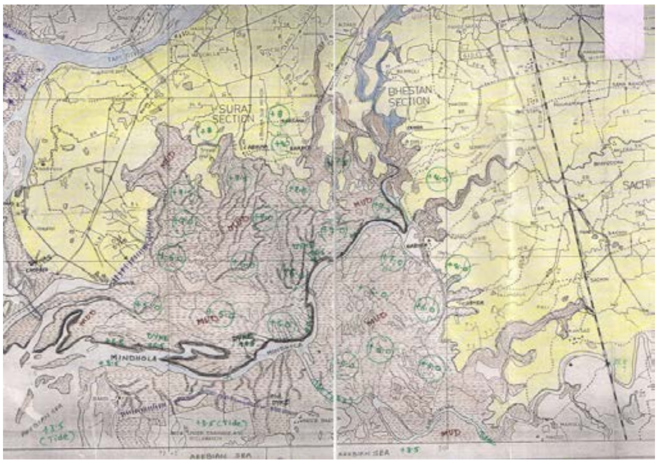


Fig. 6: Map showing the khar land area below Surat City near Mindhola

These khar lands will be utilized for creating flood detention reservoir (FDR) as shown in Fig. 7 and 8. The flood water from river Tapi will be collected though well planned storm water drainage system following natural gradient. The excess flood water collected will be allowed to flow in Sea through Balloon dam spills in low tides. The salient features for project is explained here after.

1) As shown in Fig. 7 and 8, water detention reservoir along the coast line Hajira, Bhimpore on mud – khar lands, 2 – 3 nos. of 200 MCM or so capacities to detain & download extra flood into sea by Balloon dam tidal structures (Fig. 9). This is huge raw water source above tidal level.
2) **Floods control** d/s of Singanpore weir. (Diversion of floods from spills, natural & designed to detention reservoirs along coastline)
3) **Beautification & development** of river front by Road (100 m) cum storm drain barrel along river intercepting. Present 18 or so drains, spills system to spread flood so as to decrease depth, drain it through shortcut direct drains redesigned. The flood spills and planned spills on riverfront will drain water via coastal reservoirs to sea. (Fig. 9)
4) **Coastal protection:** The erosion of coast control is ensured by the dykes for detention ponds. Needs can be seen from Udawada, Tithal, Dandi & Dumas (Sultanabad). This will protect city from rise of sea water due to global warming & ice melting.
5) **Communication:** A coastal highway along dyke Hajira – Hansot, Dumas, Umbharat linked to NH – 8 could provide outer ring road without adding afflux to city as shown in Fig. 10.
6) **Land creation / reclamation:** The khar land which is of no use can be utilized for various light structures for residential developments in between the ponds as shown in Fig. 11.
7) Recharge, khar land development by leaching and control of salinity ingress to city area are obvious side benefits.
8) Raw water source for dry 74 or so coastal villages ponds in mostly no source areas.
9) Long term recharge will revive old aquifer after 2 – 3 decades as ground water source.
10) Disaster management plans for Hajira via coastal road to jetties – sea or NH-8.
11) Development of coast line beaches, gardens & entertainment areas for city of Surat.
12) Diversion of drains will make conservation of the surplus water from Singanpore weir by Balloon dam at Umra & water works near Gavier.

Some of these components do have projects of 800 crores or so, integrated proposal will justify mega planned project of thousands of crores.

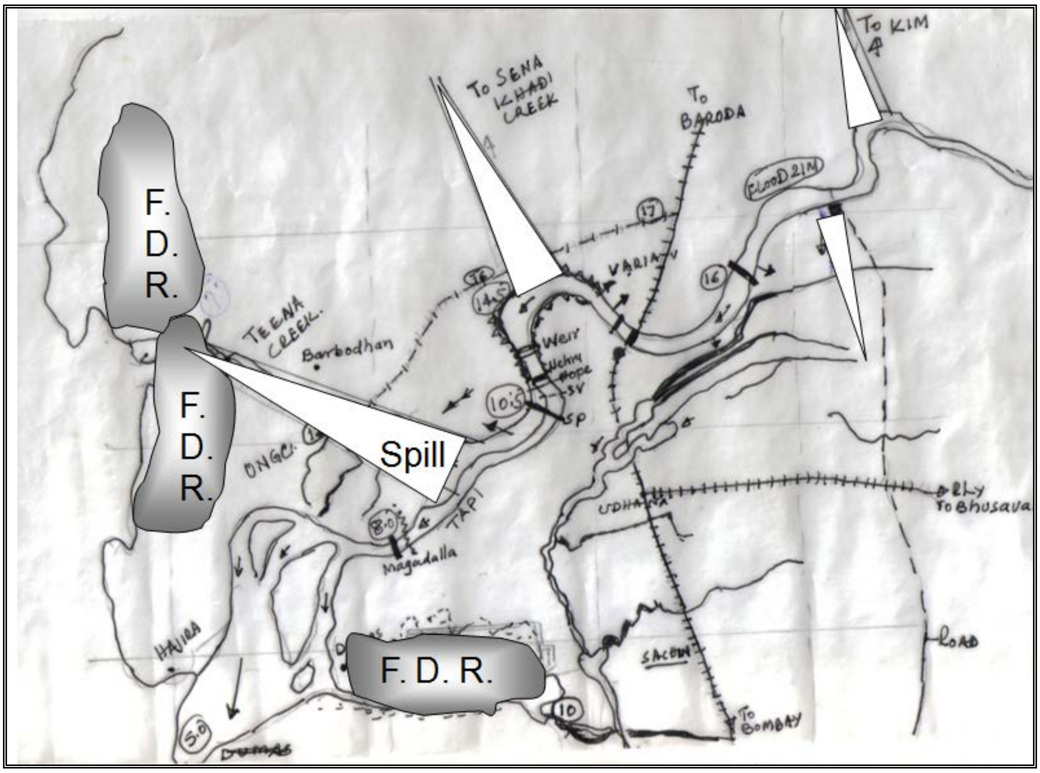


Fig. 7: Map showing proposed Flood Detention Reservoir with other spill way points for Surat City.

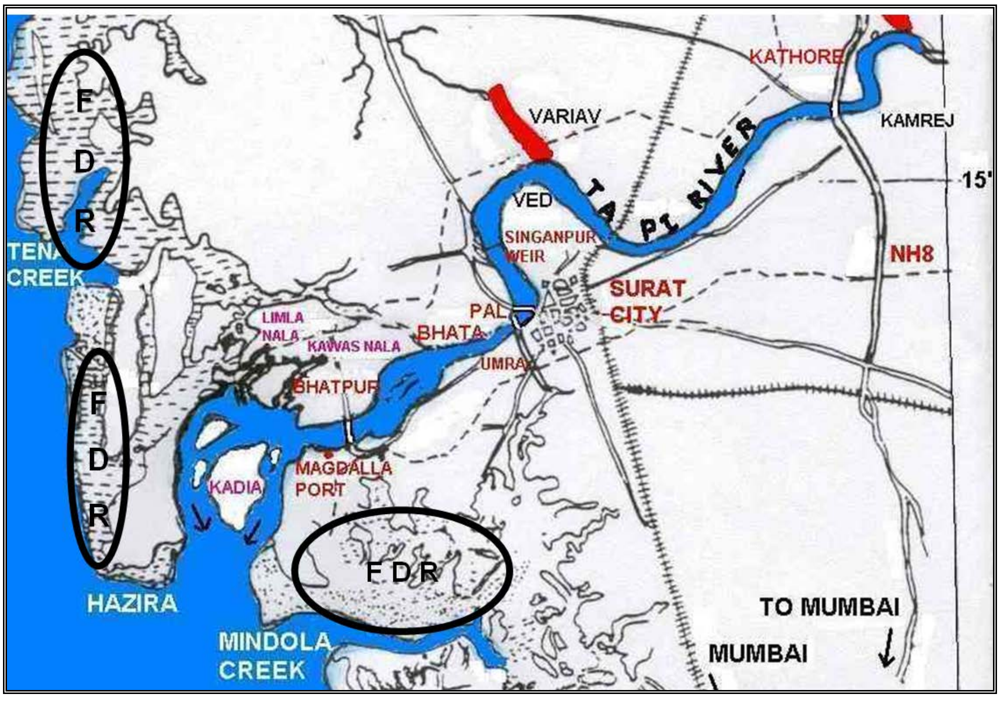


Fig. 8: Map showing locations for proposed Flood Detention Reservoir on khar land in Mindhola River at Surat

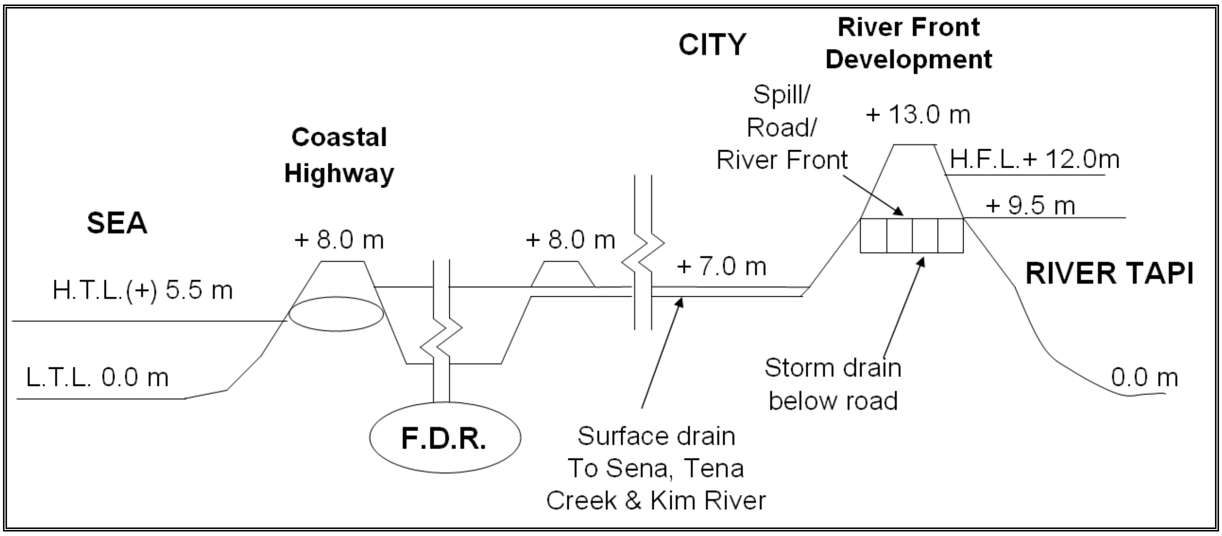


Fig. 9: Sketch showing the conceptual details for proposed integrated planning with coastal highway & flood detention reservoir.

(Plate shows flood, spills, barrel direct drain to act as storm drain interceptor, surface drain network to divert flood water to major khadies redevelopment, Tena, Sena, Kim, Mindhola)

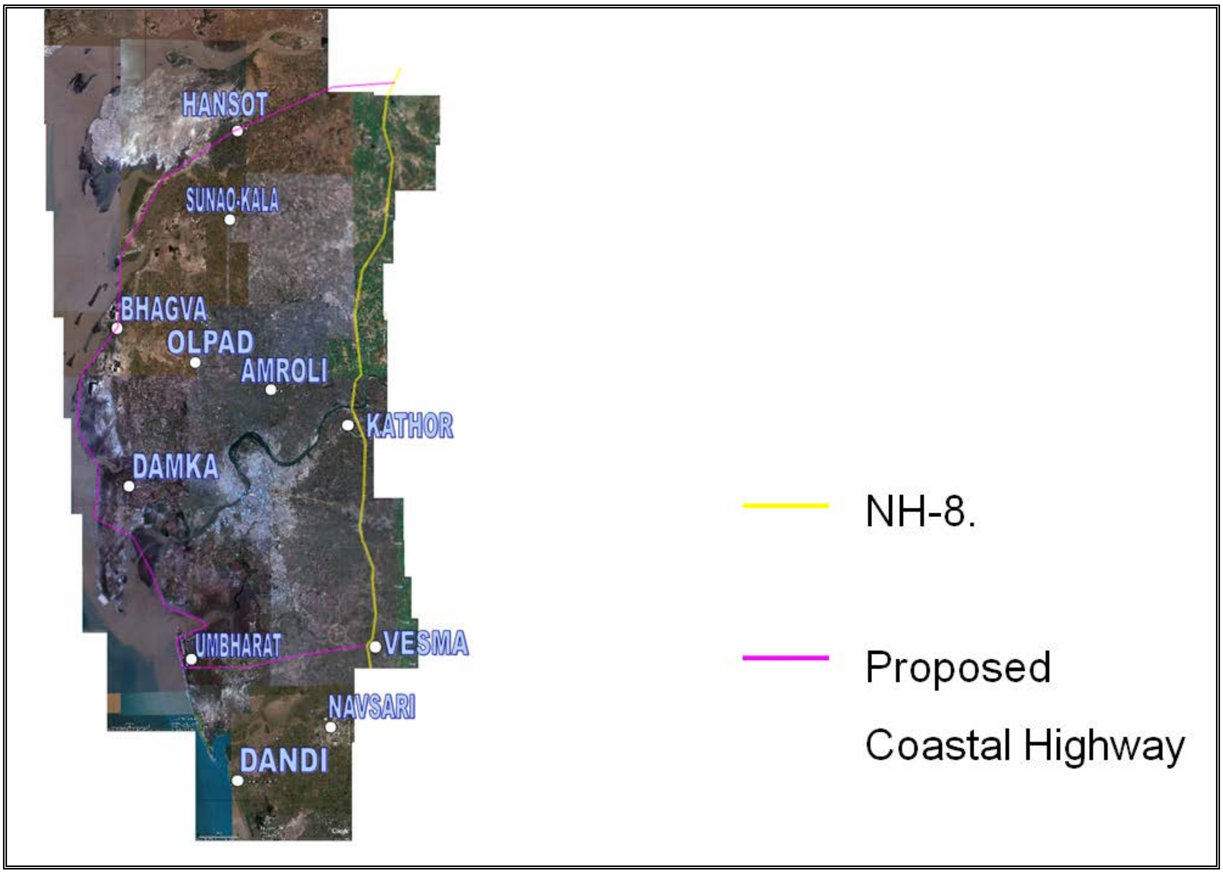


Fig.10: Proposes Coastal High with Flood Detention Reservoirs.

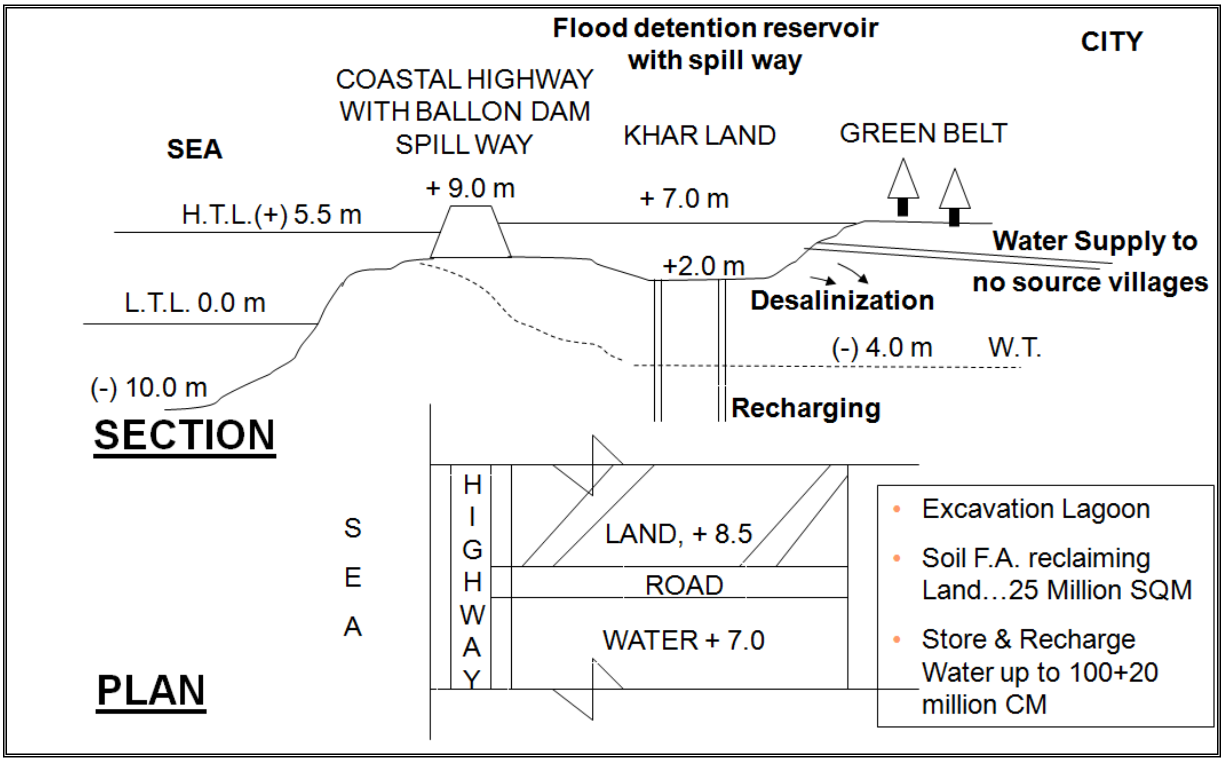


Fig. 11: Sketch showing the sectional details for proposed land reclamation though integrated planning with Flood Detention Reservoir.

**5.0 CONCLUSION**

The study carried out for Surat, a coastal urban center suggest positive opportunity for the integrated planning of River front development, Flood Detention Reservoir, Coastal erosion control, Emergency escape routes and overall area development through inter connectivity of all natural water storage ponds, lakes etc. The economic viability against desalinization plant costing 3000 crores is justified prima-facie.

The following Planning process will be adopted for any urban area water management.

1) Minimum 2 to 5 % of land reservation in any Urban Center and surrounding area for self water source generation (As per existing T.P. Act - No reservation for Water Source or Flood Water)
2) The area for water source will be identified as the low laying area in the region based on contours covering major infrastructure layouts of ring rail, roads, disaster management plans.
3) The water body e.g. pond, lake, reservoir etc shall be created depending on the existing and future population projections.
4) If the area is at coastal region there must be provision for Flood Detention Reservoir for storage of sweet water.
5) Inter connectivity of all available and proposed pond, lake with Flood Detention Reservoir shall be planned as per available natural gradient for optimum utilization of sweet water.
6) The economic technical feasibility against only options of massive desalinization plant in coastal belt using integrated planning of independent activities – desalinization, rural water supply to no source villages, escape routes for disaster prone industrial belt, flood management of river through city, connectivity of coastal transport / security schemes and control of loss of land due to decadal rise of sea now predicted.

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"Mahesh D. Desai graduated in Civil Engineering from the M. S. University of Vadodara, Gujarat, India in 1958. He obtained a Ph.D. in Civil Engineering at the South Gujarat University of Surat, Gujarat, India in 1973. From 1959 to 1961 he worked for Govt. of Gujarat at Ukai dam, specialising in soil engineering. He had served at CSMRS, Delhi during 1961 – 1970 as Research Officer and Deputy Director, Central Water Commission. In 1970 he joined as Professor at S.V. Regional College of Engineering and Technology, Surat. He initiated PG courses and consultancy services. With 25 years of academic excellence he volunteered to retire. Since 1995 he is free lance consultant / advisor, social activist, visiting professor and Ph.D. guide at S.V.N.I.T., Surat".