INCORPORATE RIVER CENTRIC URBAN PLANNING APPROACH

A CASE OF SABARMATI RIVER

Thesis submitted in
Partial Fulfilment for the
Award of the Degree of

Master of Urban and Regional Planning

By

Parita P Mathukiya
Second semester, MURP II – 2020-21

Primary guide:
Prof. Neha Sarwate

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Dr.Deepa Gavali

Master of Urban and Regional Planning (MURP) Program
Department of Architecture
Faculty of Technology and Engineering
The Maharaja Sayajirao University of Baroda
D. N. Hall, Pratap Gunj, Vadodara, Gujarat, India

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CERTIFICATE

Incorporating river centric urban planning approach

The contents presented in this Thesis represent my original work and it has not been submitted for the award of any other Degree or Diploma anywhere else.

Mathukiya Parita Pravinbhai

This Thesis is submitted in partial fulfilment of the requirements for the

Degree of Master of Urban and Regional Planning

At the Department of Architecture

Faculty of Technology and Engineering

The Maharaja Sayajirao University, Vadodara, Gujarat, India

The present work has been carried out under our supervision and

Guidance and it meets the standard for awarding the above stated degree.

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Abstract:

Due to the pressure of urbanization and population growth, riverfront areas are getting degraded with poor water quality, limited access, formation of slums etc. and are often found functioning as open sewers or dumping grounds. Such problems are not confined to a particular geographic region of the world, but are common to all places subject to the level of urbanization, and India is no exception. One can see many examples across the world, where city authorities have made successful efforts to reconnect people to the rivers by reshaping their riverfronts Major development projects in India such as Ganga action plan, Yamuna action plan and Sabarmati riverfront development have been initiated to improve the river environment. But this projects are not managing the water recourses in a way that harnesses as well as protects their complete ecosystem values. As a result, the river development projects are often undertaken without long-range and strategic planning.

Thesis Acknowledgement

I would like to acknowledge and extend my heartfelt gratitude to all the great people who stood behind me and provided me with the academic and the personal support throughout my Study.

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1. INTRODUCTION:

1.1 Rivers:

Through the ages, rivers have been the center for human existence. A vast number of earliest and most prominent ancient cities evolved as river cultures. These have been the most common centers for human growth owing to easy availability of water source for drinking and other purposes, food resource, transportation and other basic necessities for human existence. For instance, through the history many civilizations settled along the Euphrates- the Tigris Rivers in Mesopotamia, the Nile in Egypt, the Ganga in India, the Indus in Pakistan, and the Huang-Ho in China. And the practice continues till date. Some of the current examples of urban rivers include the Thames in London, the Seine in Paris, the Tiber in Rome, the Vlvata in Prague, the Danube in Budapest, the Hudson in New York, the Yarra in Melbourne, among many others. This inter-relationship between rivers and cities forms a multi-disciplinary perspective in the development sector. The rivers have been guiding the growth of cities along their banks. At the same time, the development within a city reshapes its rivers, their urban landscapes and alters the river ecology. Moreover, the cities are heavily dependent on their rivers for various infrastructural and developmental needs. In this process the cities have clearly harnessed, modified, and engineered their rivers, altering ecologies and creating new landscapes, while moving towards urbanization.

Urban rivers have always been recognized for their role in serving as water resources, protection of nature, fisheries, and provision of recreational areas with considerable contributions to landscape. In addition to these roles, rivers also have certain other definite environmental, social, cultural and economic values. Urban rivers serve as a complex balance of social-economic-ecological systems, serving the cultural and religious beliefs, the recreational needs, the livelihood dependencies as well as the ecological services of the riverine ecosystem. In particular, rivers and their associated ecosystems provide a broad range of services, including clean surface and ground water, habitat for riparian flora and fauna, fisheries, and the regulation of flood flows. Other riverine ecosystem services include carbon and nutrient sequestration, fibre production, and biodiversity protection.

However, the relationship between cities and their rivers has been a highly complex one, constituting an inescapable challenge of coexistence between two very different systems: the river environment, characterized by change, diversity and the occasional occupation of space during flood events; and the urban environment, uniform, continuous, of exclusive uses and man-made products. Each city-river case is unique, and riverfronts have been treated quite distinctly by urban planners depending on the characteristics of the river environment and also the characteristics of the urban environment: public private investments or the absence of thereof; processes of marginalization or, to the contrary, the creation of new urban hubs, albeit always governed by a logic of “vicious” and “virtuous circles”.

1.2 CHALLENGES OF Urban Rivers:

It has been observed historically that human settlements often evolved alongside water — near lakes or rivers. The river passing through a city offers ecosystem services that can be seen as a provisioning, regulating and a supporting system. It not only serves as source of water supply, but also helps in balancing flood control and landscape ecology.

Urban riverfronts particularly provide a space for a city to reduce the risks of climate change such as heat island effect and flash floods. They simultaneously provide

Figure 1: Key challenges upon urban river

greater health, space for social cohesion and socio-economic benefits to citizens. And yet, rivers are constantly polluted, moulded, abused and face grave environmental degradation due to urbanisation. Throughout a river’s course, anthropogenic activities have adverse impact on the river’s watershed. As a result, an urban river becomes a stretch where the function of that water resource is altered from its natural state.

Restriction of natural/ storm water channels: The River needs its space to perform its various functions, one of which is acting as a sponge to prevent flooding. Furthermore, channelization and excessive concretization further confine the river because of which the entire geomorphology and ecology of the river gets disturbed. This impermeabilization of the landscape in cities leads to surface flooding, excess runoff and fluvial flooding. The water quality is also damaged by the excessive runoff washing pollutants off roads and causing spills from combined sewer outflows.

Pollution: As per The United Nations World Water Development Report 2017; Wastewater- the Untapped Resource, globally it is likely that over 80% of wastewater is released to the environment without adequate treatment. The sectors highly contributing to the pollution load include waste generated from municipal & urban areas, industrial effluents and agricultural runoffs. This discharge of untreated wastewater directly into the water bodies explains the rapid growth of deoxygenated dead zones. Pollution from various sources—domestic and industrial sewage; agricultural runoffs; solid waste dumping; among others— are taking a toll on the rivers. In many cases, large stretches of the rivers are literally flowing sewers. As the cities heavily depend on these rivers, river pollution poses serious health issues. More importantly, the entire riparian ecosystem is heavily affected, sometimes threatening its very existence.

Over-abstraction of water: As the rate of urbanization in cities grows, the stress on water resources to meet the rising demand also increases. In peri-urban areas, agriculture water demand aggravates the situation. As a result, rivers and aquifers are fast depleting, causing changes in hydro morphology and natural hydrological regimes of water channels.

Degrading stagnant water bodies/ wetlands: Urban water bodies (stagnant) and wetlands are a very important avenue to stabilize the groundwater levels, in addition to providing various social and environmental benefits. They serve as an important source for groundwater recharge, augmenting groundwater levels, and thereby reducing the stress on river water resources. Economic and urban development has been further leading to environmental degradation of wetlands/ water bodies. Loss of catchment basins, change in quality of water, as well as loss of natural flora and fauna

raise concern about the impacts of rapid urbanization over these vulnerable ecosystems.

Depleting green cover: Green cover is very important from a river management point of view. On riverbanks, it serves as an erosion control mechanism. In other areas, it helps augment groundwater levels, and provide a habitat for biodiversity to thrive. Unfortunately, the cities today have been trapped within a vicious green-grey debate. The general trend is that as cities become more urbanized, there is a decrease in the green cover.

Weak citizen-river connect: Traditionally, the river was at the centre of various societal practices—cultural, religious, livelihood-related, and recreational. While this is still prevalent in some Indian towns, somehow many towns (especially the larger cities) have lost their connection with the river. Re-igniting this connect is very important so that citizens will voluntarily take on some of the responsibility for maintaining the rivers in the desired condition.

River governance: River governance encompasses several aspects— accountability of different stakeholders/ assigning roles & responsibilities, coordination between agencies, citizen engagement, monitoring and evaluation, and finances, among others. These have to be clearly mapped out for any planning to achieve its ultimate objective.

The challenges of urban rivers are diverse in nature, as explained above, involving environmental, economic, technical, political as well as social impacts. These call for a shift in the way urban water systems are managed by the city administration.

1.3 Current Scenario of River Health in Indian Cities:

In urban areas, rivers continue to be channelized to accommodate for development and flood prevention. As human conurbations have expanded, rivers at their centres have come under more pressure and lost the ability to function naturally. In India Rivers have cultural, economic and environmental aspects. Because of significant cultural aspects rivers and citizen connection is very much strong but in today's scenario, rivers are polluted and ecosystems of the rivers are degraded due to lack of conservation. With the rapid expansion of towns and cities population, the physical

characteristics of the urban space have been completely altered. The natural river channels have been altered by straightening and creation of embankments for flood protection and to maximize the use of land for housing, industry and agricultural use.

As per World Economic Forum 2019, 'It's estimated that around 70% of surface water in India is unfit for consumption. Every day, almost 40 million litres of wastewater enters rivers and other water bodies with only a tiny fraction adequately treated'. As per India Rivers Week Assessment "70 per cent of our rivers are facing existential threats. Over 60 per cent of sewage generated in India is dumped untreated in rivers and water bodies. As per latest official assessment the number of polluted river stretches in country has increased to 352 from 302 two years ago. Similarly, the number of critically polluted stretches has gone up to 45 from 34 in two years". Another major concern highlighted above is the urban flooding scenario. As per World Bank statistics, 'By 2050 nearly 20% of the world's population will be at the risk of floods".

According to the CPCB reports of the year 2009 and 2015, considering the Bio-Chemical Oxygen Demand (BOD), numbers of polluted river stretches have increased from 150 in year 2009 to 302 in year 2015. As per another CPCB Report of 200910, the estimated sewage generation from Class-I & Class-II towns in the country was around 38,255 MLD (Million Litres per Day), against which sewage treatment capacity of only 11,787 MLD i.e 30% of the sewage generated was available. In the latest CPCB report of 2014-15, these figures changed to 61,948 MLD and 23,277 MLD (37% of the sewage generated).

1.4 Current scenario of river planning in India:

Accelerated transformation of 'urban riverfront development' has been pushed along the riverbanks in the last few decades. The riverfront development has been reduced to just cosmetic 'river beautification' and unaccountable money spent to increase its real estate and commercial value. Our rivers are being narrowed far within their actual width with concrete riverbed wall embankments. Since concrete riverbed and channels are the main components of these projects for car parking, plaza, walkways, restaurants etc, the river's flooding capacity and aquatic are adversely impacted. These projects also often ignore treating the sewage flows into the river through the natural drains and tributaries in the watershed. There are various similar urban

riverfront development projects that tell the same story and focus on just the receiving end, compromising on riverbank stabilisation, riparian buffer and immediate floodplain ecological values.

Moreover, many such projects are pushed without any kind of social and environment impact assessment and data or facts are dodged for environmental clearance. There's also a lack of regulation or democratic participatory decision. The creation of such recreational areas makes riverfront accessible to public to serve more than one purpose. The riverfront is not a hard boundary, but a zone that shifts with time and topography. The riverfronts and river bank floodplains are ecologically very dynamic and meant to be undeveloped for maintaining bank storage, floodplain biodiversity along with natural tributaries and wetlands.

2. RIVER SENSITIVE URBAN PLANNING

2.1 Need of planning:

Due to the pressure of urbanization and population growth, riverfront areas are getting degraded with poor water quality, limited access, formation of slums etc. and are often found functioning as open sewers or dumping grounds. Such problems are not confined to a particular geographic region of the world, but are common to all places subject to the level of urbanization, and India is no exception. Flow is the major driver of biodiversity in rivers. River flow regime, ranging from low flows to high flows, significantly affects the river ecosystem. For various water demands, water is stored and diverted through various structures built on rivers that changes the flow regime and reduces the flow in the downstream reaches, resulting in degradation of the services that society gets from rivers.

Need for planning and restoration emerges when a river ecosystem has been degraded to an extent that the river can no longer provide the ecosystem services required out of it.in such cases, River management policies, strategies and plans need to be developed with a clear understanding of the freshwater ecosystem as well as the dependent system.

The pollution load in rivers has been increasing over the years due to disposal of human and industrial waste in the rivers. The situation is likely to be further aggravated due to impact of climate change on the water resources, including rivers. . Flood plains of the rivers in urban areas have witnessed the construction activities including the unauthorized residential development, a phenomenon which has severely degraded the overall natural environment and river ecology.

“There is need for new thinking for ‘river cities’. There is need for a new river centric thinking in planning for cities on the banks of rivers, the city master plan, at present, does not adequately address this. The river health needs to be mainstreamed into urban planning process by development of Urban River Management Plans. Cities should be responsible for rejuvenating their rivers. It has to be done not just with the regulatory mind-set but also with development and facilitatory outlook.”

2.2 What is river sensitive planning?

River sensitive planning defined by the city's administrative boundaries, which essentially treats the river as an asset and ensures that the developmental activities within the city are not detrimental to the river. River sensitive planning takes cognizance of the river and its interaction with the city. It recognizes the strong connect between a city and the river and mainstreams this aspect in the planning philosophy of the city.

In river sensitive planning, Priority are given for the restoration of the natural course of the river over a human-centric built designs. This would not only make the river conservation unique but also contribute to the ecological value accrued by the city. The dependency of the city and its inhabitants on the river ecosystem has to be accurately projected for coming up with an efficiently functioning infrastructure system. More importantly, the dependency also has to be mapped out, for bringing forth the best possible development interventions without altering the natural ecological character of the area. Thus, even while dealing with river-projects, the concept of river management has to be interwoven within the city planning stage itself. This is a relatively weaker link in the Indian context of urban river management.

Figure 2: Categories of river sensitive planning

The first category explained above, is related to mainstreaming sustainable river health management into a city's larger long-term vision. To address this, river management has to be imbibed within the current city plans and the national level policies. The present planning framework has a number of plans at varying scales and with specific needs, like the 'Regional Plan', 'Master Plan', 'City Sanitation Plan', 'City Development Plan', 'River Basin Management Plan', 'Sanitation Safety Plan' (by World Health Organization), 'City Disaster Management Plan' for Municipal Corporations and 'District Disaster Management Plan' for smaller towns, among many others, which need to follow a river-sensitive approach.

The second is associated with developing a dedicated river-specific management plan for a city. For this, the Urban River Management Plan (URMP)xi framework, as explained in the box below, defines various project-based interventions that can be identified by the cities for enhancing the three core elements of river management: River Health, Social Cohesion and Economic Value.

3. Need for study

3.1 Research statement:

Towards practising River centric urban planning approach into river planning.

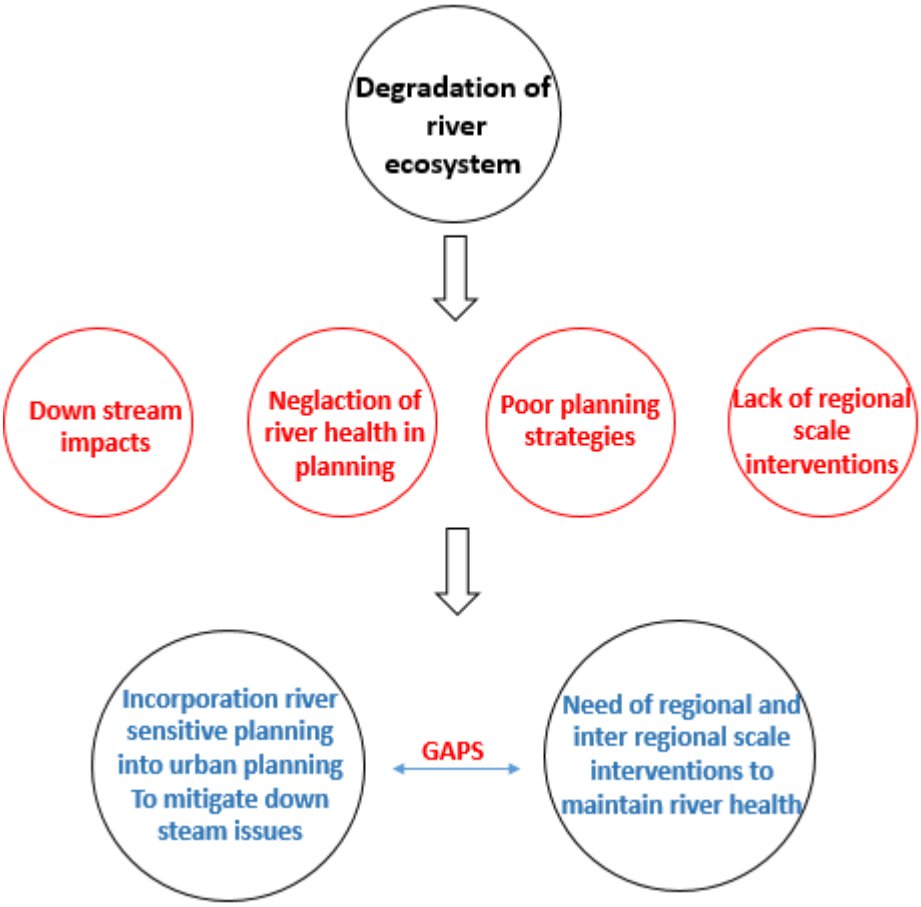


Figure 3: Need of research

3.2 Goal statement:

Incorporate River centric urban planning approach so that the downstream impacts due to riverfront interventions can be mitigated.

3.3 Objectives:

1. Finding ways to improve the current condition of river health due to riverfront interventions.

2. Propose Strategies for pre river Front River within UDA boundary.

3.4 Scope:

Incorporating river sensitive planning within urban area in Ahemdabad on Sabarmati river.

Why Sabarmati?

- Sabarmati river is passing through the largest city of the Gujarat and river runs through its centre and it is the only river that has river front interventions upon it which is operational since last 7 years. Since the river front is operational from last 7 years, the impacts of it on the river health is very much evident.

3.5 Limitations:

This study will be limited to city boundary. For study only environmental aspects have been considered.

3.6 Steps to be followed:

1. Basic Study of Sabarmati river basin.

2. Study of riverfront interventions upon the Sabarmati River.

3. Assess impact of riverfront and degraded river ecosystem.

4. Study and analysis of another factors like ground water and pollution.

5. Assess impacts of over exploitation of ground water.

6. Ways to solve this issues:
   6.1 Integration of river sensitive planning by following the guidelines and change into planning processes.
   6.2 Giving priorities to ecological factors more that economic factors.

4 Sabarmati River

2.1 Sabarmati river basin:

Sabarmati River is one of the major West flowing river of India, along with Narmada and Tapti, which originates from Aravali hill ranges in Rajasthan and after traveling 371 Km. meets the Gulf of Cambay (Khambhat) in the Arabian Sea. 48 km of the river length is in Rajasthan, while the rest 323 km is in Gujarat.

Sabarmati originates from Aravalli hills at an elevation of 762 m near village Tepur, in Udaipur district of Rajasthan. It flows generally in South – West direction in Rajasthan and enters the Gujarat State and passes through the plains and continues to flow in the same direction.

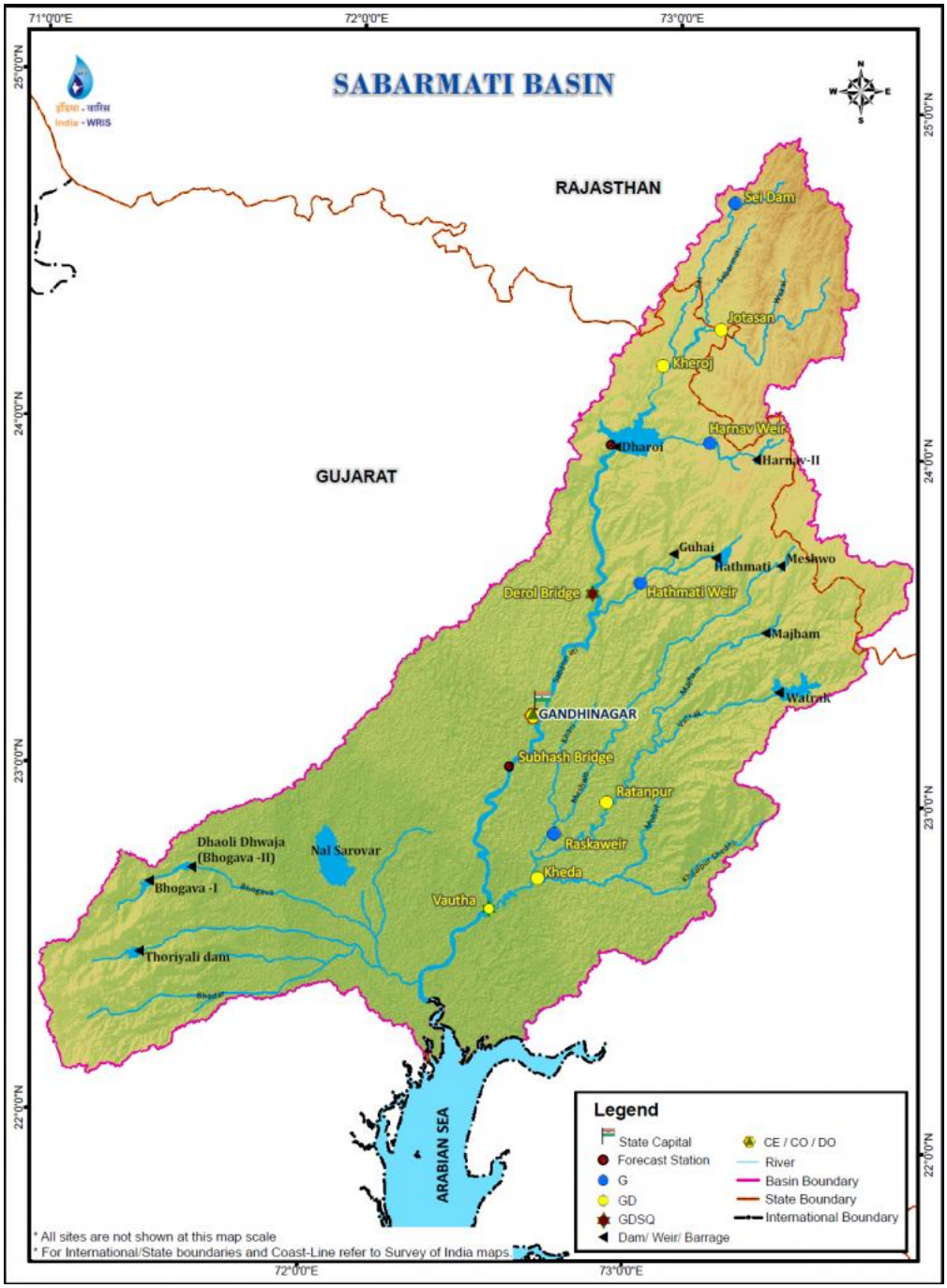
Origin	Village Tepur, in Udaipur, Rajasthan
Length	371 Kms
Discharge	Gulf of Cambay (Khambhat)
States & Major Cities	Rajasthan: Gujarat: Ahmedabad
Right Bank Tributaries	Sei, Siri and Dhamni
Left Bank Tributaries	Wakal, Harnav, Hathmati, Khari, Watrak
Major Dams	Dharoi Dam

Table 1: Sabarmati river summary

Sabarmati River Course:

At the 51 km of its run, the river is joined by the Wakal on the left bank near village Ghanpankari. After flowing generally in the South – West direction at 67th km of its run, it receives the Sei on the right bank near Mhauri and then the Harnav on the left bank at about 103 km.

From respective sources beyond this confluence, Sabarmati flows through the Dharoi gorge. Emerging from the gorge it passes through the plains and is joined on its left bank at about 170 km from its source by the Hathmati, which is its major tributary. Continuing to flow in South – West direction, the river passes through Ahmedabad and about 65 km downstream, another major tributary, Watrak joins its on the left bank, flowing for a further distance of 68 km, the river outfalls in the Gulf of Khambhat in Arabian Sea.



Source: india-wris.nrsc.gov.in

Figure 4 MAP OF Sabarmati river basin

Sabarmati Tributaries:

Sei :This is a right bank tributary of Sabarmati River.It rises in the Aravalli hills in Rajasthan and flows in South – West direction for a total distance of 95 km before it joins on its right bank. It drains an area of 946 sq km.

Wakal: This is a Left bank tributary of Sabarmati River. It rises in the Aravalli hills in Rajasthan and flows in South – West direction for a total length of 88 km. It joins Sabarmati on its left bank. It drains an area of 1625 sq km. The Menas is its main tributary.

Harnav: This is a Left bank tributary of Sabarmati River It rises in the Northern portion of the Kulalia hills of Rajasthan ranges and flows in South – West direction for a total distance of 75 km. Harnav joins the left bank of Sabarmati. It drains an area of 972 sq km.

Hathmati: This is a Left bank tributary of Sabarmati River This is a Left bank tributary of Sabarmati River It rises in SouthWest foot hills of Rajasthan range in Gujarat State and flows in South West direction for a distance of 122 km to meet the Sabarmati on its left bank. This tributary drains an area of 1526 sq km. The sub-tributary of Hathmati river is Guhai river, on which Guhai dam is constructed.

Watrak: This is a Left bank tributary of Sabarmati River It rises in Panchara hills in Dungarpur district of Rajasthan and flows in Southwest direction for a distance of 248 km and joins Sabarmati on the left bank. Meshwo, Mazam & Shedhi are sub-tributaries of Watrak River. Watrak and its tributaries drain an area of 8638 sq km. A line diagram of river system giving information of Sabarmati Basin & its tributaries and sub tributaries etc. indicating the location of major structures is enclosed.

Major Dams on Sabarmati River: There are several dams and reservoirs constructed on Sabarmati and its tributaries. The Dharoi dam is located on the main Sabarmati river,

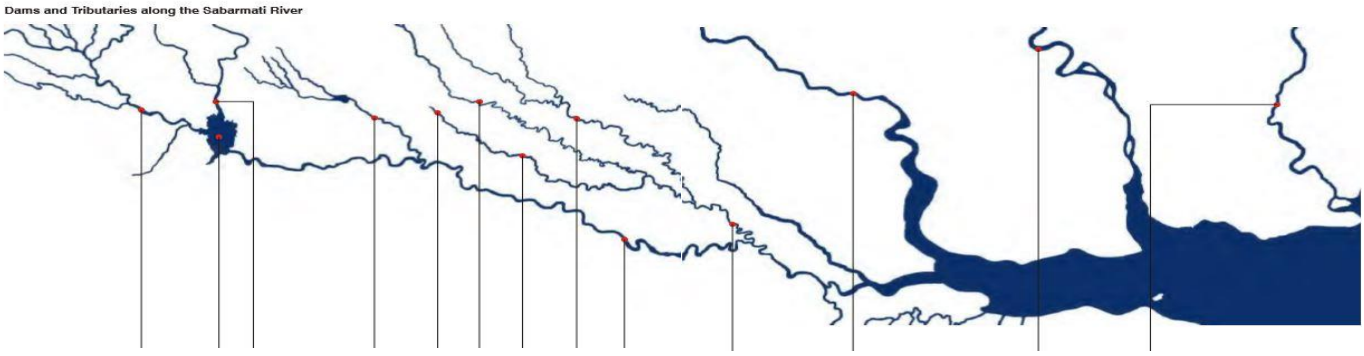


Figure 5:tributories of Sabarmati

Land use of Sabarmati river basin:

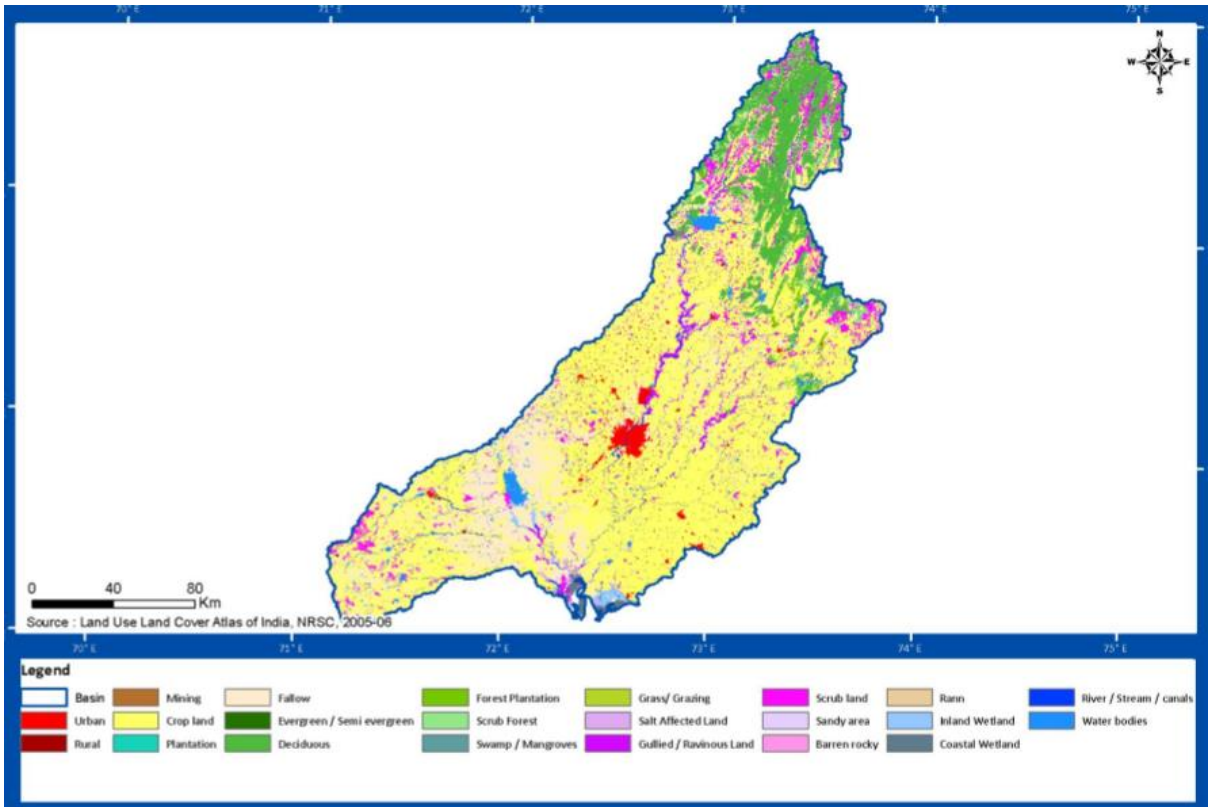


Figure 6: LULC map of Sabarmati river basin

S. No.	Category	Area (Sq. km)	% of Total Area
1	Built Up land	423.14	1.95
2	Agricultural	16186.38	74.68
3	Forest	2595.69	11.98
4	Grassland	10.72	0.05
5	Wasteland	1549.13	7.15
6	Waterbodies	908.94	4.19

Table 2:Total area in percentage covered by different types of LU/LC classes

In this watershed rapid urbanization has taken place during 1985 to 2005 which in turn has decreased forest land, fallow land, shrub lands and managed to increase crop land, built –up land etc. The land cover has been converted into land uses because of rapid urbanization and if **this will continue than our natural vegetation cover of forest will reduce which leads to degradation of our environment. Hence in order to sustain and preserve our environment, the forest cover should have to be increased which in long term will maintain ecological balance in natural environment.**

Major structures upon Sabarmati River:

Dharoi Dam:

- Dharoi dam is located about 165 km upstream Ahmedabad in village Dharoi of Mehsana district.
- It was constructed in 1978.
- It has catchment area of 5540 km^2, out of which about 2,640 km^2 lies in Gujarat state.

Vasna Barrage:

- At distance 202 km. Vasna Barrage having 10619 sq.km. Catchment area is situated.

Sabarmati riverfront:

Ahmedabad is located on the banks of Sabarmati River that serves as the city's lifeline. It is a major source of water from the city due to regular release of water from Narmada Canal upstream. The waters of the river were used for sacred and socio-

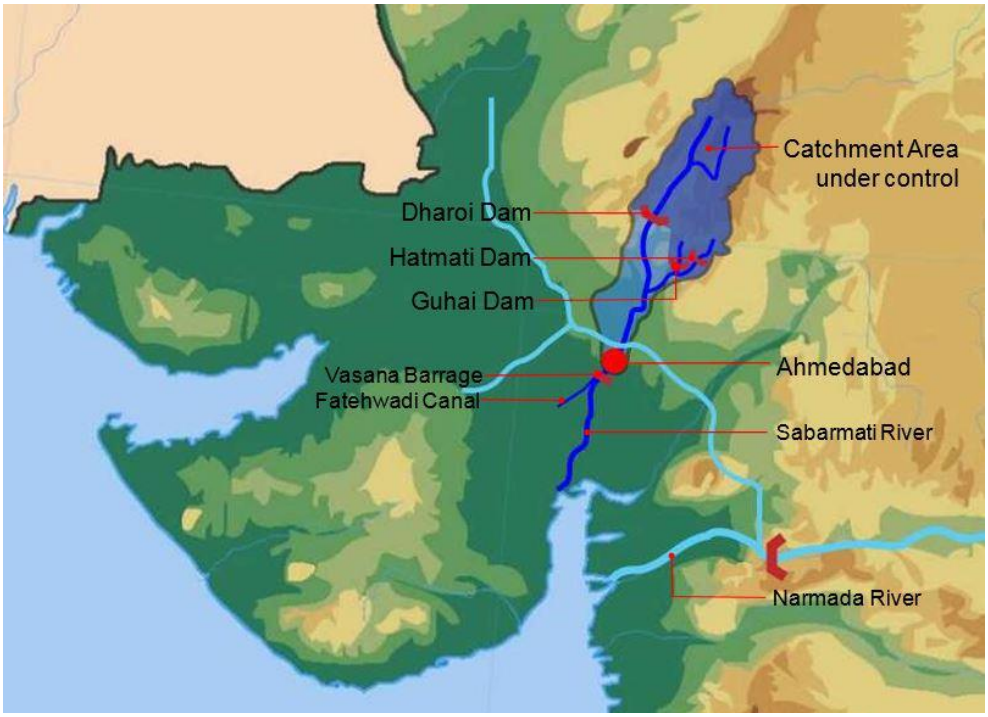


Figure 7: Dams upon the river Sabarmati

religious activities since centuries, and its banks were used for activities such as informal markets, washing, and recreation activities. The Sabarmati Riverfront Development Project is being implemented in the city as an urban design, urban renewal, and ecological and environmental improvement project.

Other dams and barrages upon river and its tributories:

There are some other dms upon the tributories of sabarmati river. There is Hathmati dam, meshwo dam and vatrak damupon Hathmati river, Meshwo river and Vatrak river respectively..

5 Sabarmati riverfront

5.1 Previous planning initiatives for Sabarmati riverfront:

The revitalization of the Sabarmati Riverfront has been attempted at least twice in the past. Bernard Kohn, a French architect living in Ahmedabad during the early 1960s, prepared one of the earliest proposals for redevelopment of the riverfront. He visualized a linear development for predominantly recreational uses along either bank of the river between the Gandhi and Sardar Bridges. The proposal included a series of parks and open spaces with intermittent access to the river via a series of steps. The government of Gujarat then set up a special committee to examine the proposal, which concluded that the project was technically feasible after a slight modification of the design. However, the project did not move forward, allegedly because of a lack of political stewardship.5 Kohn, disappointed with the poor response to his proposal, eventually left the country in the late 1960s. In 1973, a major flooding led to a renewed interest in the river and management of its seasonal flow. One initial outcome was the creation of the Dharoi Dam in 1976, approximately 200 km upstream of the Sabarmati River.

5.2 Sabarmati riverfront development and amenities:

Ahmedabad is located on the banks of Sabarmati River that serves as the city's lifeline. It is a major source of water from the city due to regular release of water from Narmada Canal upstream. The waters of the river were used for sacred and socio-religious activities since centuries, and its banks were used for activities such as informal markets, washing, and recreation activities.

The development project encompasses both banks of the Sabarmati for 11.5 kms stretch, creating approximately over 200 hectares of reclaimed land.

Several areas have particular focus in the project, namely

(i) Cleaning of the river to improve the river ecology and greening of the environment

(ii) Rehabilitation and resettlement of the Urban Poor on the Riverbank including sustaining and

(iii) Revitalizing the traditional informal activities happening on the river bank

(iv) Creation of the new area through best practices in urban design and urban renewal.

The traditional informal activities have been evident in the form of existence of Gujari Bazars or informal markets, elaborate Washermen Wharf (Dhobi Ghat), religious and recreation activities. In order to address the needs of the users and focus on the orderly and efficient transformation of these activities, the present initiatives focus on transformation of several key pockets of activities through the following projects:

1. Garden
2. Gujari Bazar (Riverfront market),
3. Dhobi Ghat, (Washermen Wharf/Laundry Campus)
4. Event Ground and Exhibition Centre
5. Flower Park
6. Elaborate road network for access to the sites.
7. Creation of new areas with best practices in urban design.
8. Recreational Activities

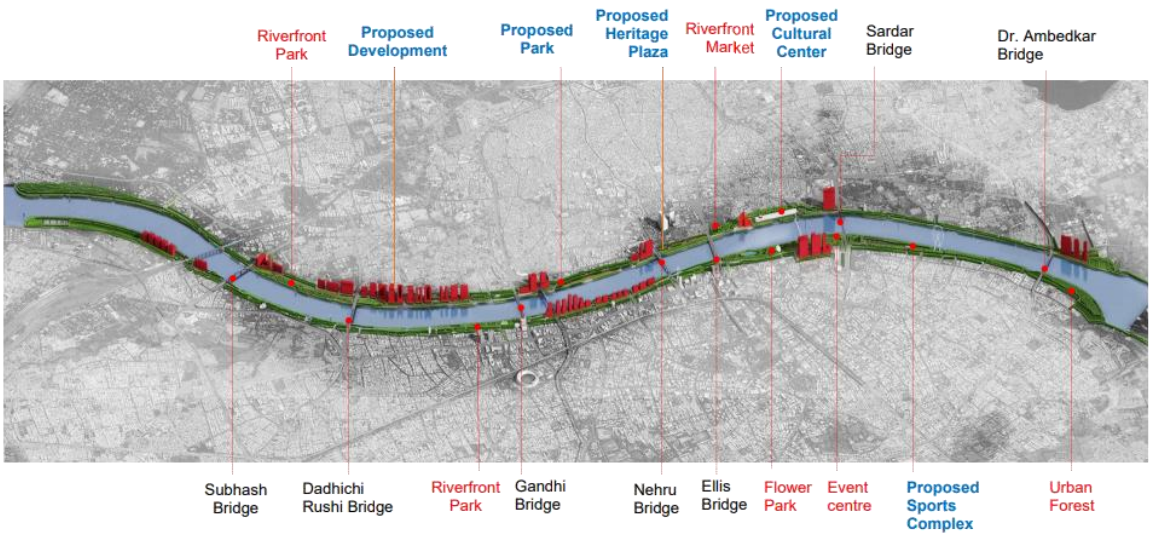


Figure 8: Projects of Sabarmati riverfront

These initiatives were sequenced in terms of

(i) Proper design reflecting the need of users and retaining the heritage character of the activities

(ii) Execution of design and

(iii) Systematic operation and management of these areas through user participation and contribution.

Gujari Bazar and Dhobi Ghat, Event Ground, Garden, Flower Park, Road network have already been executed in terms of the physical infrastructure. The urban design for the project includes many innovative features such as volumetric FSI. These projects are unique in terms of addressing specific user needs through urban design, urban renewal and sustenance of key common property resources that benefit the especially the poor and revitalization of activities which had come under developmental pressure by assuring them infrastructure, access and formalization.

5.3 Land use of Sabarmati riverfront development:

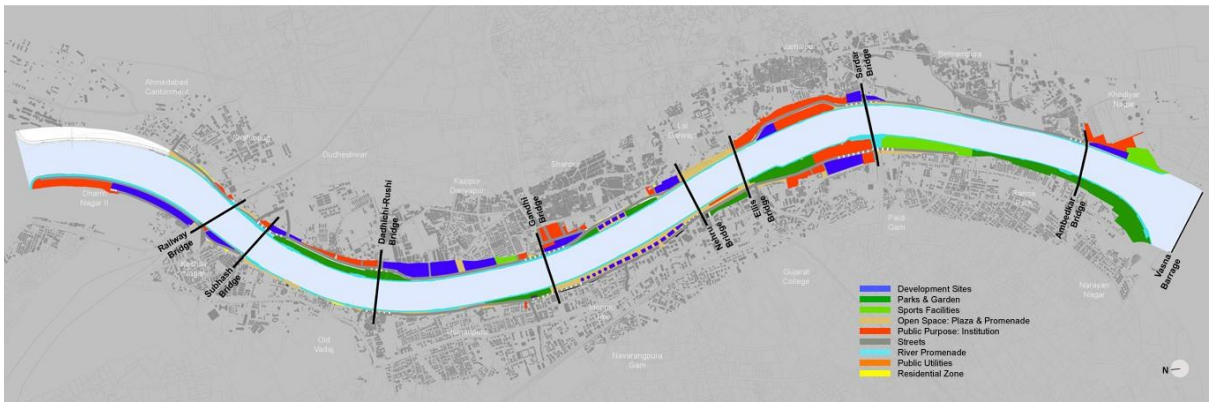


Figure 9: Land use plan of Sabarmati riverfront

Sr. No.	Sanctioned Land Use	Area Sq. m.	Area Ha.	%
1	Road	4,44,378	44	22
2.	Garden	2,74,585	27	14
3.	Open space	3,71,198	37	18
4.	Public purpose	2,88,875	29	14
5.	Lower Promenade	2,66,462	27	13
6.	Multi use for sale	2,94,083	29	14
7.	Sports	72,503	7	4
8.	Residual (Utilities, Residential, Commercial, General, Education)	15,787	2	1
	Total	20,27,871	202.8	

Table 3 land use of Sabarmati riverfront

The riverfront development is of mix land use that includes commercial, recreational and residential developments within the both side of river bank from Gandhi Bridge to Sardar Bridge.

Figure 10: Images of Sabarmati riverfront

5.4 Issues of Sabarmati riverfront:

Till the end of the last century, Sabarmati river in Ahmedabad was mainly known for its association with Mahatma Gandhi, who set up his ashram on its banks. However, things changed in the last two decades as the river made headlines for other reasons — first it was Narmada waters being diverted to its dry bed, then the Gujarat government executing an ambitious riverfront project on its banks.

Sabarmati riverfront project has attracted much more attention because of its concepts and design nationally and internationally. It has won so many awards from central government for its authorities. The international financial institutions have modelled its experiences and strategies as `best practices'. It has been projected in the list of 100 "Most Innovative Projects" hailing it as a project towards 'urban regeneration and environmental improvement which will transform the river as a focal point of leisure and recreation'. The project made it the most happening place in the city that has played host to events like international kite festival, air shows and even the Chinese Premier Xi Jinping.

Though Sabarmati riverfront is being appreciated by government authorities but also criticised by the experts and planners. The existing river restoration/ improvement/beautification schemes indicates that the 'rejuvenation' discourse in the country revolves mainly around recreational and commercial activities. It is more about real estate than river. Concrete wall embankments, reclamation of the riverine floodplains and commercialisation of the reclaimed land are innate components of these projects.

Below image shows the original state of the river and state of the river after reclaiming the land of the river flood plains. Total 202 hectors of land has been reclaimed.

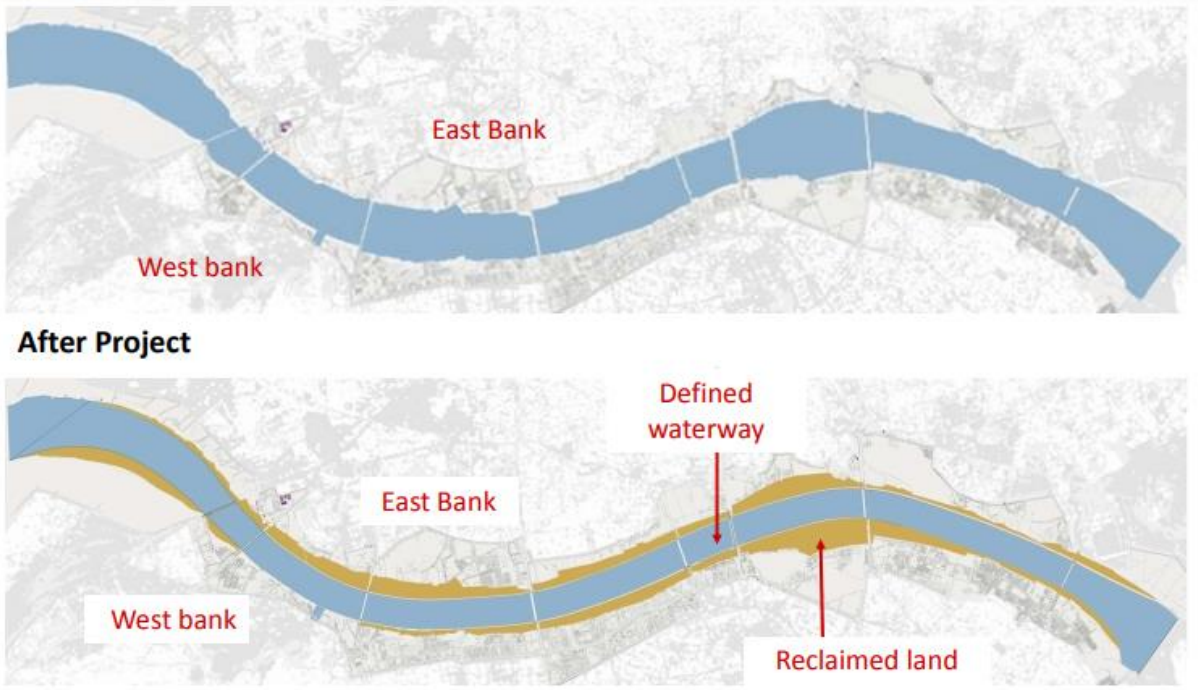


Figure 11: reclaimed land for riverfront

The natural channel width of the river having the narrowest cross-section of 330 metres and the maximum cross section of 600 metres was changed and narrowed uniformly to 275 metres.

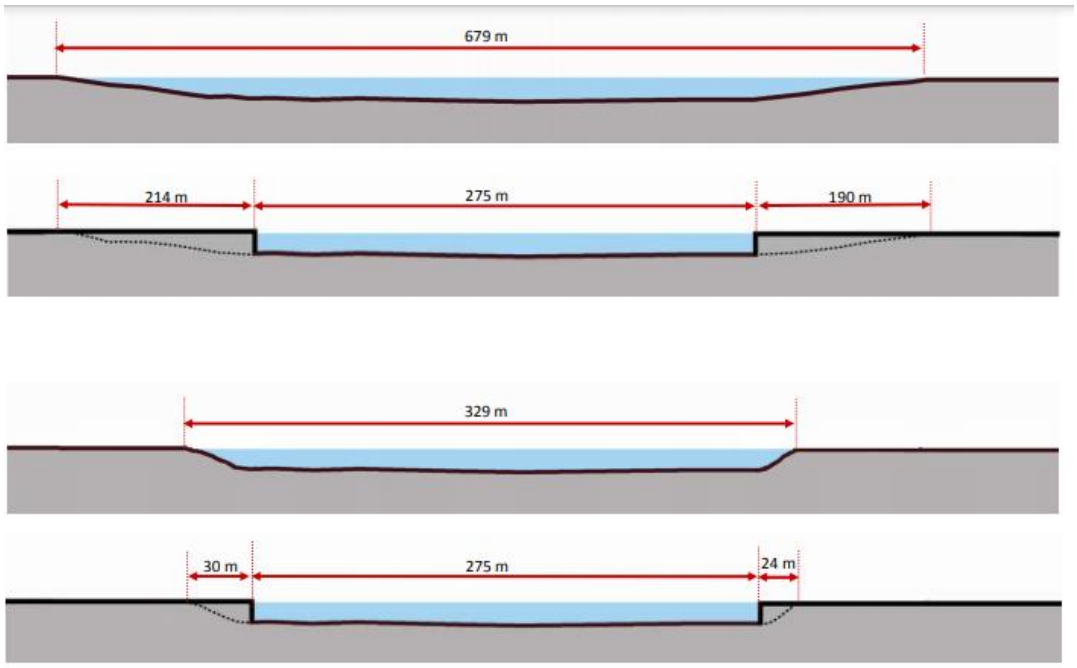


Figure 12: cross sections of the original river bed and cross section of the channelized river

This kind of riverfront development essentially changes the ecological and social scape of the river transforming it into an urban commercial space.

Nature of the sabarmati river is dry river which only flowa during the monsoon season. Also after the construction of Dharoi dam in the up stream, river's flow is drastically redused. When sabarmati river enters into Ahemdabad it doesn't contain any type of water.

Seasonal river system:

Monsoon Rivers have deep and wide floodplain aquifers that run for thousands of kilometres and are an enormous natural storage for water. They get recharged by the river flow and floods, especially during the monsoon. They feed groundwater aquifers in their environs. Recent evidence shows that monsoon flows in Indian rivers are almost unaffected, but the non-monsoon flows show a declining trend. This has manifested in the form of:

- Medium and small rivers originating from mountains, ponds, pools, forests or springs turning into seasonal rivers. Impact is wide spread
- Drying of rivers in the non-monsoon season

It also has three main parts – tributaries, main stem and delta. In the non-monsoon season, tributaries collect GW from sub-soil and transfer the same to the Main River. The Main River, in turn, transfers the same to the delta. The role of tributaries, in the non-monsoon season is to hand over GW to the Main River. In the non-monsoon season, when GW supply stops, the tributaries dry. Reduced supply reduces the flow in the Main River.

The real challenge for river revival is maintaining the continuous discharge of GW into the river. We know that in non-monsoon season, the river flows only because GW is discharged in the river. Discharge takes place only because the lowest point of the regional water table is above the river's bed (which is the lowest point of the area). The moment it drops below river bed level, the discharge stops and therefore flow in the river ceases. Therefore the challenge of a perennial river is to keep water table above the bed level till next monsoon.

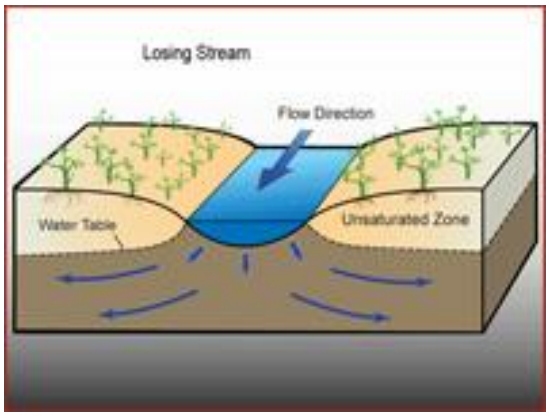


Figure 13: Losing stream during non-monsoon season

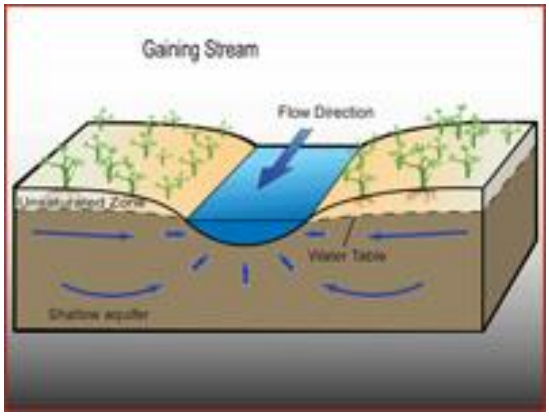


Figure 14: Gaining stream during monsoon

Ground water (GW) is regarded as a reliable water source in India and continues to be used on a large scale for agriculture, drinking water supply in rural areas and in the industrial sector. This preference has resulted in over exploitation of GW. While near normal GW replenishment is generally attained in the monsoon, lack of proportionate recharge mechanisms and excess exploitation of GW in the Rabi season has led to drying up of wells, tube wells and ponds. As a result, contribution by tributaries to major rivers has decreased leading to decreased flow of major rivers.

Ground water of Ahemdabad:

According to the CGWB reports, Ahemdabad falls under the dark zone for ground water levels. Flood irrigation technique which is practised in the area is also the major cause of wastage of ground water as there is no control on the watering depth. Replacement wells, increase in well depth, prime mover, declining well yields are also the major issues.

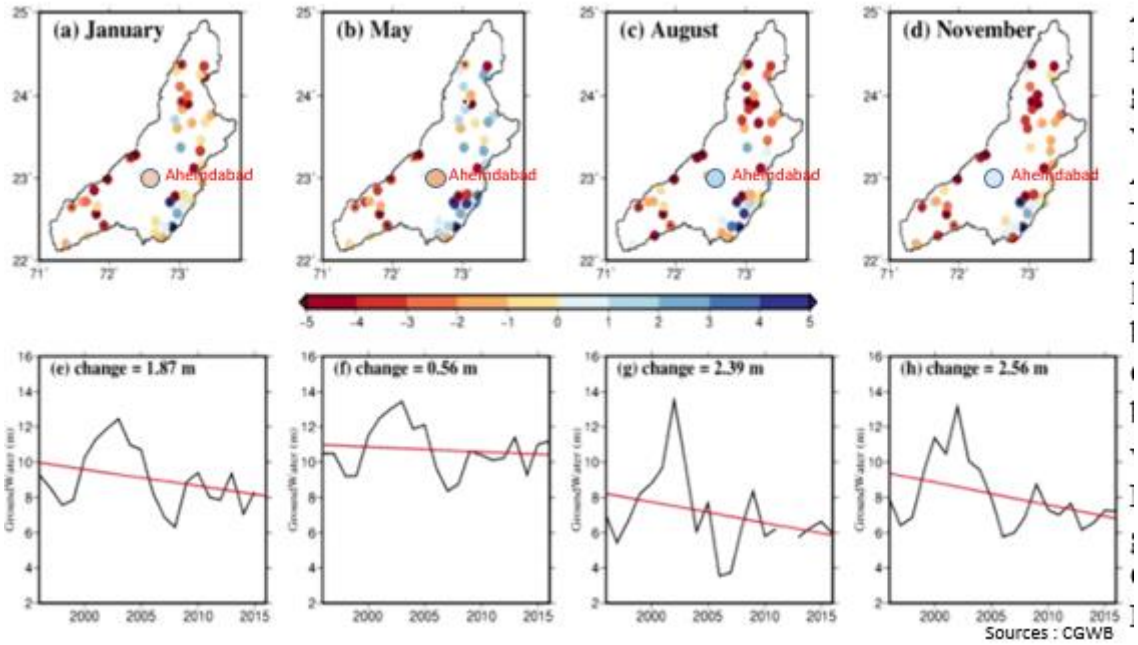


Figure 15: GROUND WATER LEVEL OF AHEMDABAD DURING WHOLE YEAR

As shown in image in January and May ground water goes very to -1 and -2 . In August and November, after monsoon water levels go higher between 1 to 2. Ground water level between 2000-05 was at its highest. But after 2005 it goes down DUE TO OVER EXPLOITATION. The ground water level during the premonsoon period ranged from 2.28 to 22.58 mbgl. The shallowest Water level was recorded 2.28 mbgl and the deepest water level was recorded 22.28 mbgl . The ground water

level during the post monsoon period ranged from 1.06 to 16.52 mbgl. The shallowest Water level was recorded 1.06 mbgl and the deepest water level was recorded 16.52 mbgl.

Because of the overexploitation of the ground water Sabarmati runs dry hen it enters into Ahemdabad. There should be some planning strategies to increase the ground water storage and to control the over usage of ground water.

Narmada water pouring into Sabarmati River:

The total storage capacity of the riverfront is 10-12 million cubic metre of water. As Sabarmati River is dry river and its own water has been stopped at Dharoi dam it runs dry in non-monsoon season. So for the aesthetic purpose, water from Narmada canal has been poured in Sabarmati.

Figure 16: Narmada water flowing into Sabarmati River

For a very long time Narmada water is being directed into Sabarmati which drew criticism. Finally state government asked the AMC to ensure that the riverfront should get water by five STPs instead of Narmada canal. This work was supposed to be completed by 2019 but still today in 2021, Sabarmati riverfront gets water from Narmada canal.
Narmada water is not meant for aesthetic purpose so it cants be used for Sabarmati riverfront. Also Narmada officials are denying to giver water for Sabarmati river front because Narmada water is for drought prone areas and irrigation purpose.

Water quality of Sabarmati River:

Sabarmati River no longer has any fresh water when it enters the city of Ahmedabad. The Sabarmati Riverfront has merely become a pool of polluted stagnant water while the river, downstream of the riverfront, has been reduced to a channel carrying effluents from industries from Naroda, Odhav Vatva, Narol and sewerage from Ahmedabad city. The drought like condition of the Sabarmati River intensified by the Riverfront Development has resulted in poor groundwater recharge and increased dependency on the already ailing Narmada River.

RESULT OF WATER SAMPLES TESTED ON VARIOUS STRETCHES OF SABARMATI ON MARCH 2, 2019

PARAMETER Pt. Co. Scale	Colour mg/l	TDS mg/l	NH3-N mg/l	Chloride mg/l	Sulphate mg/l	DO mg/l	COD mg/l	BOD mg/l
Railway Bridge	30	668	4.31	153	96	4.66	98	28
Danilimda-STP (60-106 MLD STP)	50	732		186	108		337	139
DaniLimda Storm Water Drain	150	3135	10.13	933	462		1301	536
New Pirana 182 MLD STP							587	218
MEGA	450	9813	30.18	4025	863		1052	210
Narol NTIEM	200	5290	79.91	1600	743		1126	427
Sabarmati River Downstream	150	4368	68.04	1665	612	BDL	1009	447
Miroli Village		1466	31.97	491	188	BDL	151	33
Effluent Discharge Norms	100	5000 mg/l	50 mg/l	600 mg/l	1000 mg/l		250 mg/l	30 mg/l
River Norms	Nil	500 mg/l	Nil	Nil	Nil	> = 5 mg/l	Nil	< = 3 mg/l

The cream patch is the ideal permissible of the various parameters the river should have

Table 4: water quality data

The alarmingly critical and dangerous levels of pollution, far exceeding permissible levels, as recorded in the investigation report, are summarised below:

▪ The Water in Sabarmati Riverfront has 4.66 mg/l DO, 98 mg/l COD, 28 mg/l BOD, 96 mg/l Sulphate, 153 mg/l Chloride, and 668 mg/l TDS.

▪ The First Outfall of STP of Ahmedabad after Vasna Barrage (After Sabarmati Riverfront) 160 MLD has 337 mg/l COD, 139 mg/l BOD, 108 mg/l Sulphate, 186 mg/l Chloride, and 732 mg/l TDS.

▪ The Second Outfall industrial effluent of Ahmedabad after Vasna Barrage – Strom Water Drain from DaniLimda (After Sabarmati Riverfront) has 1301 mg/l COD, 536 mg/l BOD, 462 mg/l Sulphate, 933 mg/l, Chloride, and 3135 mg/l TDS.

▪ The Third Outfall of STP of Ahmedabad after Vasna Barrage (After Sabarmati Riverfront) 800 MLD has 587 mg/l COD, and 218 mg/l BOD.

▪ The Fourth Outfall of Industrial Effluent from Naroda, Odhav and Vatva industrial Estates (Mega Pipeline) after Vasna Barrage (After Sabarmati Riverfront) 40 MLD has 1052 mg/l COD, 210 mg/l BOD, 863 mg/l Sulphate, 4025 mg/l Chloride, and mg/l 9813 TDS.

▪ The Fifth Outfall of Industrial Effluent of Narol after Vasna Barrage (After Sabarmati Riverfront) 100 MLD has 1126 mg/l COD, 427 mg/l BOD, 743 mg/l Sulphate, 1600 mg/l Chloride, and 5290 mg/l TDS.

▪ The Sabarmati River 100 mtrs. after STPs and Industrial Effluent Outfall has BDL (Beyond Detection Limit) DO, 1009 mg/l COD, 447 mg/l BOD, 612 mg/l Sulphate, 1665 mg/l Chloride, and 4368 mg/l TDS.

▪ Miroli Village pumping station 21 Kms. downstream of Vasna Barrage BDL (Beyond Detection Limit) DO, 151 mg/l COD, 33 mg/l BOD, 188 mg/l Sulphate, 491 mg/l, Chloride, and 1466 mg/l TDS.

The pathetic and dismal condition of the Sabarmati River is a cause of grave concern for the health of the people of the Ahmedabad city and the villages around Sabarmati River downstream of Riverfront who rely on the river water for their daily use and livelihood. Some of the major direct and indirect effects of the high levels of pollution on the people and environment includes contamination of ground water, food contamination, associated health hazards, loss of natural river habitat, depletion of ground water levels due to lack of water recharge, loss of flora and fauna, etc. Urgent action is necessitated in light of these findings to rejuvenate and restore the Sabarmati River and its water quality, which calls for the strict implementation of the Supreme Court Order by the concerned authorities.

For a long time the perils of dumping untreated faecal sludge into our rivers has been ignored in our government policies. Today, this neglect has manifested to become one our gravest public health threats. And now research has found the highest concentration of highly antibiotic resistant E.coli bacteria just besides Sabarmati Gandhi Ashram on the riverfront. It is exactly here that the Chandrabhaga drainage spews out the highest amount of untreated sewage - 60 million litres every day into the Sabarmati. A detailed investigation carried out by Ahmedabad Municipal Corporation (AMC) has noticed six major and 10 minor outlets in the city that circumvents our city's sewage treatment facilities.

After Chandrabhaga, the next highest untreated sewage is injected into the Sabarmati from AMC's Vasna treatment plant, 48 MLD. At Dafnala the AMC found drainage outlets that spewed 20 MLD of untreated sewage into the river. In each of these areas like Koteshwar Motera and Acher the Ausmeasured 5 VD untreated sewage being let out in the Sabarmati.

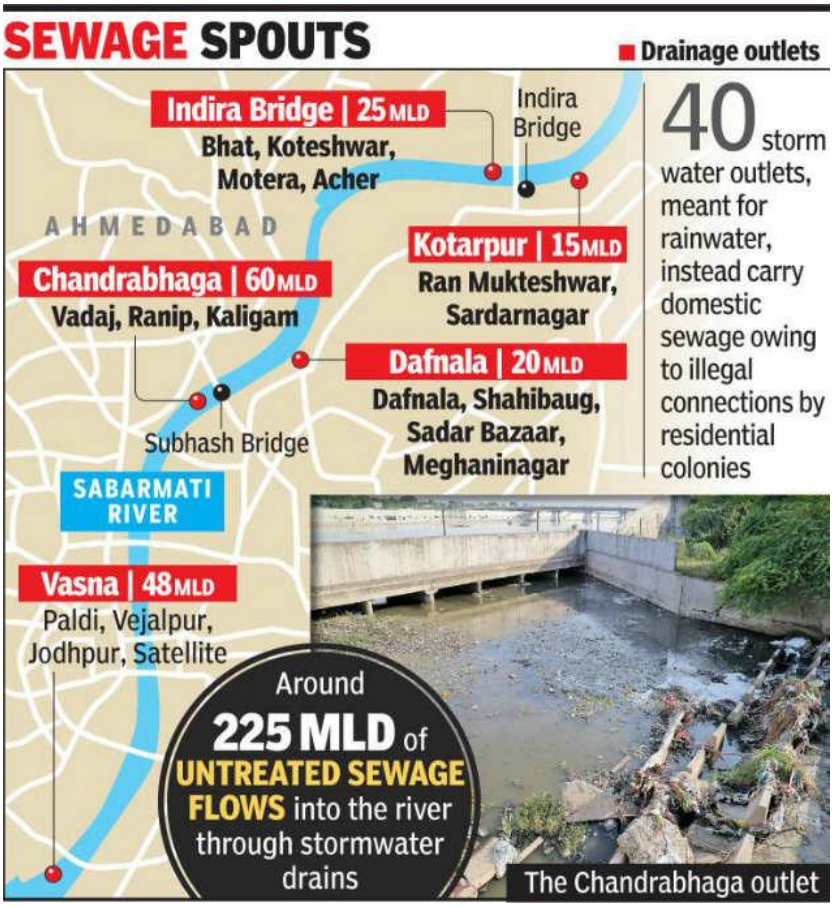


Figure 17: misuse of stromwater outlets

The upstream of Sabarmati river — the area beyond Chandrabhaga and Dafnala — there were housings societies that were major contributors to illegal untreated sewerage. But the civic body admitted that there was a lack of long-term vision in managing sewage. The city with a population close to 7 million had a capacity to treat 817 MLD of sewage against a generation of 960 MLD. The AMC recently finalized plans for enhancing treatment facility to 428 MLD. In the five years from 2011 there was no increase in the sewerage treatment capacity, despite the increase in the population of the city. The official also admitted that there were not less than 40 outlets of storm-water drainage which carry nearly 225 MLD untreated sewage every day into the river.

Major Towns on the banks of the river with population	:	Ahmedabad:- Total City Population: 65 lacs
a. Total water consumption and sewage generation in MLD	:	**Total Water consumption:-** Approx. 1350 MLD (AMC Supply every day to the city) Total Sewage generation:- Approx.:- 880 MLD in to river Sabarmati (Approx.:- 1080 MLD sewage generated from entire city area. Out of which approx. 200 MLD sewage from Northern and Eastern side of Ahmedabad city is diverted to STP at Vinzol for further treatment and discharged into river Khari and nearly 880 MLD sewage is discharged into river Sabarmati)
b. Total no. of existing STPs and the total capacities in MLD	:	**No. of existing STPs:** - 08 Nos. **Total capacities of STPs:-** 855 MLD
c. Gaps in sewage treatment in MLD and no. of towns not having STPs	:	Total Gaps in sewage treatment:- 25 MLD. However, New STPs with total 265 MLD capacity are proposed by AMC

Table 5: total capacity and gaps of STPS of Ahemdabad

Above table from GPCB reports shows that the gap in sewage treatment is only 25 MLD. Then why this 225 MLD untreat water is being released illegally into sabarmati is a big question mark.

In spite of the Supreme Court Order dated 22.02.2017, directing strict compliance of effluent treatment standards, continuous monitoring and closure of defaulting industries and Orders dated 03.08.2018 and 19.02.2019 of the National Green Tribunal, Principal Bench, Delhi, GPCB is failed in its duties for keeping river pollution free.

DPSIR MODEL:

The Driving forces-Pressure-State-Impact-Response concept (DPSIR) provides a heuristic framework for the analysis of cause-effect relationships in complex systems which are subject to human action. The general idea behind the DPSIR concept is that human activities, i.e. the drivers, exert a certain pressure on a particular part of the natural environment causing a change in its components and/or in its overall state. The outcome of this process is an environmental impact, which usually results in certain responses by society. The DPSIR framework is a systems-thinking framework that assumes cause-effect relationships between interacting components of social, economic, and environmental systems. The DPSIR framework has been used for many environmental resource applications, including management of agricultural systems, water resources, land and soil resources, biodiversity and marine resources. The DPSIR framework also can be used to integrate social, cultural, and economic aspects of environmental and human health into a single framework. DPSIR has most

commonly been used in the context of environmental management to link ecological and socioeconomic factors

1. Driving forces: socio economic or socio cultural forces driving human activities which increase or mitigate pressure on environment.

2. Pressures: direct stresses that human activities place on the environment.

3. State: the condition od currant environment

4. Impact: effects of environmental degradation

5. Actions of human system to mitigate the impacts

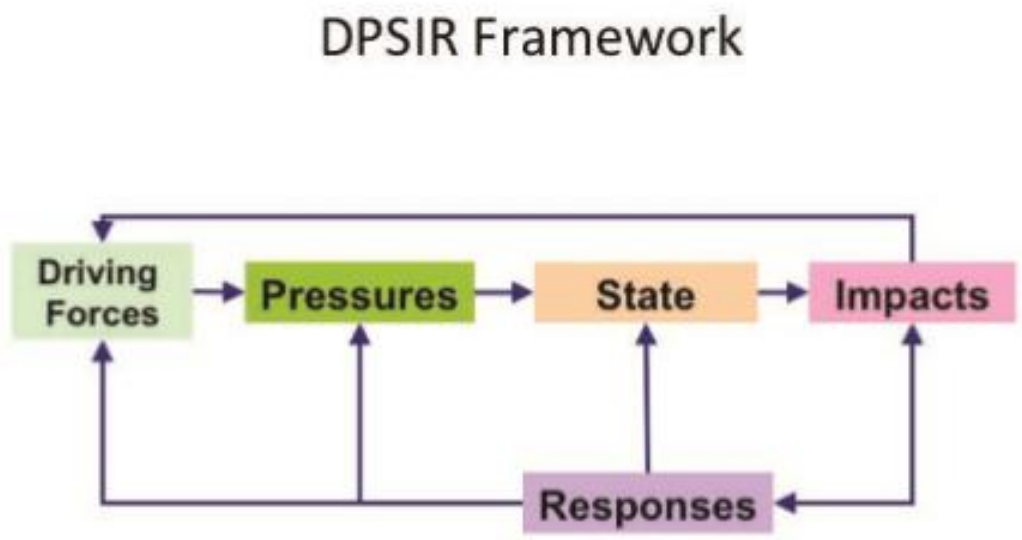


Figure 18: DPSIR frame work

In Sabarmati's case DPSIR model:

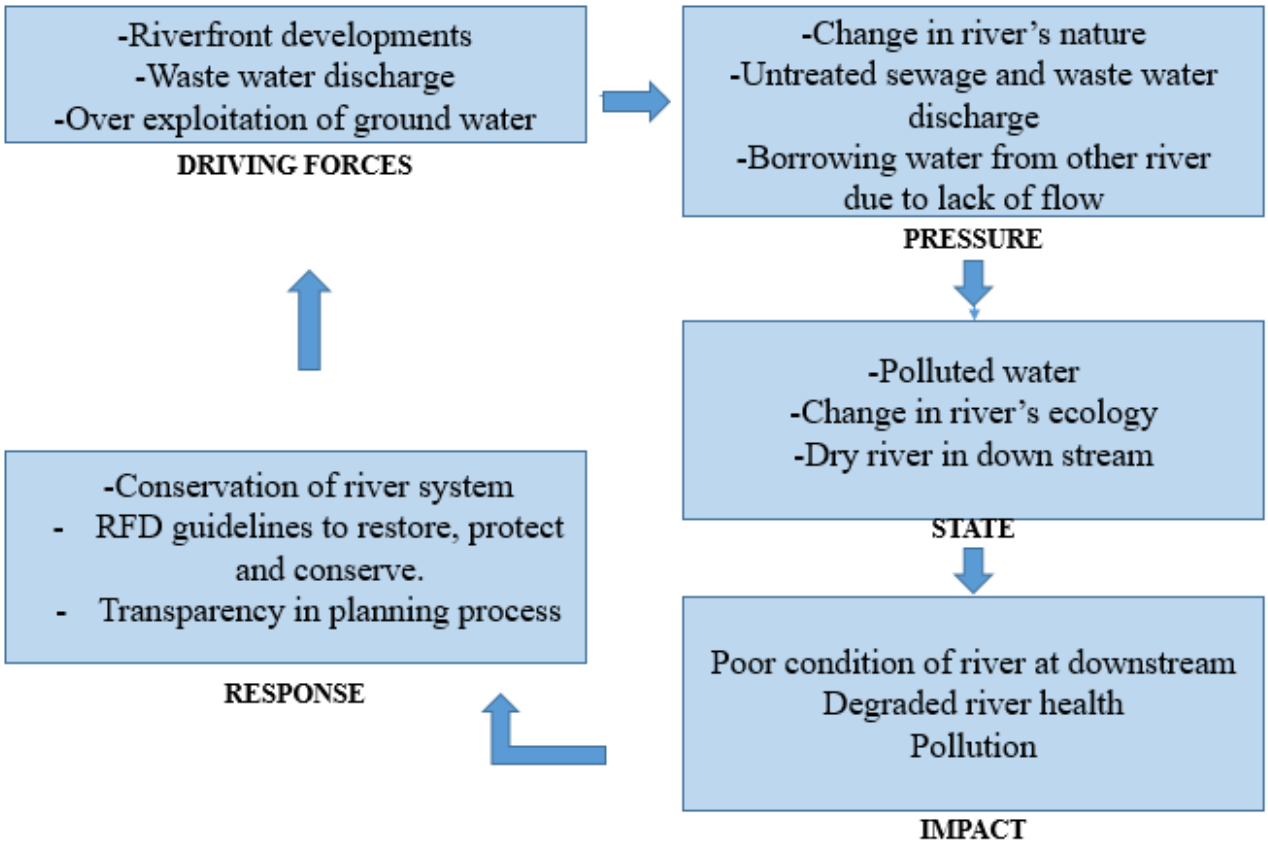


Figure 19 DPSIR for Sabarmati riverfront

6. Findings

- Currently Sabarmati riverfront is filled by Narmada water but Narmada water is not meant for aesthetic purpose so it cants be use for Sabarmati riverfront and also Narmada officials are denying to giver water for Sabarmati river front. So that other aspects for filling the water should be worked out.
- The main reason for dried river is over exploitation of ground water. Ground water usage of Ahemdabad city for irrigation and other purposes are higher. Balance between demand and supply should be maintained.
- There is a lack of environmental flow of river after Dharoi dam which needs to be maintained.
- Pollution is the biggest issue of Sabarmati river which needs to be solved as soon as possible.
- In proposed phase 2 also planners have not considered River edge conservation and river's ecological condition.
- As Ahemdabad has already 11km long riverfront for recreational, social and economic purposes so this second phase should be planned for conservation purpose rather that economical hub.
- There is no transparency in planning process of the riverfront.
- Khadakwasla laboratories has been given a safe certificate to riverfront development in 60's at that time climatic crisis and pollution was not such a prominent issues. So that tests are not viable for todays condition.
- In spite of the hydrological reports by Roorky, which says that Sabarmati riverfront is not flood controlling model, authorities doesn't made necessary changes in design which leds to the floods.
- Authorities were asked to submit the environment impact assessment but it was not submitted.
- In spite of the Supreme Court Order dated 22.02.2017, directing strict compliance of effluent treatment standards, continuous monitoring and closure of defaulting industries and Orders dated 03.08.2018 and 19.02.2019 of the National Green Tribunal, Principal Bench, Delhi, GPCB is failed in its duties for keeping river pollution free.
- The River Sabarmati itself was a perennial river till the Dharoi Dam in the upstream stopped all water at least in non-Monsoon months, making the river dry. The stretch flowing after river front through Ahmedabad was carrying the mostly untreated sewage of Ahmedabad city and toxic effluents from the City and district industries.

7. Recommendations:

- As the river is a vibrant ecosystem which bestows numerous ecological functions It is of critical importance to retain these natural functions and processes. This necessitates that the ecological value must be prioritized over the economic utility arising from the river.
- Instead of concretizing the entire area, an option of both hard & soft land, some bricked up and some left as an open expanse, which at times would be flooded and occasionally dry and retained, would create an ever changing dynamic picture with the river as the focal point.
- Instead of beautification conservation of river is much needed. For the conservation of rivers ecology urban forests should be implied and natural materials should be used like gabion wall as retaining wall which helps to seepage the water in floodplains.

Figure 20: Gabions as retaining wall

- In existing structure where urban forest has been planned, planners can develop that area as natural water front by removing concrete and using gabions as retaining wall.
- In river planning environmental planners, geographers and ecologists views should also consider.
- Incorporation of guidelines for river centric planning given by MOUAHA
- Before the construction of such a big project ENVIRONMENTAL IMPACT ASSESSMENT report has to be prepared to improve the river's health.

- For reusing the treated sewage water in Sabarmati riverfront tertiary treatment of water is required. Tertiary treatment adds a third, more advanced and rigorous level of treatment. Primary and secondary treatment typically get wastewater only clean enough to discharge safely into the environment.
- There is a prohibition for directly realising untreated sewage and industrial water into river but these rules should be followed strictly. GPCB should take strict steps for not following the rules.
- Create opportunities for peak flood storage outside the channel. This will support the maintenance of flow in non monsoon seasons and helps in ground water recharge.
- Create a continuous functional riparian corridor that provides habitat for birds, mammals, amphibians, reptiles, invertebrates, and fish within the channel bottom.
- In riverfront planning social, economical and environmental factors should be planned in a balanced way.
- As the river is a vibrant ecosystem which bestows numerous ecological functions It is of critical importance to retain these natural functions and processes. This necessitates that the ecological value must be prioritized over the economic utility arising from the river.
- As in India currently riverfront developments are following the Sabarmati's model, there should be Guidelines for riverfront development to mitigates the impacts of riverfront on rivers health:
- Construction of the riverfront should be smaller from 2-5 kms.
- Active flood plains of the river should be prohibited for any type of construction.
- In riverfront planning, reviews of environmental planners and ecologists should be taken so that rivers ecology can be maintained or improve.
- Recreation should be limited to ecotourism for example- water sports where environmentally viable, green corridors, developments of passive greens etc.
- Prohibition for releasing untreated sewage and industrial influents directly into river.

Conclusion:

- Riverfronts are the most practised projects for river planning in India. Beautification of the river should be done along with the conservation of the river. Main goal of the riverfronts should be ecological upliftment rather than economical profits. Riverfronts should be designed by proper study of river's nature and its ecology. In India planning authorities are blindly following the Sabarmati riverfront without proper understanding which led to the disaster. River being a public entity and the dependency of various livelihoods on the rivers, makes it important to consider the local river needs. The planning exercise shall involve stakeholder consultation for incorporating strategies that improve this citizen-river connect. a set of basic guideline or minimum standards is created which can be further adopted while planning and designing future riverfront projects.

APPENDICES:

Name:

Designation/Qualification:

Date:

1) **What are your views towards River sensitive planning?**

2) **How is current urban waterfront development affecting rivers?**

3) **How urban waterfront developments should be which won't affect rivers health?**

4) **What are your reviews regarding Sabarmati riverfront?**

5) **How is Narmada River's water affecting Sabarmati river basin?**

6) **Narmada should be used for aesthetic purpose?**

7) **What are the changes in LULC after riverfront construction?**

8) Is Sabarmati river front is an ideal model?

-If yes then why?

-If no then why and how it should be? What are the ways to make the situation better?

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