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1. INTRODUCTION

1.1. INRODUCTION

People are inherently drawn to water; hence waterfront is an important aspect which defines the character of place and the users. It is the lure of water, its sparkle, its reflection, its endless movement and change that both captures human imagination and provides a variety of opportunities from business to recreation, from active to passive activities. Nothing quite compares to the experience of being close to the water edge.

A waterfront is the zone of interaction between urban development and the water and a waterfront area is considered as a unique and irreplaceable resource where it is the interface between land, water, air, sun and productive plants. Moreover, the waterfront is characterized as a place integrating land with water and having a natural attraction to people. The seashore and riverfront are the most attractive water features for human settlement and, in most countries; the land in front of water is developed earlier than the inland areas.

Waterfront development refers to any development in front of water and a water body; a river, lake, ocean, bay, creek or canal. In the development area, considered that a waterfront development may not necessarily need to be directly fronting water but may only need to look attached to the water. They believe that commanding a view of water can still be considered as a waterfront property.

A detailed definition by Guo (1998) as cited in Dong (2004, p. 7) described the waterfront as the interface point where land and water meet, between approximately 200 to 300 meters from the water line and 1 to 2 km to the land site and also takes in land within 20 minutes walking distance.

In many cities in the world, waterfront areas began as commercial centers, transportation hubs and manufacturing centers, as a central focus for them. However, due to complex and multiple problems such as technology change, the historic preservation movement, increased environmental awareness and urban renewal, a dramatic change in waterfront areas was brought about and

they became large spaces of unused property in the past thirty years or so. Whereas the early examples of waterfront development primarily focused on leisure and retail, contemporary schemes have a broader scope; many are set up with the aim to create attractive mixed urban environments that appeal to the imagination of people and persuade them to work there, to live there, or to visit these.

Breen & Rigby (1996) assign developed waterfronts into six distinct groups: commercial waterfronts; cultural, educational and environmental waterfronts; historic waterfronts; recreational waterfronts; residential waterfronts; and working waterfronts.

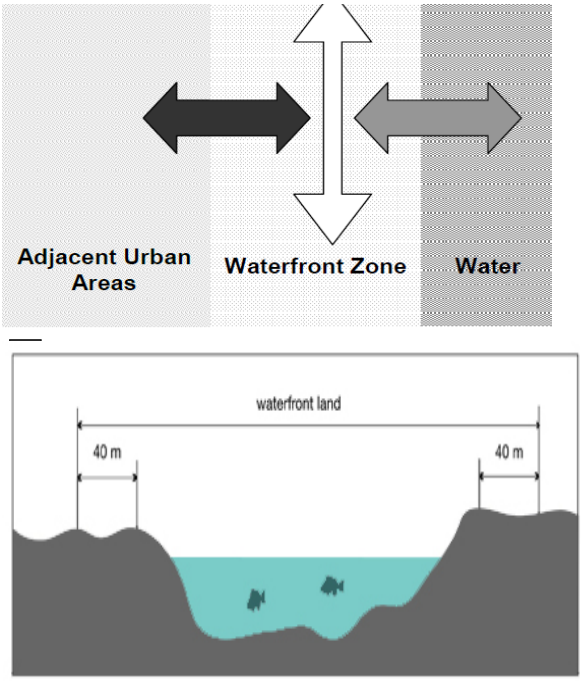


Figure 1. Waterfront Zone

1.1.1. CITIES AND WATERFRONT

Over the past few decades, there has been an increase in nationwide interest in restoring urban rivers, whether for open space or recreational purposes or as a catalyst for economic development. All across the country, cities that once turned their backs on their rivers are now welcoming them with open arms. They have realized the importance and opportunities presented by being located on the waterfront and are working towards developing a new and improved image. These cities have an advantage of inheriting rich

natural, cultural and historic values, and provide a wide variety of water oriented and enhanced recreational experiences.

Riverfront sites with the greatest potential are often among the most ignored sections of our cities. These sites are dirty, abused, derelict, and plagued by environmental issues: unstable landfills, contaminated soils and water, lost habitats, disturbed artifacts, trapped sedimentary pollutants, etc. Flooding was also a major issue in all towns located on the river. Rivers were straightened and lined with concrete to regulate their flow and control flooding. City residents were completely cut off from their rivers. Despite these issues riverfronts are still valued.

Today, cities across the world seek a riverfront that is a place of public enjoyment. They want a riverfront where there is ample visual and physical public access - all day, all year - to both water and the land. Cities also want a riverfront that serves more than one purpose: they want it to be a place to work and live as well as a place to play. In other words, they want a place that contributes to the quality of life in all of its aspects - economic, social and cultural.

Festivals and water sports are perhaps the most visible public- oriented activities that have played a key role as the main attraction for the development. Waterfront is not only a physical space to accommodate the new features but also a symbol of space.

1.2. SITE INTRODUCTION

The Gandak River is also known as the Kali Gandaki and Narayani. It is a tributary of the Ganga River and one of the major rivers in Nepal and India. The entry point of the river at the Indo-Nepal border is at the convergence of Gandak, known as Triveni.. The river flows across the Gangetic plain of Bihar state and eventually merges with the Ganga near at Hajipur.

Located at 26km from capital city Patna, Hajipur, in ancient times was known as Ukkacala. Total area of the town is 156.91 sq.km according to 2001 survey with 39 wards. The population is 1, 47,688 as per census 2011. The economy of town is 55% service based, 9% industry and 35% agriculture based.

1.2.1. NEED OF STUDY

Being enriched with such fluvial body and historical culture, the river is yet neglected. The importance could be observed during festivals like “Ganga snaan” and Chhat puja which is most important festival celebrated on river banks in Bihar. Apart from festival period, the riverfront does not mark any resonant activity. It is almost abandoned except few devotees visiting the temples located on the banks. It posses deterrioted ghats, dirty and unstable edges, garbage and sewage disposal all along the river edge. Since, it a small and densely populated town, there is no provision for any recreational space for the users to relax and enjoy. Therefore, developing the riverfront as recreational space integrated with its rich cultural history would provide the residents of town and the visitors a leisure space and the town, its unique identity.

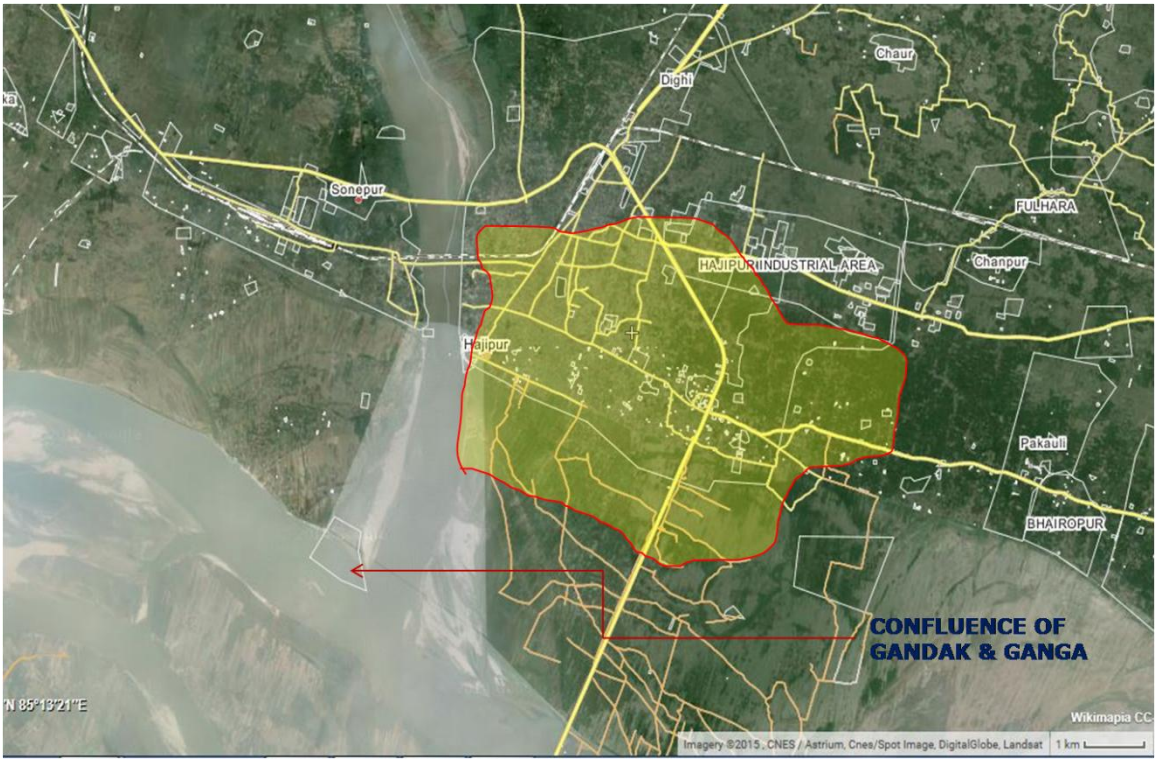


Figure 2. Site

1.3. AIM

To create a unique cultural platform with recreational facilities serving to the town, its people and tourists with the river as vibrant and vital focus.

1.4. OBJECTIVES

To understand the negotiation of town with the river over the period of time.

To study the river in its physiographic settings and its catchment.

Understanding the environmental impact of river with the surrounding.

Study the landcover and landuse to delineate the critical zone.

To map the network of open space in the town to conclude the requirement of open and recreational space in the town.

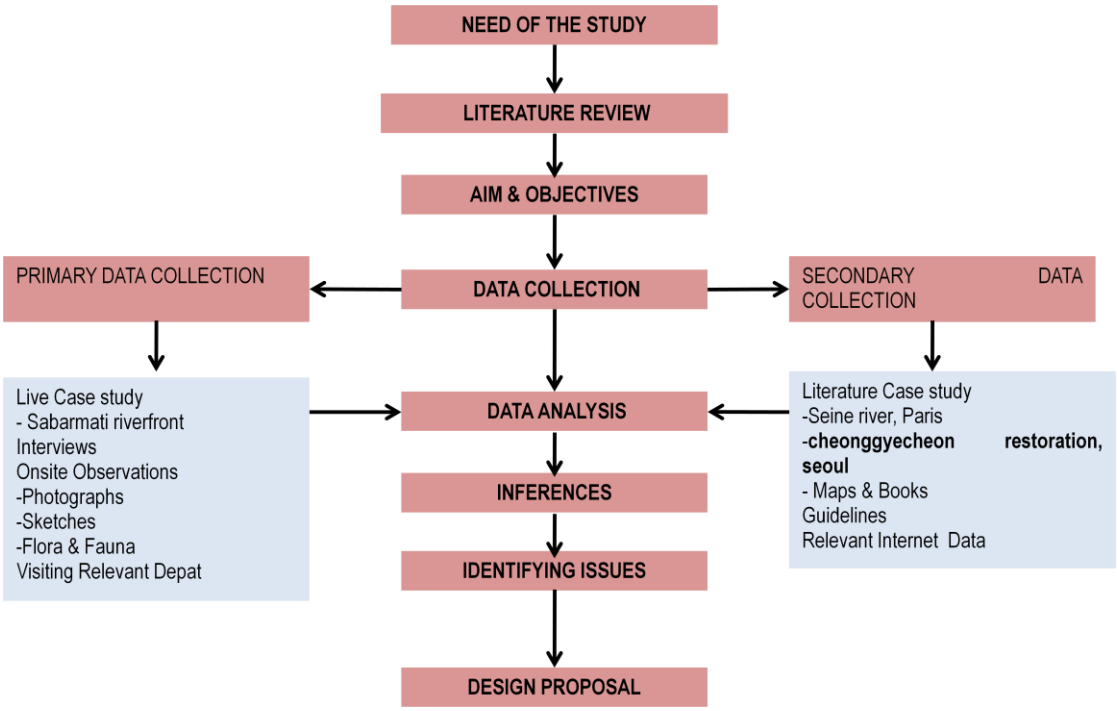
To devise a landscape design intervention.

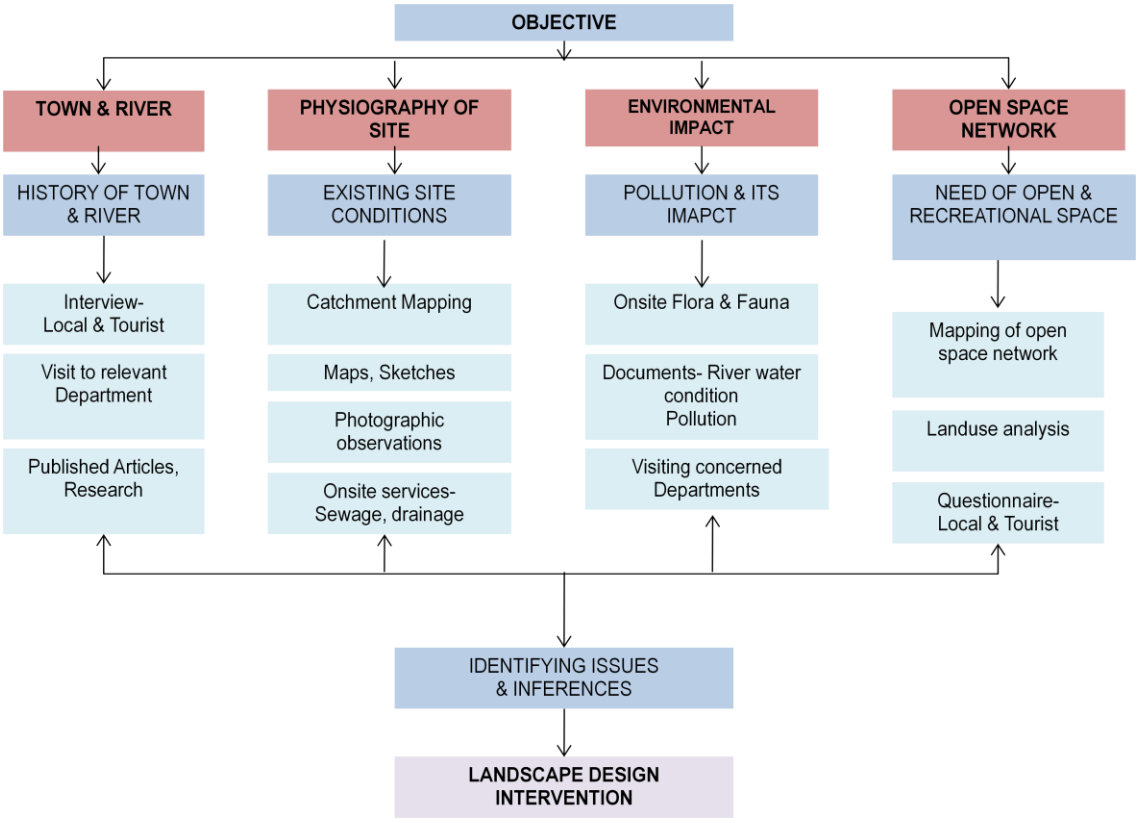
1.5. SCOPE AND LIMITATION

Study of entire 3.5 km stretch which would further help to provide guidelines.

The proposal will be environmental sustainable, it will not reinforce any idea which will harm the ecological balance.

1.6. METHODOLOGY





2. LITERATURE REVIEW

Historically many cities came into existence because of the presence of a river. Riverfront redevelopment offers opportunity for a city to educate its residents and visitors about the city's cultural heritage. River corridor represents greatest challenge and greater opportunity to redefine a city. To understand the opportunities available along the river corridor, it requires understanding the historical role of river in the development and the unique combination of factors that influence the urban riverfront development. The development should therefore be sensitive to geography, culture, timing, existing development, old structures and activities.

2.1. HISTORY OF RIVERFRONT CITIES

Kılıç (2001) as cited in Hamamcıoğlu (2005), water resources which have played an important role in most parts of the world throughout history in the establishment and formation of the settlements and through their getting their own identities (Pekin, 2008). Sairinen & Kumpulainen (2006), waterfront identifies the water's edge in cities and towns. Moretti (2007), in pre-industrial cities, waterfront areas were intensely used and thriving with people and activities.

Later industrial plants were abandoned and forms of transportation changed (Wrenn et al., 1983). Also with the increasing environmental awareness and as a consequence of the pressure for upgrade in a urban areas, waterfronts were rediscovered in the city. So, phenomenon of waterfront regeneration emerged. Urban waterfront regeneration projects have become an effective tool for urban planning and politics an international dimension since 1980's (Sairinen & Kumpulainen, 2006; Goddard, 2002).

One reason for the importance of natural water source in urban area is aesthetic effects whose creates on human. These effects are visual, auidal, tactual and psychological effects. The primarily power of attracted people on waterfronts is visual landscape effects of water on relaxation. Throughout, designs related to water takes over motion and serenity factors.

2.2. URBAN WATERFRONT FEATURES

Akköse (2007), three factors are more important in forming the cities. The first of these is the natural structure of the city, the second of these is physical structure of the city, and the other one is social structure of the city. Dong (2004) indicated that the meaning of the waterfront development has different in terms of understandings. Also he/she emphasized that the content of waterfront development varies greatly with respect to the characteristics of sites and cities.

Typical pattern of waterfront development

Throughout history, waterfronts are the most ideal living area for human being to be able to provide food, settling, reproduction, defense and learning etc.

Historically, waterfronts aren't planed carefully and consistently. Growth had been increasing and disconnected as a result, synthesis of numerous enterprise, activities and decisions of political authority.

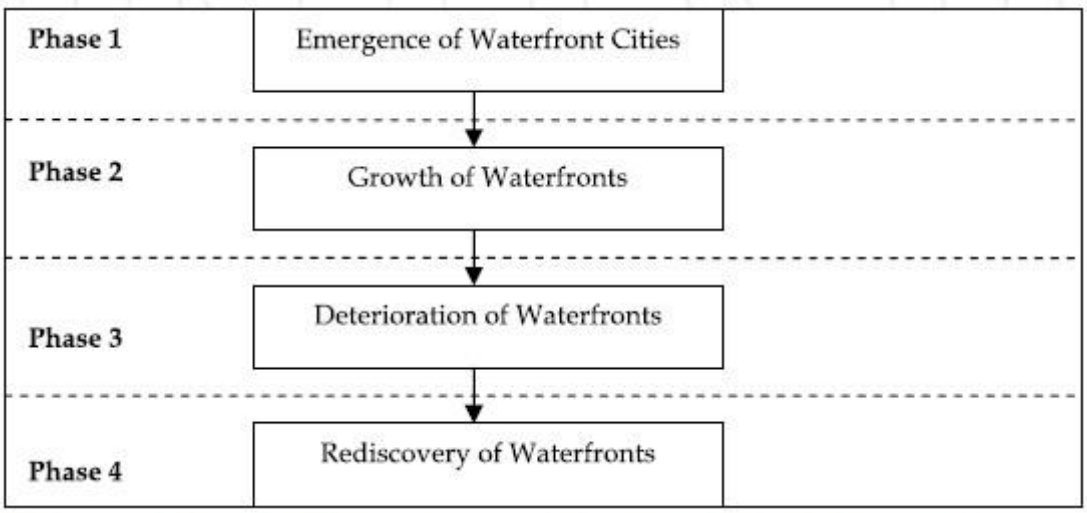


Figure 3. Typical pattern of waterfront development phases

Source: Urban waterfront Regenerations- Umut Pekin Timur

2.3. Emergence of Waterfront Cities

The early American settlements, the waterfront and the city was directly contact. Waters plays an essential role for trade activity and water transportation. Settlements were established and European immigrant colonies arrived.

2.4. Growth of Waterfronts

At this time, the settlement became a city and maritime trade stimulated urban development. In meantime, contact directly with water is lost as construction of warehouses; railway and highway create a barrier to public access.

2.5. Deterioration of Waterfronts

As a result of developments in maritime industry, thereby growing port activities started to need new areas (Akköse, 2007). So, the old ports lost the role as the transportation and industry center. Beside these changes, increasing public interest over pollution contributed to the waterfronts demise.

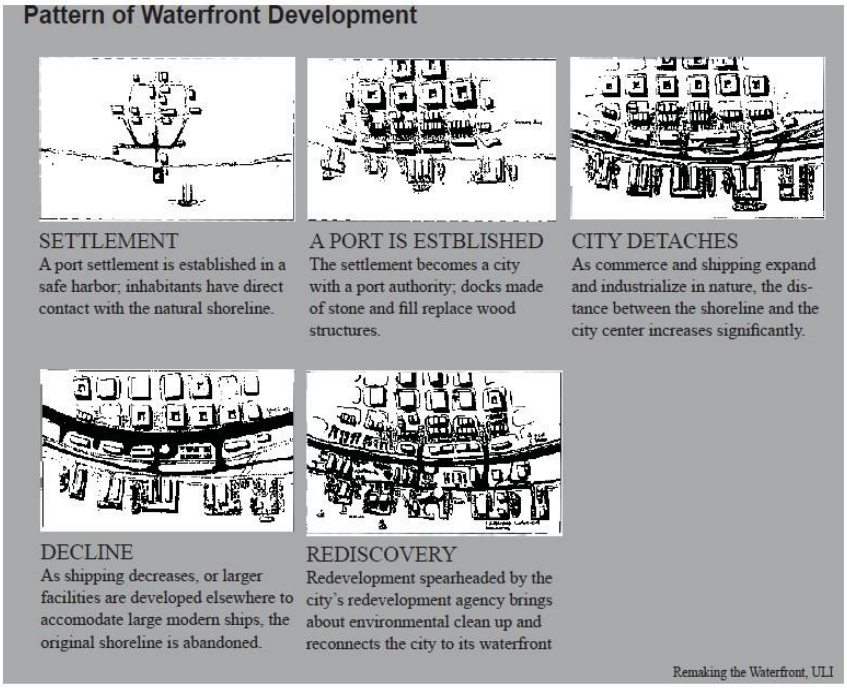


Figure 4. Remaking the Water front

Source: ULI

2.6. Rediscovery of waterfronts

In the 1960's, people became more concerned about environmental-city health and the misuse of natural resources. Locals wanted to recover the aesthetic scenery of the waterfront which had been neglected for years. U.S. Department of Commerce, NOAA and OCZM (1980), it was at this time that

an opportunity exists for the public use and a mix of recreational, residential, and commercial uses were developed.

Waterfronts vary depending on many interrelated factors. These are a city's history and size, its location, land structure and climate, the diversity of water-related uses and city's management status. For this reasons, each waterfronts may be some variance in the typical waterfront evolution pattern. But, one fact is common, urban waterfronts dramatically changed because of the influence of social and technology factors.

2.7. Urban waterfront regeneration

As most of the waterfront development projects arise in the larger context of urban renewal, for these projects a number of other expressions are used similar to this phrase.

The interest of waterfront regeneration phenomenon emerged from North America in the mid 1960's, with a rehabilitate of Baltimore's Inner Harbour, a project that transformed the degraded harbor zone to an urban leisure centre (Papatheochari, 2011; Al Ansari, 2009; Goddard, 2002; Tastsoglou & Dimitra, 2012). Also Jones (1998), indicated that the movement of waterfront in US is attributed to a few of factors which have involved the following:

The increasing amount of leisure time and the need for more recreational area,

The need to conserve historical and architectural heritage, because of being found old dockland areas of the first American ports.

The American waterfront regeneration is consisting of mixed uses including residential, recreational, commercial, retail, service and tourist facilities. Mainly residential, recreational and tourist-related uses were often the predominant than the others in this model. As a result, this phenomenon which began about fifty years ago has been applied vigorously in recent years on many waterfronts around the world (Tastsoglou & Dimitra, 2012).

2.8. HISTORY OF INDIAN WATERFRONT DEVELOPMENT

Varanasi, Ujjain and there are few other cities which mark the ancient riverfront development in Indian context. Lothal is another example along waterfront which was known for trading through waterways.

2.8.1. VARANASI, UTTAR PRADESH

Varanasi or Kashi is older than traditions. Varanasi presents a unique combination of physical, metaphysical and supernatural elements. It is the Ganga Ghats of Varanasi that complement the concept of divinity. Ghats of Ganga are perhaps the holiest spots of Varanasi.

The city of Varanasi is archaeologically proven to have been continuously inhabited by humans since ca 800 BCE and is therefore described as one of the ancient most continuously living cities in the world. Because of frequent use of clay and mud for building, human habitations were least resistant to the flooding of the river and as such physical and material evidence of earlier occupation appears to have vanished.

Figure 5. Ancient Ghats of Varanasi

Source : http://www.dreamstime.com/

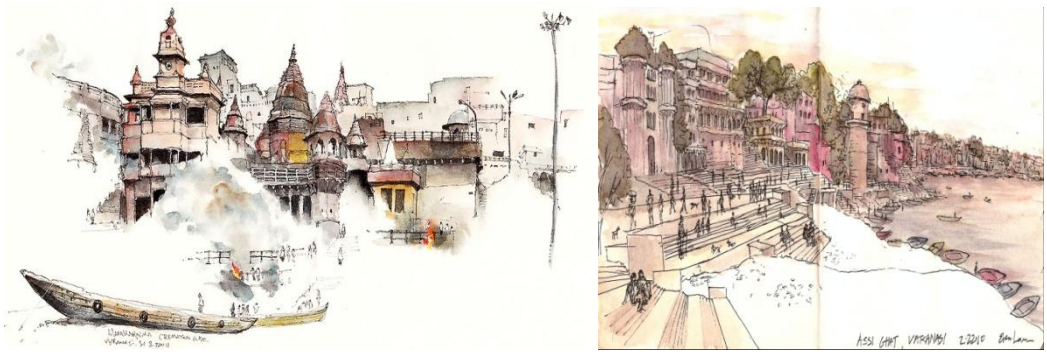


Figure 6. Artistic representation of Ghats

Source : www.pinterest.com

Growth Pattern: The built form has increased towards the river, as the river is flooding less. Initially the ghats which were mainly used were made pucca. Today every ghat is made of stone.

These ghats are the interface between the building edge alongside the river and the river, permitting an access to the Ganga. The ghat may be pakka that is constructed with stone steps or kachcha that a natural bank.

2.8.2. LOTHAL

Situated at a distance of 80 kms from Ahmedabad, Lothal city is one of the well known cities of the ancient Indus valley civilization.

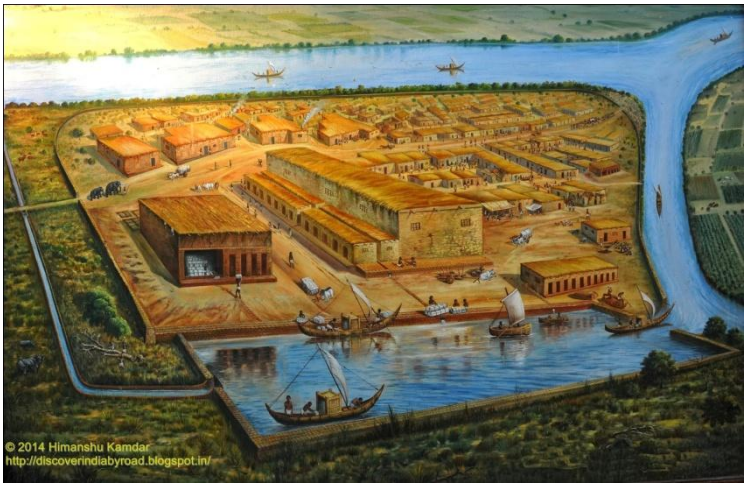


Figure 7. Artist's visualization of Lothal

Source: www.darpandodiya.com

The origin and history of Lothal can be dated back to 2400 BC. Lothal has enjoyed the status of being the leading center of trade in the bygone times. Lothal's dock—the world's earliest known—connected the city to an ancient

course of the Sabarmati river on the trade route between Harappan cities in Sindh and the peninsula of Saurashtra. It was a vital and thriving trade centre in ancient times, with its trade of beads, gems and valuable ornaments reaching the far corners of West Asia and Africa.

2.9. Benefits of urban waterfront regeneration

Urban waterfront regeneration, which is phenomenon in global dimension, has social, economic and environmental benefits to the community. According to Papatheochari (2011), Jones (2007) and Goddard (2002), the most pronounced benefits urban waterfront regenerations are:

- The increase in real estate property values,
- The preservation historical and local heritage also re-use of historic building,
- The improvement of water quality and water ecology by means of the advanced management processes,
- Providing of opportunities for new uses and activities,
- Representing of new economic regeneration opportunities for declining inner city areas,
- Attracting tourists not only at the regional level, but also nationally and internationally,
- Providing new jobs,
- The improvement of the environmental conditions,
- Providing of relationship between water and the city,
- Encoring of economic investment on degraded areas,

2.10. COMPONENTS OF A RIVER ECOSYSTEM

A river is a natural flowing watercourse flowing towards an ocean, sea, lake or another river. Rivers form as a result of precipitation, springs, or snow / ice melt. There is a fair amount of specific terminology linked to topic so it is worth taking the time to get to grips with some of the basics.

Rivers have a Drainage basin. This is the area of land surrounding a river that drains into the river. It includes water found in the water table and surface run-off.

2.10.1. Watersheds and the Hydrologic Cycle

A watershed is the area of land that drains into a given stream, river, lake, or wetland. Water movement through a watershed begins with rain or snow melt or groundwater that wells up to the surface of the land. It moves downhill over the ground as a sheet of water, and then collects in small rivulets that erode shallow channels in the soil and feed small streams.

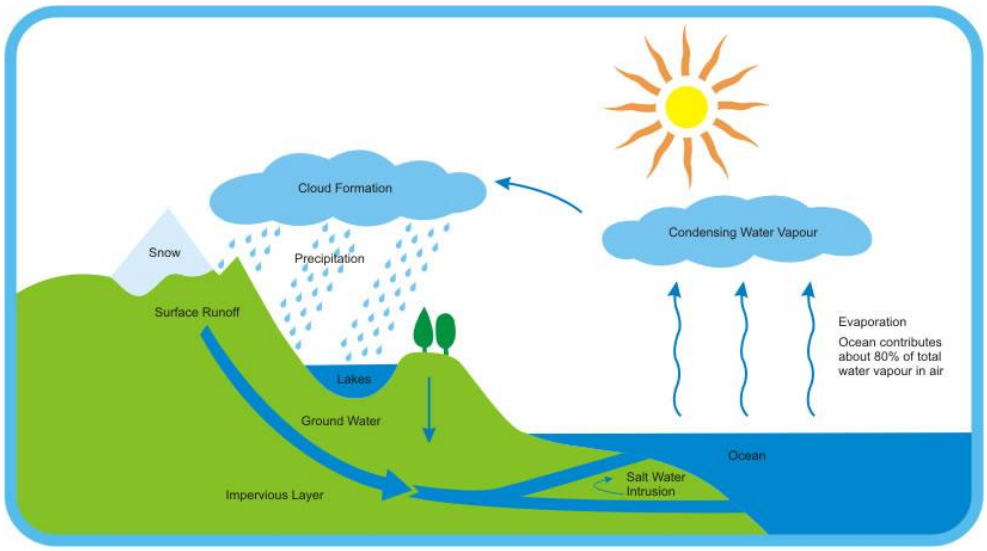


Figure 8. Hydrological cycle

Source: http://moodle.bcsoh.org

In urban watersheds, precipitation hits hard surfaces, such as roofs, roads, and parking lots (all are called impervious surfaces), and rushes into storm sewers without being absorbed, thereby short-circuiting natural hydrologic processes. As a result, larger amounts of water surge through streams and rivers in shorter periods of time.

Increased temperatures in urban streams also are a threat. Thermal loading disrupts aquatic organisms that have finely tuned temperature limits. Temperature can change significantly when streamside vegetation is removed since more solar energy reaches the water surface. Impervious surfaces act as heat collectors, heating urban runoff as it passes over paved surfaces.

Sediment Cycles

The sediment cycle starts as soils in the watershed erode and are transported by surface runoff that washes into rivers. Subsequent movement of sediments through river systems is a complex and extremely important aspect of how

rivers function. Heavy sediment particles, such as gravel and cobbles (loose rock smaller than boulders), usually originate in the channel itself. Lighter, suspended particles of silt, clay, or sand may originate on the land or be scoured from the channel itself.

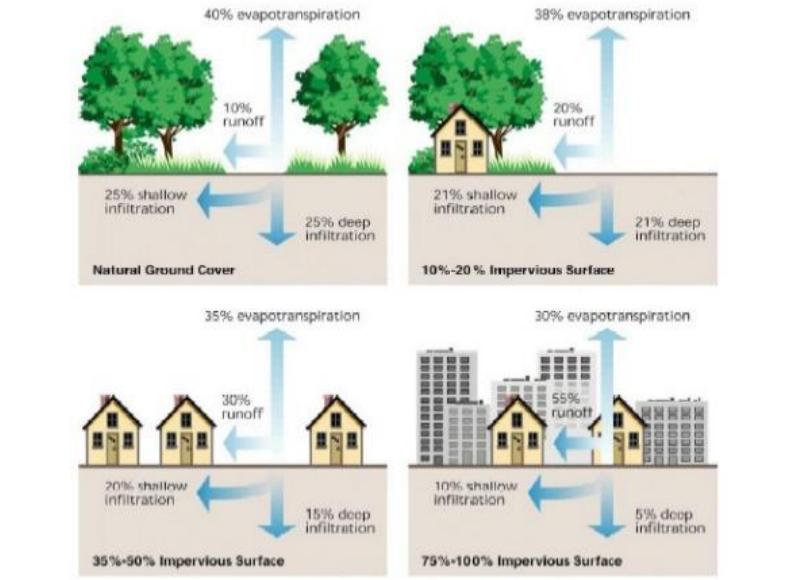


Figure 9. Influence of Urbanization

Source : www.bluespringsgov.com

2.10.2. Channel Patterns

Straight Channels - Straight stream channels are rare. Where they do occur, the channel is usually controlled by a linear zone of weakness in the underlying rock, like a fault or joint system. Even in straight channel segments water flows in a sinuous fashion, with the deepest part of the channel changing from near one bank to near the other.

Meandering Channels - Because of the velocity structure of a stream, and especially in streams flowing over low gradients with easily eroded banks, straight channels will eventually erode into meandering channels. Erosion will take place on the outer parts of the meander bends where the velocity of the stream is highest.

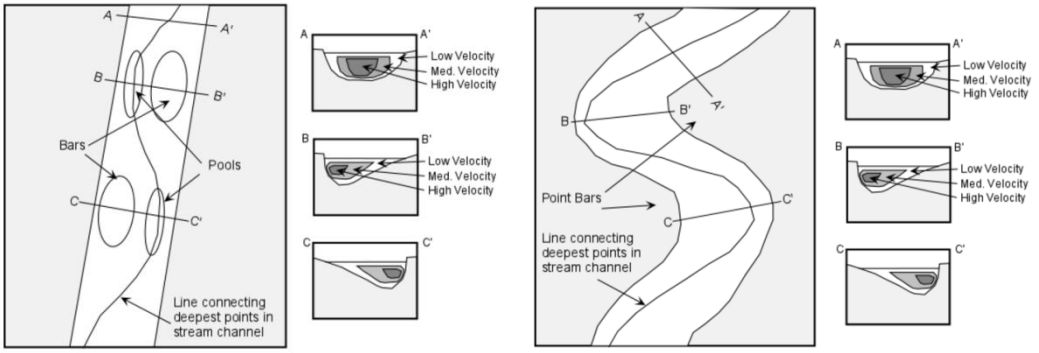


Figure 10. Straight and meandering river path

Source http://www.tulane.edu

If erosion on the outside meander bends continues to take place, eventually a meander bend can become cut off from the rest of the stream. When this occurs, the cutoff meander bends, because it is still a depression, will collect water and form a type of lake called an oxbow lake.

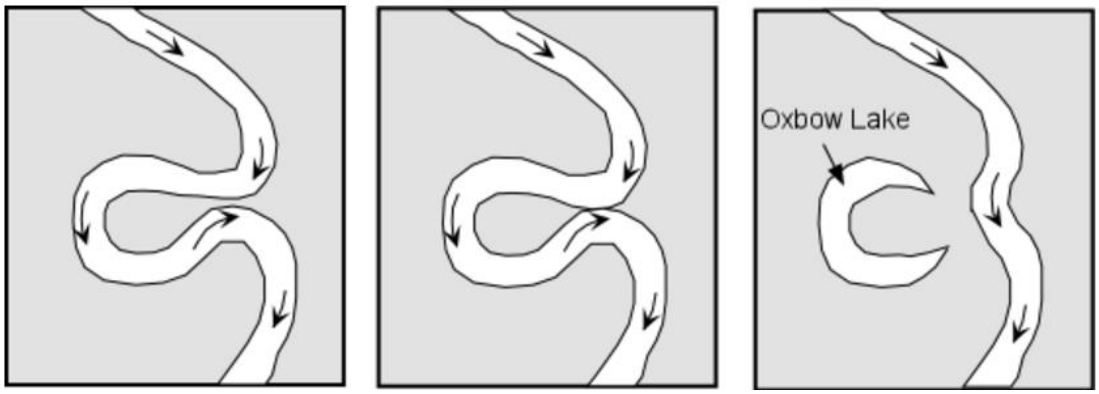


Figure 11. Formation of ox Bow Lake

Source: http://www.tulane.edu

2.10.3. Alluvial Fans

When a steep mountain stream enters a flat valley, there is a sudden decrease in gradient and velocity. Sediment transported in the stream will suddenly become deposited along the valley walls in an alluvial fan. As the velocity of the mountain stream slows it becomes choked with sediment and breaks up into numerous distributaries channels.

2.10.4. FLOOD

Floods occur when the discharge of the stream becomes too high to be accommodated in the normal stream channel. When the discharge becomes

too high, the stream widens its channel by overtopping its banks and flooding the low-lying areas surrounding the stream. The areas that become flooded are called floodplains.

2.10.5. FLOODPLAINS

Floodplains are landscapes shaped by running water. As streams and their larger forms, rivers, flow across the surface of land, they transport eroded rock and other material. At points along that journey, when their flow slows, the material they carry is dropped to create what are termed depositional landforms. Among these landforms are deltas and floodplains. A flood plain is a generally flat area of land next to a river or stream. It stretches from the banks of the river to the outer edges of the valley.

A flood plain consists of two parts. The first is the main channel of the river itself, called the floodway. Floodways can sometimes be seasonal, meaning the channel is dry for part of the year. Beyond the floodway is the flood fringe. There are two major processes involved in the natural development of flood plains: erosion and aggradations. The erosion of a flood plain describes the process in which earth is worn away by the movement of a floodway. Aggradations (or alluviation) of a flood plain describes the process in which earthen material increases as the floodway deposits sediment.

Fluvial Terraces

The sedimentary patterns of flood plains often provide scientists with evidence of past geologic activity. Thick layers of sand may indicate flash flooding, for instance, while thin, evenly spaced layers of silt may indicate more moderate and predictable flood patterns.

One of the most important geologic features of a flood plain is its fluvial terraces. Fluvial terraces are step-shaped areas of land that flank the banks of a river or stream. Fluvial terraces mark the older, higher-elevation paths of the stream, before erosion and aggregation created the current main stem of the stream or river. Fluvial terraces can mark the bluff lines—outer edges—of a flood plain.

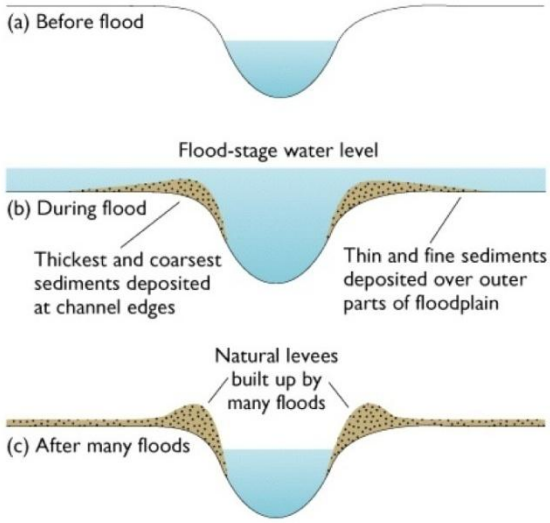


Figure 12 Floodplain & Levees

Source: http://www.slideshare.net

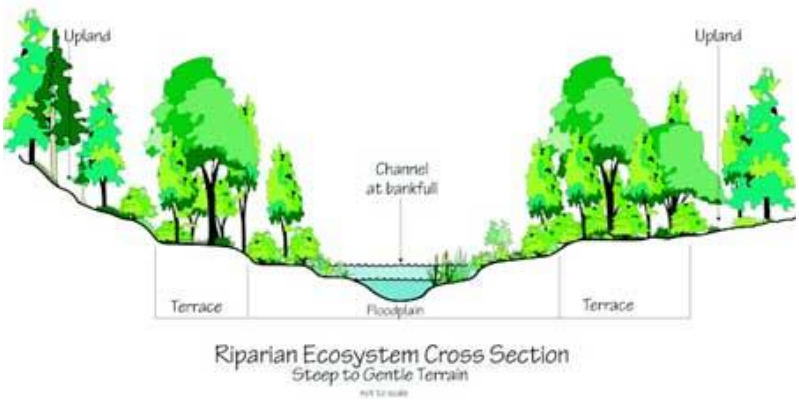


Figure 13. Cross section of Riparian Eco system

Source: http://www.fs.fed.us

2.11. People and Flood Plains

Floods are usually seasonal and can be predicted months ahead of time. This predictability can make flood plains ideal locations to develop urban areas. Rivers provide both a natural transportation network and source of water for irrigation and industry. The relatively level land can be developed either as agricultural fields or sites for habitation or business.

The three most ancient civilizations on Earth all developed on fertile flood plains. The flood plains between the Tigris and Euphrates rivers, in what are today Syria and Iraq, are known as Mesopotamia, “the land between the rivers.” Ancient civilizations of Mesopotamia include Sumeria, Akkadia, Assyria, and Babylonia. The flood plains of the Indus River, in what is today Afghanistan, India, and Pakistan, gave rise to the Indus River Civilization, also known as the Harappan civilization.

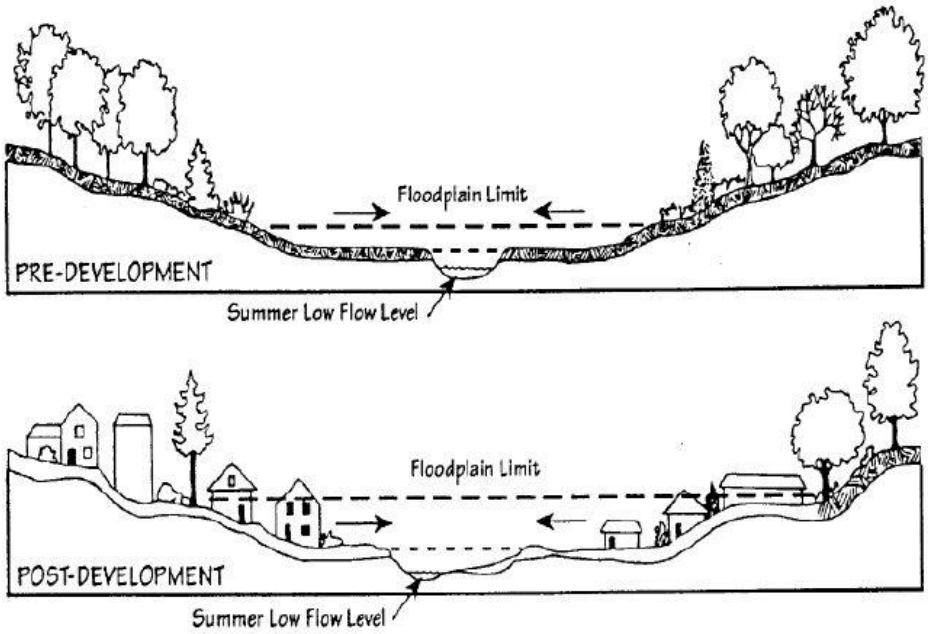
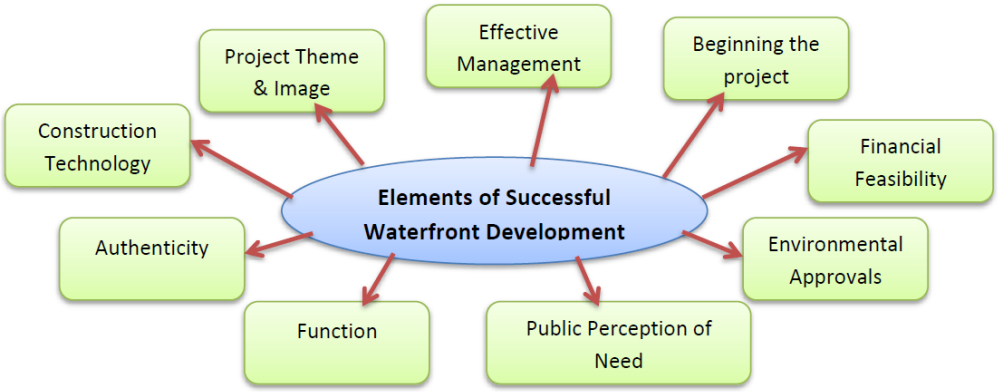


Figure 14. Pre & Post Development in Floodplains

Source: http://wgbis.ces.iisc.ernet.in

2.12. Agriculture

Flood plains are usually very fertile agricultural areas. Floods carry nutrient-rich silt and sediment, and distribute it across a wide area. Flood plains are flat and often have relatively few boulders or other large obstacles that may prevent farming.



Source: Torre. 1989: Journal of Techno Social-ISSN 2229 8940-Vol 4 No 1 April 2012 (Pg 24)
Fig 2: Elements of Successful Waterfront Development

2.13. PRINCIPLE FOR ECOLOGICALLY FRIENDLY RIVERFRONT

Ecological goals and economic development goals are mutually beneficial

Public and private development that brings people to the waterfront to live, eat, shop, relax, recreate, and participate in cultural events builds a sense of connection and stewardship for the river.

Protect and restore natural river features and functions

Rivers provide vital natural benefits that must be protected. Natural river features such as meanders, backwaters, wetlands, and gradually sloped banks serve essential ecological functions. They also provide human benefits such as cleaner water and flood storage.

Regenerate the riverfront as a human realm

A riverfront project may have to overcome physical, political, social, and economic barriers to increase public use and enjoyment of this public resource. Good riverfront designs consider the needs of all neighborhoods, ages, and cultures in the community.

Make the process of planning and designing riverfronts broadly participatory

Riverfront planning and design must include the participation of a wide variety of community members..

2.14. PLANNING PRINCIPLE

Demonstrate characteristics of the city's unique relationship to the river

Every river city has a unique relationship and history interwoven with its river. Riverfronts should have a look and feel that evokes and celebrates their city's special character and relates directly to their natural history.

Know the river ecosystem and plan for a scale larger than the riverfront

Consider riverfront development in the context of the river's natural structure, including:

• Characteristics of the watershed (the land area drained by a river and its tributaries);

• The floodplain and the river channel with the structure of its bed and banks;

• Hydrology (water flows and timing);

• The biological needs of wildlife, including insects, fish, amphibians, reptiles, birds, and mammals.

It is also important to understand how a river's structure has been altered and how it may change in the future.

Because rivers are dynamic, minimize new floodplain development

Undeveloped, connected floodplains are essential to river health. New development on the riverfront, including trails and parks, should be designed to minimize floodplain intrusions.

Provide for public access, connections, and recreational uses

Easy access is vital to draw people to a riverfront. Visual connections to the river from nearby commercial and residential areas also are important. Physical and visual access should not be reserved only for select neighbourhoods or businesses along the redeveloped river. Riverfronts can include many recreational uses, from bicycling to bird watching.

Celebrate the river's environmental and cultural history

Riverfronts are rich in both human and natural history. Interpretive and path-finding systems can describe the river, its environment, and how river and city history are intertwined. Educational and cultural programs, performances, and public art entice people to the riverfront.

Tab 1: Special Characteristics of Water front Area

Characteristics	Description
Dynamic area	Waterfront zone is a dynamic area with frequently changing biological, chemical and geological attributes.
Habitat	Waterfront zone include highly productive and biologically diverse ecosystems that offer crucial nursery habitats for many species.
Natural defense	Waterfront zone features such as mangrove forests serves a critical natural defense against natural hazards (flooding, erosion and storms).
Pollution moderator	Water ecosystems may act to reduce the impacts of pollution originating from land such as, wetlands absorbing excess nutrient sediments, human waste
Source: 'An Evolution of Waterfront Development in Malaysia ' By Azlina Binti Md. Yassin Submitted on 16Th Pacific Rim Real Estate Society Conference, Wellington 24-27 January 2010.	

3. CASE STUDIES

Basically this three riverfront projects are which plays an important role in the functioning of the city. And the study areas primarily need to include public open space providing potential for various outdoor activities like recreation. Study of the case studies is on the basis of:

Context to the surrounding/ local environment

Impact on Natural settings including flora, fauna, topography, hydrology

Change in the landscape

Inter relation with people.

Maintenance of the original ethics and culture.

The case studies are

Primary case study: **Sabarmati riverfront development**, Ahmadabad, Gujarat

Secondary case studies**: Seine River**, Paris Basin and

Cheonggyecheon stream restoration, Seoul, Korea

3.1. Sabarmati Riverfront Development, Ahmadabad, Gujarat

The sabarmati Riverfront Development project began as an urban renewal project to significantly improve the spatial structure and habitat conditions of the river and adjoining areas. This project aims to transform Ahmedabad's historic yet neglected river into a vibrant & vital focus for the Ahmedabad City. The development project encompasses both banks of the Sabarmati for a 10.5 kms, stretch, creating approximately 185 hectares of reclaimed land. The project includes water management systems to minimize flooding in traditionally flood-prone areas and to clean up the Sabarmati with new sewage treatment infrastructure. These include providing interceptor sewer lines along both banks of the river to divert sewage to Ahmedabad's two sewage treatment plants; and building retaining walls which will protect the low-lying areas near the riverbanks from flooding.

Case study Areas Features	Sabarmati Riverfront
Name of water body	Sabarmati River
Type of Project	Recreational
Company	Sabarmati River Front Development Corporation Limited (SRFDCL)
Amenities	Restaurants, River Access, Shops, Waterfront Settlements, Gardens, Walkways, Amusement parks, Golf Course, Water sports
Views	River Views & City
Proximity to River	50m
Proximity to CBD	1 KM

A key element of the project is a new linear two-level promenade. The lower promenade with a minimum width of 10 meters will be just above water level, providing uninterrupted pedestrian access to the water. The upper promenade will host a variety of public buildings, cultural and educational institutions, public parks and plazas and a few areas for commercial development, while new traffic infrastructure will connect the riverfront to the city.

The project aspires to create a unique identity for Ahmedabad by creating a unique skyline for the city. Being a landmark project with far reaching impacts, it is the backbone for rejuvenating inner city neighborhoods adjacent to the riverfront project, thereby spurring future developments within the city.

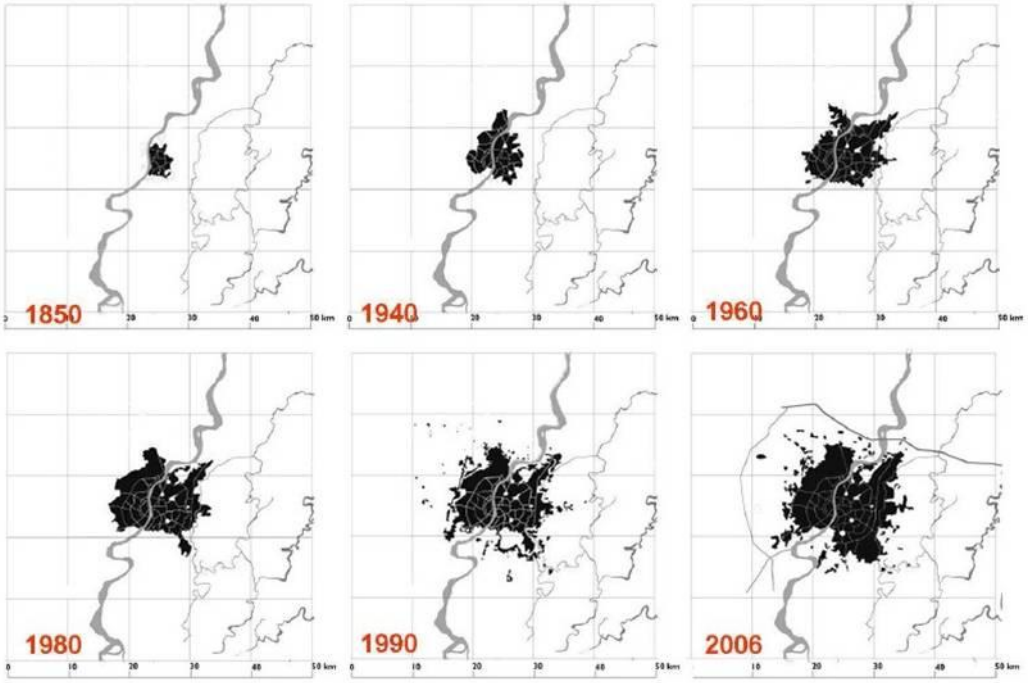


Figure 15. Growth Pattern of Ahmadabad along Sabarmati

Source: EPC

Proposal of integrated planning and development of Sabarmati riverfront by Mr Benard Kohn- 1961

A/c kohn, “I was interested in the ecology alongside the river. Ahmadabad has only a 9km stretch of the river. What I had suggested was a Ecological Valley - a valley where I respect you, you respect me, where I respect nature and nature respects me. Such a valley where I can produce things”

3.1.1. THE PROJECT BY EPC AND AMC

The project was later proposed by Environmental Planning Collaborative, an Ahmadabad-based urban planning consultancy firm in 1997.

The riverfront on either side of the Sabarmati for 10.4 kms was proposed to be developed, reclaiming about 185 ha of land. Construction of the project started in 2005.

The Sabarmati Riverfront Development in Ahmadabad city, supposed to be designed on the lines of the Thames in London or Seine in Paris

3.1.2. OBJECTIVES

The following are the objectives considered for Riverfront development project.

Stop the flow of sewage; keep the river clean and pollution-free

Reduce risk of erosion and flooding in flood prone neighborhoods

Recharge of groundwater aquifers.

Provisional of informal markets.

City level recreational spaces.

Generate resources to pay for all of the foregoing.

Relocation of slums

Beautification of the city.

No Environment Impact Assessment of the project has been conducted initially nor any credible public consultation process held.

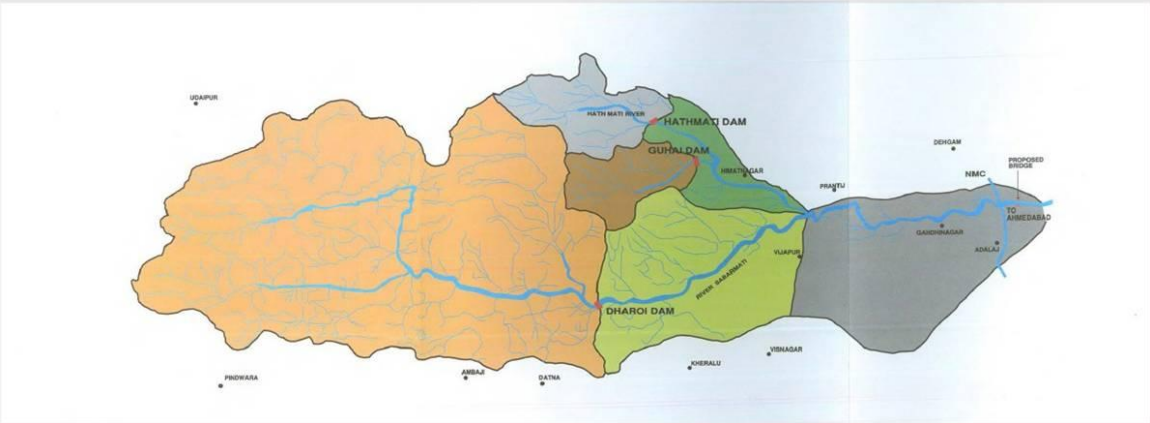


Figure 16. Catchment of Sabarmati River

Source: EPC

The objective of the river hydraulic study was to ensure for:

River width in such a way that, expected High Flood Level (HFL) in the River in its natural condition, does not significantly increase after it is constricted and trained.

Height of **Retaining walls and Embankment** in relevance to HFL

Stability of existing bridges by protecting piers against increased velocity as per the design HFL.

Sabarmati channel has been uniformly narrowed to **275 metres** during the riverfront development project from its natural width of about 350 metres, minimum width being 330 metres.

In this attempt of “pinching the river”, the original character of the river has changed completely from a **seasonally flowing river to an impounded tank.**

Figure 17. Change in River character

Source: EPC

The Sabarmati Riverfront Project will add almost 10, 00,000 sq. mts. of parks, promenades and plazas to Ahmadabad.

Having 12.5 million cubic meter storage of the water, recharge of ground water aquifers of the city.

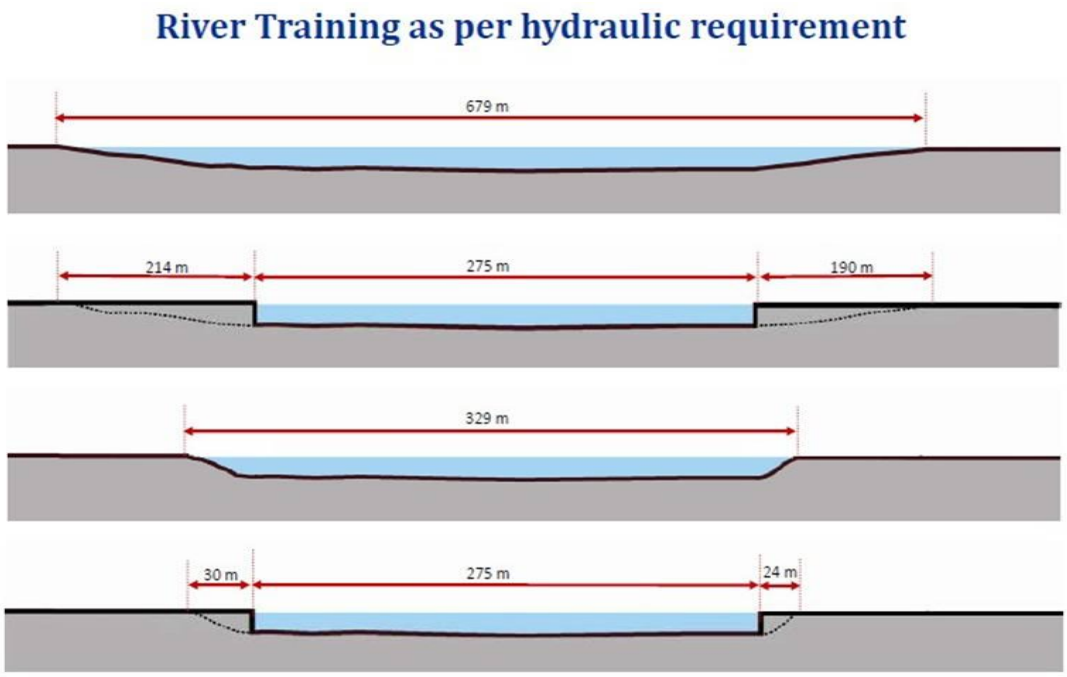


Figure 18. Change in river width due to development

Source: EPC

Prior to the floods of 2006, the river's maximum carrying capacity had been calculated at 4.75 lakh cusecs on the basis of rainfall over the last 100 years.

The report of IIT Roorkee and NIH states that "the calculations did not take into account any simultaneous rainfall over the entire catchment area" and the riverfront development is "not a flood control scheme"

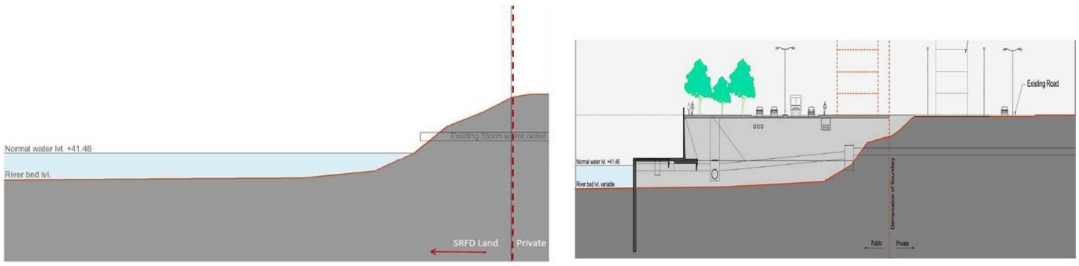


Figure 19. Change in section of river

Source: EPC

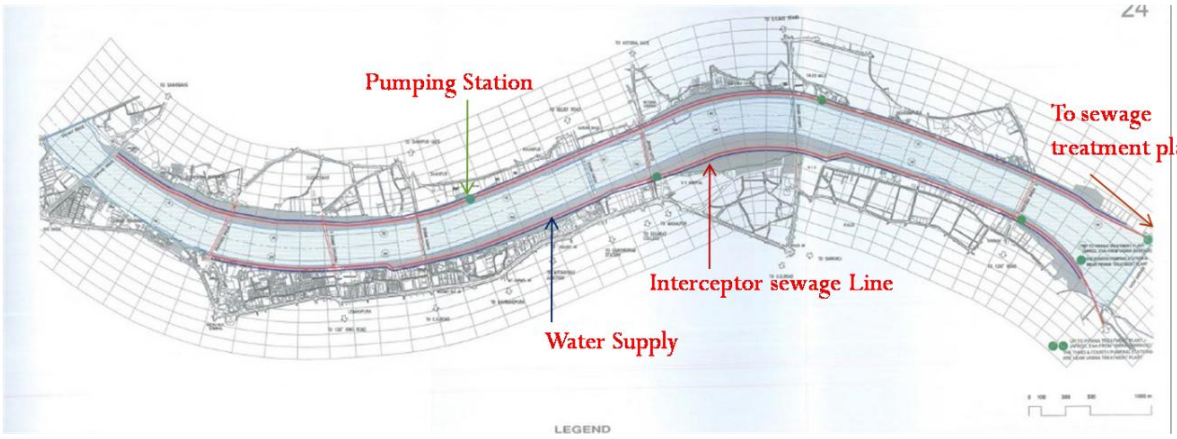


Figure 20. Different services proposed along the river

Source: EPC

To stop flow of sewage and to keep the river clean. Diversion (Interceptor) of Sewage

- East Bank: 15 Km
- West Bank: 12.3

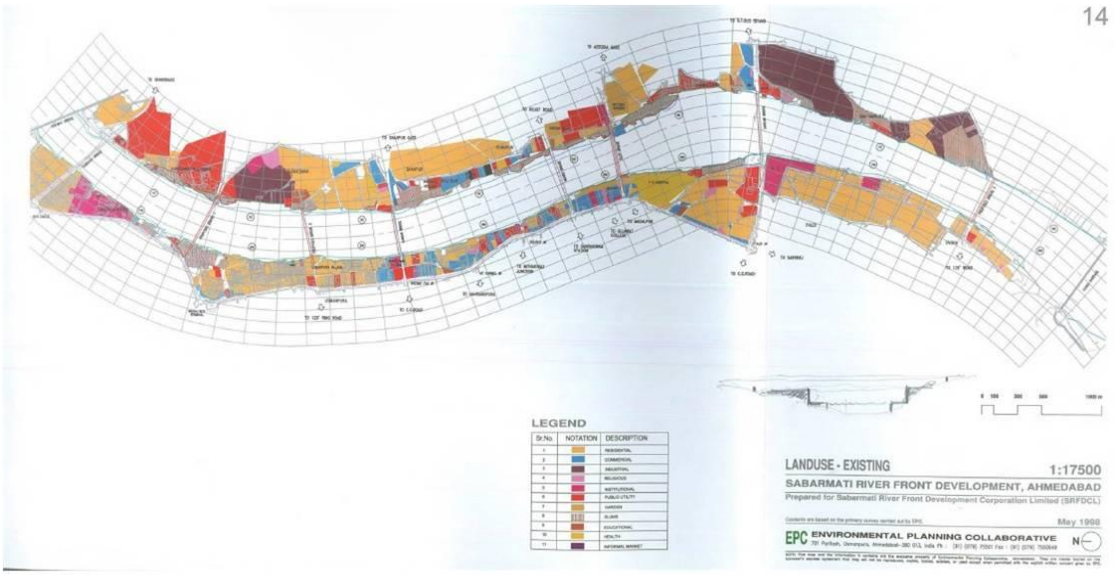


Figure 21. Exiting Landuse

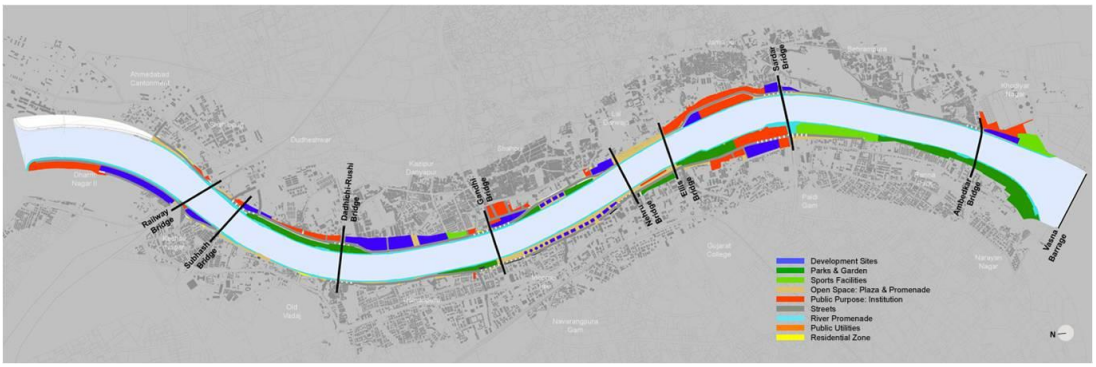


Figure 22. Proposed Landuse

Source: EPC

The proposal includes shifting of existing informal markets to nearby another site and addition on 2 new informal markets.

Dhobis using riverbed for the activity have been rehabilitated to laundry campus.

Rehabilitation of Slums: More than 10000 families residing in the riverbed/affected by the project which were relocated.

3.1.3. LANDUSE PROPOSAL OBJECTIVE

To maximize city level benefits by the provision of public facilities and to optimize revenue potential of land allocated for sale.

Consideration in allocating land users were:

- Existing landuse along river.
- The structural road network and form of the city.
- Extent, location and configuration of reclaimed land
- Potential for development

3.1.4. ENVIRONMENTAL IMAPCT ASSESMENT REPORT – Down to Earth

Construction of embankments may hamper natural drainage of city. Also, will increase the speed, thereby increasing erosion affecting the retaining walls and bridges.

EIA suggested sloping embankments as they offer greater résistance to flood water by helping dampen the flood velocity dissipate the impact of flood over a much larger surface area and withstand hydraulic pressure. While developing 10.4km stretch, pollution load will be pushed downstream.

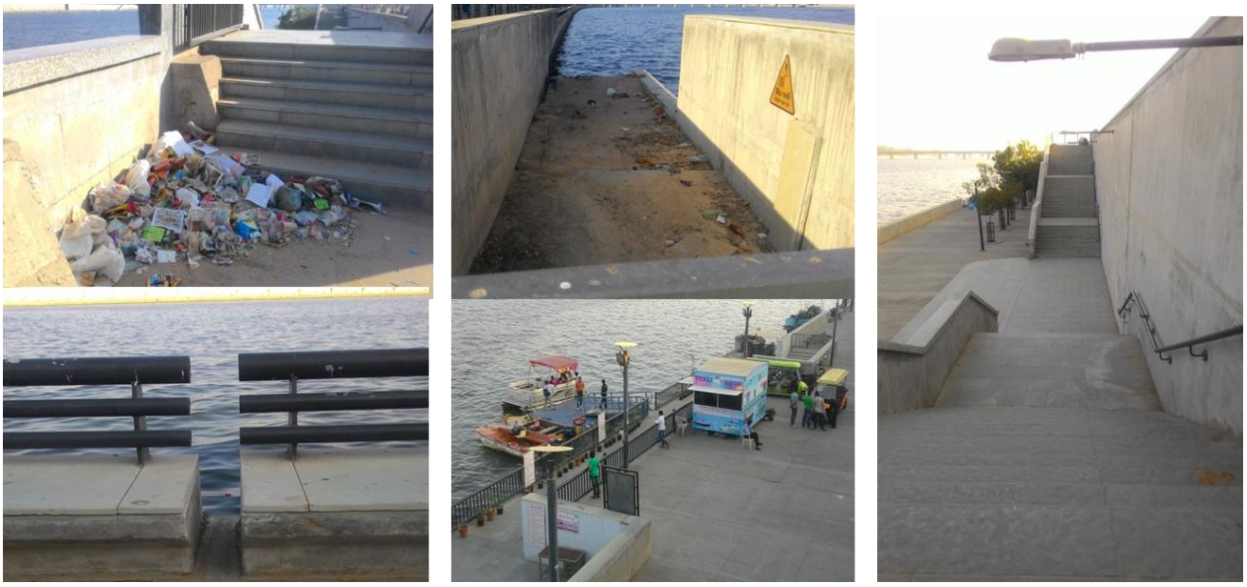


Figure 23. Existing site condition

Figure 24. Panaromic view of RIver

3.1.5. ANIKET BHAGWAT'S VIEW

The river was a dry perennial river and its conversion into an impounded tank, filled with water from another river, changes its essential character. It hence destroys an ecology of fauna, avi fauna, of the water's edge, of seasonality, but one is unclear what it replaces it with.

Flora: It does not allow a well constructed thought process about where does a grove occur, where an avenue, where a thicket, where a grassland, where a water's edge planting, and what species are good for insects, butterflies, birds, flower colour etc.

The other thing that's wrong is that it culturally breaks a bond with the city. **The river was a theatre of the cities life.** In the dry months, the bed was used to house melas, circuses, do agriculture, for children of impoverished families to use it as a play ground….the memories of these activities , made the river what it was; the complete termination of this in full , is its failing.

The good part: It lays intercepting sewers and pipes that don't allow the city's garbage to come in the river bed, and go straight to a treatment plant- but then all that was needed were sewers and pipes- that could have been done anyways.

3.1.6. INFERENCES

- Development could have attempted to:
- Look at alternate water management techniques to connect the city back to the water, re-defining the edge.
- Defining accessibility mixed with utilities and **to bring about a dynamic landscape**, a hard and softscape which at times would be flooded and some part retained, thus making one observe an ever changing and dynamic phenomenon.
- Introducing variation in Plant species
- Needs to engage in a more multi-disciplinary approach that equates demand of ecology, pressure of development, associated livelihood, contextualization of recreation.

- More importantly recognize that rivers are meandering in nature, dynamic in flow and supports living ecosystems.

3.2 Seine River, Paris Basin

The Seine River is a tributary of the Red River, with a watershed covers a vast area in Southwestern Manitoba, approximately 2500 km2, from the Sandilands Provincial Forest, to the Red River.

The dream of a linear park along the urban Seine River was first put on paper in 1980 when the City of Winnipeg adopted the Seine River Park Study.

The plan presented a vision for the development of a linear regional park along the 26 km length of the river. It envisioned natural areas plus sports facilities to meet the diverse recreational needs of Winnipeg's growing population.

The study failed to initiate any action with regard to protection, conservation, or enhancement of the Seine River corridor

Twenty years later, a new plan was developed. The Seine River Greenway Study (2000) described a "less is more" approach that minimized capital outlay.

Concerns about the condition of the Seine River led to the formation of Save Our Seine in 1990. It emphasizes the city's desire to successfully integrate public access with the environment in a way that allows us all to enjoy, while not damaging the intrinsic natural qualities of the Seine River Corridor."

3.2.1. CHALLENGE

- **Drainage ditches, bridges, agricultural cultivation and urban settlement all contributed to changes to the river basin**, the flow of the river and the river itself.

- Industrial development along the Seine River has damaged or destroyed the natural habitat.

- Significant portions of the riverbank have been previously built-up with concrete rubble to allow greater site development and reduce erosion

due to flooding. As a result of S.O.S.'s efforts some of these materials have been removed.

The city has adopted a policy of naturalization, which encourages the planting and return of native grasses, shrubs, trees and wildflowers. In essence, naturalization encourages the return of grasslands, woodlands or wetlands native to Winnipeg, restoring habitat sought by local wildlife.

3.2.2. HABITAT RESOTRATION

- **The natural habitat will draw local wildlife.** These in turn will be a draw to users; encouraging them to hike, cycle or canoe the length of what will be known as the Greenway
- **A series of formal and informal river trails align** portions of the area. Trails act as connective tissue between parks, contributing to the linear-park concept which characterizes the Seine River Greenway.
- The more informal portions of the trials, which run close to the river and tend to be surrounded by woodlands, need periodic attention to avoid becoming overgrown.
- Where new development along the river must occur**, it needs to be done as sensitively as possible** and should ideally take place on previously developed lands.
- Efforts to stabilize the riverbank against failure have been undertaken by means of active tree planting programs
- The community group Save Our Seine, with the support of government, has organized the construction of riffles in the river in response to this situation. Riffles are artificial stone structures that act as dams and mimic the effect of rapids. In this way they help to raise river water levels, dissolve oxygen into the water and provide a continuous migration route for fish.

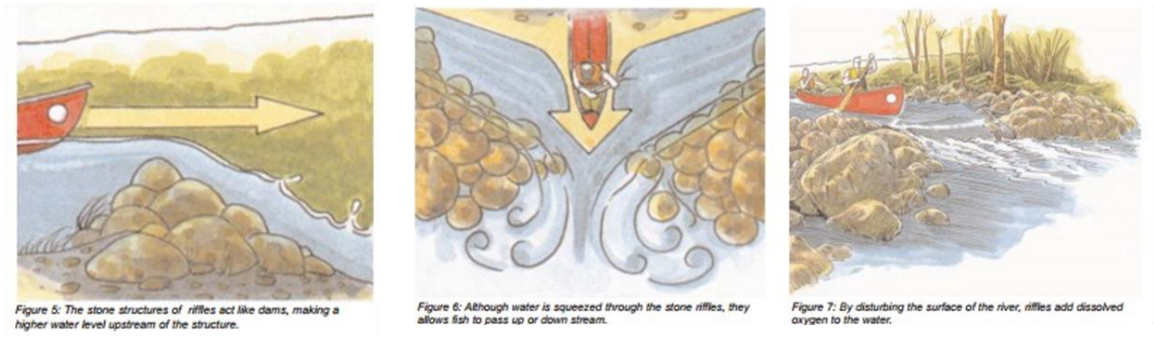


Figure 25. Riffles

Source: GPP Architecture

- **Maximize greenspace** along the Seine River and retain existing treed areas along the river and the Precinct. Greenways serve not only to link awareness of landscape ecology with action, but to build community capacity through the cultivation or protection of natural common spaces.

- This project examines to the Seine River Greenway as a best practice illustrating the importance of a bottom-up approach in linking urban ecology with community places. In addition to routine cleanups and tree planting, the volunteer-based organization is active in **encouraging the protection of natural areas and encouraging that development near the Seine is sensitive and appropriate to the riparian environment.**

- In this way the constituent components of land, water, cultural and natural resources are considered as interlocking pieces of a larger whole, rather than isolated entities with little connection to each other. The Seine River Greenway provides a unique and valued “urban wilderness” heritage to local residents. The action plan, completed in consultation with local stakeholders, seeks to protect, nurture and enhance the Seine River.

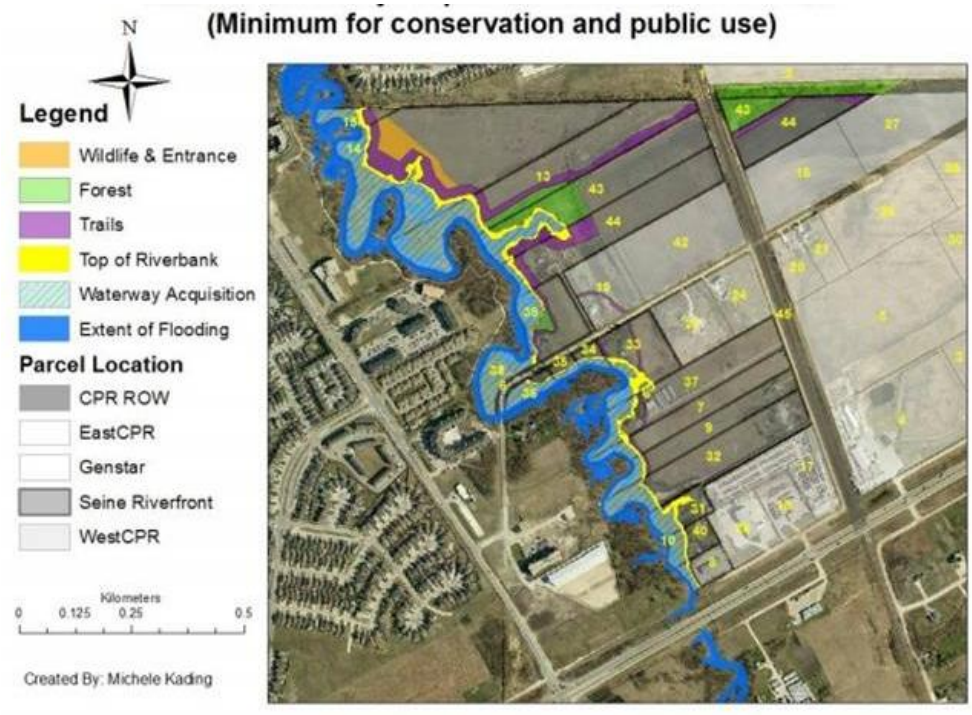


Figure 26. Land & Waterways Acquisition and Parks Dedication

Source: GPP Architecture

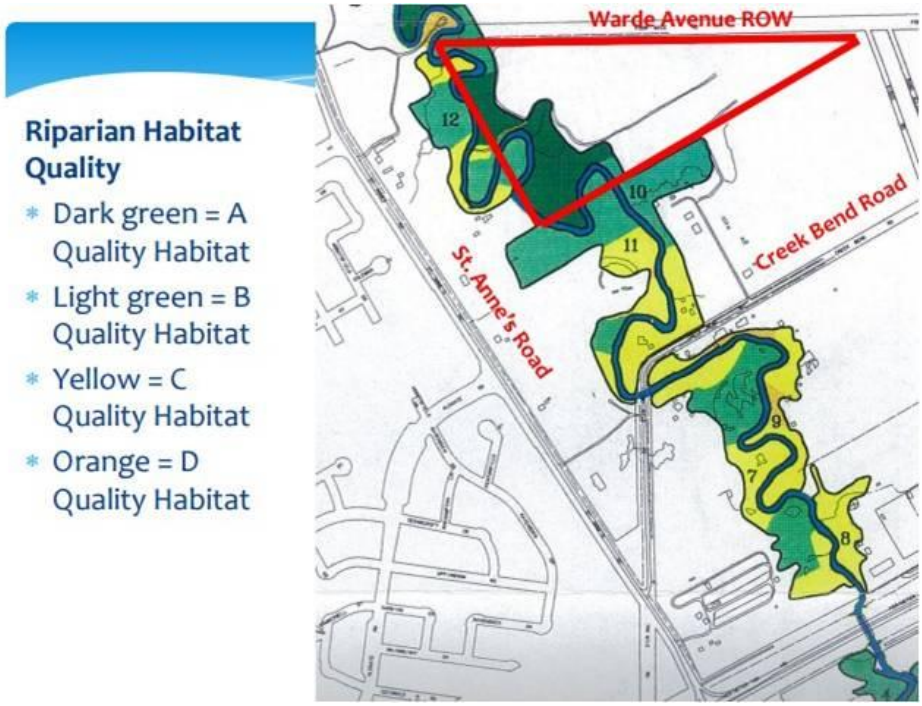


Figure 27. Riparian Habitat Quality

Source: GPP Architecture

3.3 CHEONGGYECHEON RESTORATION, SEOUL

Cheonggyecheon is an 8.4 km creek flowing west to east through downtown Seoul, and then meeting Jungnangcheon, which connects to the Han River and empties into the Yellow Sea.

Figure 28. Cheonggyecheon, Seoul

Source: Seoul Metropolitan Government

The stream was covered up with concrete over 20-years starting in 1958, and a 5.6 km-long, 16 m-wide elevated highway was completed in 1976.The covering affected CBD too and hence the economy.

In July 2003, then-Seoul mayor, Lee Myung-bak initiated **a project to remove the elevated highway and restore the stream.** It was a major undertaking since the highway had to be removed and years of neglect and development had left the stream nearly dry.

Goals of the project were to restore the history and culture of the region, which had been lost for 30 years, and to revitalize Seoul's economy and to revitalize the natural settings. The Cheonggyecheon restoration project had the purpose of preserving the unique identity of the natural environment and the historic resources. The plan encouraged the return of the pedestrian-friendly road network connecting the stream with traditional resources.

3.3.1. Design Criteria

- Satisfy with the local river standard

- Secure the stream capacity for 200 years frequency rainfall (118mm/hr)
- Flood Level: estimated by numerical model and corrected using hydraulic model test
- Combined sewer system for rainfall and wastewater

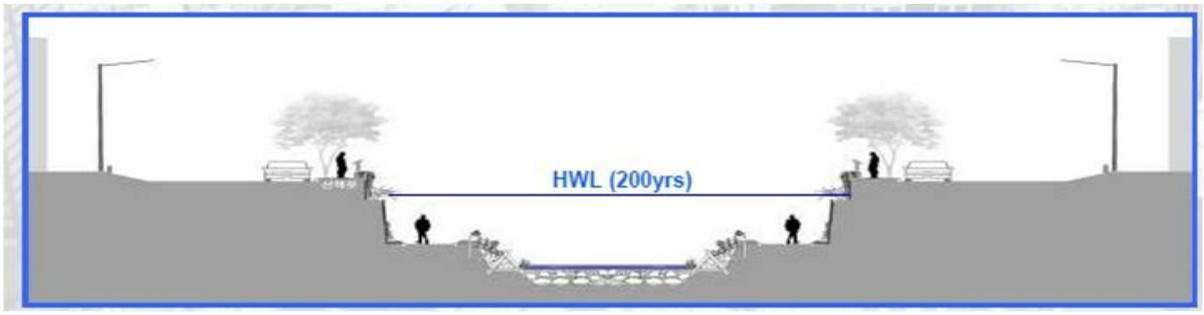


Figure 29. Cross section through Stream

Source: Seoul Metropolitan Government

Challenge: Transport

- Discourage driving cars in the city centre
- Improve traffic system: Cheong Gye Cheon area and Metropolitan
- Improve public transport system: subway system and bus only lane

Historic Relics Restoration

- Preserve or restore historic relics
- Consider current situation: flood, traffic, merchants
- Involve specialists
- Restore 600 year old bridge: Gwangtong gyo
- 150 m upstream from the original site
- Restore Supyo gyo and Ogansu gyo: future plan

3.3.2. Concepts for Landscape Design

- New green belt with waterfront: West to East

- Gradual transformation from urban landscape to natural environment
- Create ecological balance and environment
- Thematic places: waterfall and fountains

3.3.3. BENEFITS

- Provides flood protection for up to a 200-year flood event and can sustain a flow rate of 118mm/hr.
- **Increased overall biodiversity** between the pre-restoration work in 2003 and the end of 2008 with the number of plant species increasing from 62 to 308, fish species from 4 to 25, bird species from 6 to 36, aquatic invertebrate species from 5 to 53, insect species from 15 to 192, mammals from 2 to 4, and amphibians from 4 to 8.
- **Reduces the urban heat island effect** with temperatures along the stream 3.3° to 5.9°C cooler than on a parallel road 4-7 blocks away. This results from the removal of the paved expressway, the cooling effect of the stream, increased vegetation, reduction in auto trips, and a 2.2-7.8% increase in wind speeds moving through the corridor.
- **Reduced small-particle air pollution by 35%** from 74 to 48 micrograms per cubic meter. Before the restoration, residents of the area were more than twice as likely to suffer from respiratory disease as those in other parts of the city.

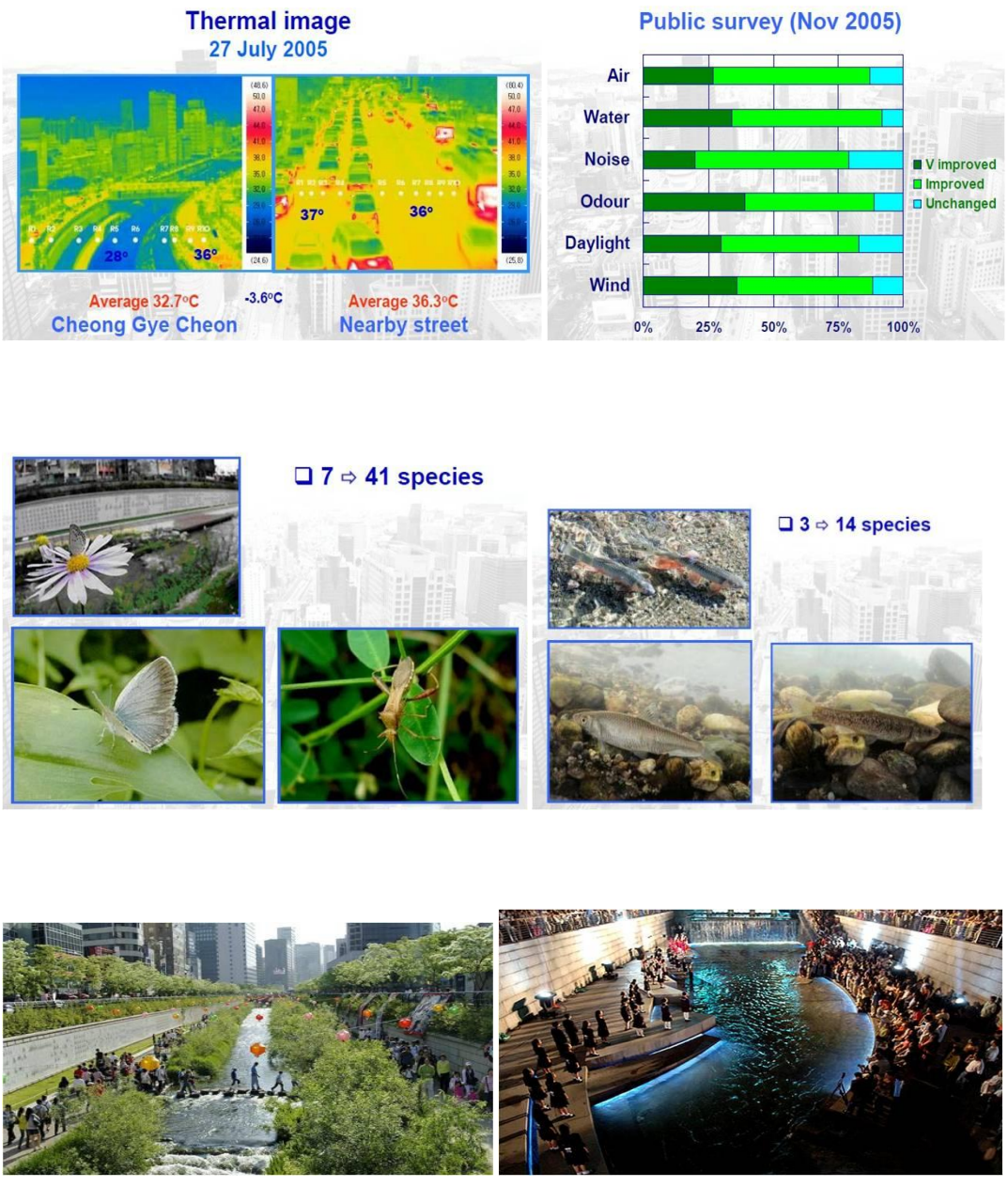


Figure 30. Condition of stream after restoration

Source: Seoul Metropolitan Government

4. SITE STUDY

4.1. INTRODUCTION

Hajipur is a town with area of 19.64 sq.km, located in Indian state of Bihar. It is second fastest growing town after Patna in state and is located at 26 km from the capital city, Patna. It is headquarter of Vaishali district.

In the ancient time, it was known as Ukkacala and was the first village to come after crossing River Ganges at Patna. It is the place where democracy found its origin around 600BC.

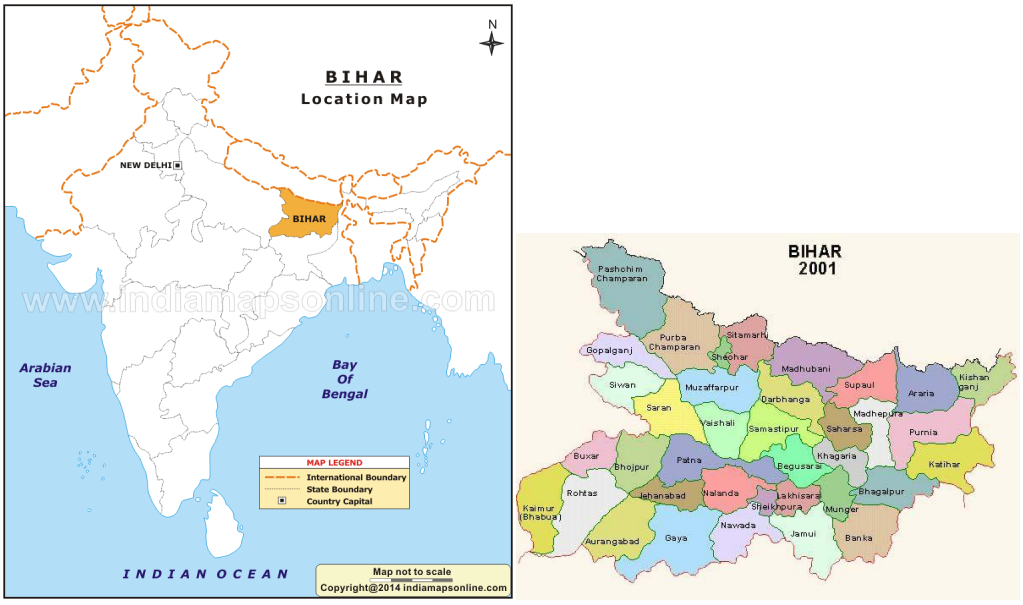


Figure 31. Bihar state Map

Source : http://censusindia.gov.in/

The town is known by the name of Hajipur as it was founded by a King of Bengal named Haji Ilyas Shah who ruled between 1345 to 1358 AD.

Vaishali is the place where Lord Mahavir took birth and Gautam Buddha delivered his last sermon and announced his Parinirvana. It is locus of Buddhist circuit, therefore, followers of Buddhism can been seen throughout the year in the town.

Accessible by good roads and enjoys strategic location,i.e, connectivity with

other parts of state. The town being bounded by Gandak river in the west and holy Ganges in the south.

Organically developed settings of Ghats and river lead to a ancient town which is rare and unique living expression of the religious and cultural importance of river.

Layers of life and traditions are superimposed one upon the other but the essence of the life has maintained its continuity.

Figure 32. Map of Hajipur Town

Source: Google Maps

4.1.1. HISTORIC EVOLUTION

Illustrative of the evolution of human society and settlement over time under the influence of the physical constraint or opportunity presented by the natural environment and of the successive social, economic and cultural forces.

4.1.2. BUILT FABRIC

The lanes dramatically open on to ghats which resemble a majestic podium stepping down to meet the rippling water. On the other end, the steps of ghats lead to narrow lane like labyrinths, which are tightly packed with houses, shops and temples.

With growing urbanization and emergence of urban areas as growth centers combined with improved living standards, Hajipur has developed rapidly. A number of small scale industries and institutions flourished. Hajipur is an important node in the region because of the presence of industrial area,

proximity to Patna and connectivity to various other cities across the state. The city has a strong potential to grow as a trade centre for the region.

Figure 33. Monuments of Religious Importance

Source: Google Images

4.1.3. CULTURAL FABRIC

Hajipur has vibrant cultural fabric. The town derives its vibrancy from religious festivals and rituals that are part of life and cultural heritage of town.

Figure 34. Festivals: Chhath , Sonepur Fair & Ganga Snan

Festivals are celebrated throughout the year on the ghats of Hajipur. They are tied to the seasons, to key moments in the solar and lunar calendar celebrating the passage of sun and the waxing and waning moon, and to the harvest cycle. The myths of Hinduism are enacted in the here and now, rejoicing in the births, marriages, and victories of gods and goddesses over demons. Festivals like GANGA SNAN and CHHATH marks the most important event in the cultural calendar of the town. Thousands of pilgrims visit during these festivals.

4.1.4. SYMBOLISM

Over time the GHATS become witnesses and narrators of events and rituals. They also symbolise the end of journey. There is no further to go. This is where time and space dissolves. The ghats architecture responds to the

changing water levels of the river Gandak. These are alinged with square, rectangular and circular platforms built over well fondation. The riverfront becomes greener towards the north with unbuilt embankments and more tree cover.

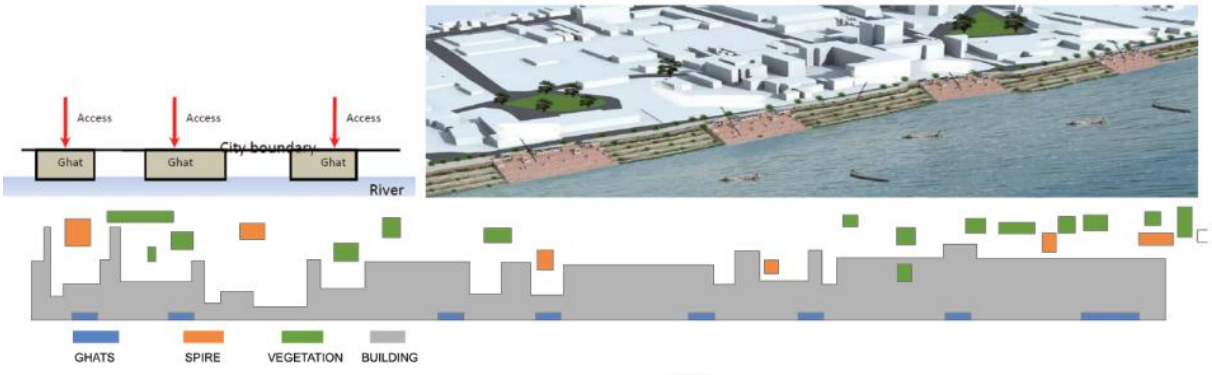


Figure 35. Symbolism of Town

The visitor on a boat on the Gandak, away from the hustle and bustle of the town, has the opportunity to see the panoramic skyline. The skyline holds significant architectural value with its temple spires, protruding balconies, platforms, and cubicles just above water. The layering of structures adds depth and serial repletion of forms provides the unifying thread in the architectural diversity of the Ghats.

BUDDIST CIRCUIT- Hajipur lies in the famous Bhuddist circuit connecting Bodhgaya, Vaishali, Nalanda and Rajgir. People prefer to make it terminal point and move to next destination

4.1.5. GANDAK RIVER

Gandak River is a tributary of the Ganga River and one of the major rivers in Nepal and India. The entry point of the river at the Indo-Nepal border is at the convergence of Gandak, known as Triveni. The total length of the Gandak River is 630 km out of which 330 km flows in Nepal and Tibet. The river has a total catchment area of 46,300 sq. km out of which 7620 sq km is located in India. The river flows across the Gangetic plain of Bihar state and eventually merges with the Ganga near at Hajipur.

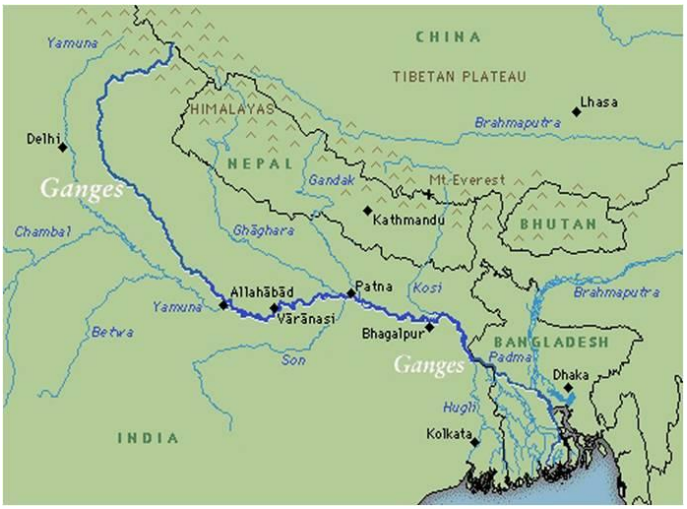


Figure 36. Gandak- tributary of Ganga

Source: india-wris.nrsc.gov.in

The Gandak plains are called the Gandak Megafan and it comprises of Eastern Uttar Pradesh and North Western Bihar and lies in the Middle Gangetic Plains. The Gandak river basin in Bihar has a series of **ox-bow lakes** due to the frequent meandering of the river. These lakes support great aquatic biodiversity.

4.1.6. NEED

Being enriched with such fluvial body and historical culture, the river is yet neglected. The importance could be observed during festivals like “Ganga snaan” and Chhat puja which is most important festival celebrated on river banks in Bihar. Apart from festival period, the riverfront does not mark any resonant activity. It is almost abandoned except few devotees visiting the temples located on the banks. It posses deterrioted ghats, dirty and unstable edges, garbage and sewage disposal all along the river edge. Since, it a small and densely populated town, there is no provision for any recreational space for the users to relax and enjoy.

Therefore, developing the riverfront as recreational space integrated with its rich cultural history would provide the residents of town and the visitors a leisure space and the town, its unique identity.

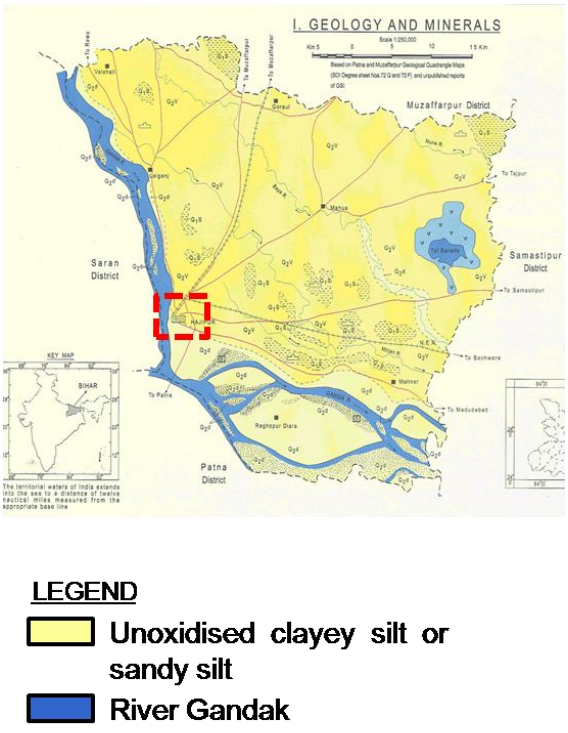
4.1.7. HAJIPUR: CLIMATIC DATA

The climate of the district is sub-tropical to sub-humid

Receives 80% of rainfall from south-west monsoon.

TEMPRATURE	MAXIMUM	MINIMUM
SUMMER	40 Degree	
WINTER	16 Degree	4 Degree
RELATIVE HUMITDITY	60-90% (Jul-Aug)	3-10% (Apr-May)
AVERAGE RAINFALL	1168 mm	
ELEVATION	51m msl	46m msl

As of 2011, service accounts for 55%, industry 9% and agriculture 35% of the economy of the town.



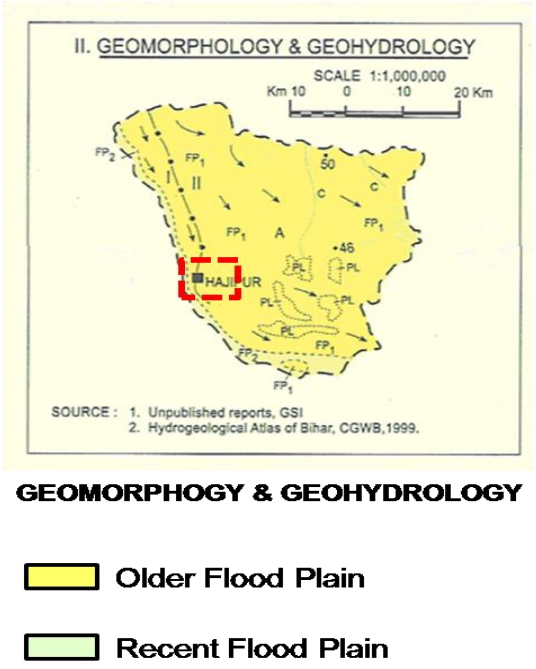
Quaternary Alluvial deposit consisting of alternate layers of sand, silt, clay and gravel forms prolific unconfined and confined aquifer system.

The clay layers at shallow depth are not regionally extensive as such the **entire sequence behaves as unconfined aquifer system**.

Hajipur confirm presence of highly potential and thick sand & gravel layers.

Figure 37. Map of Geology and Minerals

Source: District Resource Map



SOIL

Entisols**:** They are younger alluvial soils locally known as Balsundari. They are deficient in nitrogen, phosphoric acid but generally rich in potash and lime.

Inceptisols**:** Calcareous alluvial soils occur mostly in the central part and locally known as Mathivari. This soil is richer in lime content and kanker than Balsundari

Figure 38. Map of Geomorphology & Geohydrology

Source: District Resource Map

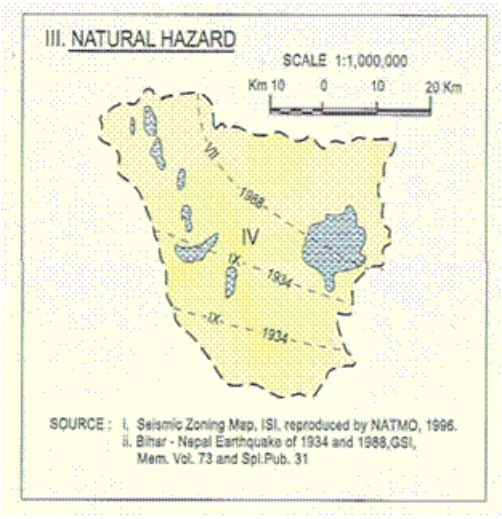


Figure 39. Map of Natural Hazard

Source: District Resource Map

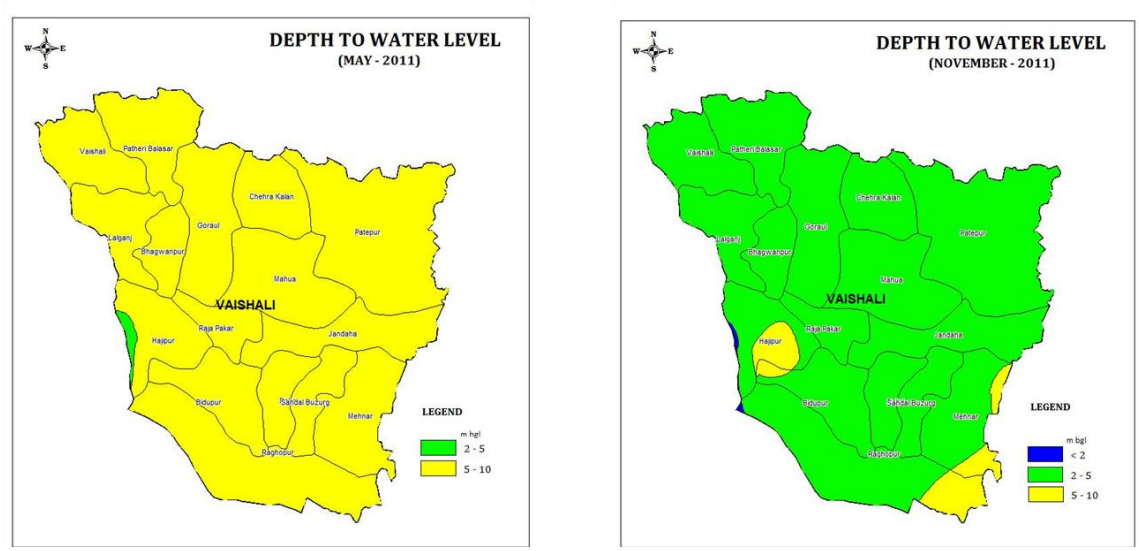


Figure 40. Map for Depth of Water

Source: Central Ground Water Board

The stage of ground water development of the district is 56% which falls under **safe category.** The groundwater table is available at depth of 3-5m Bgl. **The maximum water use for domestic and industrial purposes** The chemical analysis of ground water of unconfined aquifer of May 2006 indicates that the **water is potable** and can be used for industrial and irrigation purposes.

Annually replenishable dynamic ground water resource of the unconfined aquifer has been estimated as on 31st march 2009 for all the blocks following GEC-1997 norm. The net annual replenishable ground water resource of the district is 71952 ham. The gross draft for all uses, (irrigation, and domestic and industrial water supply) as on 31st March 2009, is 40288 ham.

ELEVATION MAP: The area shows a general slope toward S-E while the highest elevation of 51m whereas the lowest of 46m above mean sea level.

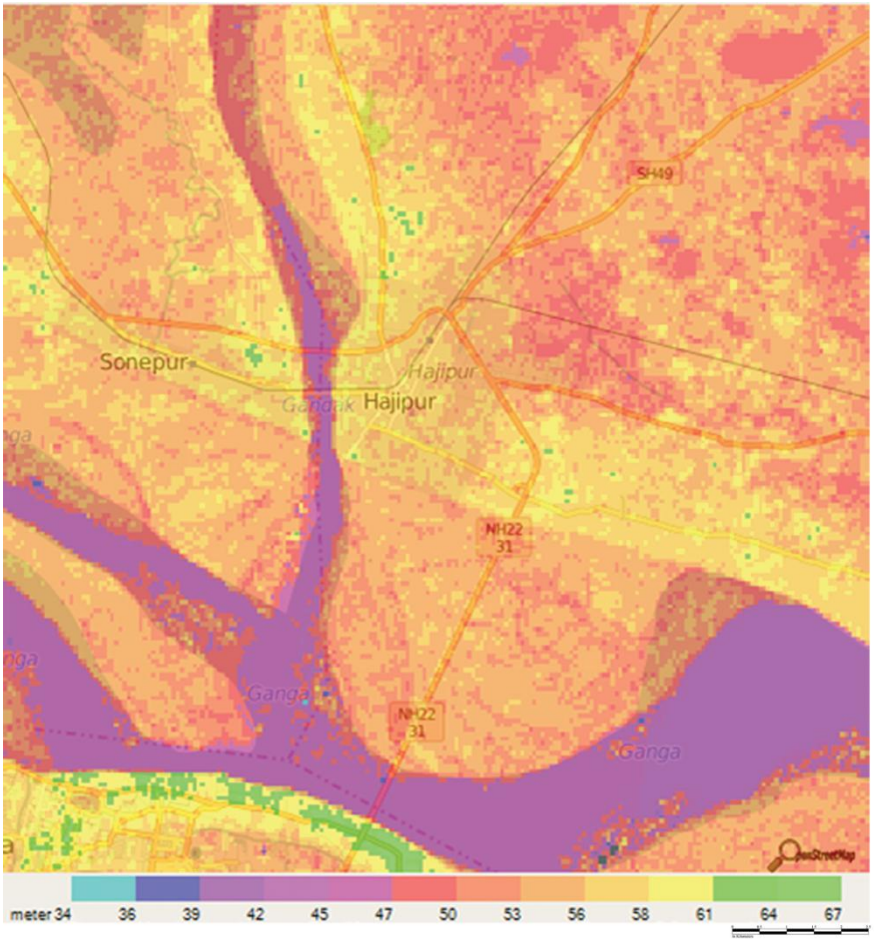
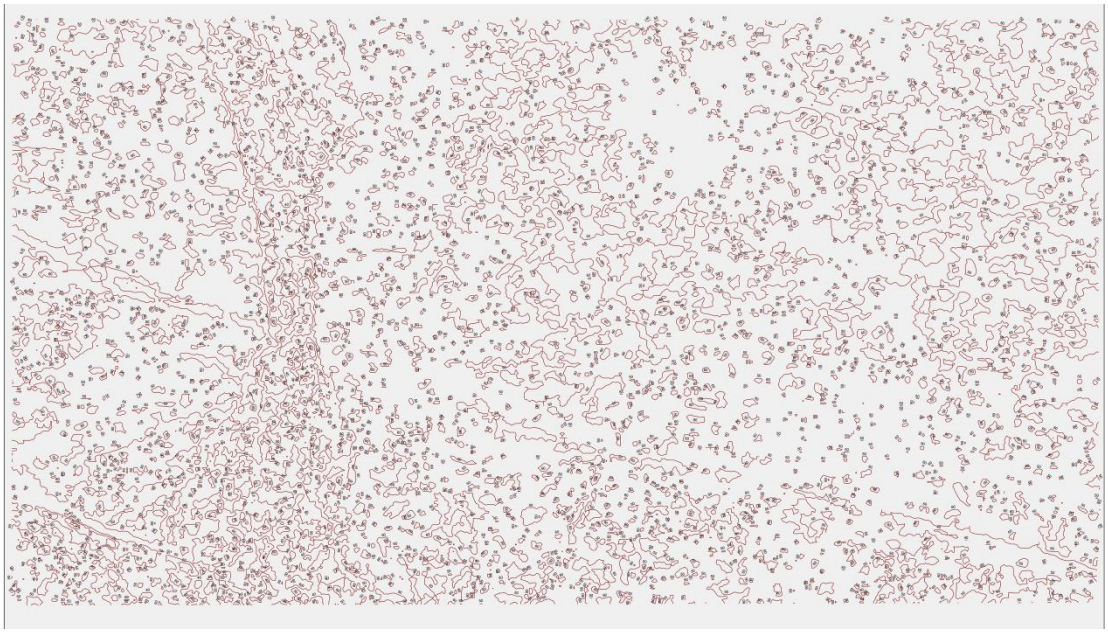


Figure 41. Elevation Map

Source: http://www.floodmap.net/Elevation/ElevationMap



Contour Map showing the gradual slope to the site towards south-east direction.

Figure 42 Contour Map

Source: GIS

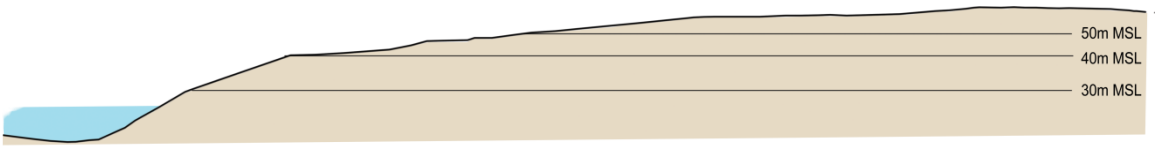


Figure 43 Cross section showing the elevation of town through river

Figure 44. Existing Site condition

Figure 45. Maps of Growth Pattern, Drainage system & Water Supply

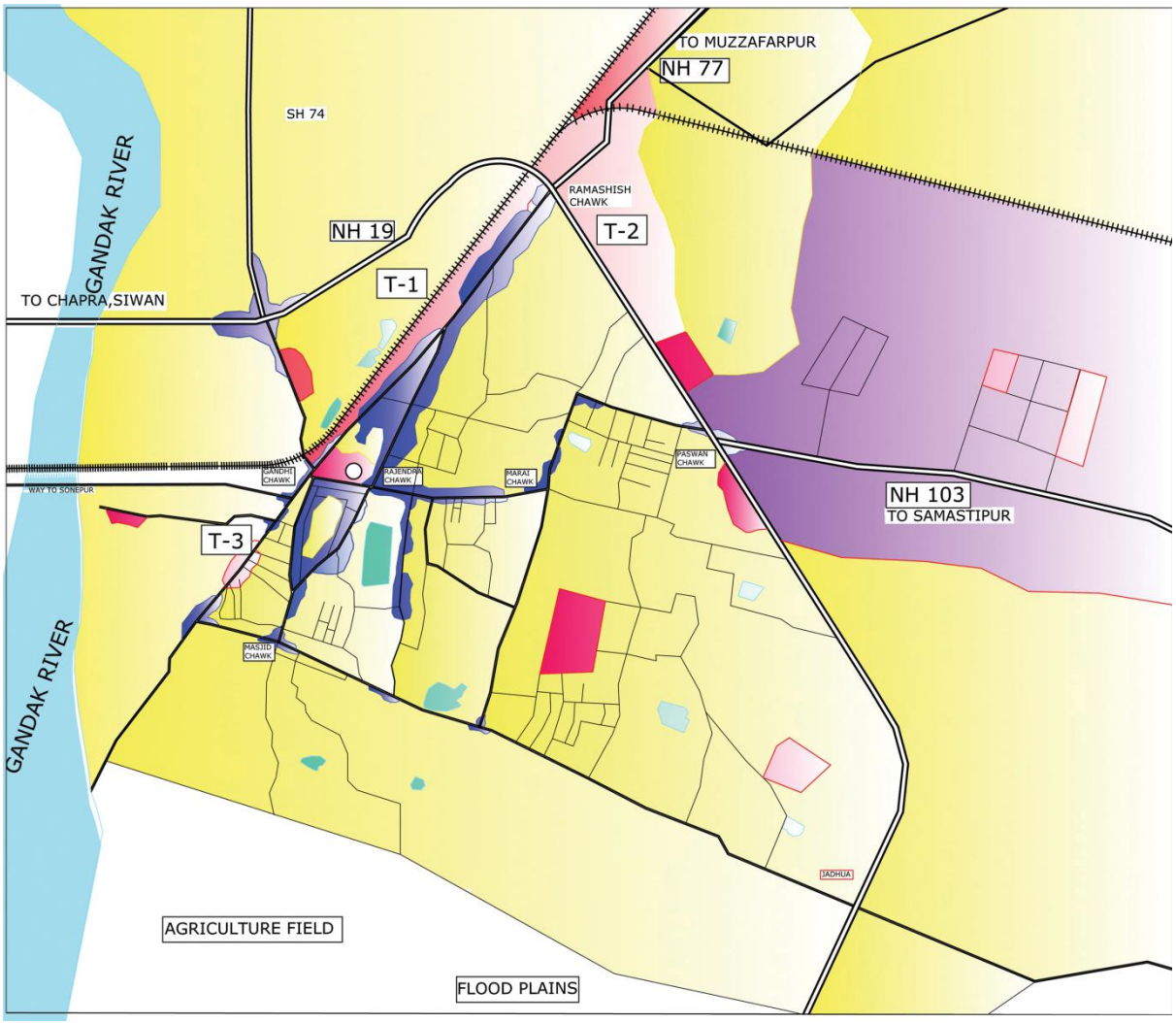


Figure 46. Existing Landuse

Source: CDP, Hajipur

LANDUSE

According to City Development Plan 2010-2030, the existing Landuse of town majorly falls under residential and agricultural land. Industrial is another sector being focused for proposed development. As per the Master Plan for Patna 2031, Hajipur is included under Patna Urban Agglomeration area which again residential land use.

GROWTH PATTERN

Hajipur, the administrative headquarter of Vaishali district is the largest town of the district. The municipal area is 19.64 sq.km. During the 90s, the population growth has been 36.2 percent. The high growth rates during the

1980s to 1990s were mainly due to the migration and Industry development happening in the vicinity of the town.

DRAINAGE SYSTEM

The existing drains are almost defunct now due to the closure of the pipelines and encroachments at the outlets in different time periods.

WATER SUPPLY

The total potable water demand for the city of Hajipur is met by underground water source, balance being procured from other sources. The existing 4 tube wells yield up to 1.28 MLD daily as against the total daily yield of 10 ML.

FIGURE GROUND

The town possesses good connectivity with the other part of state. Also offers opportunity for employment and education which migration to the town.

Due to these factors, built development is increasing. Recreational spaces are lacking and a few which are available are being neglected. The whole town is emerging as concrete network.

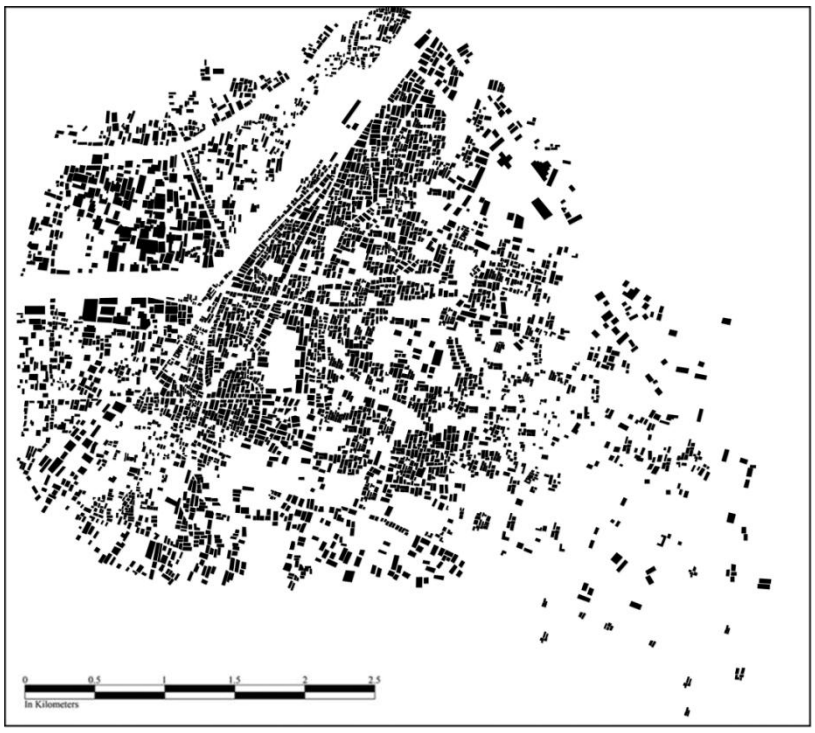


Figure 47. Figure Ground

4.2. SITE ANANLYSIS

Figure 48. Existing Site Map

STUDY AREA: Showing different characteristics on the both side of river. On the western bank lies another town called Sonepur. Both the towns are connected by 4 bridges; two of them are from British period. Both the town lies in two different districts.

LANDUSE MAP: Majorly Residential areas with sparse commercial zone. Large patch of land is used for Agricultural due to its fertile nature.

VEGETATION COVER: Northern edge has comparatively more vegetation due to large scale plantation of Banana trees on the sediments deposited by river.

COMMON NAME	SCIENTIFIC NAME	GROWTH
Peepal	*Ficus religiosa*	Natural
Bargad	*Ficus benghalensis*	Natural
Sheesam	*Dalbergia sissoo*	Natural
Jamun	*Syzygium cumini*	Natural
Neem	*Azadirachta indica*	Natural
Mango	*Mangifera indica*	Natural
Jackfruit	*Artocarpus heterophyllus*	Natural
Kadamb	*Neolamarckia cadamba*	Natural
Bail	*Aegle marmelos*	Natural
Gular	*Ficus glomerata*	Natural
Amla	*Phyllantus emblica*	Natural
Drumstick	*Moringa oleifera*	Natural
Gulmohar	*Delonix regia*	Natural
Semal	*Bombax ceiba*	Natural
Bair	*Zizyphus jujube*	Natural

COMMON NAME	SCIENTIFIC NAME	HABITAT
Red watetd Lapwing	*Vanellus indicus*	Bushes, Neating
Rock Pigeon	*Columba livia*	Bold buildings
Cattle Egrets	*Bubulcus ibis*	Trees, grass, land
Cuckoo	*Cuculus micropterus*	Trees
Red vented bulbul	*Pycnontus cafer*	Bushes, trees
Crow	*Corvus splendene*	Trees
Myna	*Acridotheres tristis*	Trees
Babbler	*Turdoides caudate*	Trees & shrubs
Sparrow	*Passer domesticus*	Trees & shrubs
Drongo	*Dicrurus bracteatus*	Trees & shrubs
Rose ringed Parakeet	*Psittacula Krameri*	Trees & shrubs

Figure 49. Table showing the exiting Flora and fauna on site

4.2.1. VALMIKI WILDLIFE SANCTUARY

The Valmiki Tiger Reserve forms the eastern most limit of the Himalayan Terai forest in India. Situated in the Gangetic Plains bio-geographic zone of the country, the forest has combination of bhabar and terai tracts. Boulder and pebble deposits by the Himalayan Rivers in the foothills characterize the Bhabar tract, while the finer sediment deposits feature terai lands.

Total forest area comprises of about 900 sq. kms out of which expense of Valmiki Wildlife Sanctuary is 880 sq. km. and spread of the National Park is about 335 sq. km. area. River Gandak forms the western boundary of Valmiki wildlife sanctuary. Due to diverse topographical the Reserve harbors varied vegetation types. The Botanical Survey of India has categorized seven vegetation types within the limits of the sanctuary and the national park:

Moist mixed deciduous, Open land vegetation, Riparian Fringes, Sub-mountainous semi-evergreen, Freshwater swamps, Wetlands, Alluvial grasslands and High hill savannah

	Scientific name	Common name	Characteristics
	*Shorea robusta*	Sal	Deciduous trees; Huge tree; medicinal and timber value
	*Mallotus phillipensis*	Rohini	Deciduous trees; grows throughout India. Medicinal
	*Streblus asper*	Sihor	Evergreen, Sand Paper Tree are rough and are utilized for cleaning
	*Terminalia tomentosa*	Saaj	a proportion of trees store water; bark is fire-resistant
	*Terminalia belerica*	Baheda	Deciduous trees; grows throughout India. Medicinal
	*Adina cordifolia*	Kadami	Deciduous trees; Huge tree
	*Dalbergia latifolia*	Indian rosewood	Deciduous trees; Its timber is of high commercial value
	*Mitragyna parviflora*	kaim	Deciduous trees; grows throughout India. Medicinal
	Ehretia laevis	Chamror	Fast growing deciduous shrub; not bothered by insects
	*Anogeissus latifolia*	Dhaura	small to medium-sized tree

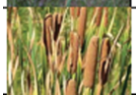
Grasses	Scientific name	Common name	Characteristics
	*Saccharum munja*	Munja	Perennial, tall, panicles silky and greenish brown grass
	*Saccharum spontaneum*	Kans	Perennial grass, colonises exposed silt plains
	*Vetiveria zizanioides*	khas khas	Perennial, long, thin and rigid leaves and can grow up to 1.5 m
	*Eulaliopsis binata*	sabai	Perennial, clump-forming grass with leaf-blades 30 - 80cm tall
	*Chrysopogon aciculatus*	seed grass	Pperennial, culm often erect, 15-25 cm tall
	*Capillipedium assimile*	Scented-tops	decumbent; 150–300 cm long; woody; rooting from lower nodes
	*Typha elephantina*	Elephant grass	long roots with an aggressive capacity to spread

Figure 50. Table of existing vegetation VWS

5. POLICIES AND DESIGN

5.1. ISSUES

At present the existing facilities at the ghats are quite poor. Practically there is no change room or toilet facility in the ghats.

There is hardly any ghat where Visitors to the town can go for an enjoyable glimpse of river.

At present only stone pitching and other temporary technique has been observed along the banks which are generally need to be repeated for every 2-3 years of time.

No proper approach road towards ghats.

Lack of recreation opportunities like garden, boating, performative space, seating areas and snacks outlets.

No proper facility to accomodate devotees during Chhath and Purnima Snan.

The most important is erosion on adjacent areas of river. This is due to lack of vegetation cover.

This leads to both erosion due to water as well as wind action.

Lack of solid waste management system leading to landing of garbage all over the area making it dirty.

Due to deficient vegetation, the fauna and avi fauna is also suffering.

Lighting and security is another issue restraining the visitors.

The visual effects are lost, no view points at river edge.

Due to all these factors, the connectivity of river with its people and users is lost.

It is being neglected since years and till date there is no attention from the government sector too.

5.2. RECOMMENDATIONS

All the ghats should be developed accordingly. Facilities such as changing room, toilets, recreational facilties, seatings etc should be integrated.

Heritage and old monuments should be preserved and renovated and this development should be sustainable. The ghats should be connected through trails.

Implementation of bank stabilization techniques to prevent both wind and water erosion.

Live staking is the placement of woody plant and tree cuttings on a graded streambank to grow and stabilize the streambank by the formation of roots and aboveground brush.

Live fascine is the placement of bundles of branches in trenches on the streambank to reduce erosion across the bank and establish soil stability.

Riprap is a layer of various-sized rocks used to protect a streambank from erosion.

Implementation of solid waste management proposals as well as lighting facilities as per standards.

Restore circulation and linkages

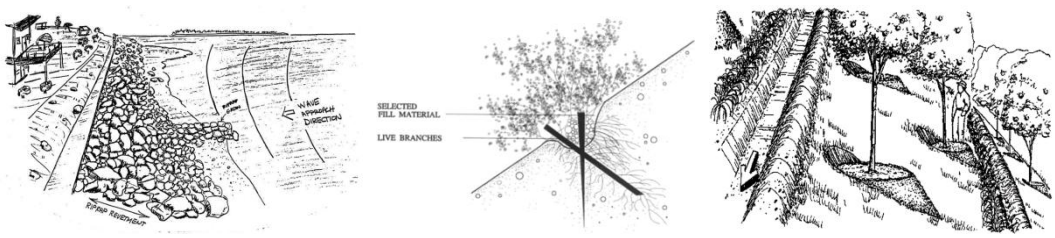


Figure 51 Different methods of Bank stabilization

Source: Google Images

5.3. VEGETATION POLICY

Native plantation withstanding the effect of water during different seasons.

Acting as soil binder and filter water and help to minimize the evaporation.

Shade along margin to reduce direct insulation.

Buffer from agricultural pollution due to fertilizers and pesticides
Grasses as important check of bank erosion.

5.4. DESIGN CRITERIA

Restoring the Banks

Loss of soil, or erosion, is caused by wind and water wearing away the soil and carrying it off.

Where erosion has not begun, it can be prevented by keeping as many plants and trees as possible, and by directing surface runoff water into ditches, ponds and natural waterways. Where erosion is already severe, it is still possible to stop it and to restore healthy soils.

Principles to prevent erosion and surface water runoff:

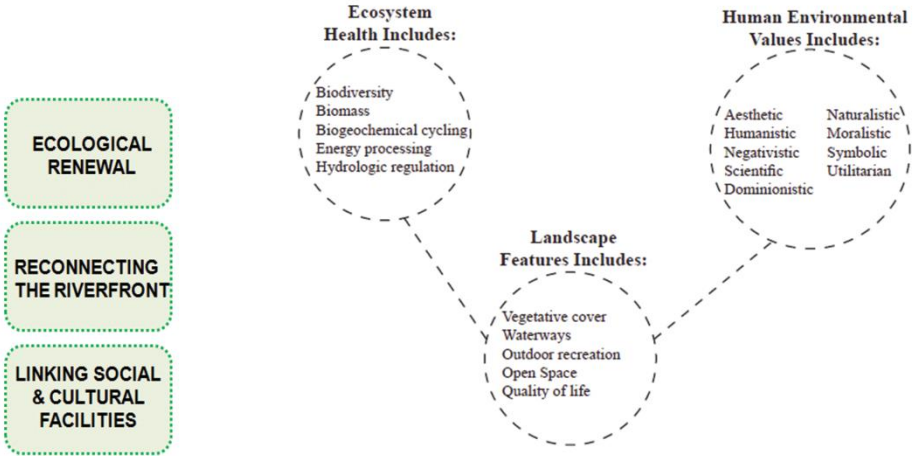
1. Slow the water by creating natural barriers from the top of the watershed down.
2. Spread the water by creating channels to divide it and direct where it flows.
3. Sink the water by improving the soil so it allows the water to filter into the ground.
4. Vegetative cover

Consideration must be given to the velocity, depth of the river at construction, slope and height of the bank, and the soils contained in the bank.

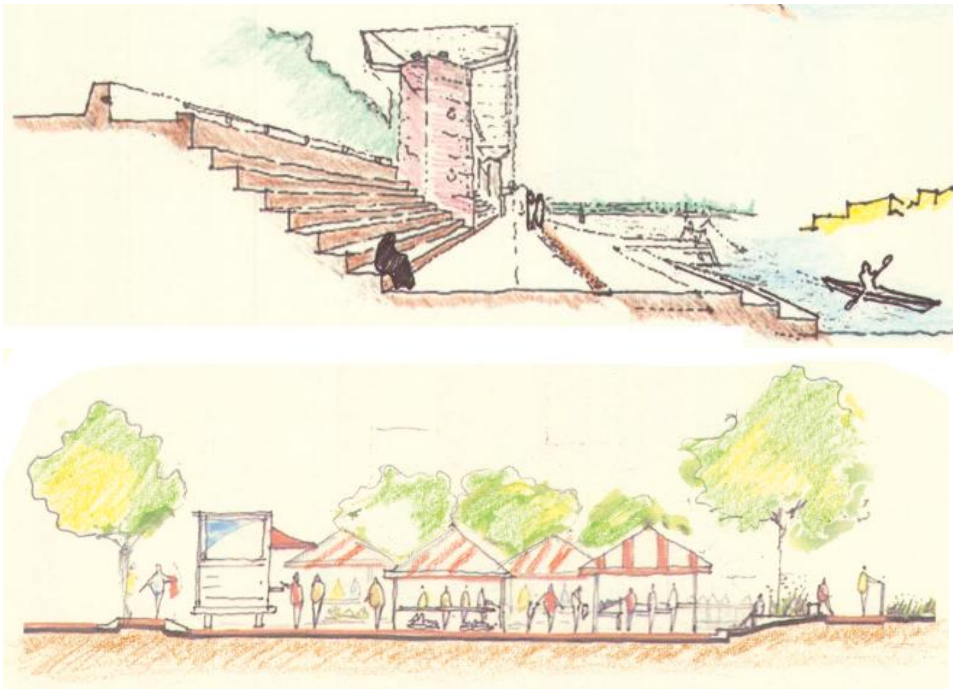
1. Velocity: Erosion can occur under any stream velocity, but becomes evident at velocities of greater than three feet per second.
2. Depth: Depths of up to three feet allow individuals to work at the water's edge without special equipment.
3. Bank slope: Slope is measured in terms of the horizontal distance from the top of the bank. Slopes of six feet horizontal to one foot vertical (6H: 1V) or flatter can be worked without mechanical techniques.
4. Bank height: The height is the difference in elevation between the top of the bank and the water at the low flow elevation. Bank height more than four feet requires mechanical methods for stabilization.

APPROACH

The design approach for Reconnecting to a Neglected River is an ecological solution that will re-link the urban core to the river. The inventory and analysis concluded that there are three main elements that the design will be focused around ecological renewal, reconnecting to the riverfront, and linking social and cultural facilities. The river corridor will look to provide river access for watercrafts, interaction with water, green open space, increase habitat diversity, and public trails to create a unified ecosystem. This river corridor will look to provide a vital social and cultural identity while protecting sensitive habitats.



Concept Sketches



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