



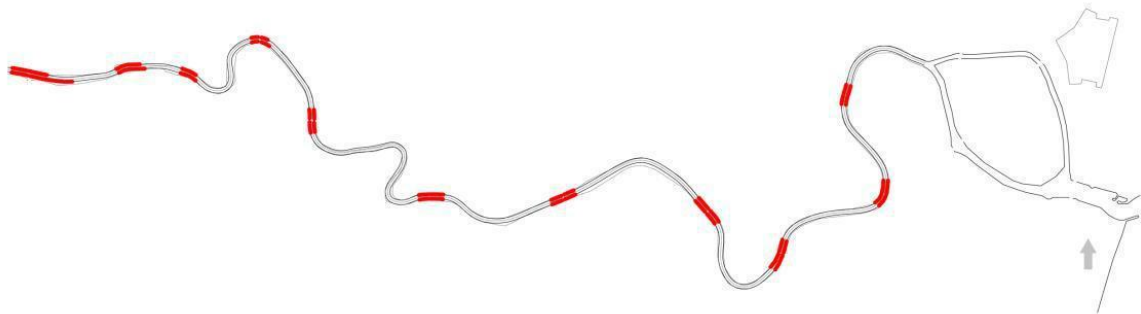
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Research Master Planning and Sustainability: Urban and Regional Planning

URBANIZATION AND ITS INFLUENCES ALONG WITH COOUM RIVER: For the situation of Chennai Flood



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DECLARATION

I declare that this master thesis titled “**URBANIZATION AND ITS INFLUENCES ALONG WITH COOUM RIVER: For the situation of Chennai Flood**” is the consequence of my work and arranged by me under the direction of Mr/Mrs **Prof. José Serrano** and that work reported herein does not form part of any other dissertation of this or any other University. Due affirmation has been made wherever anything has been obtained from different sources.

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AFFIRMATION

I wish to express my extremely extraordinary gratefulness to the whole managerial advisory group of Polytech Tours-Planning Department, Region Centre and CITERES Research Laboratory for their help and money related help. Likewise, I would like to offer my special thanks to the educators of the Research Master Planning and Sustainability Professor **Christophe Demaziere** and **Professor Laura Verdelli** and the particular scholarly board for sharing their important information and experience all through the scholastic year of the Master program, offering me the opportunity to enhance my discernment and advance my insight.

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ABSTRACT

DIVYA DHANDAPANI URBANIZATION AND ITS INFLUENCES ALONG
WITH COOUM RIVER: FOR THE SITUATION OF
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Xi and 124 pg. 5 tables and 60 figures

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Chennai is the fourth largest Indian city with a populace today around 4.7 million occupants, which has been developing consistently since Independence metropolitan of 200 km². Situated along the Bengal Sea toward the west, the urban development of Chennai runs east, north and south. Chennai is a low-lying area and the land surface is almost like a pancake. The elevation variation within Chennai district varies between 0 to 11m, with mean elevation being about 6m. Populace and urban development of Chennai which occurred rapidly today cause a few noteworthy contamination issues in the city. Most of the localities are just at sea-level and drainage in such areas remains a serious problem. Chennai City has experienced major flooding during 1943, 1976, 1985, 1996, 2005 and 2015.

The sewage system in Chennai was originally designed for a population of just over half a million at 114 liters per capita per day of water supply. Today, the population of Chennai is pushing 8 million, that stated poor carrying capacity of water. Water is the life saver of networks and the prime determinant of the settlement. Previously, it was effortlessly available yet today innovative headway hinders the connection amongst individuals and regular components. The settlements are never again restricted to water bodies or characteristic highlights; this improvement influences the city's wellbeing by disregarding the foundation of the city. These water bodies are dealt with as a thin line to convey the seepage of the city all things considered, its multi-practical quality is covered up and lost in numerous urban communities because of human exercises.

Henceforth over some undefined time frame because of the requests of urbanization, improvement has gradually crawled up to the bank of these waterways, changing over the one sprawling water bodies into the negligible dark layer.

In the present setting waterfront improvement is viewed as a urban advancement that helps city development and giving an alternate size of open space which draws in tourism. The waterfront is a critical component of the city that supports socio-social and financial esteem. This impression is clear in places like London, Singapore, Paris, and numerous stream edge urban communities.

Urban change is giving numerous chances to the rebuilding and redevelopment of regular spines of the city, for example, streams and lakes. The motivation behind the investigation is to comprehend the issue and need through numerous devices, for example, inquire about, site visits, perception, documentation and individual meetings ideal from the concerned individual identified with the undertaking to the normal man. The investigation is likewise to answer the exploration question of building an association with the general population and the stream in a urban setting and to investigate formal and casual open space along the characteristic water

bodies. And furthermore to propose a viable plan system and suggestions that assistance in city improvement.

Today, numerous urban communities confront issues as a result of the carelessness of normal components like Water bodies, woods and so forth... It is clear that urbanization is overlooking the base layers of the city that is geology and hydrology. This is one reason for urban communities getting overwhelmed. Today, urban areas are following the common forms to deplete out the water and give a surge free city in future. On other hand, urban communities are creating waterfront models to grandstand the significance of water bodies and bring back the connection between water bodies and individuals in the middle of their bustling urban life.

This postulation approach endeavors to think about the significance of urban water bodies and waterfront improvement if there should be an occurrence of Chennai, Tamilnadu, which confronted a noteworthy surge lately (Dec 2015) that close down the entire city for over seven days separating every general action.

In conclusion, Water is the lifeline of communities and the prime determinant of the settlement in the past it was easily accessible but today technological advancement blocks the link between people and natural elements. The settlements are no longer confined with water bodies or natural features; this development affects the city's health by neglecting the backbone of the city. These water bodies are treated as a thin line to carry the drainage of the city but actually its multi-functional quality is hidden and lost in many cities due to human activities. Hence over a period of time due to the demands of urbanization, development has slowly crept up to the bank of these rivers, converting the one sprawling water bodies into mere grey layer.

In today's context waterfront development is considered as an urban development that helps city growth and providing different scale of public space which attracts tourism. The waterfront is a significant element of the city that encourages socio-cultural and economical value. This impression is evident in places like London, Singapore, Paris and many river edge cities. Urban transformation is providing many opportunities for the restoration and redevelopment of natural spines of the city such as rivers and lakes. The purpose of the study is to understand the problem and need through many tools, such as research, site visits, observation, documentation and personal interviews right from the concerned person related to the project to the common man. The study is also to answer the research question of building a relationship with the people and the river in an urban context and to explore formal and informal public space along the natural water bodies. And also to propose an effective design strategy and recommendations that helps in city development.

Cooum restoration project was initiated by a lot of chief ministers of the TN starting from 1990 times. But till now it was not executed. It has many reasons interconnected starting from fund management and lack of governance team which very important to execute such important project. CMDA is one of the governing authority to approve any development in the city. The development control regulations for the Cooum river corridor has been not framed in a way that any development is not affecting the flood path. After the massive flood happened in December 2015. All the slums have been removed along with the river corridor as it got affected by the flood. CMDA should take necessary steps to frame new development controls for the developments of the new buildings.

There are various reasons has been identified for the cause of the Flood and one of the main reasons for the flood is urbanization along the riverfront and it has strongly agreed by the government of the Tamil Nadu as stated in the above study. After the flood in December 2015, CM has ordered TNSCB to shift the slums along the Cooum River to different locations but

due to the voting bank politics, it has been not executed till date. The study clearly states that crowd along Cooum and encroachments along the river to be removed from as soon as possible.

In the same country, Ahmedabad has framed a lot of development control regulations along the Sabarmati River to control the new development which should not impact the river in negative ways. And also it has designed the river stretch in such a way that no encroachments can happen along its periphery and it has a lot of tourism proposal which will earn to funds for maintenance and take out the investment for river development

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RUNDOWN OF ABBREVIATIONS

WHO	World Health Organization
UN	Habitat United Nations Human Settlements Programme
CMDA	Chennai Metropolitan Development Authority
PIL	Public Interest Litigation
CSE	Centre for Science and Environment
COC	Corporation of Chennai
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
PWD	Public work Department
CRRT	Chennai River Restoration Trust
DMK	Dravida Munnetra Kazhagam
ADMK	All India Anna Dravida Munnetra Kazhagam
TNSCB	Tamil nadu Slum Clearance Board
GoI	Government of India
GoTN	Government of Tamil Nadu
NGO	Non - Governmental Organization
MoEF	Ministry of Environment and Forest
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MRTS	Mass Rapid Transit System
LPCD	Litres Per Capita per Da

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INTRODUCTION

Chennai is the fourth largest Indian city with a populace today around 4.7 million occupants, which has been developing consistently since Independence metropolitan of 200 km². Situated along the Bengal Sea toward the west, the urban development of Chennai runs east, north and south. Chennai is a low-lying area and the land surface is almost like a pancake. The height variety inside Chennai area shifts between 0 to 11m, with mean rise being around 6m. People and urban advancement of Chennai which happened quickly today cause a couple of essential tainting issues in the city. A large portion of the regions are exactly adrift level and seepage in such territories remains a difficult issue. Chennai City has encountered real flooding amid 1943, 1976, 1985, 1996, 2005 and 2015. In 2015 flood Adyar carried 1 lakh 6 thousand cusecs of water. The sewage system in Chennai was originally designed for a population of just over half a million at 114 litres per capita per day of water supply today, the population of Chennai is pushing 8 million that started poorly carrying capacity of water.

The sewage system is upgraded in the early 1990s but remains much below capacity. The city has only 855 k.m storm drains against 2,847 K.m of roads. The level of congestion on major arterial roads has increased eightfold in less than 20 years. Waste disposal along the public area, dumped openly without preventive measure, near water bodies of water like River and wetland, due to the demographic explosion there is poor sanitation network for the treatment of wastewater. The level of a clog on major blood vessel streets has expanded eightfold in under 20 a long time, and in this way, the air quality presently surpasses the WHO proposals. The Squander transfer issue is additionally a repeating worry inside the city. Most are put away in open dumps, without prudent steps, on spaces that are still urbanized or neglected, frequently close waterways, for example, streams and wetlands. The solvent substance segments at that point adjust the nature of the soil and that of surface water and underground. Besides, the urban development of Chennai, reacting to the statistic blast, has not generally possessed the capacity to set up a compelling sanitation arrange for water treatment squander. Subsequently, the number and limit of treatment plants stay much lower contrasted with the measure of wastewater produced every day to be dealt with. Next, to no wastewater, mechanical, household or business structures are productively cleaned and are then emptied straightforwardly in the waterways of Chennai. Past the natural results, the nearness of these waters the nature of which is corrupted additionally offers to ascend to a specific level of sterile Urban. These are perfect regions for mosquito reproducing and the multiplication of microscopic organisms that can cause numerous infections.

A group of enthusiasts who have for the last two years been chronicling the cultural landmarks on the banks of the Cooum River that flows through Chennai is making the most of the heavy rains. The heavy rainfall Chennai has received 1,049 mm (41.3 in) of rainfall in November, the highest recorded since November 1918 when 1,088 mm (42.8 in) in of rainfall was recorded. The flooding in Chennai city was described as the worst in a century. Which leads to heavy flooding in several parts of the city. The areas close to the city's waterways and the newly developed parts towards the south of the city, where real estate has boomed in the last two decades over the city's water catchment areas, have been most affected by the flooding. In Chennai city, the growing urbanization and rapid industrialization lead to the generation of huge quantities of wastewater. The uncontrolled release of sewage, refuse, and modern effluents into the downstream of the Cooum waterway, permeates through the dirt and polluted the Groundwater sources. According to the WHO, around 80% of the considerable number of ailments in individuals are caused by polluted water. The bigger of the two Rivers of Chennai,

Cooum, which runs to a total length of approximately 64 kilometres, Cooum River origin from Kesavaram dam(kallur River), Thiruvalluvar District and ends under Napier bridge towards to sea. Cooum River runs 64 km totally from thiruvallur District which splits 32km under urban area rest towards villages, In Chennai district, the River flows through three corporation zones—Kilpauk, Nungambakkam, and Triplicane—for a total length of 16 kilometres. Historically, it was clear water which is also used for drinking, fishing and trading etc., and also named Thames River by British people.

Cooum River carried 98,000 cusecs of water and the Cooum River does not have that kind of carrying capacity. So suddenly all the entire adjacent area, the neighbourhood of these Rivers are flooded. A number of capacity treatment plants exists lower compared to the amount of wastewater generates. Cooum River in Chennai the natural spine of the city has got contaminated due to rapid urbanization and industrial edge. They are mostly polluted due to the disposal of sewage and solid wastes. However the two natural Rivers Cooum and Adyar are not at the same stage of pollution. The Cooum River is much more polluted than the Adyar River (The Hindu, September 2011). Moreover, the Cooum River surroundings are denser and urbanized areas, with less free spaces along the Riverbanks compared to the Adyar River.

Unpolluted: It is still using for drinking, fishing, farming from kesavaram to thiruverkadu (Paruthipattu Anaikat).

Polluted: Paruthipattu Anaikat to the River Mouth in the Bay of Bengal.

The total catchment area of the River is about 400 square kilometres (150 sq. mi), and the bed width ranges from 40 to 120 meters (130 to 390 ft.). In the non-rainy months, the River is hard to track as the flow of water is diminished and the waterways meant for the River within the city carries untreated sewage.

The issues confronting Cooum River is both geographic and political. There are many unapproved encroachments, educational establishments, housing colonies and industrial units that let out untreated sewage through the year into the waterways. One of the researchers points out that the blackish waters reported by the media a week back at the city's Marina and Besant Nagar beaches were probably the sewage being flushed out because of the increased flow of the Rivers. Padmapriya Baskaran, who is also a part of the group and is planning to write a book identifying over 140 sanctuaries on the banks of River Cooum, said that poor support of the River has likewise removed some sheen from its significance in recognizing it as a marker for a few Chola tradition sanctuaries. "A main part of the water contamination begins just at the mid-route sign of the River's 70 km stream," she included.

The Madras High Court passed an order on an open intrigue suit (PIL) trying to regularize unlawful infringements along the Kolathur tank close Chennai. The PIL contended that the state government had just divided that specific piece of land for building minimal effort lodging for poor people and along these lines the ghetto must be regularized.

Justice Sanjay Kishan Kaul and Justice Pushpa Sathyanarayana expelled the request of that day, dropping the hammer on the state government all the while. "At this point, this Court, taking legal notice of the way that notwithstanding amid the becoming aware of this case, the State of Tamil Nadu is truly influenced by uncommon surges, that is, amid November 2015, and hence, the quantity of individuals were dead and numerous individuals lost their property, is constrained to put its perspectives that the whole misfortune because of the surge was because of maladministration and the overarching rehearses by the experts," said the request (see Madras High Court Order on Illegal Encroachments). Four days later, torrential rains hit the

city. On the fifth day, large swathes of Chennai went underwater for over 24 hours, as the Cooum River and Adyar River swelled, washing away homes and belongings of those living near its banks. Near a 100 lives were lost in the surges in Chennai alone and harm to property is yet to be ascertained.

Demands for an independent commission of inquiry have been made in the Madras High Court as well as by political parties, based on allegations that the state administration failed to manage the release of water from the Chembarambakkam reservoir, the city's drinking water supply. Near 1 lakh cubic feet for every second (cusecs) of water streamed in the Adyar River on December 2, three times its ability.

The subject of why the city overwhelmed however is established in extensive part, as the Court sees, in many years of random spontaneous advancement, which has hindered the common channels of the city.

Favelas along the banks of the Rivers Adyar and Cooum are a piece of the scene of Chennai. Both Dravidian parties, the Dravida Munnetra Kazhagam (DMK) and the All India Anna Dravida Munnetra Kazhagam (AIADMK), when in control have declared different plans to migrate these ghettos. Be that as it may, vote bank legislative issues run by the day's end and these ghettos remain. While the Madras High Court arrangement was passed on the issue of ghettos, specialists demand that it isn't the ghetto tenants yet the state government which is conceivably the greatest encroacher of all. "When talking about infringements, everybody discusses clearing ghettos," said Nithyanand Jayaraman, the ecological lobbyist. "Government needs to migrate them in more awful, far-flung places.

The poor too have a privilege to live in minimal effort lodging inside the city," he included. Specialists point to different government-claimed structures inside the city that are really infringements, numerous based upon water bodies themselves. The second runway of the Chennai airplane terminal, Koyambedu transport end, the whole IT Corridor, ring streets flanking the city and the Adyar Eco Park are a few illustrations referred to by them. For the rest, they say, the state government has disregarded existing guidelines and given consent for private engineers to manufacture wantonly in catchment regions of water bodies and along the Rivers.

The surge would have been moderated as more water from the River would have hurried into the ocean," he said. Resigned civil servant MG Devasahayam rubbished the state boss secretary K Gnanadesikan's cases of the surge being a "rarest of uncommon cataclysmic event" in a December 13 articulation. "We have the best guidelines on paper to guarantee our water bodies are ensured," said Devasahayam. "Master plans, development plans are all being prepared but all this goes out when money comes in. The people who are in charge of governance have failed the people miserably, all for money. What nature gave was not a fiasco but rather just some extreme rain to a water-starved city," he said.

The Way Forward Experts say that there can be no greater alert than the surge for the Tamil Nadu state government. Research by Professor S Janakarajan, president, South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERS), demonstrates that the bed (width of the Riverbed) of Chennai's Rivers are currently not as much as a large portion of their unique size in a traverse of 40 years, decreasing the limit of these Rivers to convey more water amid substantial downpours. "Chennai, Tiruvallur and Kanchipuram areas should be viewed as one constant hydrological substance," said Janakarajan.

"There are 3,600 tanks in these territories together, all of which deplete into the three Rivers experiencing Chennai. The first stockpiling limit of these tanks is around 40 tmcft, which is

three times the drinking water interest for Chennai city. The majority of these tanks have been infringed and have vanished. We have to desilt them, secure the watershed and guarantee that infringements are expelled," he said.

Ecological financial analyst Venkatachalam concurs and encourages prompt activity from the state government. "Take a gander at the quantum of harm exacted by the surge," he said. "We have to expel existing infringements and migrate those living in catchment regions quickly.

Regardless of whether we factor in migration and resettlement costs, it will even now be a more practical way. This sort of flooding will repeat over and over, almost certainly," he said. Specialists are joined on one other point — that individuals should now wake up to natural and biological perils of living in an unsustainable city and request quick change. "Our inability to act does not come just from government offices," said Jaishankar, a senior authority at Chennai's Metro water. "It is because of the lost needs of every one of us. We are for the most part mindful. Each one of us is pushing the needs of the administration," he said.

Ecological lobbyist Nithyanand Jayaraman included that it was the ideal opportunity for common society to act. "Individuals need to characterize what the edge is," he contended. "Open outrage has now influenced legislators to pay lip benefit — they are currently encouraging to cut down infringements. We have to maintain and channelize open outrage. We have to influence courts and government to work in broad daylight intrigue," he said.

Last January the state government submitted pivotal responses to a few PILs recorded in the Madras High Court on what move was made amid the surge to caution inhabitants and to oversee water assets. In February and political gatherings would go into high rigging, crusading for the 2016 Assembly surveys. One thing is without a doubt — Chennai, Kanchipuram, Tiruvallur and Cuddalore areas will always remember the storm and will absolutely request activity from their pioneers.

Water is the lifeline of communities and the prime determinant of the settlement. In the past, it was easily accessible but today technological advancement blocks the link between people and natural elements. The settlements are no longer confined with waterbodies or natural features; this development affects the city's health by neglecting the backbone of the city. These water bodies are treated as a thin line to carry the drainage of the city but actually, its multi-functional quality is hidden and lost in many cities due to human activities.

Hence over a period of time due to the demands of urbanization, development has slowly crept up to the bank of these Rivers, converting the one sprawling water bodies into the mere grey layer.

In today's context waterfront development is considered an urban development that helps city growth and providing a different scale of public space which attracts tourism. The waterfront is a significant element of the city that encourages socio-cultural and economic value. This impression is evident in places like London, Singapore, Paris, and many River edge cities.

The study is also to answer the research question,

- ***Does urbanization along the Cooum River reduce carrying capacity of water which leads to the impact of flood and does poor governance forgot to maintenance the urban River and thus results in less carrying capacity of the Cooum River?***

Urban transformation is providing many opportunities for the restoration and redevelopment of natural spaces of the city such as Rivers and lakes. The purpose of the study is to understand the problem and need through many tools, such as research, site visits, observation, documentation and personal interviews right from the concerned person related to the project to the common man. This at that point prompts the accompanying exploration question: How does cognizance happen today? Condition around the Cooum River in Chennai? My suspicion is that the focus on the Cooum River by the administration, understudies, common society, journalists and locals illustrate.

CHAPTER 1: CONTEXT, URBANIZATION AND ITS CONCERN ALONG WITH COOUM RIVER: CHENNAI

1.1 CHENNAI CITY PROFILE

1.1.1 PROLOGUE OF CHENNAI

Chennai is the State capital of Tamil Nadu lies in the Eastern Coast along the Bay of Bengal of South India where three waterways wind through it in particular, Cooum River, Adyar River and Buckingham Canal. The settlement with History of 376 years, tracing fragments of Colonial Architecture. The city is divided into four regions: north, central, south, and west. North Chennai is primarily an industrial area. South & West Chennai with Residential & Commercial expansion. Chennai is the fourth largest Metropolitan in India having a total population of nearly 47 Lakhs with a growth rate of 13% and density of 26903. Within a century, Chennai has grown 8 fold times in population. The city is well-known for its IT parks, Sports stations, Health institutions, Educational Institutions and etc.



Figure 1: Map showing the old settlement along the River

Chennai city map shows the trace of waterbodies in the core city at 1914 and the old settlement in the east along the shoreline. The Cooum was the off centre during the city development and with a large water tanks, Nungabakkam tank and spur tank. George Town is the oldest settlement near to the fort area and Chintadripet, Triplicane, Vepery and Purasavakam was developed later. Railways network of the city evident the development of the city during 19C.

1.1.2 UNPLANNED GROWTH OF CHENNAI CITY

Chennai, having a plain terrain is bounded by Bay of Bengal in the East with an average elevation 6.7m from the mean sea level. Chennai encounters the greater part of its precipitation amid October to December related with Depressions and incessant typhoons amid this period. Average annual rainfall is about 1200 mm – 1300 mm being situated on the coastal side.

City is drained by Adyar and Cooum Rivers, in addition to many major & minor drainage channels through Buckingham Canal to Sea (Figure 2). The city is also having more than 50 Temple tanks in addition to natural water bodies to capture flood water and acts as ground water recharging wells. Chennai additionally has Pallikaranai swamps, Madhavaram and Manali heels, Adyar and Cooum Estuaries as a wetland sources separated from regular and artificial water bodies.

In addition, unplanned and often illegal urban development has led to many wetlands and natural sinks being built over; this, along with ageing civic infrastructure and poorly designed drainage systems, has resulted in an increased frequency of severe flooding.

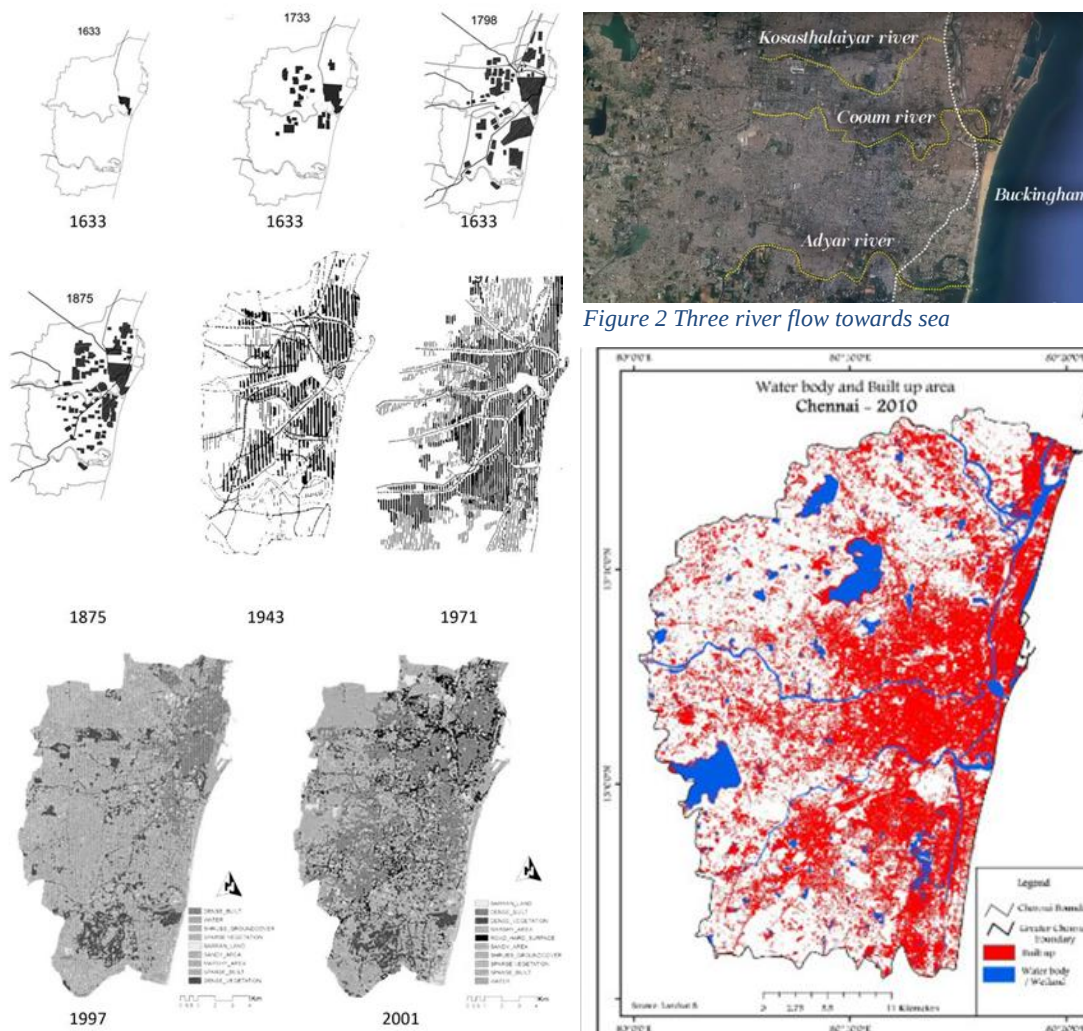


Figure 2 Three river flow towards sea

Figure 3 Growth of Chennai City (Source: Chennai Municipal Area Corporation)

1.1.3 HISTORY OF CHENNAI FLOODS

In the recent decades, Indian cities are witnessing devastating floods more often due to heavy rainfall, cyclones, etc., Though Tamil Nadu is not under flood risk-prone zone as mapped by meteorological division (New Delhi), inside the nearby body there are few low-lying zones which are defenceless to immersion which likewise depends principally on the advancements close real waste frameworks, infringement of water bodies, inability of major canals to carry heavy rains, overflowing reservoirs. Chennai, one of the fast-growing metros is likely affected by the lack of drainage mainly due to uncontrolled developments of concrete spaces, encroachment of major drainage channels, shrinking of marshlands, etc. In spite of the fact that Urbanization, the fundamental factor of reaction for the surge dangers is combined with the climatic inconstancy and natural irregular characteristics. The paper examines causative components in charge of surge hazards in Chennai, the quick requirement for appropriate surge chance diminishment and administration systems.

Chennai frequently experiences flooding due to heavy rain associated with depressions & cyclones. Of which few catastrophic floods during 1976, 1985, 1996, 1998, 2005, 2008 and 2010 caused heavy damages. Nowadays, unexpected holidays due to heavy downpour are quite common especially during October – December. To put it plainly, Chennai isn't starving for rain; it is starving for water which is because of botch of water stockpiling. In 2010, Chennai got around 760mm precipitation just amid October – December period. Ongoing most elevated precipitation in multi day was 423 mm on 27.10.2005. Every one of these shows whether Chennai is set up to deplete this blaze surge without having impediments in their day – to day life? The end of schools because of flooding each year is regular in numerous parts of Chennai. Since it is more continuous consistently why compelling administration isn't so happened? Where is the lacuna? This article is expected to land out the holes in settling the determined issue. Despite the fact that the paper is significantly in view of information from auxiliary sources, the information investigation and inductions out of that is absolutely touched base based on current happenings.

South India experienced overwhelming downpours amid the long stretch of November and December 2015 because of the development of dejection over southwest Bay of Bengal and inferable from a solid El Niño. Substantial across the board relentless precipitation action prompted waterlogging and surge like condition in parts of Karnataka, beach front Andhra Pradesh and Tamil Nadu. Tamil Nadu was one of the most exceedingly terrible influenced states where precipitation in everything except two of the 34 areas in the state has surpassed the typically watched levels, while five locale have been beat by finished double the normal precipitation got amongst October and the finish of November 2015. Chennai, specifically, was one of the most exceedingly bad hit locale in the state which got just about 1200 mm of rain in November, which is almost 300 percent over the typical perception of 407.4 mm. While precipitation in the city broke the about extremely old record for November, the record for the most noteworthy precipitation got in a solitary day in December was likewise modified. On December 1 - 2, 2015, the Indian city of Chennai got more precipitation in 24 hours than it had seen on any day since 1901. The past record for precipitation in a solitary day in December goes back to 1901 when the city got 261.6 mm of precipitation in a traverse of 24 hours. On December 1, 2015, the city got around 290 mm of rain in a solitary day causing disastrous surge calamity. The downpour took after multi month of tenacious rainstorm rains that were at that point well above typical for the Indian territory of Tamil Nadu. Tamil Nadu, particularly Chennai city was horribly hit by the surge amid November-December 2015 which guaranteed

in excess of 400 lives and caused gigantic harms, both locally and financially. Principally the areas close to the shoreline of Chennai, Kanchipuram, and Tiruvallur were the most influenced.

This has given a test to established researchers in building up a far reaching comprehension of the occasion. Surges are likely the most repeating, across the board, sad and visit common perils of the world. There has been an incredible perplexity and numerous inquiries were brought up in the brains of individuals because of the quick destruction caused by the surge in Chennai. The conceivable reasons for the surge have been recognized like substantial precipitation, uncalled for waste framework to deplete out the spill over water, soil character, watershed of the River and so on, In perspective of potential outrageous atmosphere occasions, we attest that there is a pressing need high-determination information keeping in mind the end goal to extend inquire about the hazard in the Chennai city [2]. Be that as it may, the reason for the Chennai surge is very unique in relation to other regular surges. It was discovered that Chennai surge was because of the high-power precipitation caused by the troublesome barometrical condition, precipitation appropriated spatially and transiently, the amount of stream happened in the Rivers to be specific Kosasthalaiyar River, Cooum River and Adyar River.



Figure 4 Aerial view during flood 2015-Chennai

The task of the two repositories in the upstream of the city were the Chembarambakkam repository and the Poondi supply, The measure of stream created in the city is because of precipitation over the city alone, way of the tempest water seepage framework reacts, regions where the city was immersed, change of geological highlights in the city throughout the years worsen the flooding. By an Earth-wide temperature boost and because of the natural changes the occasional precipitation fizzles and causes extraordinary climatic changes brings about tornado impacts causes the surge. Surge is one of the normal hydrological wonders which is to a huge degree flighty and wild. More than 1/3rd of the world's property zone is surge inclined influencing nearly 82% of the total populace. According to UNDP, around 170,000 passing were related with surges worldwide in the vicinity of 1980 and 2000.

1.1.4 CAUSES OF CHENNAI FLOODS

Chennai – is not an exceptional one from other metros which is suffering due to rapid urbanization. It is also contributing with the increase in floating population every year as it is a hub of all major economic activities. The accompanying are the components which hamper the living in Chennai because of surges however it can be arranged comprehensively under changes in atmosphere and smaller scale local ecological elements. Each factor (Table 1) is managed in detail in the ensuing conditions.

Table 1 Cause of Chennai Flood

CAUSES	TYPES OF FACTORS	ELEMENTS
Direct Factors	Increase in rainfall	Due to global climatic change
	Urbanization	Encroachment of all water bodies, wetlands, etc.,
		Construction of transportation networks all along the major watercourses
		Increase in concrete spaces which stops percolation of water into the ground
		Decrease in open areas/green spaces
Indirect Factors	Inadequate & poor drainage systems	Lack of Transportation facilities (esp. in slums)
		Plain terrain lacking natural gradient for free run-off
		Sewage systems were planned originally before 4 decades and only few minor modifications made which is far below the required capacity
	Disposal of solid waste & other debris	Heavy siltation all along the drainage channels
		Lack of coordination between the agencies
	Vehicle parking on roads	Attitude of people
		Lack of management measures by the agencies
		Increase in concrete spaces
		Discrepancies between public & local authority



Figure 6 Urbanisation Growth in Chennai City



Figure 5 Slum settlements near Cooum River



Figure 7 Flood 2015 Chennai roadways

1.1.5 DIRECT FACTORS AND INDIRECT FACTORS

DIRECT FACTORS

Increase in Rainfall

Chennai represents visit streak surges because of a predictable increment in the measure of precipitation likewise, out of which amid 2005, 2008 and 2010 are significant one (Figure 8). The city gets a large portion of its occasional precipitation from the upper east storm twists amid mid of October to mid of December. Violent winds in the Bay of Bengal additionally now and again hit the city.

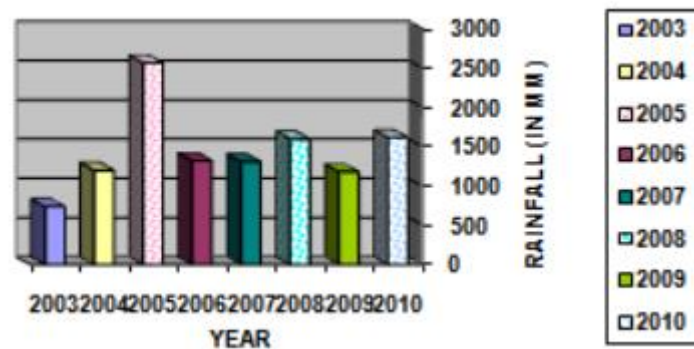


Figure 8 Average annual rainfall in Chennai (Source: Chennai Meteorological Department)

Urbanization

Chennai with the fast pace of developments has witnessed a steady deterioration and decrease in the number of water bodies. It is estimated that more than half of the wetlands have been converted for other uses. Chennai had about 6502 small and big water bodies in and around the city, but today the number has been reduced to less than 30. Ownership of water bodies is scattered among various government departments and is the root cause for lack of proper management. The Protection of Tanks and Eviction of Encroachment Act, came into effect from October 2007. However, there has been lack of implementation of this law.



Figure 9 Encroachment along river



Figure 10 MRTS station, Mandaveli

This 65-year old map (Figure 11) shows the locations of several water bodies. The grey areas of the map represent are, or small ponds. The dark water bodies are regular, in that they show up amid the blustery seasons and stay dry amid whatever is left of the year. At the point when this guide is contrasted and the ongoing one, it demonstrates a considerable lot of the water bodies have either contracted or vanished. According to records of the Water Resources Department (WRD), the area of 19 major lakes has been shrunk from a total of 1,130 hectares to nearly 645 hectares and hence reduced their storage capacity. Also, the groundwater level came down to 10m within 5 years (1995 – 2001)

The radical change in Land Use of Chennai because of urbanization (1995 – 2007) likewise adds fuel to the present danger of surge each year. The change in land cover from 1997 to 2001 is given in Figure 5. Most of the green cover is reduced to non-vegetative or a concrete space. Due to this, the surface run-off is too high and the infiltration capacity of land has gone down drastically. Because of the expansion in impenetrable territories, Chennai encounters seriousness of surges amid each overwhelming precipitation.

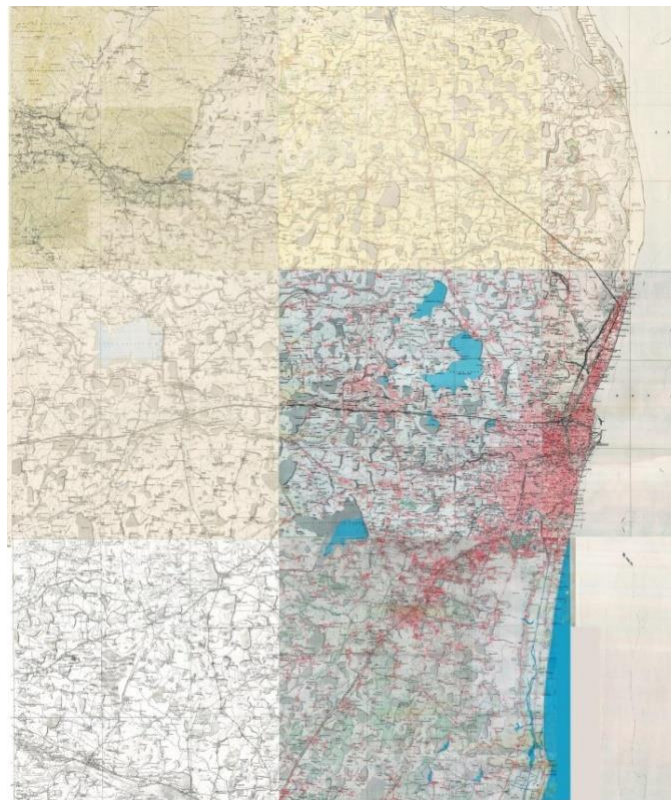


Figure 11 Map showing the locations of various water bodies located in and around Chennai before 65 years

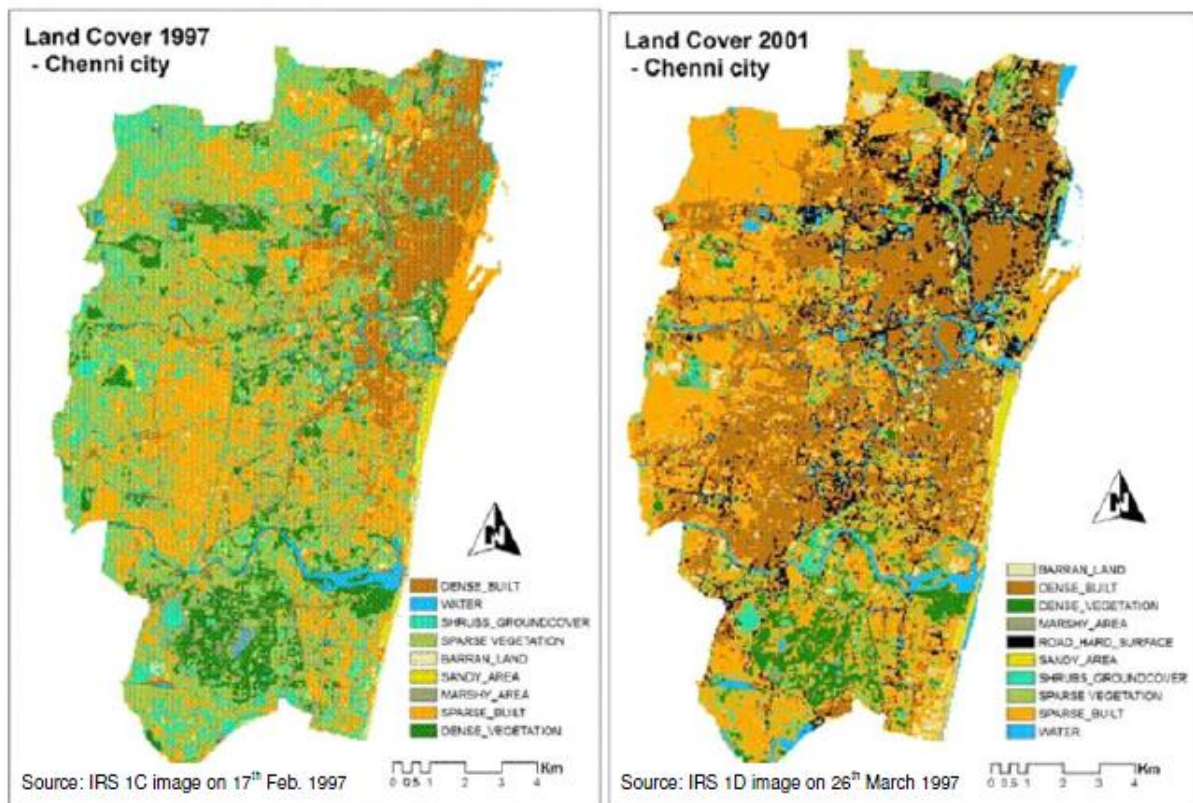


Figure 12 Chennai City's Land Cover (Source: Sundaram, Map India 2009)

A significant number of the water bodies, green cover and common despondencies have vanished because of the human-actuated progressions as it is loaded with squanders or advancements/infringements and move toward becoming surge inclined territories. (Figure 12).

Topography



Chennai has a landscape slant changing from 1:5000 to 1: 10000. It is a low-lying territory and relatively like a hotcake. It rises marginally as the separation from the ocean shore increments however the normal rise of the city isn't more than 22' above MSL, while the vast majority of the territories are exactly adrift level and waste in such regions remains a significant issue.



- | | | | |
|-------------------------|-------------------|---------------------|----------------------|
| 1. Tondiarpet | 10. Villivakkam | 19. Ice House | 28. Trustpuram |
| 2. Royapuram | 11. Ayanavaram | 20. Nammalwarpet | 29. Ashok Nagar |
| 3. MKB Nagar | 12. Choolai | 21. Purasawalkam | 30. K.K Nagar |
| 4. Sathyansoorthy Nagar | 13. Periamet | 22. S.S. Puram | 31. East Velachery |
| 5. Kannadasan Nagar | 14. T.P. Chattram | 23. Kospet | 32. West Velachery |
| 6. Muthamirai Nagar | 15. Virugambakkam | 24. Mirasulpet | 33. Saidapet |
| 7. Pulianthope | 16. Arumbakkam | 25. Valluvar Kottam | 34. Adyar |
| 8. Perambur | 17. Choolaimedu | 26. Mambalam | 35. Foreshore Estate |
| 9. Kolathur | 18. Anna Nagar | 27. Rangarajapuram | 36. Tiruvanmiyur |

Figure 13 Flood risk hotspots in Chennai Metropolitan area (Source: CMDA)

INDIRECT FACTORS

Inadequate and Poor Drainage Systems

Aside from plain territory lacking characteristic inclination with the expectation of complimentary run-off, the sewage framework was initially intended for around 6.5 lakhs populace at 114 LPCD of water supply. Later it was modified during 1989-91 even then it has not reached the required capacity. Due to dumping of garbage and massive reclamation, marshland especially in south Chennai has reduced to one-tenth of its size.

Also, the government has built a slum resettlement colony along the River channel and multi-storeyed housing estates have come up which blocks the natural drainage of River basin into the sea. The original silting pattern was shifted due to the development. Moreover, sewage and industrial effluent dumped into the canal and silting have left the waterway stagnant. Arranging of individual division situated tasks without including related experts is the significant downside which is reflecting as a noteworthy hole from the organization side. Absence of accurate topographic map is worsening the situation more. Total waste water outfalls in water ways accounts to 85%. This is an alarming issue which has to be addressed immediately.

Solid Waste Disposal & Vehicle Parking on Roads

The highest per capita solid waste generation in India is in Chennai (0.6kg/day). Majority of strong squanders is dumped in a blended frame in low lying regions and in open territories by Chennai Corporation. The Attitude of people is appalling causing the pile of solid wastes in the vicinity of the residential areas itself. Even though there is a proper system of collection, segregation & disposal of wastes, it is a serious environmental concern which has to be addressed separately.

Chennai witnesses 425 new vehicles put out and consistently causing weight for engine capable and parking spot. Increment in impenetrable expanding the surge seriousness and later dry spell to take after. Increment in street space is representing just 3 - 4% when contrasted and the created urban communities like London (20-25%)



1.1.6 DRAINAGE BASINS IN CHENNAI

Indeed, even in the present situation, Chennai isn't prepared to take one more surge if there should be an occurrence of substantial rain due to different disgraceful arranging. The aggregate zone of CMA (Chennai Metropolitan Area) is 1189 km² and three Rivers specifically: (I) Kosasthalaiyar, (ii) Cooum and (iii) Adyar course through the CMA. Kosasthalaiyar River begins close Kaveripakkam in North Arcot region and streams by and large eastbound course. It bifurcates into Cooum River and Kosasthalaiyar principle branch at Keshavaram anicut. The principle branch of Kosasthalaiyar River at that point streams northwards and goes into Poondi Reservoir. Nagari River, starting in Chittoor region, is a northern tributary and joins the Kosasthalaiyar River at Poondi supply. On the downstream side of Poondi supply, Kosasthalaiyar River moves through Thiruvallur area and CMA, lastly joins the ocean at Ennore. Cooum River bifurcates from the primary Kosasthalaiyar River at the Keshavaram anicut and streams eastwards through Kanchipuram region into CMA lastly joins the ocean close Napier Bridge. Surplus from around 75 tanks in the catchment achieves the Cooum River.

Table 2 Details of macro drainage of Chennai Metro politician Area.

Macro Drainage	Drainage Area (km ²)	Total Length (km)	Length within CMA (km)	Width (m)	Bankfull Discharge (m ³ /s)	Flood Discharges in 2005 (m ³ /s)
Adyar	720	42	24	10 to 200	2038	1700 (~3000 during 2015 floods)
Cooum	502	72	24	40 to 120	991	708
Kosasthalaiyar	3741	136	16	150 to 200	3540	2548
Buckingham Canal		418	48		42.5	99 to 280
Otteri Nullah	38.4		38.4	4 to 20	17	51
Virugambakkam - Arumbakkam drain			6.9		17	48
Kodungaiyur drain			6.9			
Captain Cotton canal			4			
Velacheri drain	3.88		2.14	5.6	18.5	21
Veerangal Odai			2.78		18.5	18.5
Mambalam Drain			9.4			

(Sources: www.cmdachennai.gov.in/SMPS/SMPS.html; Narasimhan, B. 2016;

<http://www.cmdachennai.gov.in/volume3.html>; IWS, 2007)

There are three noteworthy tanks in the CMA (Figures 11a, 11b), which take into account the drinking water needs of the Chennai City. These are (i) Sholavaram Tank (25Mm³), (ii) Red Hills Tank (93Mm³) and (iii) Chembarambakkam Tank (103 Mm³). Poondi Reservoir (91 Mm³) situated outside CMA is additionally a noteworthy wellspring of drinking water supply to Chennai city. Sholavaram Tank gets water from Poondi Reservoir and supplies the water to the Red Hills tank. Surplus water from the Red Hills tank is discharged into Kosasthalaiyar River amid surges. Chembarambakkam Tank is likewise a drinking water supply. It has its own catchment, and it additionally gets water from the Poondi supply. Overabundance water from this store is discharged into the Adyar River. Other than these three noteworthy tanks, a few water bodies exist in CMA territory, in spite of the fact that their number has descended fundamentally over the most recent three decades because of urbanization and infringement of lake beds.



Figure 16 Macro Drainage network in Chennai city (Source :Adopted from www.cmdachennai.gov.in/SMPS/SMPS.html)

Hence it can be seen that the large scale seepage of the CMA amid surges is done by an unpredictable web of three Rivers and a few noteworthy channels. The three drinking water stores bend over as surge control supplies if there should arise an occurrence of crises, and the large number of water bodies play out the confinement capacity to lessen the pinnacle releases

Yet, these Rivers are not intended to take up the Storm water and surges. So this investigation will include research of the Flood Risk Analysis and how to interconnect the different Rivers together to defeat the Flood Risk and every one of the three Rivers has real tourism and entertainment scope. Every one of the Rivers are dirtied because of Outfall of Industrial waste and sewage straightforwardly released into the River.

The fourth bowl is the pallikaranai swamp which is associate 31 distinctive water bodies, all of which discharge surplus water into the bog amid the rainstorm. Abundance water is depleted into the ocean through the Kovalam estuary. Quickly developing metropolitan city which is influenced by the absence of seepage primarily because of uncontrolled improvement of solid space, infringement of real waste channel, contracting of marshland. The factor of reaction for the surge dangers is combined with the climatic fluctuation and environmental unevenness, a city is likewise having in excess of 50 sanctuary tank notwithstanding common water bodies to catch surge water and goes about as groundwater reviving wells.

Problems with Drainage System

Chennai has encountered significant surges amid the most recent three decades in the years 1976, 1985, 1996, 1998 and 2005 and afterward the huge one out of 2015. The seepage framework has been discovered needing in view of a few reasons. These include: (i) lessening in the vent was caused by the development of extensions, (ii) sandbar arrangement at the mouths of Rivers, (iii) stopping up of the channels because of aimless dumping of strong waste and development garbage, (iv) insufficient plan limit, (v) absence of network of tempest sewers with large scale seepage, and (vi) infringements. While progressive governments have concentrated on digging of Rivers and desilting of real depletes, support of minor channels is disregarded because of the shortage of assets and also open indifference. In this unique circumstance, it is critical to draw out the impact of awful strong waste administration on the state of seepage channels, both major and minor.

In spite of the fact that a street system to the length of 6000 km (387 km of transport course and 5623 km of inside streets) is kept up by the Greater Chennai Corporation, just around 1660 km of tempest channels exist (around 205 km of these channels have a width of at least 0.6m). Tempest Water Drains are typically furnished just for streets with 12 m width or more. Prior, storm water channels were intended for a precipitation force of 31.39 mm/hr (storm term of 1hr with 2-yr return period). Be that as it may, this was hence re-examined in 2014 to 68 mm/hr in light of suggestions from

Aggradation of streets because of consistent remerging without sufficient processing is additionally one of the real purposes behind restricted flooding and water logging amid the ongoing surges. Limited flooding and waterlogging are very normal and broadly predominant over the CMA consistently, notwithstanding amid typical showers, because of aggradation of streets and absence of satisfactory cross seepage framework. According to Indian Road Congress codes (IRC: 120-2015), the streets must be processed before remerging. In spite of the fact that this is ordered by the enterprise, this standard is typically coasted by the temporary workers and not entirely implemented.

World Bank (TNUIFSL, 2014), however it isn't quickly clear as to which return period this force relates.

Chennai city has been urbanizing quickly finished the most recent couple of decades. Populace in Chennai city has expanded from a unimportant 500,000 in the year 1901 to in excess of 45 lakhs in the year 2011 [Source: Census of India, 2011]. The movement of urbanization and subsequent land utilize change in and around Chennai as of late is appeared in Figure 13 (Murawski, 2015). It is evaluated that the territory secured by the high-thickness urban zones expanded from 81.32 km² in 1988 to 330.30 km² in 2014. The region secured by low-thickness urban territories expanded from 53.79 km² in 1988 to 303.14 km² in 2014 (Murawski, 2015). A noteworthy outcome of this urbanization is the lessening in the penetration part of the hydrologic cycle, which would expand the pinnacle run-off release. Another outcome of urbanization is the vanishing of numerous minor and medium water bodies. These water bodies filled in as confinement bowls and brought about the decline in the pinnacle release. Urbanization has lessened the detainment impact.



Figure 18 Culvert with inadequate capacity



Figure 17 MRTS station on Buckingham canal



Figure 19 Panel in compound wall taken off to let water flow

Unseemly urbanization may likewise prompt the infringement of the conduits, which lessens their vent way. A glaring case of this is the development of Mass Rapid Transit System (MRTS) along and in a few areas in the Buckingham channel, as appeared in Figure 14. The new runway of the Chennai airplane terminal has been based on the Adyar River. Essentially, courses gave on a significant number of the new streets have insufficient ability to pass the spill out of one side to the next (Figure 18).

Another impact of urbanization which is typically disregarded is the "compound divider impact". Compound dividers are worked around all establishments, business and modern associations and huge private edifices, keeping in mind the end goal to anticipate infringement. These compound dividers change the neighbourhood overland stream ways and once in a while even square the nearby channels due to lacking arrangement of ducts. This, thus, changes the neighbourhood flooding design, ensuring a few zones while flooding the others. Amid real precipitation occasions, a large number of these compound dividers crumple in light of the fact that they are not typically intended to take water weight from one side. In a few cases, the compound divider and streets have influenced the normal stream and the absence of sufficient cross seepage has prompted much-restricted flooding and waterlogging. At times, individuals who are influenced by a surge harmed these dividers and streets with a specific end goal to empty floodwaters out of their territory, as appeared in Figure 19.

Reservoir Releases

Chembarambakkam tank gets water from its own particular catchment and additionally some surplus water from Poondi through the Krishna water connect waterway. Before releasing at Chembarambakkam, Krishna water connect trench crosses/joins Cooum at Aranvoil anicut and assembles some water from Cooum also before taking off to Chembarambakkam. Chembarambakkam tank can hold water up to a most extreme level of 7.315 meters, with a full limit of 3645 million cubic feet (103.214 million cubic meters) (The News Minute, 2015). At the point when the Chembarambakkam tank is full, abundance water is discharged into the

Adyar River. The day by day repository stockpiling information got from Chennai Metropolitan Water Supply and Sewerage Board (<http://www.chennaietrowater.tn.nic.in/>) amid the period 10 November 2015 to 30 December 2015 for Chembarambakkam and Poondi stores are appeared in Figures 17 and 18. On Nov. 17, 2015, 18,000 cusecs (509.7 cumecs) was discharged from the store in Chembarambakkam, causing enormous flooding in zones, for example, Mudichur, West Tambaram, and Manapakkam among others. On Dec. 1, 2015, the Chembarambakkam repository was at 93% limit with capacity of 3396 million cubic feet because of a precipitation of 47.5 cm. This prompted the arrival of 29,000 cusecs (821.2 cumecs) more than 12 hours into the Adyar River (The Hindu 2015a). The surge from Poondi store (which purges into the Cooum River) was at 8,552 cusecs (242.2 cumecs) on Dec. 1, 2015. On Dec. 2, the outpouring was at 30,200 cusecs (855.2 cumecs) – more than that of Chembarambakkam. On Dec. 3, Poondi released 36,484 cusecs (1033.1 cumecs), while the discharge from Chembarambakkam around the same time boiled down to 11,000 cusecs (311.5 cumecs) (The Wire, 2015).

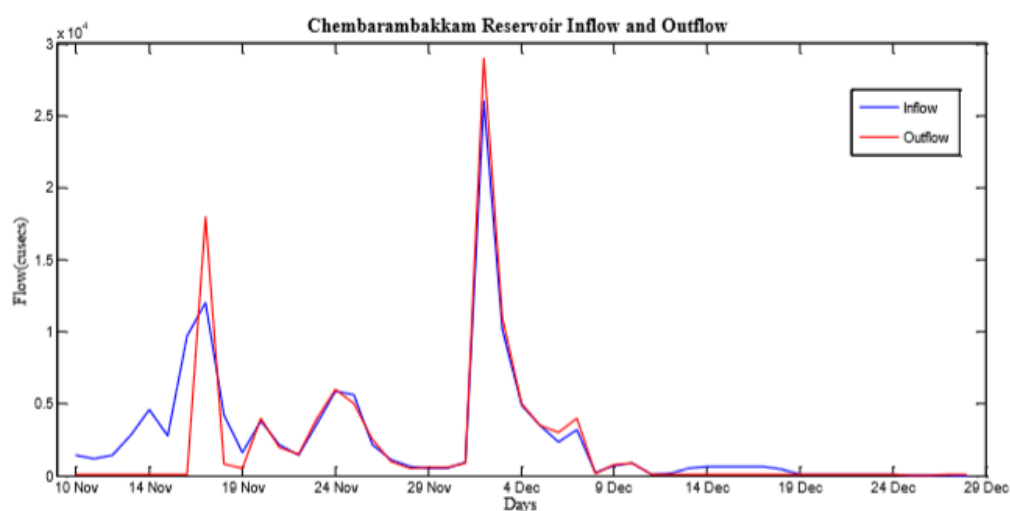


Figure 20 Daily inflow and outflow of chembarabakkam tank of madras of Nov. and Dec, 2015 (source: Chennai metro politician water supply and sewage board)

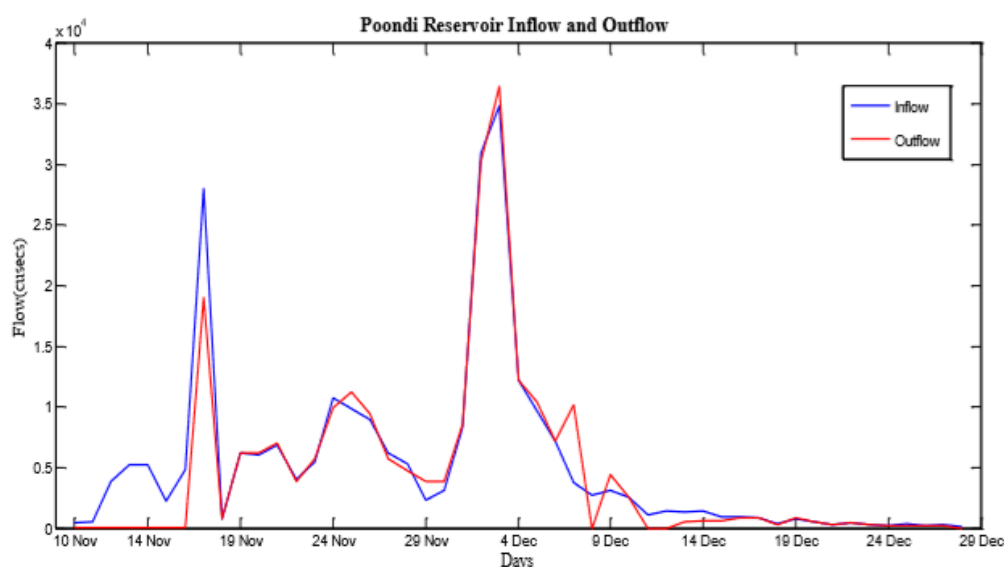


Figure 21 the Daily Inflow and outflow (Cumes) of Poondi Reservoir for the months of Nov. And Dec, 2015 (Source: Chennai Metropolitan Water supply and sewerage Board)

Starter demonstrate re-enactments (Figure 22) utilizing the hydrologic display HEC-HMS for the Adyar River bowl demonstrated that when contrasted with the supply arrival of around 800 m³/s, the surges spill out of the parallel catchment (uncontrolled by the repository and spilling out of Manimangalam, Perungalathur, and Tambaram) alone may have contributed as much as 3000 m³/s. Together, the surge at its pinnacle when it entered the city has been assessed to be around 3,800 m³/s (1, 34,195 cusecs), though the surge conveying limit of the Adyar River is just around 2,038 m³/s (72,000 cusecs).

There are solid sentiments from different parts that the specialists ought to have discharged the water from the Chembarambakkam store bit by bit well in front of the substantial precipitation since Chennai had been cautioned by IMD in mid-October of 2015 (NDTV, 2015). The circumstance would have been exceptional if the specialists had discharged controlled amounts of water from Chembarambakkam and different supplies all through November 2015. Be that as it may, these are preservation repositories and not surge control stores. Thusly, they are directed in an unexpected way. Being protection stores, without a solid climate estimate (gauges with ~70-80% false alerts) and a supply inflow conjecture, choices on the convenient arrival of surge waters are fairly troublesome. Further, all water bodies were totally full from the above-typical November precipitation and the catchment was totally immersed, bringing about substantial overflow (Figure 19). Consequently, the repository discharge alone can't be reprimanded for the enormous downpour in Chennai. In any case, ample opportunity has already past to have an extensive surge conjecture framework set up for helping the experts in settling on educated choices about working the repositories for overseeing surges notwithstanding ensuring that the capacity for drinking water supply isn't imperilled.



Figure 22 Floods runoff predictions using HEC-HMS for the catchment uncontrolled by Chembarambakkam tank

Tidal Levels in the Ocean

It is very evident that depleting of surge waters through the three Rivers in Chennai would rely on the tidal levels in the Bay of Bengal. Flooding would be exacerbated and retreat would be deferred if an extraordinary precipitation occasion agrees with the event of high tidal levels. In any case, this issue has not been centred around the standard dialogs on Chennai surges.

Information on tidal levels for the long stretches of November and December are acquired from an association which guides angling exercises. This information is exhibited in Figure 20. From this figure, the tidal effect on the flooding occasion seems to have been insignificant as the substantial precipitation and flooding isn't found to correspond with the high tidal level.

Magnitude of Floods – Loss of life and property

It's anything but an exaggeration to state that the December 2015 surges in Chennai have been mammoth in spite of the fact that there have been differing provides details regarding the quantity of setbacks, the areal degree of flooding and the size of financial misfortune. Figure 21 demonstrates the regions in the fundamental piece of Chennai which were influenced by the surges on December 3, 2015.

As right on time as December 3, 2016, the Home Minister of India educated the Lok Sabha that downpours and surges have guaranteed 269 lives in Chennai alone until that time (The Indian Express, 2015a). Likely the most stunning news was that of the passing of 18 patients in MIOT International Hospital, gave an account of December 5, 2015. The healing centre is found near the Adyar River and the surge waters harmed the power units providing capacity to the ventilators (The Hindu, 2015b). The loss of life additionally mounted to 347 (in the whole province of Tamil Nadu) by December 11, 2015, according to the official discharge from the State Government (The Hindu, 2015c). The Chief Minister of state affirmed that an aggregate of 470 lives have been lost in the province of Tamil Nadu amid the North East rainstorm (The Hindu 2016a). More than 18 lakh (1.8 million) individuals were dislodged in light of the flooding occasion. Around 30.42 lakh (3.042 million) families had endured aggregate or halfway harm to their homes; 3,82,768 lakh hectares of harvests had been lost because of flooding, including more than 3.47 lakh hectares of farming products and 35,471 hectares of agricultural yields; about 98,000 domesticated animals creatures and poultry had kicked the bucket (The Hindu, 2016b). It is accounted for that in excess of 100,000 structures were harmed because of the surges. Right around 30% of Chennai families have each confronted misfortunes between Rs.2 lakh and Rs.20 lakh (DNA, 2015).

Additionally, because of the extraordinary idea of urban flooding, the openness issues and contemplations for giving quick help to the more destitute, the alleviation activities couldn't be completed consistently in all territories (The Economic Times, 2015). Additionally, in the wake of such a remarkable debacle occasion, there was some absence of coordination between various alleviation and safeguard endeavours which were being completed by various offices and associations in the underlying days. Huge numbers of the save work force were apparently from faraway places; subsequently, they needed information about neighbourhood conditions. This made hatred in a few segments of the populace and has been a piece of broad exchanges in online life. These encounters ought to be accepted as an open door to learn and enhance the adequacy of debacle help activities later

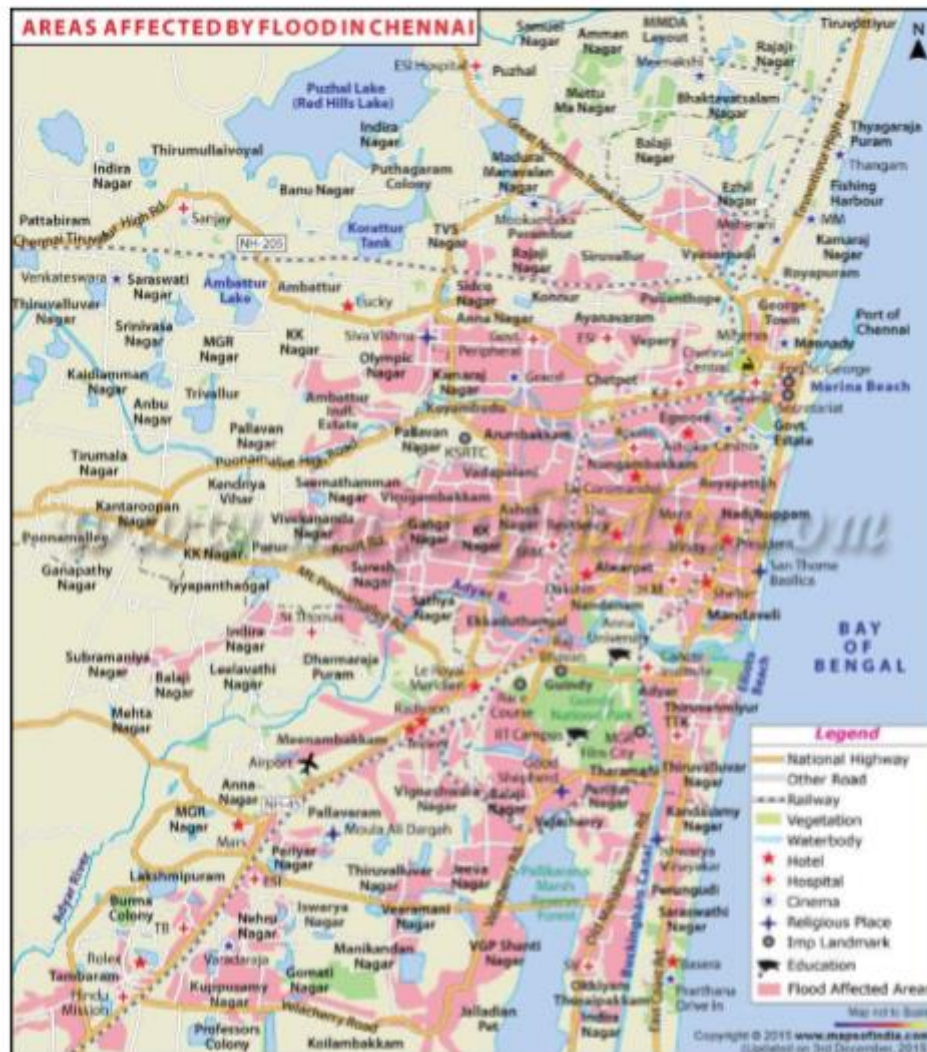


Figure 23 Areas affected by floods in Chennai on December 3, 2015 (Source: Maps of India, 2015)

It has been attested by the National Disaster Response Force (NDRF) that the Chennai flooding occasion was their biggest safeguard task (The Economic Times, 2015). An aggregate of 50 safeguard groups were squeezed into benefit, beginning with 16 groups on December 2, 2015, and coming to up to 50 groups by December 4, 2015. The groups remained in the field until December 15, 2015. A sum of 1715 people, 194 pontoons, 1571 life coats, 1071 lifebuoys were sent, alongside other fundamental life-sparing hardware, drugs and so on. NDRF protected 22,450 people and 30 creatures, recuperated 30 bodies and gave medicinal treatment to 359 people. Inside and out 2, 41,904 sustenance bundles and 2, 10,372 water parcels were conveyed.

Numerous legislative offices (The Coast Guard, the three branches of Indian Armed Forces, The Chennai Corporation, The Chennai City Police, The National Crisis Management Committee and others), non-administrative associations, common society gatherings, mechanical houses and a lot of people helped hugely in the save and alleviation tasks. Official articulations from the State Government demonstrated that roughly 1.7 million individuals had been moved to 6,605 help camps (The Indian Express, 2015b). Larger part of these camps were situated in Chennai, Cuddalore, Thiruvallur and Kanchipuram areas. The alleviation activities in Chennai were generally finished by December 19, 2015. The size of alleviation tasks can be checked by the accompanying numbers: the aggregate number of sustenance bundles appropriated - 12.8 million; the measure of rubbish gathered - 186,000 tons; add up to number

of restorative camps - 10,833 and the aggregate number of individuals screened - 1.679 million (The Hindu, 2015d).

As can be normal, individuals confronted much hardship amid the times of flooding. Media reports are found to say the intense shortage of fundamental necessities, for example, drain, water, vegetables, candles, fuel, transportation, and so on. It was accounted for that airfares were right around 10 times the typical cost.

Modern and business exercises were gravely hit by the surges. The Chennai airplane terminal was shut from Dec. 1, 2015, until Dec. 6, 2015 as the surge waters immersed the airplane terminal and the runways were submerged. Industry sources said that real players including Hyundai, Ford, BMW, Nissan, TVS, Renault-Nissan and Ashok Leyland were compelled to incidentally close generation amid the rain. As indicated by the Auto Component Manufacturers Association (ACMA), over half of the representatives have lost their homes and protests (The Indian Express, 2015c). The majority of them continued tasks by Dec. 8, 2015. Significant Information Technology (IT) organizations situated in Velachery and Tiruvanmiyur zones were immersed. They needed to close their workplaces because of loss of intensity and lack in supply of sustenance and water (Deccan Chronicle, 2015).

Fast gauges by Confederation of Indian Industry (CII) and Assocham, made as right on time as December 8, 2016, put the financial misfortune coming about because of the surges at Rs. 15,000 crores because of stoppage of mechanical generation (Hindustan Times, 2015). In any case, the state government has put the aggregate misfortune at Rs 8,481 crore (ZEE News, 2015). Aon Benfield, a UK reinsurance merchant has guaranteed that the surges in Chennai can cost Indian economy walloping Rs.20,034 crores, making it the eighth most costly catastrophic event on the planet amid 2015 (DNA, 2015). Table 3 outlines the assessments of monetary misfortune in a few parts as announced in a few daily papers.

1.1.7 MASTER PLAN & FLOOD MITIGATION IN CHENNAI

The development of Chennai did not happen in a managed way nor did it relate to the accessible framework offices. Chennai needs regular slope with the expectation of complimentary spill over which shows the need of a successful storm water waste framework. The sewage framework in Chennai was initially intended for the number of inhabitants in 0.65 million at 114 l for each capita every day of water supply (additionally altered amid 1989 – 1991) which is presently wasteful as it is underneath the required limit. The two Rivers Chennai, Cooum, and Adyar are relatively stable and don't convey enough water with the exception of amid downpours when they assume a noteworthy part gathering surplus water from around 75 and 450 tanks, in their individual catchments amid surges. Buckingham Canal, worked by the British, initially a route channel and conduit, now serves just as a seepage channel. Chennai being a seafront city is immersed with low-lying zones which have an eco-delicate association with the water driven arrangement of the city.

The city encounters surges amid rainstorm which is the prevailing period of the year. Amid surges, the water level of various water bodies' rises and stream to various floodplains submerging them. The fast development of populace which acquired a dire requirement for urbanization prompts infringement on water bodies and waterways, spontaneous laying of streets against characteristic incline in unapproved designs and development of structures well beyond these naturally huge territories. These exercises prompt extreme surges amid

overwhelming precipitation, causing immersion of abiding territories. Chennai had encountered such surges amid 1943, 1978, 2005 and further, the ongoing remarkable precipitation in the fall of 2015 caused by the El Nino marvel had crumpled Chennai greatly with streak surges. Knowledge of the past is critical and it can keep each catastrophe before it starts. In any case, shockingly, it generally stays after this occasion. It is surely an impulse to perceive how the city may have been spared if the current characteristic protections hadn't been abused.

Chennai with the quick pace of advancements has seen a relentless crumbling and decline in the quantity of water bodies. It is evaluated that the greater part of the wetlands have been changed over for different employments. Chennai had around 6503 little and huge water bodies in and around the city, yet today the number has been decreased to under 30. In a significant number of the water bodies, green cover and characteristic despondencies have vanished because of negative human collaboration and loading with squanders or improvements/infringements driving it to be surge inclined regions. Figure 24 thinks about the surge inclined zones and change in the urbanization of the region around a couple of water bodies in North-West Chennai. It can be seen that the surge inclined territories have been proclaimed as new regions for advancement as indicated by the ground breaking strategy.

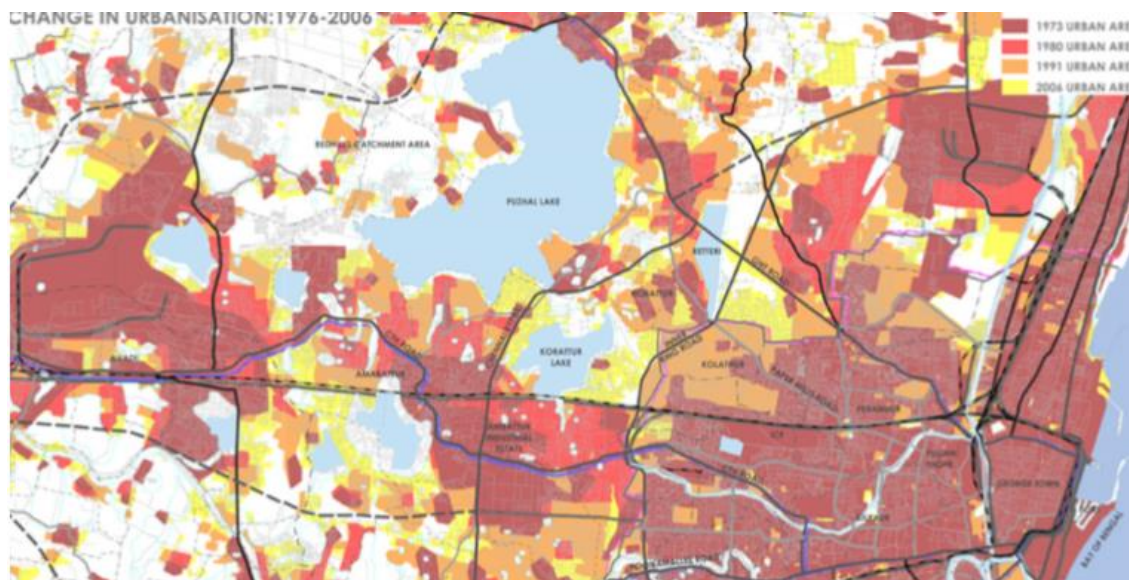


Figure 24 Flood prone zones and changes in Urbanisation along CTS road

Chennai, a city that is so urgently shy of water, is additionally inclined to flooding, particularly in purported low-lying regions. as a rule, it is most noticeably bad in suburbia, however focal territories, for example, T. Nagar and mambalam which didn't exist on the old maps which are especially inclined to immersion are either on the edge of a lake or was a piece of a lakebed. It can be watched today that flooding because of overwhelming precipitation seems to be 'naturalized' just like the aftereffect of 'normally low-lying regions'. Despite the fact that not false, this translation disregards the reasons for filling in conventional water tanks and their interconnections, which would at last lead out to ocean. The old city of Madras was brimming with Yeris over its length and expansiveness. A large number of them have been topped off and based upon as we talked about before amid the British Raj time. For example, the purported lake Area that traverses Nungambakkam and parts of T. Nagar is presently one of the perpetually risky regions. Parts of this region had four to five feet of water in the city and were inaccessible for quite a long time after the storm. Occupants were caught in their homes without power or water. The main sustenance was what they had before the rain began. Dry ground was minutes away sometimes however there was no chance to get of getting to it.

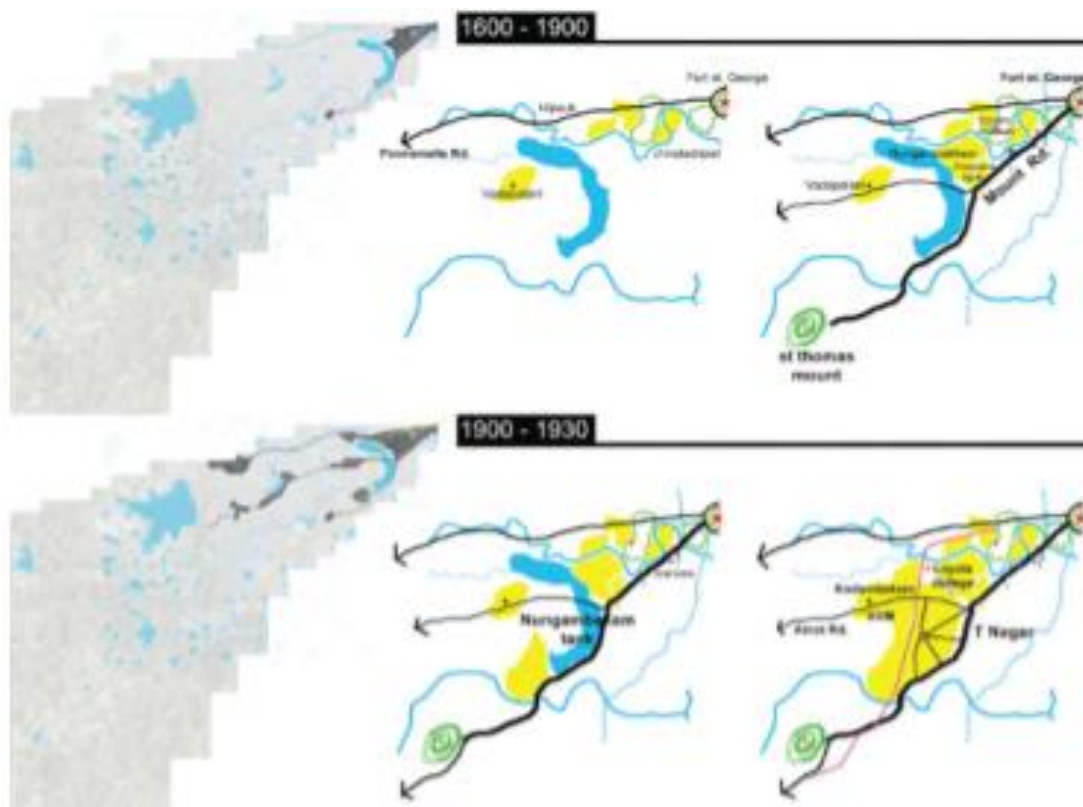


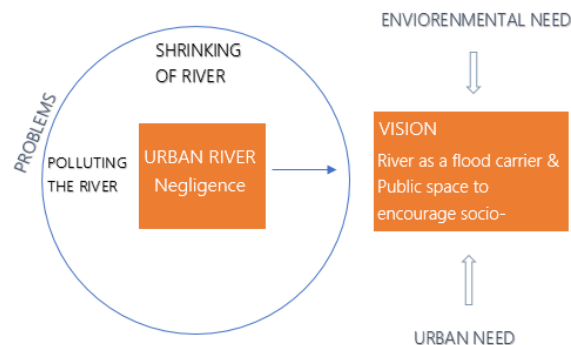
Figure 25 Urbanisation, open spaces and topography of parts of Chennai

"Make in Chennai" blast has likewise helped in exacerbating the circumstance. The air terminal based on the floodplains of the River Adyar, an immense transport terminal in surge inclined low lying place that is known for Koyambedu, a Mass Rapid Transit System developed totally finished the Buckingham Canal and the Pallikaranai marshlands, freeways and sidestep streets developed with no respect to the propensity of water to stream, IT hallway and a Knowledge Corridor comprising of designing universities built on water-bodies, car and telecom SEZs and gated local locations based on essential waste courses and catchments are the consequences of this.

The majority of the zone of the IT Park was a freshwater overwhelm until autonomy. Pallikaranai, the zone near where the IT stop is arranged, was at one time a total sea-going biological community spread crosswise over around 80 sq. km, the city's just surviving wetland and one of the final normal wetlands of south India. It is likewise a huge deplete for the abundance of storm precipitation in a catchment territory of around 235 sq. km. Today around 90 percent of the bog has been lost to improvement however the shrinkage was steady until the point that the IT hall was assigned. This set off a land blast around there and the bog was gradually cleared, filled and based upon. Pallikaranai turned into a piece of the Chennai Corporation in 2011 and is one of the nation's best venture goals in the private land. A report by worldwide property consultancy Knight Frank assessed that lodging costs would increment 93 percent in the period 2012-177. It's a habitation skyscraper loft for the IT representatives. The towns encompassing the swamp likewise transformed into a prime land. All the notice about waste, low-lying zones, a peril of immersion and encounters of the past surges were totally disregarded.

1.2 URBAN ISSUES TOWARDS AN ACKNOWLEDGEMENT OF THE STREAM

Urban Issues



1.2.1 SHRINKING OF RIVER: ENCROACHMENTS

River edges are encroached by slums and squatters, which are washed away by the past flood and knowing the risk people still settles down along the edges. River edges are also occupied for small scale industrial use and activities such as car parking, motor vehicle workshops, car wash and etc.



2.1.2 WETLAND AND BUILT-UP LAND OF CHENNAI METROPOLITAN AREAS

80% of Chennai was wetland in 1980s, now 15%

It has dependably been an open mystery, talked about and discussed after the December surges a year ago. Be that as it may, now it has developed that as the city extended, in excess of 150 water bodies, that were a piece of a surge relieving framework in the city and its rural areas, were infringed and transformed into a human home. The outcome was there to see: Plum land wanders in Mudichur and Tambaram went submerged. As indicated by an examination done via Care Earth Trust (a Chennai-based biodiversity look into association), just 15% of the city's wetlands are left, down from the 80% when Chennai's region was lesser. The scientist, Prem V, has investigated the spatiotemporal varieties, particularly focussing on wetland and the developed place that is known for the Chennai metropolitan territory from 1980 to 2010.

According to the discoveries, the developed territory of the city was 47.62sqkm of every 1980, just 20%, while the wetlands were spread more than 186.30sqkm (see maps). In 1991, the

developed territory expanded three-fold, 152.33sqkm, and nearly measured up to the wetland spread which in the 11 years had boiled down to 159.41sqkm.

The IT blast at the turn of the thousand years set off a development blast in the southern parts of the city to oblige workplaces, and to house geeks, the land business thrived in the region. Throughout the years, the city extended and edges like OMR and Perungudi changed. As concrete supplanted the shrub lands and dry lake beds, the developed zone expanded. In 2000, it was 250.58sqkm (68%) when contrasted with the 117.48sqkm of the wetlands. After 10 years, the developed territory contacted 402.10sqkm (85%) and the wetlands had contracted to 71.05sqkm (15%).

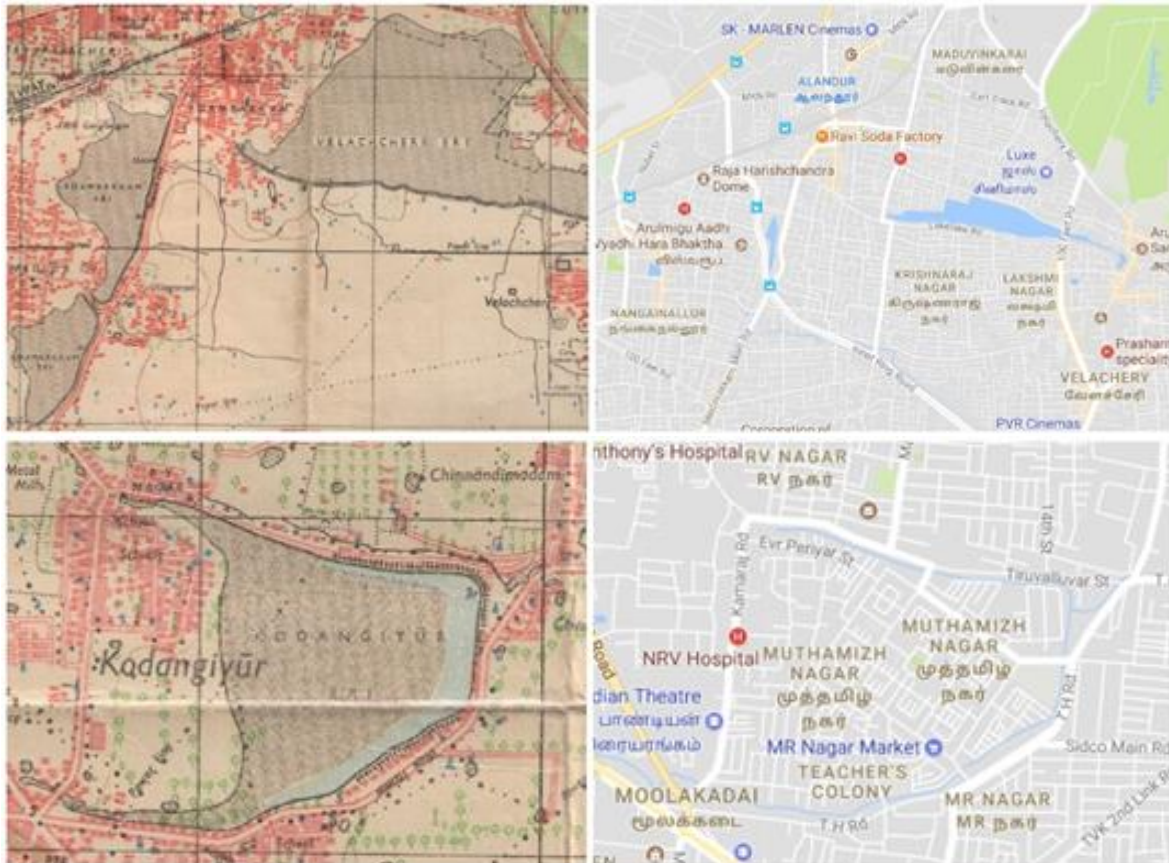


Figure 26 Image showing urbanisation over waterbodies (Many of the water bodies, green cover and natural depressions have disappeared due to the human induced successions as it is filled with wastes or developments/encroachments and become flood prone areas)

The study found that most of the water bodies affected were in the southern and western suburbs. The regions where the water bodies infringed, some institutionally, included Tambaram, Perungalathur, Vandalur, Ramapuram, Manappakkam, Valasaravakkam, Ambattur, Alandur, and Adyar. Unexpectedly, a few of these territories were hit hard by the December storm.

According to the study, buffer areas of a lake are the first casualties of rapid urbanization. Known as odai porambokku and yeri porambokku in Tamil - meaning rivulet across a wasteland and lake on a wasteland respectively - these buffer areas connected lakes and drained excess water from one water body into another. These channels formed an integral part of a natural flood mitigating system, but over time, with the lakes dry, these were encroached upon, the study said. Also, pastoral land adjoining the lakes acted as floodplains during monsoon. With the channels and farmlands went, flooding was imminent.

As a conservation-oriented study, the research provides a roadmap for the government to protect the wetlands from further degradation. Six years ago the Union ministry of environment and forests enacted Wetlands (Conservation and Management) Rules 2010. One of the key features of this legislation was powers vested in the state machinery to determine the “wise” use of water bodies. This May, Tamil Nadu set up wetland authority to protect the water bodies. How effective it will remain to be seen.

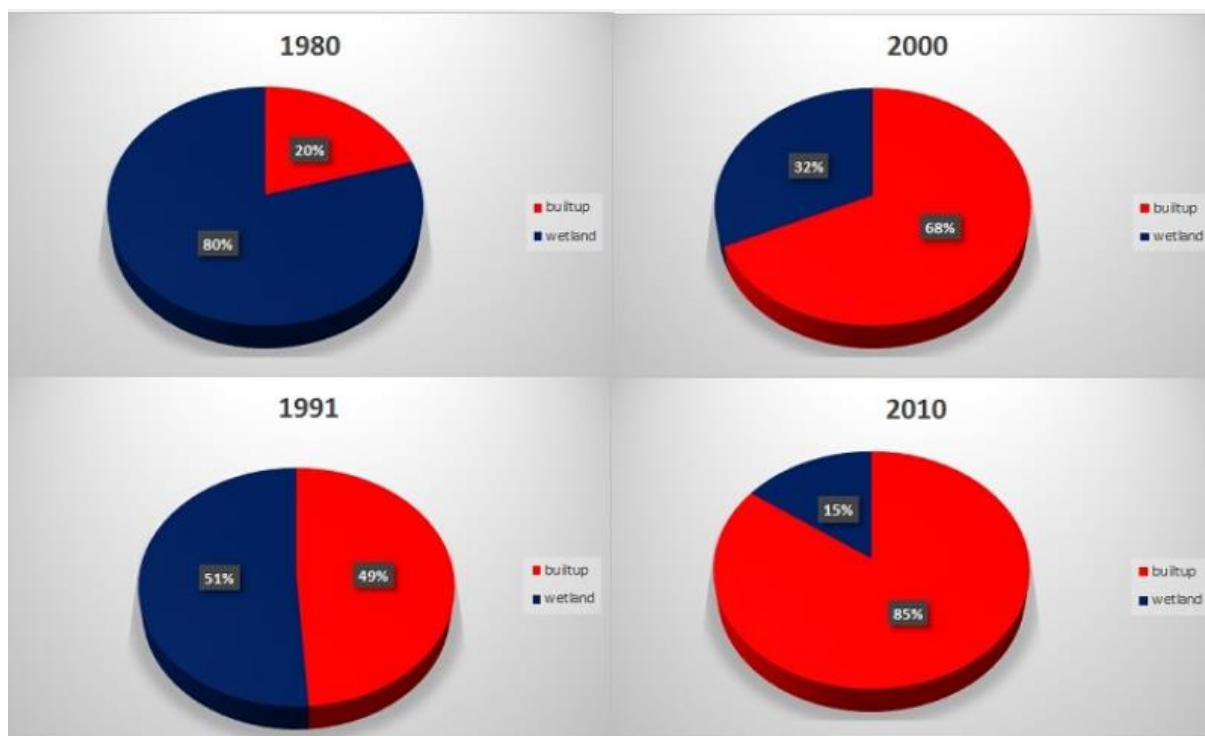


Figure 27 Graphs showing that the urbanisation development from 1980 to 2010

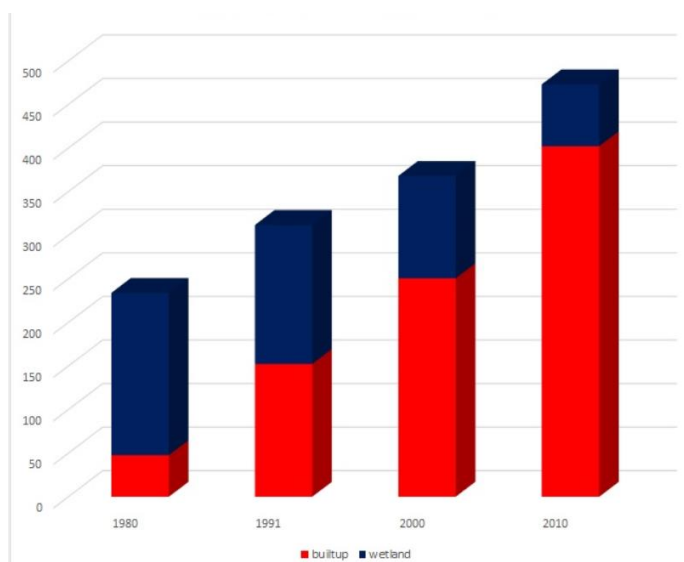


Figure 28 Ratio of wetland and built-up lands

From an 80%-20% split in 1980 among wetland and created region in the city, wetlands were reduced to 51% of city's zone in 1991, to 32% of each 2000, and just 15% of each 2010. In 2016, the wetlands offer of the city's zone could be essentially lesser.

The developed zone of the city was 47.62sqkm out of 1980 and wetlands were more than 186.30sqkm. In 2010, as the city developed, the developed region was at 402.10sqkm and the wetlands only 71.05sqkm, the discoveries say.

1.3 METHODOLOGY OF THE RESEARCH THESIS

1.3.1 BACKGROUND OF THESIS

Today, many cities face problems because of negligence of natural elements like Water Bodies, forest and etc... It is evident that urbanization is forgetting the base layers of the city that is topography and hydrology. This is one of the reasons for cities getting flooded. Today, cities are tracing the natural contours to drain out the water and provide a flood free city in future. On other hand, cities are developing waterfront models to showcase the importance of waterbodies and bring back the relationship between water bodies and people in-between their busy urban life. This thesis approach attempts to under the current situation of Chennai Cooum River and to study importance of urban water bodies and waterfront development in case of Chennai, Tamil Nadu, which faced a major flood in recent times that shut down the whole city for more than a week disconnecting all regular activities.

The rapid industrialization and urbanization of Chennai city and the River banks have led to severe contamination of the Rivers. They are mostly polluted due to disposal of sewage and solid wastes. However the two natural Rivers Cooum and Adyar are not at the same stage of pollution. The Cooum River is much more polluted than the Adyar River (The Hindu, September 2011). Moreover the Cooum River surroundings are denser and urbanized areas, with less free spaces along the Riverbanks compared to the Adyar River. Also the Adyar River was for a long time a barren land, then become the southern limit of the city, and now the urbanization has even expanded further south.

Finally the beginning of the research was also focused on a project of integrated Cooum eco-restoration at Cooum River, The project has been launched by the government and implemented by external consultants (Still under process).

1.3.2 PROBLEM STATEMENT AND HYPOTHESIS

Based from a theoretical corpus (interviews, thesis, books, articles, documents available online), my statement is that most parts of the population of Chennai are taking into consideration the pollution on water bodies. Again the Government has taken measures and implemented projects to address the issues on the Cooum River's pollution. To me, it demonstrates a situation in Chennai and reason behind the flood. Also if the restoration of the Cooum River is pursued on the whole stretch, a movement of Riverfront development in Chennai might happen later.

I assume that there is no awareness among the general public and governing body of the column as well as the Chennai development authority regarding the importance of the control of various factors affecting the colour River as one among illegal settlements along the column River and importance of recycling the routing of the sewage generated in the city on day to day basis. And increasing the carrying capacity of the Cooum River which is in the hands of the PWD and CMDA as well as the PCB who are all the most important governing bodies of the Cooum River.

The hypothesis will be verified by looking at the governmental measures, the Riverfront projects, and the ecological restoration projects, by exploring the discourse of newspaper, analysing the discussions with the different parts of the society of Chennai, investigating on the direct site the happenings, and examining theses about the Cooum River in various fields (chemistry, biology, planning, and architecture).

RESEARCH QUESTION

The study is also to answer the research question,

- **Does urbanization along the Cooum River reduce carrying capacity of water which leads to the impact of flood and does poor governance forgot to maintenance the urban River and thus results in less carrying capacity of the Cooum River?**

‘We have forgotten the art of drainage. We only see land for buildings, not for water’. Chennai is perhaps experiencing the worst impact of freak weather, but the city could have fared better had it protected and preserved its natural water bodies and drainage channels, experts at the Centre for Science and Environment (CSE) said. The unprecedented deluge that Chennai has been subjected to is a reminder of increasing frequency of such freak weather events across the Indian subcontinent, they said.

Talking regarding the matter, CSE chief General Sunita Narain stated: "We have more than once attracted consideration regarding the way that our urban sprawls, for example, Delhi, Kolkata, Mumbai, Chennai, Srinagar and so forth have not given careful consideration to the regular water bodies that exist in them. In Chennai, every one of its lakes has a characteristic surge release channel which depletes the overflow. In any case, we have worked over huge numbers of these water bodies, hindering the smooth stream of water. We have overlooked the craft of waste. We just observe arrive for structures, not for water."

1.3.3 JUSTIFICATION OF THESIS

Loss of Water Bodies

CSE's examination demonstrates that Chennai had in excess of 600 waterbodies in the 1980s, however an end-all strategy distributed in 2008 said that lone a small amount of the lakes could be found in a sound condition. As indicated by records of the State's Water Resources Department, the territory of 19 noteworthy lakes has contracted from a sum of 1,130 hectares (ha) in the 1980s to around 645 ha in the mid-2000s, diminishing their stockpiling limit. The channels that convey surplus water from tanks to different wetlands have likewise been infringed upon.

Lack of Storm water Drains

The investigation additionally demonstrates that the stormwater channels built to deplete surge waters are obstructed and require prompt desolation. Chennai has just 855 km of storm water channels against 2,847 km of urban streets. In this way, even a barely overwhelming precipitation causes destruction in the city. Various urban areas including Chennai are both water-rare and additionally inclined to flooding. The two issues are connected — over the top development prompts poor energize of groundwater aquifers and obstructing of common seepage frameworks. Sushmita Sengupta, representative program director with CSE's water group, stated: "While Chennai has been attempting to meet its water needs and has been notwithstanding desalinating seawater at a colossal cost, it enabled its aquifers to get depleted. "Chennai's human-made waste is no swap for its normal seepage frameworks — a CSE examination demonstrates that there are regular channels and depletes that specifically interface the city with wetlands, water bodies and Rivers, for example, the Cooum and the Adyar that go through Chennai. The Cooum should gather surplus water from 75 tanks in its catchment region

inside the Chennai Metropolitan Area, while the Adyar should convey the surplus water of around 450 tanks in its catchment region and furthermore from the Chembarambakkam tank (which isn't in its catchment).

The downpours in Chennai have broken a 100-year record (374 mm in only 24 hours). In November, the city had gotten 1,218 mm of rain, which was just about three times more than the normal the city gets (407 mm).

A recent report by the Indian Institute of Tropical Meteorology (IITM) in Pune had said that extraordinary precipitation occasions were expanding in recurrence and force in India amid the period from 1950 to the 2000s. CSE's environmental change specialists say that while point by point attribution contemplates should have been done to discover more connections between the Chennai disaster and environmental change, existing logical examinations to set up the likelihood of an association.

Absence of wetlands

The absence of wetland, which goes about as a wipe, dousing up water, assumed the fundamental part in surges. As indicated by a report of driving every day, more than 5,550 hectares of wetlands around there have been created into the business land and just 10 percent of the first wetlands remain. Thus, water overflow has no place to go and settles rather onto streets, causing flooding. Botch and infringement of standards in urban arranging have caused such extreme flooding.

Poor administration of Cooum River

The Cooum River is one of a few Rivers of the Madras Basin in southern India. It streams east into the Bay of Bengal through the focal point of the Chennai (once in the past Madras) Metropolitan Area. With an expected populace of 4.2 million inside as far as possible in 2001 (and 6.4 million in the urban agglomeration), Chennai is the fourth biggest city in India (Census of India 2001). It is the overwhelming urban focus in the south of the nation. The area of the Cooum River in the core of Chennai and the city's circumstance as a city in a creating nation, with accompanying issues of such urban communities (e.g., insufficient sewerage and stormwater frameworks, jurisdictional fracture, absence of assets, an unthinking administration condition, debasement, and poor adherence to civil controls) and also deplorable physical attributes of the region, have imagined to make the Cooum River a to a great degree contaminated stream. There have been various endeavours to clean this very noticeable conduit, yet there has been no long haul change of the circumstance. Truth be told, the issue has intensified.

While the Tamil Nadu government burned through many crores of citizen cash to re-establish the Cooum River, blackguards have wreaked destruction on the venture heaping huge amounts of development and plastic waste in and around the Riverbed.

Uncontrolled dumping of waste is unmistakable on the stretch of Cooum between Maduravoyal sidestep and Koyambedu metro rail station. Tipper trucks add to the loss by abandoning development trash on the Chennai-Bengaluru national parkway while organizations like Greater Chennai Corporation and the police office seem to have chosen not to see to the illicit action.

The Chennai Rivers Restoration Trust (CRRT), which is entrusted with monitoring the advance of the Cooum River rebuilding venture, had no clue unlawful dumping was occurring. "We

have not investigated the undertaking's advancement for quite a while. It is being actualized by the PWD and the partnership," a CRRT official told TOI.

On Union Road close to the Dr. MGR Educational and Research Institute, the Adayalampattu panchayat had dumped huge amounts of plastic and non-biodegradable waste on the Riverbed. "The panchayat labourers likewise set fire to the waste when the stature of the landfill increments," said Viswanathan, an inhabitant of the town. The spot has additionally transformed into an open poop site.

While panchayat authorities couldn't be gone after remark, enterprise sources revealed to TOI that their situation is anything but hopeful as the dumping was occurring at destinations outside of their ward. This, in any case, is inaccurate as the landfill site falls inside partnership limits.

C. N. Annadurai propelled a Cooum Improvement Scheme at a cost of ₹ 19 million in September 1967 ₹ 12,000-million Chennai City River Conservation Project (CCRCP) in January 2001.

In 2010, the Tamil Nadu government marked a MoU with Singapore Cooperation Enterprise (SEC), a Singapore office for the reclamation venture. In 2011 The World Bank has endorsed Rs 22.41 crore for the Cooum reclamation venture towards the advancement of its water system potential. In 2012, the administration distributed ₹ 3,000 million towards the development of 337 sewage cleaning frameworks in the conduits in the city, incorporating 105 areas in the Cooum River. So Politicians are attempting over and over, yet till date, Cooum reclamation venture isn't done because of the poor support of the administration.

CHAPTER 2: COOUM RIVER STUDY AND DOCUMENTATIONS

2.1 STUDY AREA AND SITUATION OF COOUM RIVER

2.1.1 COOUM RIVER STUDY

The Cooum River is one of several Rivers in the Madras Basin in Southern India (Figure 1.2). It flows to the Coromandel Coast and into the Bay of Bengal from west to east through the centre of the Chennai Metropolitan Area (CMA). Chennai, with a population of 3.9 million within the city limits and a metropolitan area population of 5.4 million persons in 1991, is the fourth largest city and third largest port in India. It is the dominant urban centre in the south of the country. The city is the capital of the southern Indian state of Tamil Nadu, and is situated at approximately 13° North latitude and 80° East longitude. Chennai city at present envelops a zone of 172 km², and the metropolitan zone includes right around 400 km² of urban agglomeration to this figure (Nagaraj and Ramani, 1991: 1.38). Figure 29 presents the land area of Chennai inside India, and Figure 30 demonstrates the city in its provincial setting. The geography of the Chennai territory is level, with the landscape rising marginally inland from the drift. Mean rise above ocean level for the city is 22' or 6.7 meters, however the vast majority of the city is at or just marginally above ocean level, making waste an issue. The transcendent soil in the region is alluvial, with scattered pockets of gravelly soil. Seaside zones and tanks (supplies) have prevalently saline, sandy soil (Government of Tamil Nadu, 1981:10-12). The subsoil is dark mud with fluctuating solidness at various profundities. Chennai gets a normal of roughly 1300 mm of precipitation for every year – a large portion of this (~800 mm) falls amid the North-East storm in the long stretches of October through December. Two primary conduits move through the city from west to east: the Adyar River in the south and the Cooum River through the topographical focus of Chennai. Additionally, the Buckingham Canal runs north to south along the drift through the city and converges both the Adyar and Cooum Rivers on their north and south banks. All the conduits in Chennai are thought to be contaminated, yet the Cooum River and Buckingham Canal are generally perceived to be the most noticeably awful. The Cooum has a length of around 70 kilometres and starts where surplus from the Cooum tank joins the Kesavaram Anicut² worked over the Kortaliyar River in Kesavaram town. For around 18 kilometres in its most reduced achieves, the Cooum twists through the developed zone between as far as possible and the Coromandel drift.



The River depletes a catchment of around 290 km², including around 140 tanks or stores (Gowri, 1997:43). Inside the city, the River's channel ranges from around 170-180 meters wide close to the mouth with the River itself representing 140-150 meters of this, to a channel width extending between around 45 and 100 meters and the River itself changing in the vicinity of 25 and 60 meters (Mott MacDonald, 1994, Table 5.12:49). This River has been depicted as a "sluggish stream" which is relatively dormant and which conveys little water aside from amid the rainstorm. It has additionally been noticed that the Cooum "gets a sizeable amount of sewage from its neighbourhood for transfer" (Government of Tamil Nadu, 1981:10).

Figure 29 The regional setting of Chennai, in the southern Indian state Of Tamil Nadu

Up and down the River's course businesses discard their waste and family units hurl their refuse (Table 4). Despite the fact that parts of the city are adjusted by essential and auxiliary sewerage treatment, in the most thickly populated zone encompassing the lower reaches and mouth of the Cooum River, crude sewage is occupied into the conduits and sea (Srinivasan, 1991:III.17). Table 4 exhibits this circumstance, demonstrating a sum of 407 wastewater outfalls into conduits in Chennai (116 into the Cooum) that were recognized by a consultancy firm in 1994 (Government of Tamil Nadu, 1997: TOR-3). Indeed, even this huge number of wastewater outfalls is likely a think little of. A later study of contamination outfalls by an ecological NGO in Chennai distinguished 720 outfalls to conduits in Chennai (WAMP, 1999a). For quite a long time, the state of the Cooum has been of concern. Srinivasa Chari composed of the blockage of the mouth of the River, its low stream and "underhandedness smell" as far back as 1939 (Appasamy, 1989:13). Then again, there are prior records of the River being adequately perfect to give the water to day by day ablutions, and of being traversable (Muthiah, 1999). As Chennai developed, in any case, the squanders that its subjects and enterprises exhausted into the Cooum turned out to be more than the indigenous habitat could absorb. The River was changed from a resource for nationals of Chennai, into a flaw on the city. Numerous variables confound the circumstance of the Cooum. One such intricacy emerges from ghettos (Figure 31). These hutment zones have regular open toilets and waste transfer zones along the River. In 1986 there were 37 ghettos, absolutely un-adjusted by open luxuries, arranged specifically on the banks of the Cooum River itself, and numerous more in its close region (MMDA, 1986). Besides, fecal matter and other waste related with creature cultivation in the city (which is regularly connected with ghetto occupants), additionally add to contamination of the Cooum. The consequence of these and different exercises is that along quite a bit of its course through the city of Chennai the Cooum River is a dark, noxious, open sewer. There are a wide assortment of detailed water quality pointers for this River.

All show that the River is seriously dirtied, (in spite of the fact that the markers change generally and are frequently in view of undisclosed strategies). The nature of water in the Cooum River is best shown by estimations of the 5-day biochemical oxygen request (BOD5) which demonstrates the measure of natural substance in the water by the measure of oxygen devoured by vigorous microscopic organisms in breaking down it. These qualities have been accounted for as high as 315 mg/l in the Cooum River (Gunaselvan, 1999). Contrast this with the normal BOD5 estimation of crude sewage in the sewerage framework in Chennai of 250 mg/l (Ananthapadmanabhan, 1998). Much greater many-sided quality is shown when physical and water driven attributes of the River are considered. The development of the harbour has brought about nearby adjustment of the solid littoral float along the Coromandel drift. This has caused expanded disintegration of the drift north of the harbour, and statement of sand in the south. One impact of the changed beach front streams is emphasis of the development of sand bars which hinder the mouth of the Cooum (Mott MacDonald, 1994:22). This blockage, and lacking stream amid the dry season (which neglects to keep the sandbar clear of the mouth), result in the catching and stagnation of water in the lower ranges of the River. Natural dry muck is found on the banks of the Cooum, with a normal profundity of 0.4 meters. The aggregate volume of ooze in the Cooum that is of water driven and natural concern is around 1 210 000 m³. Muck tests taken from the Cooum as a feature of a consultancy think about in the mid-1990s, were found to contain low convergences of pathogenic parasites, (e.g., worms, for example, *Ascaris lumbricoides* and *Trichuris trichuria*). It is accepted that the slime likewise contains *Cryptosporidium*, (a noteworthy reason for diarrhoeal ailment) and enteric pathogens including *Vibrio cholerae* (Mott MacDonald, 1994:42). Different issues are likewise connected with the Cooum contamination issue. For instance, a few family units and endeavours have unlawful associations with the stormwater seepage framework as opposed to the sewerage framework,

bringing about the inappropriate transfer of wastewaters. This is thusly connected with issues of implementation of by-laws and controls which are proposed to guarantee appropriate conduct regarding transfer of sewerage, strong waste, flotsam and jetsam from development, and so forth. And the defilement of authorities.

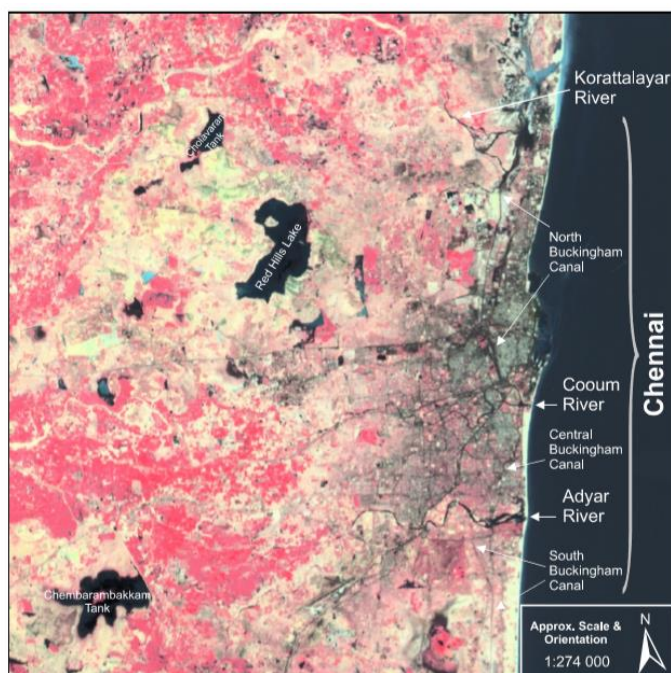


Figure 30 IRS satellite image of Chennai and surrounding region with Important surface water features indicated.

IRS satellite image of Chennai and surrounding region, with important surface water features indicated. Grey areas in this satellite image are the built-up areas of Chennai and the Chennai urban agglomeration. Reddish colours indicate vegetation, and bright whitish colours are typical of highly reflective sandy areas. Notice the absence of water in the Cooum outside (west) of Chennai. This image was acquired in August of 1988, a dry season for Chennai. (Technical note: this image is a false colour composite from bands 4, 3, and 2 of an IRS LISS-2 scene. The spatial resolution is 36.25 metres. The image is uncorrected geometrically and has been enhanced for visual interpretation using a histogram equalization stretch of the digital numbers).

The sandbar additionally restrains tidal waters which would some way or another enter the mouth of the Cooum and help to flush out a portion of the Blockage of the mouth by the sandbar, and low stream of the River (Table 5), bringing about the amassing of sediment and natural silt on the overnight boarding house. The silt comprises of a blend of alluvium from the basic alluvial bowl, silt transported from upstream, dregs transported into/over the River mouth by littoral float, overflow from the city avenues, suspended solids from coordinate release of wastewater, and direct transfer of strong waste (Mott MacDonald, 1994:28). It is a blend of sediment, sand and natural silt. Mott MacDonald (1994:48) show that the profundity of delicate silt on the base of the Cooum River changes from around 0.3 to 0.7 meters (thicker in the lower comes to), with a likely normal profundity of around 0.5 meters.

Numerous directions exist which are arranged toward controlling contaminating action, yet these are not regularly upheld. One investigation of water quality in the Cooum embraced by specialists at the Institute for Water Studies of the Tamil Nadu Public Works Department (PWD) features the significance of this point by prescribing that current laws ought to be "entirely implemented" against the polluters of Rivers in Chennai (Chengalvarayan et al., 1999:76). Likewise, medical problems emerge from the state of the Cooum. In numerous spots, the River gives natural surroundings to mosquitos which spread sicknesses, for example, jungle fever and filariasis. In spite of the fact that in numerous spots the River is excessively dirtied, making it impossible to permit the reproducing of the *Anopheles stephensi* mosquito which conveys jungle fever, the *Culex* mosquito, a vector for filariasis, breeds there (Mott MacDonald, 1994:42; Appasamy, 1989:36). Infections, for example, cholera, typhoid, hepatitis and others, and pathogenic parasites, are related with contamination of the water and the amassing of natural (fecal) muck. City occupants living in the region of the conduits are at higher hazard concerning wellbeing. This is particularly valid for the individuals who have physical contact with the water, for example, kids playing in the River and fishers in stretches of the River close to as far as possible. The Chennai Metropolitan Development Authority (CMDA) has communicated worry over this exceptionally focused on condition and has shown the requirement for activity to balance out, restore and support the River and encompassing

territories. The Development Strategy for Madras 2011: An Agenda for Action (Dattatri and Anand, 1991:6) delineates this worry;: Expedite and Complete Cleaning of Water Ways: The conduits in the City are directly general wellbeing risks. To enhance the nature of living as likewise to enhance the City's potential for tourism it is vital that the activity design confined for cleaning and keeping up the conduits is actualized inside next two years. No activity has happened. All things considered, the advancement and usage of an administration get ready for the Cooum River is a need for offices managing urban improvement and administration of the urban condition in Chennai (Ranganathan, 1995).

Table 3 Climate parameters of Chennai

Month	Mean Rainfall ¹ (mm)	Mean Temp ² (C)	Humidity ² (%)	Sunshine ² (hrs)	Wind Speed ² (km/day)	Open Water Evaporation (mm)	Potential Evapotranspiration (mm)
Jan	36.6	24.6	73.5	8.2	122.4	124	114
Feb	11.5	26.4	73.1	9.4	182.5	146	132
Mar	8.6	28.7	70.5	9.5	196.8	192	170
Apr	13.4	30.9	70.2	9.7	235.2	213	153
May	40.2	32.9	64.8	9.8	266.4	238	171
Jun	53.4	32.4	59.2	7.1	266.4	198	200
Jul	99.1	30.7	65.0	5.8	220.8	170	170
Aug	130.8	30.8	67.1	6.0	213.6	167	165
Sep	125.2	29.8	73.4	6.4	168.3	153	129
Oct	290.6	28.4	77.1	6.3	134.4	136	127
Nov	352.3	26.1	78.0	6.0	129.6	111	103
Dec	146.2	25.2	76.7	6.8	134.5	112	105

¹ Rainfall data from 1901-1992, Meenambakkam Rainfall Station

² Other Climatic Data from 1983-1992

Source: Government of Tamil Nadu, 1997, Table 6: "Climatic Parameters of Madras":TOR-18, derived from data supplied by Meteorology Office.

Table 4 Waste water outfall details for inner Chennai waterways

Waterway	Sewage	Storm Water	Industrial	Others	Total
Cooum River	109	6	1	-	116
Adyar River	58	23	-	-	81
Otteri Nullah	42	4	1	-	47
South Buckingham Canal	26	1	-	-	27
Central Buckingham Canal	30	-	-	1	31
North Buckingham Canal	58	5	3	1	67
Mambalam Drain	14	8	-	1	23
Captain Cotton Canal	13	-	-	-	13
Kodungaiyur New Drain	2	-	-	-	2
Total	352	47	5	3	407

Source: Wardrop Engineering (1995) as reported in Government of Tamil Nadu, 1997, Table 1:TOR-3.

However, planners are presented with a situation of rapid development and industrialization, the poverty of a large portion of the population, the persistence of slums, political corruption, a drought-prone climate and limited resources. The problem is highly complex and extends beyond physical and ecological considerations. Management of such an overwhelming, complex, and persistent problem is a nightmare. The problem is exacerbated because public policy and decision making in Tamil Nadu and Chennai are decentralized and sectoral. Jurisdiction to address environmental problems is distributed among a large set of inadequately funded, poorly coordinated or no cooperating agencies, with the result that environmental problems are likely to be addressed in a piecemeal way (see Khator and Ross, 1991 for an analysis of water pollution policy in India). Recognizing such institutional aspects of environmental problems, the Government of India (1999:Ch11, Part 4) has stated that; the weakness of the existing system lies in the enforcement capabilities of environmental institutions, both at the centre and the state. There is no effective coordination amongst various Ministries/Institutions regarding integration of environmental concerns at the inception/planning stage of [projects]. Current policies are also fragmented across several Government agencies with differing policy mandates. Lack of trained personnel and

comprehensive database delay many projects. Most of the State Government institutions are relatively small suffering from inadequacy of technical staff and resources. Each of the many agencies involved in the situation, has jurisdiction over only part of the problem situation. These agencies often do well within their own dominion, but budgets, time-lines and priorities to address various aspects of the problem situation differ among agencies. As a result, efforts of one agency may not be well coordinated with, nor supported by, complementary efforts of other agencies. In some cases, it may be that agencies find themselves in opposition to each other over projects that each considers to be within its own domain, and outside the purview of competing agencies. In addition, the nature of the decisions needed regarding the Cooum River are broad in scope with a long time horizon. Normally this leads to high-cost solutions and to a greater likelihood of disagreement among vested interests, concerned parties, politicians and bureaucrats (Briassoulis, 1989:382). Also, the planning horizons of politicians and government agencies typically operate on a shorter cycle than appropriate to address environmental problem situations.



Figure 1.3: A residential area (including a small hutment or slum area) backing onto the Cooum River. Notice the sludge on the banks of the river, the organic solid waste floating in the foreground, the open drain letting domestic wastewater into the river, the rubbish littering the banks and the open area reserved for defecation. (Photo by Martin J. Bunch, 1999).

Figure 31A residential area backing on cooum river

Table 5 Typical dry season and flood velocities in the cooum River

General Location	Dry Season (m ³ /s)	Flood (m ³ /s)
Upper Reach	0.24	2.50
Middle Reach	0.00	1.50
Lower Reach	0.10	1.80

Source: Mott MacDonald, 1994, Table 3.1:22.

Be that as it may, organizers are given a circumstance of quick improvement and industrialization, the destitution of a vast bit of the populace, the determination of ghettos, political debasement, a dry season inclined atmosphere and constrained assets. The issue is exceedingly mind boggling and stretches out past physical and biological contemplations. Administration of such a staggering, complex, and persevering issue is a bad dream. The issue is exacerbated on the grounds that open strategy and basic leadership in Tamil Nadu and Chennai are decentralized and sectoral. Purview to address ecological issues is circulated among a substantial arrangement of insufficiently financed, inadequately organized or no

cooperating organizations, with the outcome that natural issues are probably going to be tended to piecemeally (see Khator and Ross, 1991 for an examination of water contamination approach in India). Perceiving such institutional parts of natural issues, the Government of India (1999: Ch11, Part 4) has expressed that; the shortcoming of the current framework lies in the authorization capacities of ecological establishments, both at the inside and the state. There is no compelling coordination among different Ministries/Institutions with respect to reconciliation of natural worries at the beginning/arranging phase of [projects]. Current approaches are additionally divided over a few Government organizations with contrasting arrangement commands. Absence of prepared faculty and exhaustive database defer numerous tasks. The majority of the State Government organizations are moderately little experiencing the deficiency of specialized staff and assets.

Every one of the numerous offices engaged with the circumstance has ward over just piece of the issue circumstance. These offices regularly do well inside their own particular domain, yet spending plans, courses of events and needs to address different parts of the issue circumstance vary among offices. Accordingly, endeavours of one organization may not be very much planned with, nor bolstered by, correlative endeavours of different offices. Now and again, it might be that organizations wind up contrary to each other over tasks that each considers being inside its own particular space, and outside the domain of contending offices. Moreover, the nature of the choices required in regards to the Cooum River is expansive in scope with quite a while skyline. Ordinarily this prompts mind-boggling expense arrangements and to a more prominent probability of contradiction among personal stakes, concerned gatherings, government officials and civil servants (Briassoulis, 1989:382). Additionally, the arranging skylines of legislators and government organizations ordinarily work on a shorter cycle than suitable to address natural issue circumstances.

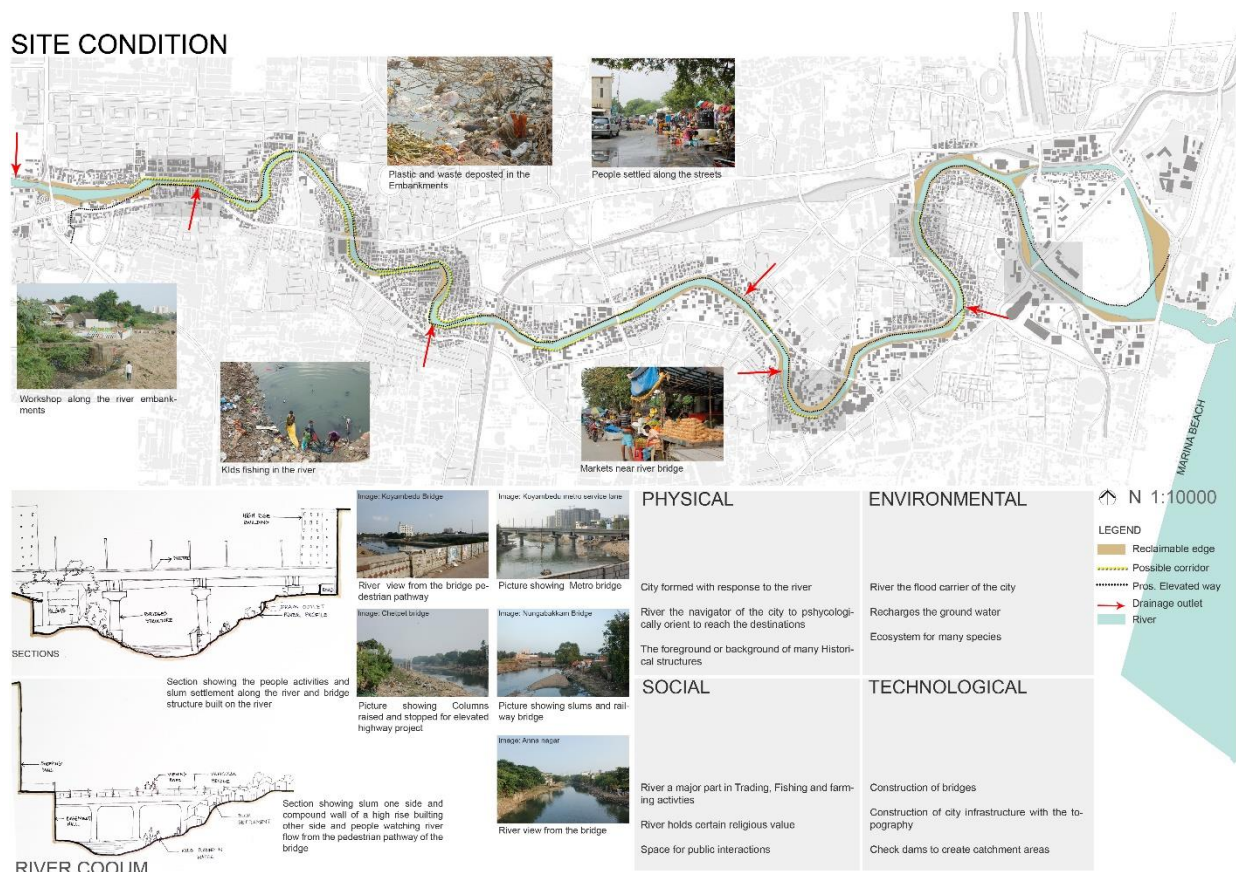
By and by, numerous administration offices have made valiant endeavours to enhance the circumstance. The rundown incorporates offices, for example, the Tamil Nadu Public Works Department, the Chennai Metropolitan Development Authority, the Corporation of Chennai, the Chennai Metropolitan Water Supply and Sewerage Board, the Tamil Nadu Slum Clearance Board and others. One of the biggest activities embraced was a Rs. 2.29 crores⁴ (2.1 million USD in 1969) noteworthy change plot embraced from 1967 to 1972⁵ (Appasamy, 1989:12-14). This included channelization, removal and coating of different stretches of the Cooum. A controller and sand pump were introduced. Watercraft wharfs and a vessel club were manufactured. In 1999, the controller was rusted and non-practical. The sand pump, which did not keep the reconstruction of the sandbar, is dead. The pontoon piers have been transformed into cows sheds, or filled in by the enterprise to deny reproducing environment to mosquitoes. An examination directed just 6 years after the fruition of the undertaking discovered levels of the 5-day Biochemical oxygen request at 2 to 3 times higher than the farthest point adequate for treated sewage gushing, and measures of fecal coliform microorganisms at in excess of 1000 times the standard (Appasamy, 1989:27). The Cooum, at the season of this examination, is messier than any other time in recent memory. In spite of the fact that reviews and recommendations for upkeep of the conduit proceeded with, no works were started for about 10 years after the real upgrades plot in the mid-1970s. After that period there have been a few tasks of a littler scale, for example, different desilting and digging ventures, and a current HUDCO financed, (Rs. 99 crore, or USD ~23 million), venture went for de-silting and cleaning segments of the Cooum River, the Otteri Nullah, the Virugambakkam-Arumbakkam Drain and the Buckingham trench, the development of surge banks, and ghetto freedom and migration of ghetto tenants (New Indian Express, 5.3.1999:5). Recently the state of conduits in Chennai has turned into an issue at the more elevated amounts of the State and Central governments. In mid-

1999 the Government of Tamil Nadu declared 3 "Thousand years Projects" went for rebuilding and change of the conduits in Chennai, and financed by Rs. 300 crore (roughly USD 71 million) in credits from HUDCO. These will include

- (1) The improvement of a Master Plan and the arrangement of offer reports for the advancement of Chennai conduits for route, entertainment and abuse of land potential;
- (2) The evacuation of sand bars hindering the outlets of the Cooum and Adyar Rivers; and
- (3) Sediment and slime expulsion and the resettlement of ghetto tenants. By February 1999, 37 organizations had reacted to offer on the first of these undertakings, and 7 organizations had reacted to the second, while the third had not yet opened for offering (Hindu, 1.2.1999:3). Also, the Ministry of Environment and Forests, Government of India, is attempted an assessment of "logical and building" parts of tasks related with a proposition, declared in January of 2000, of a 800 crore (USD ~184 million) push to clean Chennai conduits (Hindu, 1.10.2000). Hence, not exclusively is the circumstance of the Cooum River and environs a basic natural issue, however it is additionally an auspicious one for this program of research. There exists a chance to add to endeavours to address the issues of the Cooum and different conduits in the city. It is in light of this that the accompanying areas of this part present the approach attempted in this examination and the objectives of the Cooum River.

2.1.2 CURRENT SCENARIO OF COOUM ANALYSIS

SITE CONDITION



The current position of the Cooum River has been studied as a part study. In which the current status of the Cooum has been mapped along its corridor.

- Plastic and waste deposited in the Embankments
- Slum people settled along the river banks

Various small-scale business activities and industrial workshops at the long river corridor and leaning its wastewater in the banks of the river. In few places kids uses those spaces as the playing area which is actually affects their health.

With reference to the image shown if we cut the section through the Cooum River, slums and illegal settlements are clearly seen that the carrying capacity of the river has been reduced to a larger extent. And various characters of the Cooum River has been shown all follows,

PHYSICAL

- The city formed with response to the river
- River the navigator of the city to psychologically orient to reach the destinations
- The foreground or background of many historical structures

ENVIRONMENTAL

- River the Flood carrier of the city
- Recharge the groundwater
- The ecosystem for many species

SOCIAL

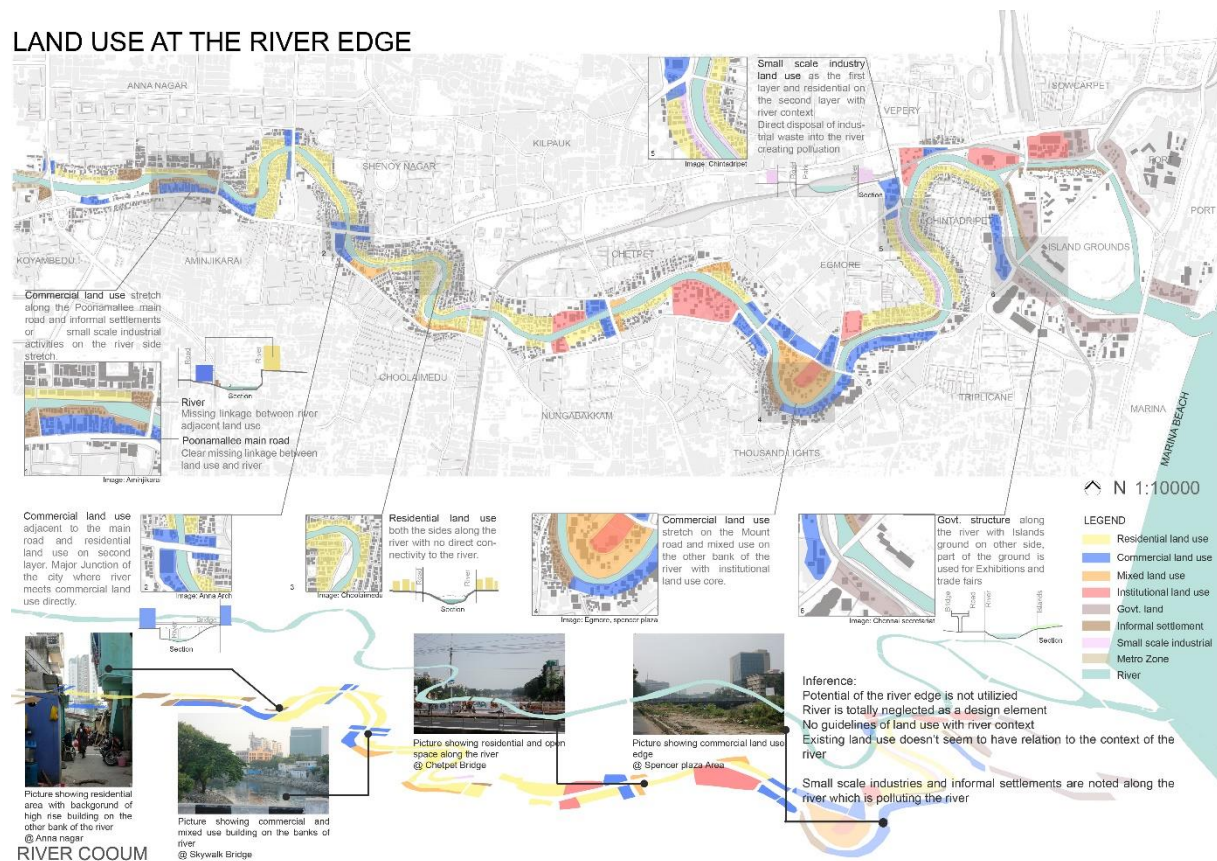
- River a major part in trading, fishing and Farming activities
- The river holds certain religious value
- Space for public interactions

TECHNOLOGICAL

- Construction of Bridges
- Construction of City Infrastructure with the topography
- Check dams to create the catchment areas

2.1.3 LAND USE ANALYSIS AT THE RIVER EDGE

LAND USE AT THE RIVER EDGE



COMMERCIAL LANDUSE

Commercial land use stretch along the poonamallee main road and informal settlements or small-scale industrial activities on the riverside stretch. Commercial land use adjacent to the main road and residential land use on the second layer. Major Junction of the city where the river meets commercial land use directly.

RESIDENTIAL LANDUSE

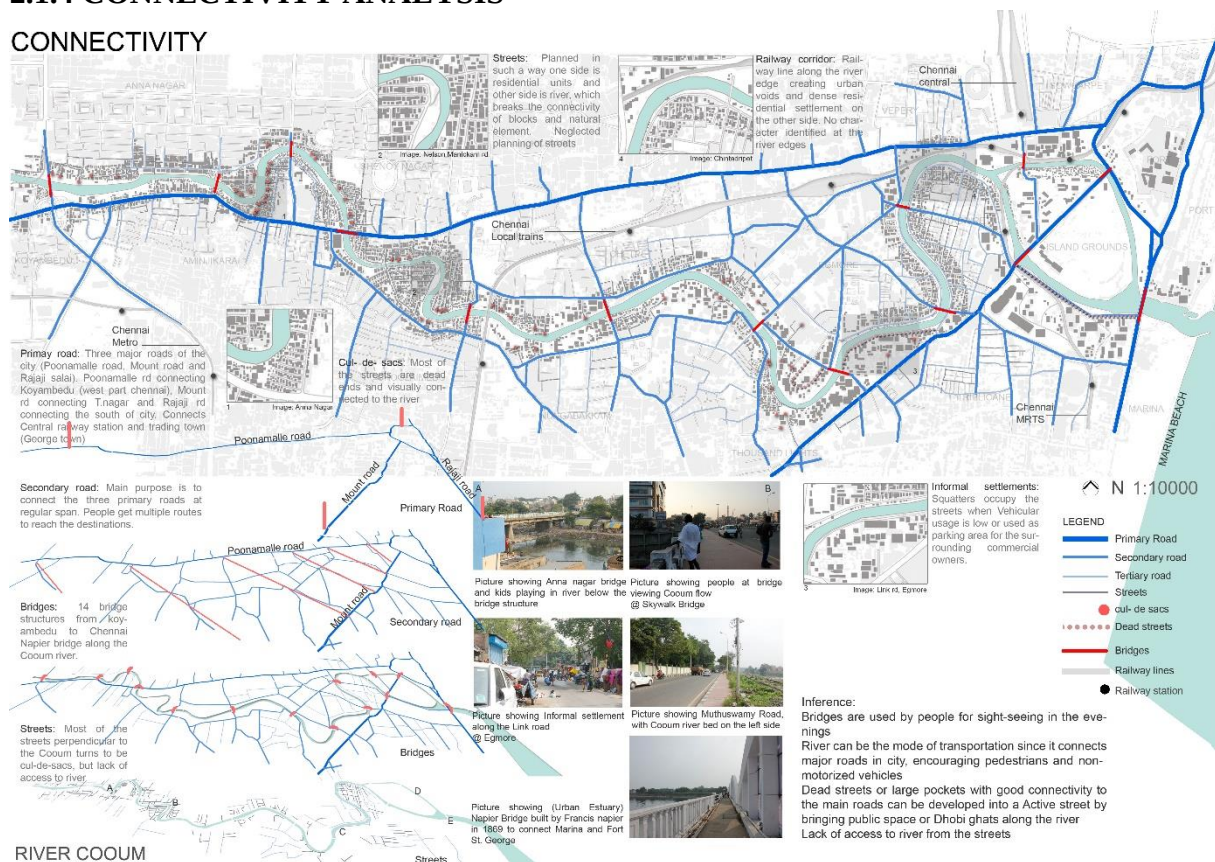
- Residential land use is the major use along the corridor but there is no connectivity along the river.
- Few government structures along the river with Islands ground on another side, part of the ground is used for exhibitions and trade fairs

INFERENCE FROM THE LAND USE STUDY

- Potential of the river edges has been not utilized properly.
- A river is totally neglected as a design element
- No guidelines of the land use with river context
- Existing land use doesn't seem to have relation to the context of the river.
- Small-scale industries and informal settlements are noted along the river which is polluting the river.

2.1.4 CONNECTIVITY ANALYSIS

CONNECTIVITY



- Three major roads of the city (Poonamalle road, mount road, and Rajaji Salai)
- Poonamalle is connecting koyambedu (west part Chennai), Mount road connecting the south of the city.
- Connects central railway station and trading town.

The main purpose is to connect the three primary roads are a regular span. People get multiple routes to reach the destinations

- 14 bridges structures from koyambedu to Chennai Napier bridge along the Cooum

Streets

- Most of the streets perpendicular to the Cooum turns to be cul - de - sacs, but lack of access to the river.

- Bridges are used by people for sightseeing in the evenings
- The river can be the mode of transportation since it connects major roads in the city, encouraging pedestrians and non-motorized vehicles
- Dead Streets or large pockets with good connectivity to main roads can be developed into an active street by bringing public space or dhobi Ghats along the river lack access to the river from the streets.

OPEN SPACES & SURROUNDING AREA



Open space available around the Cooum River, as well as the important areas around the Cooum, has been studied to analyse the importance of the Cooum in and around.

Koyambedu: Bus terminus, city market, and city water treatment plant. one the busy spot in the city.

Choolaimedu: Dense Residential settlement area

Egmore: City railway junction, the lot of govt structures and hospitals are located.

Anna Nager: Planned settlement, High rise residential area and commercial as well as recreational space on the core. Traffic is a major issue at Anna Nager.

Kilpauk: Well-known institutional area in Chennai

Chintadripet: Old settlement with dense population, small-scale industrial at the edges.

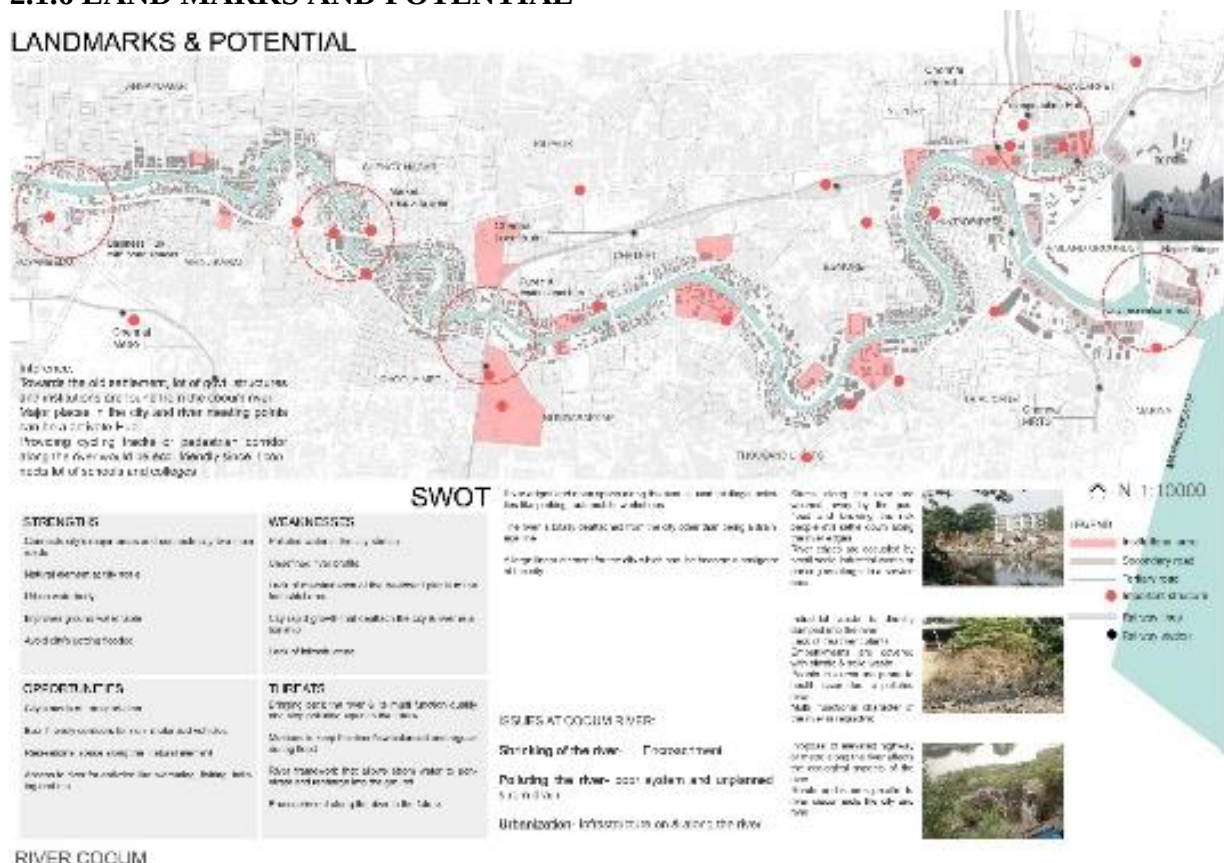
Chennai Central: Railway junction, where all surrounding village, town people arrive to reach Chennai for various work every day. Vibrant junctions. Govt hospital and institutions also located.

INFERENCE:

- Lack of community-level parks at regular interval
- Visual connectivity is lacking at the existing parks, compound walls design becomes a barrier to identify the parks easily
- Some residential area fails to provide recreational space within a walkable distance
- City level parks and open playground encourages people interaction and a breathing space in the urban cities
- A large urban natural element has been neglected in open space activities

2.1.6 LAND MARKS AND POTENTIAL

LANDMARKS & POTENTIAL



- Towards the old settlement, lot of govt structures and institutions are found from the Cooum river major places in the city and river meeting points can be a activate hub
- Providing cycling tracks or pedestrian corridor along the river would be eco-friendly since it connects a lot of schools and colleges.

The issue at Cooum River

- Shrinking of the river - Encroachment
- Polluting the river - Poor System and unplanned storm drain
- Urbanization - Infrastructure on and along the river.

CHAPTER 3 MUNICIPAL CORPORATION OF CHENNAI & BACKGROUND OF SLUMS SETTLEMENT

3.1 Cooum River governance (government bodies)

S.No.	Department	Headed by	Responsibility
1	Council	Council Secretary	Functions as the Secretariat of the Council, the Mayor and the various standing committees. Aids the Mayor in the discharge of his duties as well as the Council and Standing Committees.
2	General Administration	Assistant Commissioner	In charge of the personnel and administrative matters for the Corporation as a whole
3	Financial Management	Financial Adviser	Preparation of Corporation budget, receiving loans and grants from the government and overseeing and controlling the expenses of the Corporation
4	Land & Estate	District Revenue Officer	Leasing out Corporation lands and buildings and renting out shopping complexes
5	Revenue	Revenue Officer	Collection of taxes such as property, professional, advertisement, parking fees and other taxes. At the head office, change of name of ownership of properties, revision petitions against fixation of tax review of progress in collection of taxes and scrutiny and approval of assessment proposals.
6	Works	City Engineer	Town planning, sanction of plan and permits (up to first floor) for industrial and residential buildings, and maintenance of private streets and central asphalt plant and central yard.
7	Mechanical Engineering	Superintending Engineer (Mechanical)	Purchase and maintenance of all vehicles of the Corporation, attending to body building and repairing of lorries, and purchase and maintenance of school and office furniture. The Printing Press, General Stores, and General Workshop of Corporation function under the control of this department.

8	Electrical	Superintending Engineer (Electrical)	Installation and maintenance of all street lights, laying of cables, and maintenance of electric crematoriums
9	Solid Waste Management	Superintending Engineer	Removal of solid waste and executing night conservancy in all important roads and commercial areas of the city
10	Buildings	Superintending Engineer	Construction of school buildings, public conveniences, community halls, shopping complexes and hospitals
11	Storm Water Drain	Superintending Engineer	Construction, maintenance and desilting of storm water drains
12	Bridges	Superintending Engineer	Construction and maintenance of bridges, causeways and subways
13	Health	Medical Officer	Administration of dispensaries, public health, sanitation, prevention of food adulteration, issue of birth, death, and sanitation certificates
14	Family Welfare	Medical Officer	Administration of maternity and child welfare centers, family welfare and immunization programmes
15	Education	Education Officer	Administration of schools from elementary to higher secondary levels, community colleges and nutritious meals centers
16	Parks & Play Fields	Director, Urban Forestry Wing (assisted by two Park Superintendents and one Stadia Officer)	Maintenance of parks, play fields, and swimming pools

3.2 SLUMS IN CHENNAI

INTRODUCTION

Chennai is evaluated at the fourth position as far as ghetto populace of India. The city is home to 820,000 ghetto individuals (Census 2001) living in ghetto conditions. A large portion of the ghetto homes are along the water bodies, for example, Adyar River, Cooum River, Buckingham Canal and other open spaces.

A ghetto, as characterized by the United Nation office UN-HABITAT, is a run-down territory of the city described by substandard lodging and griminess and ailing in residency security. As per the United Nations, the level of urban occupants living in ghettos diminished from a monstrous 47 percent to 37 percent in the creating scene in the vicinity of 1990 and 2005. Be that as it may, because of rising populace, and the ascent particularly in urban populaces, the quantity of ghetto occupants is rising. One billion individuals overall live in ghettos and the figure is anticipated to develop to 2 billion by 2030.

The term has customarily alluded to lodging territories that were once moderately prosperous yet which disintegrated as the first occupants proceeded onward to more up to date and better parts of the city, yet has come to incorporate the immense casual settlements found in urban areas in the creating scene. In spite of the fact that their attributes differ between geographic districts, they are generally occupied by the plain poor or socially impeded. Ghetto structures change from straightforward shacks to perpetual and very much looked after structures. Most ghetto needs clean water, power, sanitation and other essential administrations.

ABOUT SLUM

As indicated by UN Report: "Ghetto is a building, gathering of structures or is portrayed by congestion, crumbling, unsanitary conditions or nonattendance of offices which, on account of these conditions or any of them jeopardize the wellbeing, security or ethics of its occupants or network. A ghetto, as characterized by the UN-HABITAT, is a run-down region of a city described by substandard lodging and dirtiness and ailing in residency security.

National Building Organization – a smaller territory/group of staying units ineffectively worked with insufficient/dishonourable fundamental enhancements, for example, sanitation, drinking water, and unhygienic conditions are viewed as a ghetto.

An Objective

- To clear all the ghettos in Chennai and to professional independent lined clean tenements. The development of ghettos and infringements.
- To keep, the expulsion of ghetto inhabitants by and to furnish the ghetto families the with the security of residency.
- Luxuries like water supply, road lights, storm water channels, sewer line, and so on to the ghetto territories.
- To lighten destitution through financial projects, vocation exercises, Skill preparing to youth to upgrade their employability.

- **Slum Formation**

- Slum idea framed amid industrialization. There is no ghetto at first be the fore development of industrialization in light of the fact that there was no urban or country contrast be the fore mechanical transformation.
- The whole world was total them to approach of modern upset and revelation of different missions ventures began going.
- The mechanical preliminary upset changed families and way of life of urban needy individuals.

Slum Clearance Board Formation

- Slum clearance board formed due to protection of slum dwellers, no one can avit slum dwellers on their own accord to make them live as a human being and protection for them to exist for survival in slum areas, one fine day in 1971 slum clearance board came into exist, there were 1202 slum identified in Chennai.
- we started only to build concrete vertical tenements for 1202 families and the slum clearance board was started only for a period of 7 years, which is up to 1971-1978
- The reason behind the extension of clearance board is due to improper work done by board and scientifically and historically developed countries a have vertical slum.
- Until urbanization process slum board will continue especially in developed countries
- As long as urbanization process exists in developing countries slums will exists, as long as slums exits, organisation working for the benefit or the welfare of the slum dwellers will also exists.

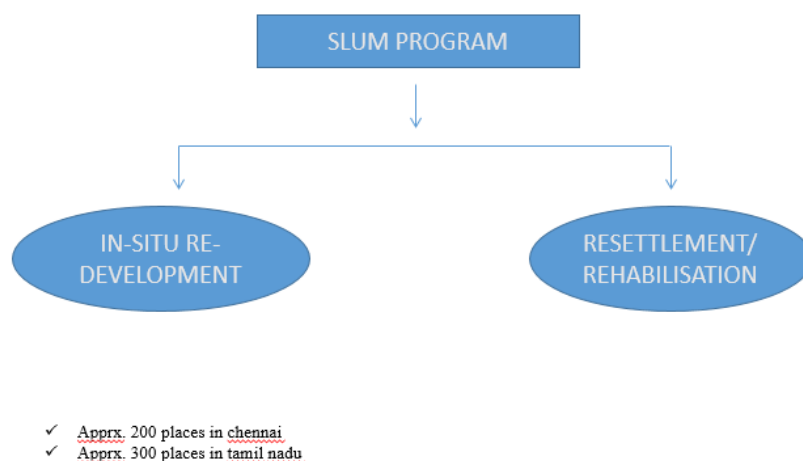


Figure 32Slum program

3.3 Slum Control Board (TNSCB)

Tamil Nadu Slum Clearance Board was set up in September 1970 and has been actualizing different Housing, Slum Development and Rehabilitation and Resettlement projects to improve the living states of the ghetto families in Tamil Nadu. The Board at first began its exercises in Chennai and its exercises were bit by bit reached out to other urban territories of Tamil Nadu from 1984 onwards in a staged way.

The adage of Tamil Nadu Slum Clearance Board is "GOD WE SHALL SEE IN THE SMILE OF THE POOR". The Board has been executing different projects like In-situ tenement plans, In-situ plotted and foundation advancement and Rehabilitation and Resettlement plans to enhance the environs of the ghettos and the expectations for everyday comforts of the urban ghetto families to accomplish the Slum Free Cities Vision before 2023.

As the Chennai Corporation expels and migrates ghetto occupants, the influenced say they have been left stranded Chennai is conceivably amidst a colossal agitating procedure. Following quite a while of looking the other route as individuals settled down on River banks, courses of conduits, even amidst lakes, the Tamil Nadu government is rushing to remove individuals from these spots. The exercise of the December 2015 surges that desolated Chennai, leaving a few dead and numerous others seized, has been a hard one.

With a measure of legal request, a craving to evade a comparable situation and with the endorsement of social liberties activists, the legislature has started to free the conduits from infringements. Be that as it may, as it shifts families out of the centre city regions and resettles them somewhere else, is the State doing everything inside its forces to guarantee a better than average personal satisfaction in the new zone — inaccessible from their work environments — great medicinal services and training for them?

Formally, this is the biggest moving since the Tamil Nadu Slum Clearance Board (TNSCB) was set up in September 1970. Inside a limited ability to focus time, as on November 30, more than 3,000 families over the city have been removed and moved to TNSCB apartments as a feature of the Integrated Cooum River Eco-Restoration Plan. In simply the most recent multi month, about 2,000 families from six ghettos have been migrated.

In broad daylight intrigue what has prompted the sudden increasing speed of ghetto migration? The underlying foundations of the advancement return to March 2015 when the Madras High Court guided the State government to evacuate infringements along the waterways.

The court requested the State to "earnestly evacuate infringements, as the bigger open premium can't be imperilled simply in light of the fact that the encroachers chose to sit on government handles." The court noticed that there were delays in building storm water depletes and trench desilting by virtue of infringements on the waterway banks. The December 2015 surges, normally, came in for the specify. In November a year ago, the Chief Secretary met a gathering of the officers of the Chennai Corporation, the Tamil Nadu Housing Board, District Collectors, the police division and the Water Resource office in which the Advocate General was likewise present, to chalk out an arrangement of activity for the removal of infringements along the Adyar River, the Cooum, and the Buckingham channel.

Around then, of the 55,000 infringements distinguished, just 4,134 had been evacuated and their inhabitants resettled. Taking note of this, the Madras High Court guided the State government to make brisk strides for the early evacuation of infringements and develop elective apartments for those to be resettled.

In January 2017, the High Court communicated disappointment with the advance of ghetto migration drive. In September 2017, the court requested that quick advances be taken for the evacuation of such infringements subsequent to following the due procedure of law. On the off chance that the infringements couldn't be evacuated even after the due procedure, the experts were at freedom to utilize 'drive', if require be. The police were coordinated to give all help.

It depends on these unmistakable bearings of the court that the present ghetto freedom drive is being executed, with re-established enthusiasm. Be that as it may, what is really occurring on the field?

Legitimate strategy?

Sixty-five-year-old Mariama, who left Tiruvannamalai with her family to settle down in the Mackay's Garden in the city with the desire for having a superior existence, asserts that the expulsion happened rapidly and surprisingly. "The company authorities went to our place to check and recognize inhabitants. A couple of days after the fact, we were ousted. We were not given whenever, nor points of interest of where we would be moved. It was very sudden," she guarantees. Nonetheless, TNSCB authorities demand that all occupants were educated about the migration "months ahead of time" and are being moved to better houses for their own particular wellbeing. The vast majority of those resettled discover it relatively difficult to go ahead with day by day life due to the long and monotonous drive to the city, gigantic costs associated with the movement, wellbeing and security issues in their new neighbourhood, and a large group of other area particular concerns. The Tamil Nadu Slum Areas (Improvement and Clearance Act), 1971, orders the issuance of notice ahead of time and time for individuals to react and bid on the off chance that the choice isn't positive. The Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007 likewise expresses that the officer should issue a notice calling upon the individual worried to evacuate the infringement before a date determined in the notice.

"Be that as it may, none of this has been taken after," cases D. Jagadeeshwaran, a lobbyist. "The general population from the ghettos are not associated with any council meeting nor are they given any notification ahead of time. The State must comprehend their predicament," he says. Specialists call attention to that no legitimate notification were issued in any of the 19 settlements expelled so far in the Chennai Rivers Restoration Trust (CRRTs) venture, which is an infringement of the High Court arrange.

"Tune in to us""Nobody asks us what we need," says Prabhu, a representative at a private firm in Anna Salai. His family and 603 others were as of late migrated from Thideer Nagar, Greams Road, to the TNSCB apartments in Perumbakkam, one of the resettlement destinations. He whines that there is no water or power supply in the apartments. "The authorities have moved us here, shouldn't they influence these fundamental game plans previously we to arrive," he inquires. The occupants depict the Perumbakkam apartments as a 'ghetto'. Another site, at Gudapakkam close Thirumazhisai, is about 30 km far from the city, and individuals need to pay ₹ 60 consistently to movement to their work environment. "Of the ₹3,000 I win multi month,

₹1,800 goes on movement," claims Suguna, a residential specialist who, with her two little girls, was resettled from Aminjikarai at Gudapakkam a year ago.

The expulsions completed under the CRRT's Integrated Cooum River eco-reclamation design is being executed by the Greater Chennai Corporation and the TNSCB. The CRRT, in its last cover the task, proposes three alternatives for the influenced families — inside advancement wherever conceivable, in situ recreation and, at long last, resettlement. Activists have more than once addressed why just the third choice has been endorsed by the TNSCB when the other two would have guaranteed that no less than 87 percent of those influenced would not have endured a gigantic effect on their lives and occupation.

Vanessa Peter, strategy scientist, Information and Resource Centre for the Deprived Urban Communities (IRCDUC), takes note of that some created ghettos, which had a large group of offices, were in the rundown of those distinguished for removal. Of the removed 19 ghettos, four were produced under MUDP (Madras Urban Development Project). In the following period of ousting, in territories like NSK Nagar and Moovendar Colony, close Arumbakkam, a few families have MUDP distribution requests and some deal deeds. Will these families be removed as encroachers, activists inquire.

Among those moved, there are many who are thankful to the State for giving them a solid rooftop over their heads. Be that as it may, they stay uncertain about their future, particularly their youngsters' instruction. The issue went to the fore a week ago when families in Thideer Nagar brought up issues about the planning of the removals and dissented, requesting time to migrate as their youngsters were amidst getting ready for their mid-term exams.

"My girl hasn't gone to class since we moved here. There is no transport to drive," says Sarita, who fills in as household help in the area. In spite of the fact that the correct numbers are difficult to find, the dropout rate among the individuals who have been moved is more than half. This has prompted political gatherings taking up the reason.

In the interim, there are a couple of cases of the individuals who have declined to leave their old homes and figure out how to make due in the midst of the clean and rubble of obliterated houses – in spite of the way that living there has moved toward becoming hellfire. The sum total of what luxuries have been pulled back, including water and power. Likewise living close by them are those sitting tight for house distribution. Thirty-five-year-old Velankanni and his mom Sarasa are among the few remaining behind in Thideer Nagar. Velankanni is stressed over his activity and his debilitated mother's wellbeing. "There aren't significantly appropriate healing facilities to give therapeutic guide. The authorities should be sensible, they can't request that we abandon everything at such a short notice," he said.

There is another class of individuals that are moving back to the city from the resettlement destinations. V. Mahesh started searching for houses the day after he was moved to Perumbakkam from Rangoon Street, and will soon be taking off. "My sibling has helped me discover a place close Royapettah. Our (my better half and mine) work environment and kids' school are adjacent. On the off chance that we live here, we will lose everything," he clarifies as he stacks his packs into an auto-rickshaw with his family in Perumbakkam. "I will

3.4 DEVELOPMENT CONTROL BOARD (CMDA) (Chennai Metropolitan Development Authority)

Unlawful Construction, Encroachments Make Chennai Vulnerable To Heavy Rain

Multi year after gigantic surges destroyed Chennai and remaining 17 lakh individuals without homes, a board of trustees of MPs has faulted infringements of lakes and River quaint little inns town arranging. In its report, the parliamentary advisory group has suggested activity against the "land mafia and infringements". In any case, the express government's drive against unlawful developments, propelled a year ago while the city was endeavouring to recuperate from the surge, appears to have come up short on steam. The Kallukuttai Lake, which was once among the biggest characteristic water bodies in Chennai, remains the city's greatest ghetto. A piece of the lake was first assumed control by the railroads for an overhead scaffold more than 10 years back. Before long, encroachers moved in. Presently Chennai's law school has its classrooms and playfields there.

"Indeed, even water bodies outside the city are being infringed upon. In the event that some development must be evacuated, we need to do it," says Arun Krishnamurthy, organizer of the Environment Foundation of India. The decision AIADMK government has named infringements and unlawful developments a heritage issue. The chief restriction in the express, the DMK, blames the legislature for inaction. "The AIADMK can't be cleared of its risk. A year ago, it didn't discharge the waters of Chembarambakkam Lake on time, which caused flooding," DMK's A Saravanan told NDTV.

Those living on the infringed lake bed say they have no place to go. 50-year-old Manivannan, an auto-rickshaw driver, has been remaining there for a long time now.

The kind of rain that caused flooding in Chennai last December is just months away. With unlawful developments as yet standing, and infringements flourishing, specialists feel Chennai might be as badly arranged for confronting the downpours as it was a year ago.

While the open deliberation perseveres on whether the city is overflowed prepared, a give an account of the Chennai surges by the Parliamentary Standing Committee on Home Affairs was tabled in the Lok Sabha and exhibited to the Rajya Sabha on August 12. The board of trustees' 31-page report depended on contributions by the Water Resources service, the Ministry of Urban Development and the Ministry of Home Affairs.

Itemizing the harm, the part of different concerned organizations and the perceptions made, the report brings up that the dominating purposes behind the surge were illicit infringement and flawed town arranging.

As indicated by the report, infringements had a major impact by diminishing the conveying limit of the lakes in Chennai and abutting locale. This was especially obvious in the instances of Cooum, Adyar and Kosasthalayar Rivers which run dry through urban regions and have a releasing limit of only a couple of hundred cusecs. The flooding of these Riverines was typically caused by additionally limiting the conveying limit by infringing on them, the report watched.

How did these Riverines flood? The report focuses to the Chennai Metropolitan Water Supply and Sewerage Board, which discharged water from supplies that were flooding because of exuberant precipitation. This, thusly, released water into the Kosasthalayar, Adyar and other

Riverine frameworks. The Rivers flooded their separate relies upon either side at numerous spots and had in this manner immersed the low lying connecting territories.

Requesting strict activity against unlawful infringements, the advisory group report guided the State Government to handle the developing mafia associated with illicit development and clear surge channels and Riverbeds where this stand. While the State Government has promised to evacuate 11 unapproved developments, the board of trustees watched that was an insufficient measure.

For the report, the Tamil Nadu government had presented that there were 117 infringements over a length of 500 m over the Vayalur River in Kancheepuram District, of which 41 were expelled. In the banks of the Adyar River, 4046 houses were distinguished as infringements over a length of 839 m in the Riverbank albeit no move had been made yet.

Holding the Chennai Metropolitan Development Authority and Chennai Municipal Corporation capable, the report watched that no evaluation of the surges had been finished. Having been the organizations responsible for design designs and observing infringements in the city, carelessness with respect to the Corporation was noted.

Another perception made was the flawed waste framework that seriously required desilting and was gagged subsequently. The advisory group suggested that general support of the seepage framework ought to in a perfect world be of highest need "anyway overwhelming the assignment might be".

In the finishing up section of the report, here is the correct proclamation of Home Secretary Rajiv Mehrishi while ousting before the Committee.

"Along these lines, fundamentally there can be no planning for a fiasco that happens once in hundred years on the grounds that the cost of getting ready for the catastrophe would be excessively high."

3.5 SEWAGE AND WATER SUPPLY BOARD (CMWSSB)

The city, much to its disgrace, has three dead and contaminated Rivers – the Cooum, Adyar, and Kosathalaiyar, which navigate it to stream into the Bay of Bengal. Be that as it may, this isn't all the water abundance of the city. Chennai is befuddled with trenches and spotted with lakes and other water bodies. As indicated by the City Development Plan, arranged for the halfway supported Jawaharlal Nehru National Urban Renewal Mission (JNNURM), there are upwards of 320 tanks and lakes inside the city's limit.

Likewise, its 'human-made' waterway – the Buckingham (referred to locally as the B-Canal) – adds to the contamination. The waterway, worked for saltwater route, is more than 420 km long, associating the Pulicut Lake in Andhra Pradesh to Tamil Nadu. In this trip, it crosses the city of Chennai and connections its two regular Rivers, already with its water, and now with its wastewater. Previously, the waterway used to be an imperative channel for transport; now, it is for all intents and purposes non-traversable as a result of its residue and natural waste load. All contamination reviews have discovered that the channel is intensely dirtied.

Be that as it may, this isn't all. The city additionally has numerous different conduits – the Captain Cotton Canal, just 3 km long, depleting into the Cooum; the Otteri Nullah, which

streams into the B-Canal; and the Mambalam, which joins the Adyar River. The aggregate length of these conduits inside the city is more than 23 km; in the Chennai Metropolitan Area, they reach out more than 158 km.

The Cooum nearly isolates the city into the half. The most essential conduit of northern Chennai, it ventures for 18 km in the city and another 22 km in the metropolitan region. What is clear, say natural researchers from the city-based Anna University, is that given the power through pressure of the four conduits of that piece of the city, all the contamination created would hypothetically go into the Cooum. The River is portrayed as a lazy stream as it has no stream in many months.

Adyar, the River of south Chennai, streams for 15 km in the city and 9 km in the metropolitan zone. It enters Chennai at Nandambakkam and in its adventure to the ocean, it gets changed into a wide tidal pond – the Adyar estuary, with numerous islands and vast muck filled backwaters. The Kosathalaiyar is a River of the Chennai metropolitan region; it doesn't enter the city.

All these water bodies are in a bad position. Clarifying the issue of contamination, the City Development Plan says: "The conduits of Chennai (see Map: Waterways in Chennai metropolitan area) are not enduring in nature and get surge release just amid the rainstorm season; whatever is left of the year these go about as transporters of wastewater from sewage treatment plants and others." The examination on ooze in Chennai, done in the mid-1990s, additionally indicates the majority of these conduits were gagged with slop and squanders. In Adyar, for example, the water width was just 15-200 m in the dry season, while slime topped off 90-500 m.

3.6 WHY CHENNAI'S WATER BODIES POLLUTED?

The unavoidable issue is, the reason do these Rivers and waterways remain so contaminated when the city has a close impeccable reputation in water and sewerage provisioning? Additionally critical to note here is that Chennai has gotten the single greatest piece of the cash under the National River Conservation Program – exactly 11 percent of the authorized expenses till 2005 – for cleaning of its Rivers. The Adyar and Cooum together were authorized 15 percent of the River cleaning spending plan of the whole nation.

The key issue in Chennai is that the city is arranging with the supposition that its close immaculate sewerage scope, pumping and funnelling plan will effectively catch all its wastewater. In this manner, its whole program for River cleaning is centred on putting resources into building and enlarging sewage treatment limit; expanding the length of the underground sewage system, and adding to pumping and funnelling limit.

In the late 1990s, the Union service of condition and timberlands authorized three noteworthy activities to the state under its River cleaning program, among them the Chennai City River Conservation Project (CCRCP). This incorporated undertaking was authorized for Rs 1,200 crore, of which the Central government consented to pay Rs 492 crore as an allow. The state government paid the rest, which added up to about Rs 700 crore. The goal was to enhance city conduits and transfer systems for expanding the limit of the current sewer framework.

Before the finish of 2005, Metro Water had executed in excess of 95 percent of its segments under the undertaking. Under CCRCP, another 80 km of sewerage lines were included at a cost

of about Rs 12 crore to accomplish 100 percent scope of Chennai city. Metro Water likewise set up five new drawing stations under the project.⁴⁷

All the cash spent has not made a difference. In 2006, the City Development Plan cited a state contamination control board report, saying, "all waterbodies in the city are dirtied and not appropriate for any assigned uses; the level of sullying is more regrettable in B-Canal, trailed by Otteri Nullah and Cooum River". So what is turning out badly in Chennai?

Why is the contamination not under control?

Chennai's STPs are altogether arranged at the most distant corners of the city (see Map: The wastewater labyrinth). Wastewater is pumped over the city to these plants situated on the edges. This would bode well if the treated wastewater was reused in adjacent regions, for water system or by businesses. Rather, the main part of the treated and clean wastewater is discarded off into Rivers and trenches, which cross the whole length of the city (conveying this wastewater) before streaming into the ocean. This may in any case have been sensible if the Rivers and conduits did not have any outfalls of sewage and were themselves perfect and clear. However, they are most certainly not.

In spite of Chennai's highly vaunted sewage treatment foundation, its conduits keep on receiving sewage from the states and enterprises along their way. In 2000, somewhere in the range of 532 MLD of sewage was produced in the bowls of Chennai's waterbodies (see Table: The condition of sewage). Along the length of the B-Canal, which cuts crosswise over both the Adyar and Cooum Rivers, as much as 158 MLD of sewage was created. The Tamil Nadu Pollution Control Board (TNPCB) has distinguished somewhere in the range of 116 outfalls into simply the Cooum. Inside and out, nearly 423 outfalls have been situated in the city (see Table: Wastewater outfalls in Chennai's conduits). An article in the day by day daily paper, The Hindu, says that despite the fact that Metro Water authorities demand that exclusive treated wastewater streams into the conduits, this does not clarify the colossal measure of slop and sewage which is obvious in these channels and Rivers.

Truth be told, the daily paper's reporter even captured and announced occurrences of tankers exhausting crude sewage into the Cooum. Along these lines, the treated profluent is blended joyfully with tremendous amounts of untreated effluents. Furthermore, the activity of contamination control, hence, winds up perpetual and silly.

Indeed, for some odd reason, the administration's own particular investigations acknowledge that the conduits in Chennai pass on treated and untreated sewage and junk together. These conduits, which are additionally the city's surge release channels, are infringed and based upon also, in this way extremely decreasing their stream. A 1994 slop transfer consultancy appointed by the state government had uncovered that colossal measures of untreated waste in the Rivers had prompted muck development, stopping up the conduits.

These conduits additionally navigate the developing external city territories of this city. The Chennai Metropolitan Area (CMA) covers somewhere in the range of 1,189 sq km, of which as far as possible are a minor 176 sq km. The sewage created by this enormous expanded territory streams into the same conduits, which get vigorously dirtied before they even enter as far as possible!

For example, the regular chart for biochemical oxygen request (BOD) focus in the Cooum demonstrates that the River is now dirtied when it enters the city. It gets more contaminated as it navigates the city, with the huge hop coming after the B-Canal blends its loss with the stream (see Graph: The Cooum's natural load).

Looking ahead

The city government has set out its vision for the future to the extent water and sanitation is concerned. It needs to have 100 percent of funnelled water supply scope in the metropolitan partnership and encompassing regions by 2016. The point is additionally to have a for every capita water supply of 150 LPCD by expanding the long periods of supply to eight daily by 2011, and 16 daily by 2016. By 2021, the city anticipates having a 24-hour supply.

It additionally says that it intends to diminish conveyance misfortunes to 20 percent by 2016 and complete a 100 percent recuperation of its expenses. In any case, it is a difficult request when contrasted with its current circumstance (see Table: Aiming high). By what method will Chennai adapt to its source limitations? Chennai's water supply is very subject to the returning storms. The city stays at the last part everything being equal.

At present, in the best of circumstances, with immense ventures to convey considerably seawater to its kin, the city deals with a supply of scarcely 90 LPCD. The smallest change in any of its sources can prompt a drop in supply of as meagre as 35 LPCD. The city has evaluated that by 2016, it will require around 1,800 MLD of water – its ebb and flow supply is near 800 MLD. By 2010, while water accessibility had hoped to 1,200 MLD, request had likewise

The alternatives to increase its water sources are restricted says the city government. It needs, subsequently, to focus on the ocean for its future. It is putting money on building desalination plants up to a limit of 700 MLD, for which it is caught up with anchoring area and credits. What will it cost the city to supply more Chennai Metro Water has had the upside of being an open utility which has kept a sensibly decent control over its funds. Be that as it may, its expanding reliance on more costly water ventures will risk this position. Its cost of water is expanding (see Table: Variable expenses) and this ought to be a wellspring of stress for its organizers – especially as it charges high rates from shoppers and still needs tremendous interests in overseeing sewage. Working up neighbourhood water sources As said previously, Chennai has the nation's best water reaping program. In 2001, the city presented metropolitan by-laws which make water collecting structures required in all multi-story structures. At that point, in August 2003, looked with an uncommon dry season, the state government passed a law making water gathering obligatory for all structures (existing and new) in the city. It set a due date of October 31, 2003, for the procedure to be finished and put its most capable officers responsible for guaranteeing this was done (see Box: Catching precipitation in Chennai). Getting precipitation in Chennai In spite of hiccups, water collecting has borne organic product In 2001, the Tamil Nadu government had made water reaping (RWH) compulsory for every single new working in Chennai. The state was racked by a remarkable and serious dry season in 2002-03, increasing the groundwater emergency to a such an extent, to the point that in August 2003, the state government passed a statute making RWH obligatory for all structures (existing and new) all through the state. The due date given for the procedure to be finished was October 2003 – a simple three months.

A lively and escalated attention drive was propelled, both to persuade general society that the administration was not kidding about actualizing the program and to give specialized direction in the outline and development of RWH structures. A period of escalated movement followed,

and the program was touted as a win. Be that as it may, there were a couple of disadvantages: The time given for execution was too short. There were dreadfully couple of experts with the information and experience expected to configuration as indicated by generally fluctuating conditions. The supply of prepared and talented work to execute the works was deficient; nor was sufficient great quality material accessible for usage. There was not really any efficient follow-up to check the advance of the works answered to be finished.

In 2004-05, CSE led a family unit review in Chennai: According to it, around 92 percent of the overviewed families announced having introduced RWH frameworks; 86 percent of these had been introduced after the proclamation of the mandate. Just 11 percent of the example family units got their RWH frameworks composed with MetroWater's assistance, while another 12 percent procured advisors to carry out the activity. A substantial lion's share (66 percent) looked for the assistance of neighbourhood handymen in planning the framework, while a little under one-fourth outlined their own RWH frameworks. Non-legislative associations were engaged with less the 1 percent of the cases.

Regarding outline, around 52 for every penny of the example families have composed an appropriate framework for redirecting housetop water to a revive well or permeation pit, or for putting away in sumps. Around 10 percent have detailed flawed structures.

Regardless of the provisos, water reaping has had its effects. As per a recent report led by the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), the groundwater table in the city has gone up by very nearly 50 percent from November 2004 to November 2007. The city's normal groundwater level, which was 6.18 meter (m) in 2004, has enhanced to 3.45 m in 2007. Villivakkam, for example, which recorded a groundwater level of almost 14 m in 2004, now gloats of a water table level of under 1 m profundity. Correspondingly, the level in Anna University, Guindy, which was 12 m, has been recharged and remains at 5 m. The examination fights that the nature of water has likewise enhanced with a drop altogether broke down solids (TDS). The TDS estimation of water in Chintadripet has dropped from about 5,000 sections for each million (ppm) in 2004 to almost 300 ppm in 2007. As indicated by Metro Water, the saltiness of groundwater in seaside territories, for example, Besant Nagar and MRC Nagar, Santhome has gone down over the most recent three years.

Notwithstanding ghetto pockets, around 75 percent of the about 4.35 lakh family units in the city has now introduced RWH structures. Regardless of absence of support, Metro Water office authorities keep up that current RWH structures are as yet accommodating in producing a 40 percent revive. The statute ordering water gathering happened similarly as the city was in the grasp of it's more awful ever water emergency. Individuals were open to the thought since they comprehended the estimation of water. They needed to spare and energize their home burrowed wells. The consolidated outcome was a fruitful program.

A family unit level example overview, done in the winter of 2003-04 covering about 1,500 families in the city, set up the significance of water gathering. The energetic and concentrated exposure crusade attempted by the state organization had worked. Individuals comprehended the idea of water collecting and needed it done in their homes. The issue was that there were excessively couple of experts with learning and experience to adapt to the scale and speed of the program. In any case, the effect was high. As much as 92 percent of the respondents of the review revealed that they had introduced water gathering structures – 80 percent of these organized to channelize housetop water into tanks and energize structures around burrowed wells. The inquiry that emerged was the means by which could Chennai presently grow such a framework to have any kind of effect in the city's water future. A model, created by specialists from Stanford University in the US, has taken a gander at this issue. Without gathering, no less

than 9 percent of water in Chennai makes it to the aquifer. The model gauges that utilizing approach as a driver, water gathering might be executed to expand revive to 27 percent of the precipitation. The outcomes demonstrate that forceful water collecting keeps the aquifer revived, because of which lesser quantities of private wells run dry amid dry spells and the tanker showcase gets decreased by very nearly 33%. The examination suggests that speculations enhance the effectiveness of water utilize, joined with forceful techniques for revive of groundwater, give the best choices to what's to come.

In any case, if water reaping must be a key choice for the city's water supply, at that point it must go past getting precipitation from housetops and move towards ensuring its huge lakes and lakes. As of now, these are under risk from manufacturers and surveyors alike. The designers have not saved the Chembarambakkam Lake, which is key for the city's water supply. In 2007, the state government reported plans to manufacture a modern stop close to this lake. A gathering meeting up as the Association of Chembarambakkam Lake Drinking Water Consumers recorded an appeal to in the Madras High Court. The court requested stoppage of work. At long last, in 2008, the legislature bossed that the terrains around the lake would stay farming.

This security should be given to all tanks and water bodies in and around the city, contends water master A Vaidyanathan – "The tanks and wetlands in the city assume a critical part as a wellspring of water system and household water and energize structures." His investigation takes note of that the quantity of tanks is more than 1,500 and their appraised stockpiling limit is around 939 million cubic meter (MCM). Be that as it may, these structures are in a genuine condition of decay. What is required is to commission a point by point overview of the wetlands utilizing remote detecting, and to utilize this examination to organize recovery and give legitimate assurance to each water structure.

Desalination: water from the ocean

Chennai had some past involvement in utilizing seawater for drinking – Metro Water manufactured a battery of turn around osmosis plants in the provinces along the ocean – for the most part occupied by fisher folk. The point was to give drinking quality water from a source near where individuals live. These plants – three of a limit of 0.15 MLD and two of 0.1 MLD – are little, constructed particularly to drink water of nearby networks.

With this experience, the city had tasted salt. In 2005, the Tamil Nadu government consented to an arrangement with a private gathering to fabricate and work a 100-MLD desalination plant for city water supply. The Minjur plant went operational in 2010. It takes seawater and after that puts it through a progression of water treatment and invert osmosis advances to expel salt.

As indicated by senior civil authorities, the capital cost of this plant was Rs 473 crore. Under the assertion, Metro Water will pay the privately owned business Rs 48.66/kl for the following 25 years. This rate does exclude control, which is paid for independently, as a result of its variable expenses. In the event that this is added to the bill, at that point it would cost Metro Water another Rs 10-12 kl, taking water expenses to Rs 59-61 kl for this seawater. Be that as it may, authorities say the cost is justified, despite all the trouble as it gives them a solid source.

Along these lines, the cost is certifiably not a hindrance to the city. It is presently putting resources into another 100-MLD plant at Nemmeli, this time claimed by the water load up itself. The cost of this desalination unit is being bolstered through the Union government's JNNURM

reserves. The cost of the undertaking has been separated – section one involves development and tasks and upkeep for a long time, granted at a cost of Rs 1,033.68 crore (generally half and a half). The plant is required to be prepared by December 2011.

In any case, it doesn't stop here. The city is likewise making arrangement for two more plants. Obviously, the organizers believe that the ocean and not the rain is the response for what's to come. What this costly water will do to the city's water accounts isn't yet clear.

Reusing and reuse

The reuse of sewage and wastewater for mechanical and even household water utilize is another alternative worth investigating. Chennai has the refinement of having the nation's first reusing venture – the city's sewage was sold to the Chennai Petroleum Company Limited (CPCL), which thusly utilized invert osmosis innovation to channel the sewage and transform it into the water for its utilization. This industry discovered sewage more solid than water and the expenses were low when contrasted with its utilization.

The CPCL tertiary treatment plant, with a limit of 41 MLD 'recovers' sewage of the city. Even better, MetroWater acquires Rs 12 crore for every annum from the offer of sewage to this industry. This way to deal with transform squander into riches should be advanced in this city of water pressure and shortage. Chennai has demonstrated that it can deal with enhancing its water administration framework. Presently it must work to give new and inventive plans to give it water, in the most exceedingly awful of dry season, and for all.

CHAPTER 4: GOVERNMENT SYSTEM AND FUND CONTROL

4.1 GOVERNMENT PROJECTS AND BUDGET ALLOCATION

The Tamil Nadu government would spend Rs 3,833.62 crore for its goal-oriented program of re-establishing the Cooum River, which has turned into a sewage transporter in the course of the most recent four decades, to its unique magnificence. The monstrous task, with a course of events of five years, would be embraced by the Cooum River Restoration Trust (CRRT). The CRRT will keep on being the nodal office for the program.

The rising populace and quick extending framework apply a gigantic weight on the city condition. The task includes Rs 2,077.29 crore for alleviation and restoration of influenced families. In any case, an entirety of Rs 500 crore will be distributed for the monetary year 2014-15, the fund serve.

Chennai has three noteworthy conduits, including the Adyar, the Cooum, and the man-influenced Buckingham to channel. The legislature, as a major aspect of the rebuilding, has initiated stopping of 179 sewage outfalls out of the distinguished 337 outfalls which contaminate the conduits at Rs 150 crore. The works will be finished by 2015 was said by the Chief Minister of that time.

4.2 FLOOD DECEMBER 2015 | FUND LOSS

The misfortune to the state and the general population from the rain and glimmer surges this upper east storm season may have crossed an amazing Rs 50,000 crore as of now. Furthermore, if the circumstance endures for the following couple of days, the aggregate money related misfortune could raise to an incredible Rs 1 lakh crore, a senior income official said. The authority went ahead to expand that the state's legitimate gauge of the rain harm crossed Rs 9,800 crore in the November downpours itself notwithstanding when such harm was limited for the most part to the state's framework with streets and boulevards broken while the harm to nationals' lives came generally in the cottages along the Cooum and Adyar Rivers being washed away. According to the TOI, (Times of India) Flood has influenced heaps of government properties and open lives and additionally the properties.

December 2015 Flood has achieved around misfortune 1 lakh crore which 4 times more noteworthy than the financial backing allotted for the Cooum rebuilding.

The administration of Cooum for cases the bodies sitting above the Cooum River isn't working legitimately is additionally one of the significant explanation for the Cooum venture on hold.

A ton of times reserves has been permitted and later the undertaking was not ready to execute because of different political and different reasons.

CHAPTER 5: CASE STUDIES –PROJECT UNDERSATANDING

CASE EXAMPLE 01

The case studies are chosen considering the inference from Literature study. Analysis of urban projects will be conducted which will include flooding and design responses through flood carrier system and infrastructure development in the river edges. The case study includes Thames River, London which was well-known as Dead River, The Sabarmati riverfront development, India, The Lyon river bank, France and Haussmann redevelopment of Paris.

5.1 THE REMEDIAL CHANGES OF RIVERFRONT ADVANCEMENT IN INDIA

SABARMATHI RIVER FRONT

In spite of the water thought of the channels, India is in like way exhibiting vitality to the urban surges of the urban systems. The nation has taken endeavours for the patching up of water bodies, the CRZ headings keep the difference in exercises harming nature on the coastline and the inhabitants wish to esteem the Riverside with perspectives, gets to, and works out. Several urban systems in India in like way began to make waterfront of channels, for adding to the individual satisfaction in the majority of its perspectives like money related, social and social. It gives a separating contrasting option to the urban thickness that the prevailing piece of them are facing, by giving open and tremendous zones, and it permits another dynamism inside the city, a rebuilding system which can be gotten a kick out of by everybody.

They are different concentrations behind this Riverfront movement meanders. It is done to enhance spatial structure and area of the conductor and abutting districts. The waterfront progress will get pull in meander chances to besides refresh the money related headway and security of the city. It builds up the city as a noteworthy business and association focus with overall class work environments. It sales to loosening up and redirection constrain and creates the general wants for consistent comforts of individuals in the city, making a few bucks condition. The courses are re-established, updated and upgraded, to advance recreational and business works out.

The pioneer meanders in Riverfront change in India is asserted to be the Sabarmati Riverfront Development meander in Ahmedabad. As declared by the Sabarmati Riverfront Development Corporation Ltd responsible for the utilization of the undertaking, "[it] would like to give Ahmedabad a basic waterfront condition along the banks of the Sabarmati River and to rename a character of Ahmedabad around the conductor. The endeavour looks to reconnect the city with the conductor and unequivocally change the ousted parts of the Riverfront."

This meander impelled other Riverfront change plots the nation over, for instance in Nanded, Lucknow, Guwahati or Pune. As it occurred before in North America and Europe, India is moreover starting at now assessing the bit of the conductor in urban systems and the stream banks utilize.

At any rate, this meander has been inspected in light of the way that the channelization of the course shows up, from each edge, to be a danger to flooding and condition, and the movement of those livings on the banks was just insufficiently guaranteed.

The quick industrialization and urbanization of Chennai city and the stream banks have incited extraordinary contamination of the conduits. They are generally debased on account of the

exchange of sewage and solid misuse. The Cooum conduit is extensively more polluted than the Adyar stream (The Hindu, September 2011). Furthermore, the Cooum stream surroundings are denser and urbanized zones, with less free spaces along the Riverbanks stood out from the Adyar conduit.

As demonstrated by my gatherings in Chennai, the banks of Cooum stream are extremely not totally sullied by dumping areas, they are debased just particularly extends and a couple of segments of the banks are included by ghetto inhabitants. Already, the stream was extremely used for drinking, calculating, and private purposes like articles of clothing washing. Today the water quality is dangerous to human prosperity and causes common calamities, on biodiversity for example.

The Sabarmati Riverfront improvement, a disputable model

The initiating meander reliably insinuated as the best portrayal, is the condition of the Sabarmati stream in Ahmedabad, in Gujarat State. The reflexion about the waterfront of the stream began in 1997 beginning at this point. An Ahmedabad-based urban arranging consultancy firm, Environmental Planning Collaborative, considered working up a stretch of 10,4 km of the banks on the two sides of the stream, by making solid dike dividers with walkways. Later an extraordinary reason vehicle is made: the Sabarmati Riverfront Development Corporation Ltd (SRFDCL) for the usage of the undertaking. "The undertaking expects to give Ahmedabad an enormous waterfront condition along the banks of the Sabarmati River and to rethink a character of Ahmedabad around the course. The endeavour looks to reconnect the city with the conductor and emphatically change the insulted parts of the Riverfront." (SRFDCL) On the site of SRFDCL, three targets appear:

- "Trademark Improvement: diminishing in weakening and surge to shield the city; sewage diversion to clean the conductor; water upkeep and animate.
- Social Infrastructure: recovery and resettlement of Riverbed occupants and exercises; age of parks and open spaces; strategy of socio-social good times for the city.
- Sustainable Development: time of points of interest, restoration of neighbourhoods."

The stream has been diverted and dependably confined to a persistent width of 275 m when ordinarily a common width of the channel was 382 m and the most impervious cross-zone was 330 m. The Riverbed arrive has been recovered to make 11.25 km of open Riverfront on both the banks. The aggregate land recovery is 202.79 hectares (Bharat Lal Seth, 2007). The work began in 2004 and was begun in 2012. SRFDCL says today that "the stream has added the dynamic quality to the urban scene of Ahmadabad with its open spaces, walkways, all around portrayed out porch nurseries close-by exercises which add to monetary headway."

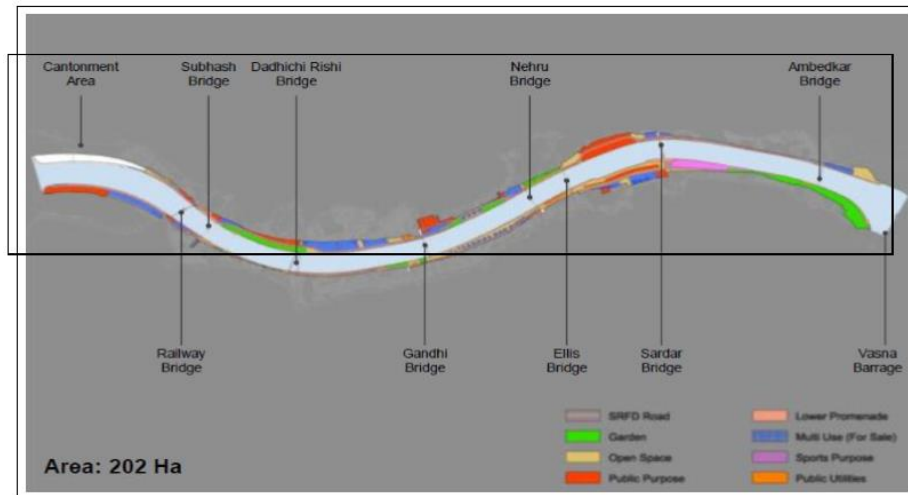


Figure 33 Land use map



Figure 34 this image shows before and after development

In any case, the Sabarmati Riverfront meander got two or three scholarly people also and raises a few feelings of dread. One of them is that SRFDLC changed the conventional stream of the course: the Sabarmati is truly not a general stream any longer, nevertheless, a persisting channel. The water is spouting truly a little bit at a time, reasonably stale in light of the way that kept in the course in the midst of the time in the 10,5 km expand. Around the entire of the conductor, the Vasna Barrage is holding the water of the stream in the city of Ahmedabad.

Furthermore, to guarantee the transparency of water all the year and a consistent stream amidst the dry season, the surplus water in the Narmada fundamental channel is being redirected. This trench is found north from the city, and its water is proposed for dry season inclined regions of Kutch, Saurashtra and North Gujarat (General Administration Department, Government of Gujarat site), not for Ahmedabad city. CR Babu, the Chair of the notice gathering master evaluation for the Yamuna River said concerning the errand that "there is no Sabarmati conductor. It's lethargic water with solid dividers on two sides. The floodplains have been concretized to make pathways and arrive meanders."

Furthermore, there has been a poor recovery of the ghettos emptied and the most imperfect bit of the ponder that should have affected 4,400 families living on the Riverbanks, the greater part of them dhobi wallah⁴. In perspective of the undertaking, 3,000 to 4,000 families were removed from the Riverfront in the year 2004-2005 (Mathur, 2012). These families have been moved with unessential pay to a marshland at the city's edge in Piplaj, which lay under power transmission towers and nearby a city strong waste dump site. The families were given open plots of 10 by 15 feet, with little and unprecedented access to drinking water and unimportant sanitation working environments. Despite what might be expected side, they were verbally guaranteed planning, success, and sanitation working environments, and more over pay and advances to make new inn. None of these affirmations were really passed on in the seven years that the evictees have been sulking in Piplaj. Everything considered, the general population who utilized the channel for quite a while have been flung out.

Mingling a River and Inclusive Development

Recuperation of Slum Dwellers

There were appropriate around 12000 hutments on the two banks of the course including around 20 percent of the essential errand territory. A main gathering of trustees was encompassed under an ex-High Court Judge for the choice of recipients and a Comprehensive Settlement was gotten together at under the supervision of the Hon'ble Gujarat High Court. In excess of 10000 families have as of late been relegated houses for resettlement. 9078 odd families have as of late been moved and the remaining is under the framework. Of the aggregate scattering, 6 were Christian, 3874 were Muslims and 5198 were Hindus. Each house is of 26.77 sqm cover a zone. They were equipped with a playing zone for kids near to redirection office. Routinely, such improvements of ghettos generally occur in faraway edge zones of the city, while for this condition, the resettlement spaces were particularly in the prime zones in the city. Current market estimation of these houses is in the degree of INR 10 to 25 Lakhs.

Since a waterway is dealt with as the mother in India, it was chosen to engage the ladies in this restoration venture by allotting the house for the sake of the lady part or in joint name.



An interceptor sewer system was produced on both the banks of the stream to catch the sewer running into the conduit and divert it to the treatment plants.

The sewage from 36 squander centres used to fall particularly into the conduit earlier, affecting the water to dingy, mosquito-ridden and making a lamentable area. All sewage by and by goes to pumping stations, provoking the adjustment in conduit quality, and radical change in the earth around the stream.



Partner River to Community

Sabarmati conductor acknowledges an essential part in among every religious collecting in Ahmedabad. Regardless, a little piece at any given moment a refinement made between the stream and local people of Ahmedabad. The Riverfront change activity discharged this capability and related both by building 36 Ghats (Steps pushing toward the conductor).

For most recent 122 years, it has been a convention that the Mahant of the Jagannath shelter, near to the social affair passing on Kalash (Pot) on elephants approaches the Sabarmati stream and after administrations performed by the erudite people, the water of Sabarmati River is steadfastly passed on back to the refuge to love Lord Jagannath, before the Rathayatra begins.

The Riverfront has seen huge religious social affair of Jains, wherein the broad number of Jains perform collect Parna (Releasing smart through a custom). Religious procession of Tajiya marches of the Muslims amidst Muharram and the structure is submerged in the channel through its stairs and ghats (Steps).



The cases clearly address how the course has added imperativeness to the urban scene of Ahmadabad with its open spaces, walkways, particularly shaped gardens near to hones which add to budgetary headway. Two or three different purposes of enthusiasm of this meander like

engaging of groundwater inferable from the persevering closeness of water in the stream and decongestion of the vital north-south street (Ashram street) by giving extra linkages street to the parallel lanes running along the Riverfront are accessible to the tenants.



The Sabarmati Riverfront meander is really multi-dimensional. Notwithstanding, the sweeping progress demonstrate that the meander attempted to accomplish has been amazingly exceptional. At no other time has a urban structure super meander, by an uncommon thorough change outline, anchored all parts of the city and made world-class working environments for the whole city to appreciate.

An inspiration in light of different setting and condition

b) A motivation in context of various setting and circumstance The Riverfront of Thames in London and Seine in Paris, or Asian streams in Malaysia, Singapore and others, are reliably insinuated as profitable models of Riverfront change in India. Regardless, the regular, and furthermore the social setting of Indian streams and the inconveniences that they go up against, are in a general sense not precisely the same as these remote models. An apparently crippled replication of these "models" can't be a reaction for clearing up the issues on Indian streams, in light of the way that the way of life, the urban setting, the contamination rates, and even the general character of the course are specific and novel to India.

c) An essential for stream "modifying" These Riverfront movements basically changes the regular and social parts of the conductor by changing it preferably into a urban business space than a trademark, social, social, natural scene. Most by a wide margin of them combine brief parts of water treatment or channel recuperation space. It is legitimately a beneficial scene based

change meander, in context of visual perspectives, which besides take a gander at "recovering" the stream banks for rehearses like shops, preoccupation zone, promenades, and budgetary profit all around.

These activities are not away for a revamping of the stream, particularly when they change its key character. For instance, stream channelization and modification of shoreline detach the conductor connects from circumscribing characteristic structures and prompts risks of condition pollution, changes in the stream association and siltation, while stream, openness, and surge are key attributes of courses and they require space for that. Precisely when these are abused, the conductor water spreads uncontrolled through the living course of action causing awful occasions. The guaranteed essential for the stream is channel recuperation regardless, with tidying up practices against contamination by sewage outlets and strong waste dumping, which happens in a broad piece of the Indian conductors. Right when condition guarding and human security is guaranteed – flooding and pollution related turmoil, Riverfront movement of the stream can be considered. The general bit of the conductor ought to be a need and the enormous basic nature of the water and the banks an objective. The building holding dividers and channelizing the stream essentially ruin the conductors further.

So also, it is essential to assess cash related, social and typical upgrades, along these lines engaging the undertaking to advance from the start with the demand indeed years and decades. For this just participatory is required amidst every time of the fundamental expert process. Not just the high genuine assistants should pick what they need to execute, something else, the undertaking will be at the cost of desperate people, the earth, and who and what is to come. At the at the present time, the Riverfront updates in India ideal position to arrive organizers and a section of the urban administrative class. The undertakings, isolated from the stream, go for commodifying the conductor and accomplish practical therapeutic changes of urban spaces.

CASE EXAMPLE 02

5.2 KOREA - THE FOUR RIVERS RESTORATION PROJECT

Challenge

The undertaking is intended to address the huge natural difficulties looked by the Han, Nakdong, Geum and Yeongsan Rivers in Korea. Continued flooding and dry spells have caused human setbacks, biological system misfortune, and environment corruption, property harm and constrained relocation of Riverine inhabitants. Outrageous climate occasions that prompt flooding and dry spells are required to decline in recurrence and force because of environmental change impacts. On account of the Yeongsan River, harmful sullyng from residential and mechanical waste transfer has brought about water quality levels unfit notwithstanding for agribusiness and modern utilize. These natural difficulties have emotional financial results. In Korea, instances of heavy precipitation more than 100 mm in multi day have expanded by 1.7 times amid the most recent 10 years. In 2002, Typhoon Rusa brought record-breaking precipitation of 870 mm daily in Korea. Also, exuberant precipitation is relied upon to increment by 2.7 times and dry seasons are required to wind up 3.4 times more successive sooner rather than later. The yearly normal precipitation of Korea is 40% more prominent than the world normal. Be that as it may, the measure of water accessible per capita in multi year is just around 12% more noteworthy, in light of the fact that 66% of the yearly precipitation happens amid the stormy season from June to September, and no rain happens in the dry season. Thus, calamities caused by

rehashed surges and dry seasons used to be ordinary. Furthermore, the River comes to in Korea are generally short and channel inclines are steep. Along these lines, flooding happens rapidly, crest surge releases are extraordinary, and stream varieties are relatively substantial.

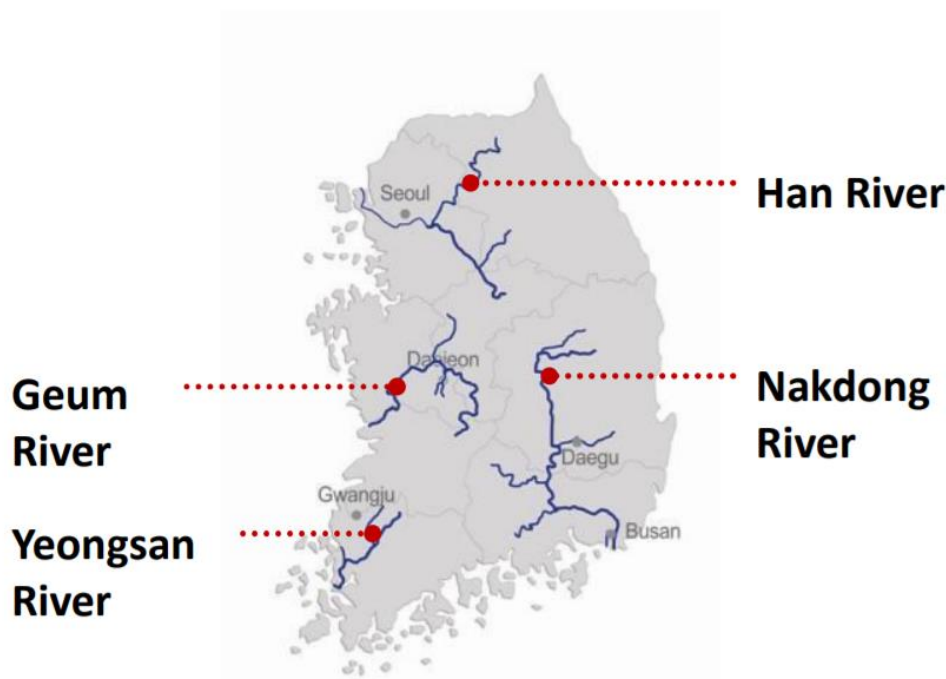


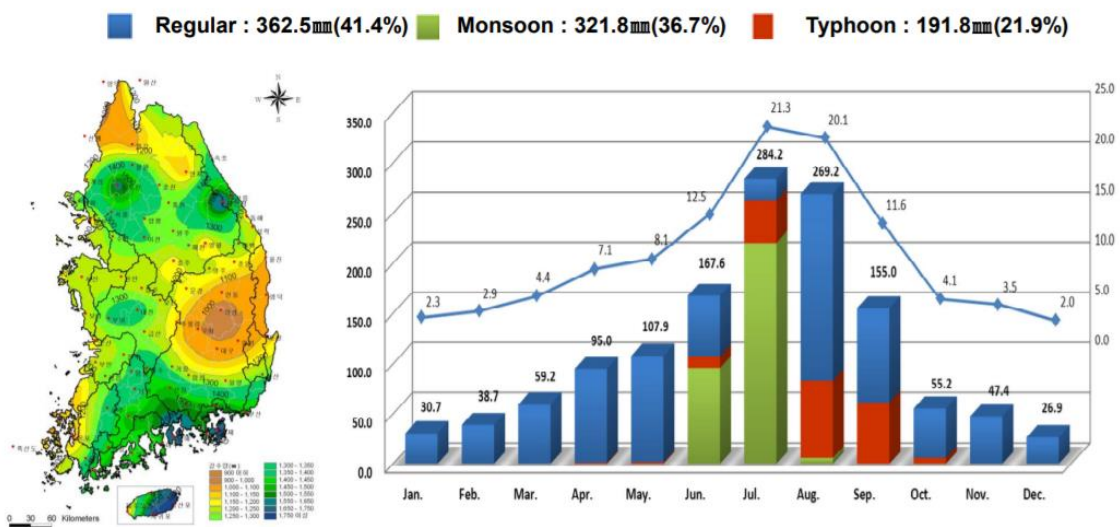
Figure 35 Four river map

Objectives

The objective of the Four Major Rivers Restoration Project of South Korea is to re-establish the Han, Nakdong, Geum and Yeongsan Rivers and to give water security, surge control, and biological community imperativeness. The venture will forestall catastrophic events, for example, surges and dry spells, secure nature and advance authentic and social tourism. The venture will bring about the formation of numerous new occupations, promoting monetary development and expanding the skyline of Korea's green development activity. The Four Major River Restoration Project comprises of three arrangements of tasks: (1) Main undertakings – the Han, Nakdong, Geum and Yeongsan Rivers revitalisation ventures; (2) extends on the 14 tributaries of the four noteworthy Rivers; and (3) repair for other littler estimated streams. The task has five key destinations: (1) anchoring copious water assets against water shortage; (2) executing far reaching surge control; (3) enhancing water quality and re-establishing environments; (4) formation of multipurpose spaces for neighborhood inhabitants; and 5) provincial advancement fixated on Rivers. This venture was first reported as a feature of the "Green New Deal" arrangement propelled in January 2009. It was later incorporated into Korea's five-year national arrangement discharged in July 2009. The Four Major Rivers Restoration Project methodically approaches its goals of re-establishing the Rivers. As an exhaustive open task, the program incorporates an assortment of plans put together by a few services yet organized by the Office of National River Restoration under the Ministry of Land, Transport and Maritime Affairs.

- Annual arrived at the midpoint of precipitation Korea: :1,277mm

- Precipitation During Rain Seas:: : 870mm (68% of the Total)
- Generally, Typhoon influenced in pre-fall precipitation (Aug. ~ Sep.)



* Recently, after 2000, Typhoon was overlapped with monsoon in Early Summer

Drivers of change and project initiation

The Four Major Rivers Restoration Project is a far reaching, skilful administrative task, speaking to the arranging responsibility of a few Korean legislative services to cooperate to reestablish the Han, Nakdong, Geum and Yeongsan Rivers. The parts of every Ministry in resulting ventures are as per the following:

- The Ministry of Land, Transport and Maritime Affairs: Restoration of the four Rivers and nearby tributaries
- The Ministry of Culture, Sports and Tourism: The "Waterways of Culture" venture
- The Ministry of Knowledge Economy and Korea Communications Commission: Production of new and sustainable power source and data advancements
- The Ministry for Food, Agriculture, Forestry and Fisheries: The "City of Beautiful Scenery" venture, referred to in Korean as "Geum-Su-Gang-Chon," and upkeep of timberlands in the upstream watersheds of the four Rivers
- The Ministry of Public Administration and Security: Restoration of little branch streams streaming into the four Rivers.

At the level of arranging and notwithstanding amid venture execution, the administration set master warning gatherings from seven distinct fields: senior board of trustees meeting, approach warning gathering, water assets, water quality, biology and condition, scene, culture and tourism, and nearby improvement. The warning gatherings comprise of teachers, masters, scholastics, and neighborhood agents. Notwithstanding the activity of the master warning gathering, the administration accumulates NGOs, for example, religious gatherings, condition gatherings, neighborhood subjects affiliations, and so forth all the time to examine and check feelings. From these participatory procedures, twelve urban communities and areas submitted 836 proposals worth 98.3 trillion KRW. 213 River-related cases worth 6.9 trillion KRW that were sound with the end-all strategy were consolidated into the Four Major Rivers Restoration Project toward the start. Cases are digging residue, invigorating existing levees, and reestablishing natural Rivers. The legislature has stepped toward usage: 1) Dec. 2008. The Project was started at the Presidential Committee on Regional Development as a major aspect of the "Green New Deal Project." An all-inclusive strategy was drafted by the Korea Institute of

Construction Technology and the Korea Culture and Tourism Institute. The main activities were propelled: December 2008 in Andong and Naju, February 2009 in Chungju, and March 2009 in Busan. 2) Feb. 2009. The Ministry of Land, Transport and Maritime Affairs built up a joint team included a few services to direct the rebuilding as a far reaching skillset legislative undertaking. The Project has since created as takes after:

- In April 2009, the team, which had worked at the directorate level, turned into the Office of National River Restoration at the ecclesiastical level to enhance relations and correspondences among the taking an interest services

- The Association for Government Support at the Office of the Prime Minister started tasks, alongside the Local Government Association of the Four Rivers, which gathers contribution from neighbourhood networks. 3) April 2009. A joint preparation was assembled with three advisory groups and the four taking an interest services and government offices. 4) May 2009. A progression of territorial meetings and gatherings were held with open authorities, specialists and recognized visitors. 5) June 2009. The Master Plan for the Four Major Rivers Restoration Project was distributed. 6) Dec. 2009. Noteworthy functions were held. The approach: how the Four Major Rivers Restoration Project tends to the difficulties The Four Major Rivers Restoration Project includes the accompanying exercises to accomplish its five destinations:

- Water stockpiling. The undertaking will intend to anchor adequate water amounts by building conduits and 16 weirs. These 16 weirs are required to anchor 800 million cubic meters of water. The task will expand crest water levels of 96 horticultural supplies to anchor 250 million cubic meters of water. Also, the development of three little and medium-sized multipurpose dams is relied upon to yield another 250 million cubic meters of water. These frameworks will empower the capacity of water required amid the dry season. By digging Riverbeds, the surge water level will diminish, and the water stream limit will increment altogether. This will essentially diminish yearly surges and the harm they cause.

- Flood control. Surge control measures include a development of the water doors of tributaries, permitting a snappy water level decay and quick depleting of surge. Likewise, two surge control zones and three sub-current zones of Riversides will together grow the surge control limit up to 920 million cubic meters of water. • Water quality and natural reclamation. By 2012, the water nature of the standard will be enhanced to a normal of level two (Biochemical Oxygen Demand under 3ppm) by growing sewage treatment offices and building up green growth lessening offices. Additionally, the service is endeavouring to re-establish environmental Rivers, make wetlands, and move farmlands in the Rivers to restore the River biological system.

- Creation of multipurpose spaces for neighbourhood occupants. To make the Riverfront as a multipurpose zone for enhancing way of life, recreation, tourism, social exercises, and green development, bike paths (1,728km) will be produced, hands-on visit projects will be advanced, and walkways and sports offices will be extended.

- River-situated network improvement. The task will likewise add to provincial advancement through different plans that use the foundation arranged in the venture and the view. The cases are 'our significant Rivers that stream with culture' of the Ministry of Culture, Sports, and Tourism, and 'Making a clear place where there is excellent view' of the Ministry for Food, Agriculture, Forestry, and Fisheries. The execution of the undertaking takes after three stages. In stage 1, around KRW 16.9 trillion will be spent on the 'primary venture' digging activities, and building dams and stores on the four noteworthy Rivers. The greater part of the principle ventures are wanted to be finished by 2011; ventures for dams and stores for water system will be finished by 2012. In stage 2, another KRW 5.3 trillion will be contributed on enhancing water stream and sewage frameworks of tributaries. Undertakings for the advancement of Sumjin River and different

tributaries to the four Rivers would be finished by 2012. Stage 3 incorporates re-establishing nearby and little Rivers, and creating social and tourism attractions around the four noteworthy Rivers. The Ministry of Culture, Sports and Tourism is associated with this stage. The Office of National River Restoration under the Ministry of Land, Transport, and Maritime Affairs is the lead office for the undertaking. In the execution of the undertaking, the workplace will work in collaboration with the Ministry of Culture, Sports and Tourism, the Ministry for Food, Agriculture, Forestry and Fisheries, the Ministry of Environment and the Ministry of Land, Transport and Maritime Affairs.

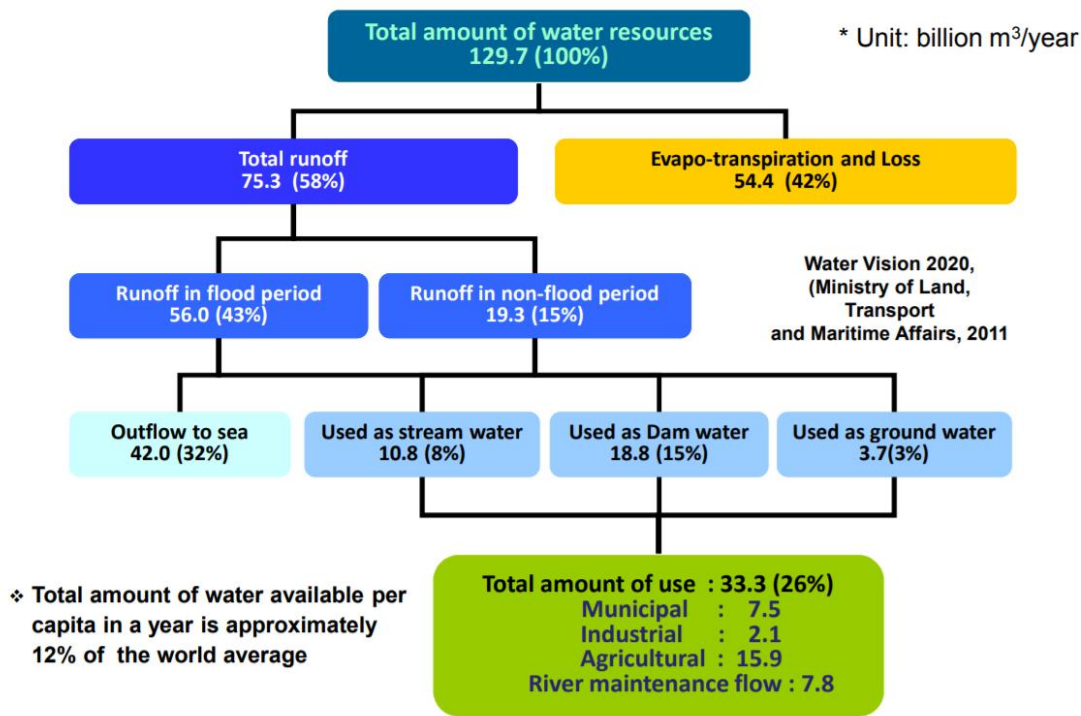


Figure 36 Water of Korea

4



Figure 37 The four Major River Restoration Project has the accompanying strategy bearings

The proactive reaction against environmental change

- secure water assets in different approach managing dry spells

- Change over from venture fixated on fiasco recuperation into speculation concentrated on aversion

Enhancement of approaches to secure water assets

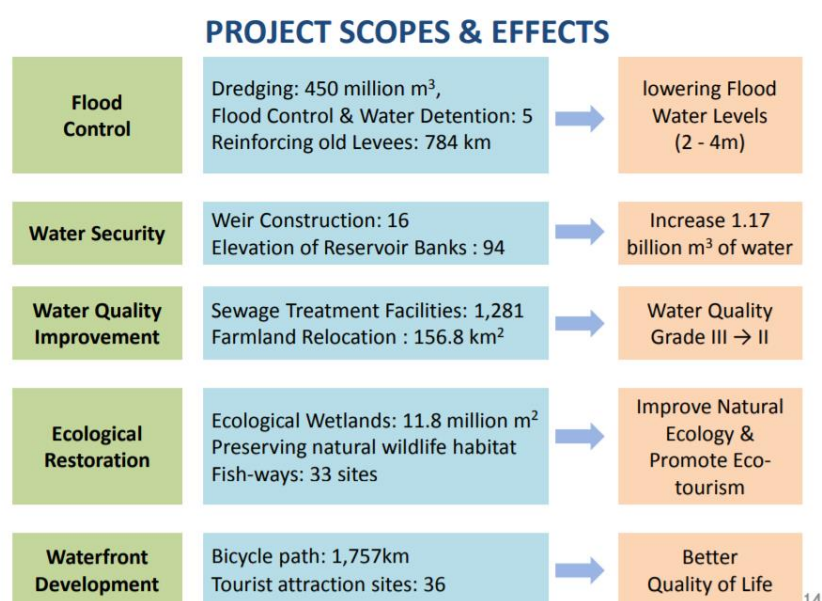
- digging resithe due, rise of banks around horticultural supplies
- Extension and association of existing water assets offices
- Consistent advancement of new water assets

A change in outlook in stream administration strategies

- Stream administration arrangements, for example, digging dregs will extend the surge spilling limit
- The underlying venture for anticipation measures to limit surge harms will be enlarged.

Usage of waterway regions as multipurpose spaces for the concurrence of the general population and condition

- Progressive modification of Riverside farmlands
- making of new zones for relaxed exercises using streams
- Change of the entrance to waterfronts
- Improve the estimation of the Riverside as picturesque zones
- Seek after local advancement focused on streams that raise local culture, biological scene, and personal satisfaction



14

5.3 CASE EXAMPLE 03

THE LYON RIVER BANK, FRANCE



Figure 38 Image showing the transformation of the edge condition

Length: 5 km

Site area: 10ha

Project: Local authority

Study Synthesis:

- Design proposal to improve the connectivity and linkages to the river and change to an active spot.
- Removing parking and visual barrier along the river edge and provide a design to improve the access to the river edge
- Provided with Non- motorized pathway such as bicycle lane, pedestrian pathway and Public Square along the river.
- Encouraging the recreational activity for the surrounding area and develop the ownership sense for the users.

5.4 CASE EXAMPLE 04

THE THAMES RIVER, LONDON

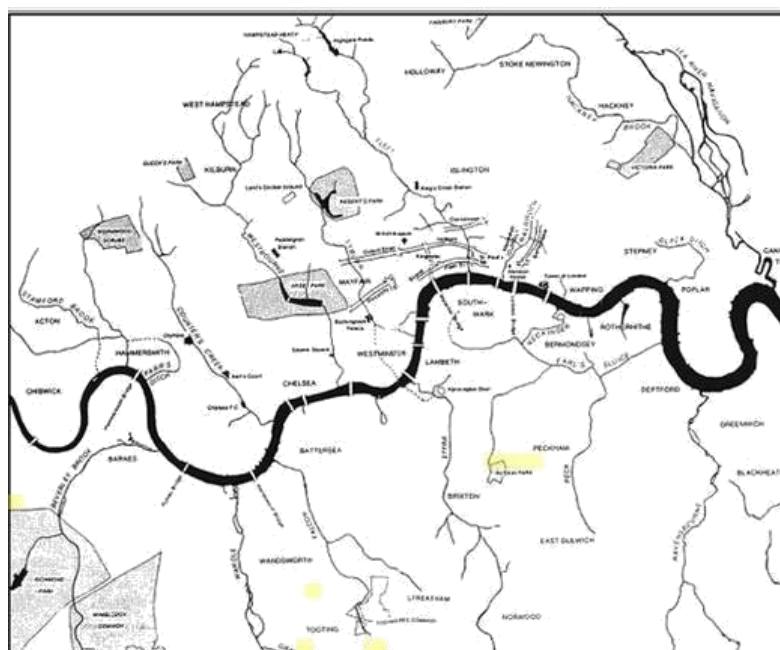


River Length: 346 km

River Width 252mts

Chief Engineer: Sir Joseph Bazalgette

The waterway Thames was proclaimed as the Dead River and the 'Incomparable Stink' loaded with smudged and causing Cholera due to stagnated waste water. Joseph Bazalgette was the central architect to handle the issue and give an answer for chance foul stream into a solid waterway. His outline set the benchmark in the History for River Restoration ventures with a delicate plan approach. The undertaking set up approach for development of waste framework, storm water framework, and railroad arrange along the enormous bank to stop the sewer joining the waterway straightforwardly. The bank surface was utilized for the parks and open spaces, associating points of interest of the city, today the waterway fills in as a water source.



London's hidden rivers; they still flow, mostly concealed by streets, and freed from sewage by Bazalgette.
(Thames Water plc)

Study Synthesis:

- Underground sewer system along the river and the topography of the city
- Flood barrier to avoid city flooding during monsoon
- ‘V’ Shaped tunnel drainage pipes considering sufficient flow and pressure
- A means of transport, majorly lot of daily commuters
- Filthy river transformed to a river that serves as public water supply for the city
- Planning of the infrastructure to support decades and can shift 2 billion litres of water and waste out
- Roads, parks, walkways proposed on top of the drainage lines and in thereclaimed land of river Thames.

CHAPTER 6: PROBLEMS AND OVERCOMING

6.1 Awareness lacking among public and Chennai government about the importance of Cooum prevention.

The State of Tamil Nadu is made plans to improve the regular conditions of conduits and water bodies and have made Chennai Rivers Restoration Trust (CRRT) to make a basic advance toward this way. The Government of Tamil Nadu has guided Chennai Rivers Restoration Trust to pass on the limit of orchestrating, arranging and watching practices for the revamping of various streams and water bodies. As modifying of Cooum River has been at the most noteworthy purpose of the inspiration for the Government of Tamil Nadu, an examination was supplied to a Consultant to set up an intensive course of action for recovery. The endeavor utilization recommendation was set up in the meeting with the Line Departments and point by point discoursed was done at each stage. The suggestion has a game plan of 60 subprojects to be done in three years. The genuine utilization of restoring the Cooum stream will be done by the Line Departments, for instance, Chennai Metro Water Supply and Sewerage Board (CMWSSB), Corporation of Chennai, Public Works Department (PWD), Directorate of Municipal Administration and Department of Rural Department in the assignment region where Chennai Rivers Restoration Trust will accept an important piece of arranging and watch the wander. In the examination, it was represented that the tidal effect is found in the stream from the conduit mouth up to Chetpet Railway Bridge (9.6 Kms). Out of 60 subprojects, 20 subprojects fall under tidal association zone. In this stretch, distinctive pollution lessening measures are proposed to improve the water quality and conduit bank bequests are needed to overhaul the fair assortment of verdure in the Cooum Riverine system. To lead Rapid Environmental Impact Assessment and to show the answer as indicated by the CRZ Notification 2011, Chennai Rivers Restoration Trust requested Tamil Nadu Urban Infrastructure Financial Services Ltd (TNUIFSL) to recognize a specialist to coordinate Rapid EIA consider and submit principal reports to Coastal Zone Management Authority as per CRZ Notification 2011. The PDGF managed by M/s. Tamil Nadu Urban Infrastructure Financial Services Ltd has gone into a consultancy understanding (LOT No. PPGF/Cooum CRZ/2015 Dt: 18.06.2015) to endeavour the Consultancy errand for gaining CRZ opportunity for a wander falling under CRZ for Integrated Cooum River Eco-Restoration wander in Chennai.

Study Area

The Cooum River starts from the surplus course of Cooum tank in Tiruvallur region. It runs east for a partition of around 65 km and conjunctions with Bay of Bengal downstream of Napier Bridge, exploring a division of 22 km inside Chennai City limits. As the conduit courses through peri-urban domains, locale and Chennai City has extending issues of water quality greatly influencing the Riverine condition. To revive and restore the essentialness of the conduit in the urban zone among the system, the Government of Tamil Nadu composed CRRT to set up an Integrated Cooum River Eco-Restoration outline from Paruthipattu to stream mouth (32 km). The Detailed Project Report (DPR) of the Eco-remaking prepare for this stretch of the stream has been prepared and the genuine parts proposed are catch endeavour and distraction of wastewater, solid waste organization configuration, surge organization outline, resettlement and recuperation plan, biodiversity organization plan and Riverfront headway plan. The examination district of the back and forth movement assignment includes the stretch from the stream mouth up to Chetpet Railway Bridge (9.6 Kms) and involves 20 sub-wanders having the tidal effect in the Cooum conduit and fall under CRZ Notification 2011 (Figure 40)

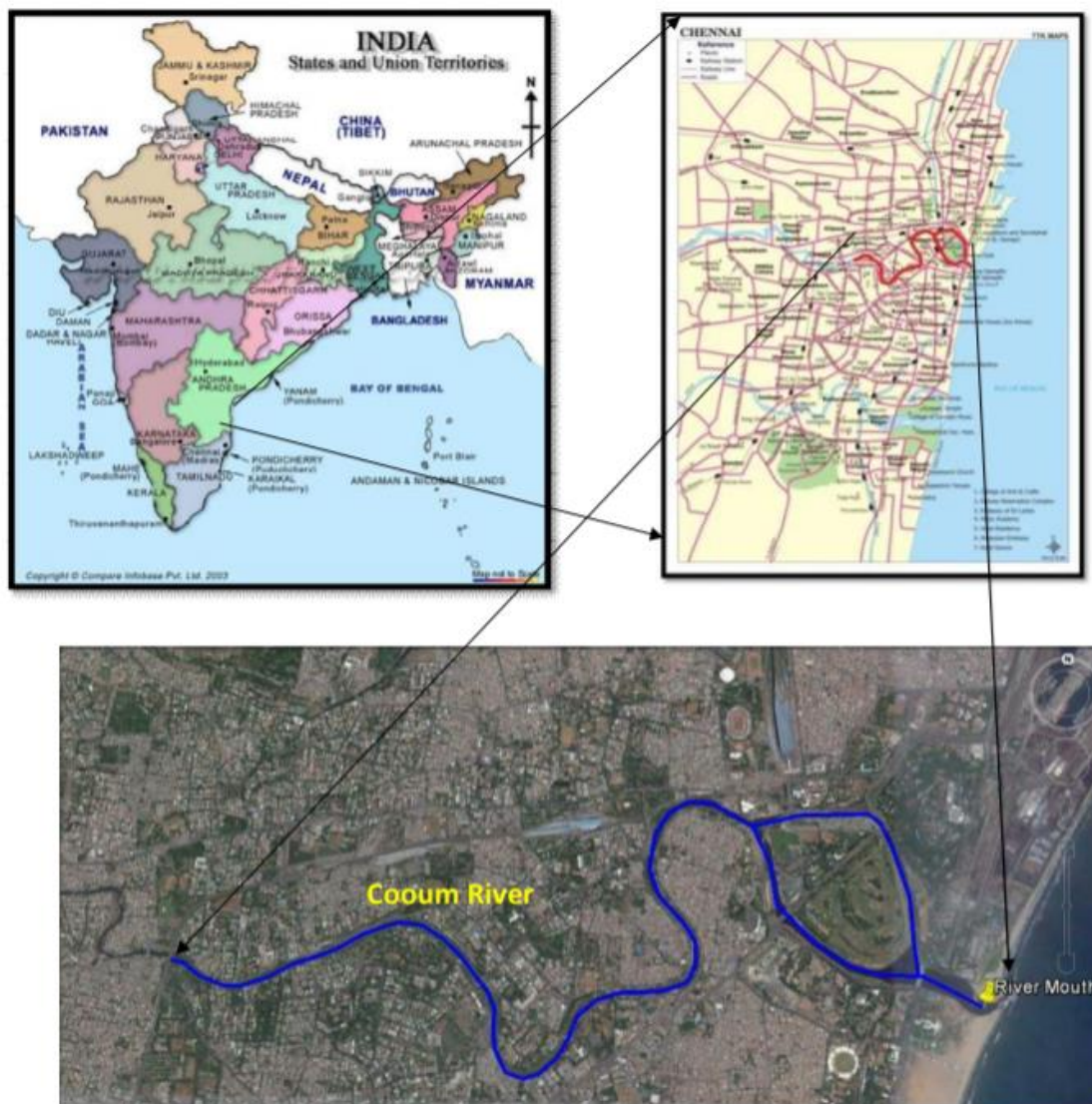


Figure 40 Map elobrating cooum river from Tamil nadu

6.1.1 INTEGRATED COOUM RIVER ECO-RESTORATION PLAN

Goals: The objective of Integrated Eco-Restoration of Cooum River Master Plan is according to the accompanying:

- To ensure convincing decline of sullyng and confirmation of conduit by grasping a plausible approach progressing between sectorial co-arrangement through entire facilitated orchestrating and organization.
- To upgrade and keep up the surge passing on utmost of the stream
- To ensure great diminishment of defilement.

Focal points of Project Ecological revamping, brisk and whole deal practicality are the key focuses of the Integrated Cooum River Eco-Restoration wander. All aspects of the Cooum conduit reconstructing displays a strong vow to the earth. The upsides of the proposed wander are according to the accompanying:

1. Confirmation, assurance, reclamation, and overhaul of biodiversity of Cooum Riverine system earth.
2. Upgrading and keeping up water quality that backings wide collections of land and water proficient biota and safe house nearby and transient avifauna
4. It will give nourishment significant data and perception of the typical Riverine organic network and will make an area to support a relationship of shared exchange between Cooum River Eco-Restoration and open, understudies, experts, hipsters, and NGOs through the course of action of biological preparing programs.

Brief on the "Official Summary of the Integrated Cooum River Eco-Restoration Plan (November 2014)"

The Chennai River Restoration Trust (CRRT) is an assembly had Trust with the objective of restoring Chennai's streams and conductors. Through the Tamil Nadu Urban Infrastructure Financial Services confined, CRRT attracted pros LKS India Pvt Ltd, to set up a plan to "revive the Cooum stream and restore the noteworthiness of the conduit in the urban locale among the system" from Parithipattu to the mouth of the conduit. The Plan was orchestrated and introduced by LKS India Pvt Ltd in November 2014 and the official summary was influenced available to the overall public through the CRRT to site in mid-2015. The last report remains closed off to general society. This is a unique of the Plan, in perspective of the Executive Summary. The objectives of the Integrated Cooum River Eco-Restoration Plan (hereinafter implied as the Plan) are to diminish tainting and secure the conduit through a sensible approach, keep up natural floods of the conduits with the purpose of ensuring water quality and practical progression, upgrade and keep upsurge passing on point of confinement of the stream, make a Riverfront change wherever possible, research likelihood of course and other future work. An assessment of the current condition was done before proposing exercises. The accompanying is a portrayal of the assessment took after by the contrasting proposed outline.

Environmental assessment: The 26 tests attempted showed almost nil separated oxygen and critical proximity of fecal coliforms, effectively making the stream an open sewer. Considerable metals, for instance, lead, zinc, and cadmium are furthermore present.

Sewage and Sanitation: 118 exceptional outfalls of sewage were perceived – generally, stormwater channels passing on sewage and outfalls from sewerage sort out (92 of the 118). The report, referring to from CMWSSB's site ensures that 100% of the old city limits has an underground sewage structure, while as of late extended zones are to a great degree lacking. Meanwhile, the report says that ghettos along the stream have no sanitation establishment, condemning inhabitants for contributing the tainting. Substitute reasons perceived are: extremely populated zones with no sewerage structure, genuine treatment constrain mishap in working sewerage systems, drenching of existing establishment (undersized or blocked channels flooding into stormwater channels and the stream, disreputably working sewage pumping stations), and illegal sewage pipes exhausting into the stormwater drain. Proposed course of action: Installation of 16 km of catch endeavor and distraction pipelines to divert

unrefined sewage from the current framework, and 6 specific sewage treatment plants of a total proposed farthest point of 14.6 MLD, with the advancing advancement of the underground sewage sort out.

Solid Waste: There are unfilled zones along the conduit used for dumping waste by areas that are neither controlled nor checked by any association. The report blames tenants for settlements along the Cooum calling their "purposeless dumping" an "extended affinity" of certified stress that is a high wellspring of tainting, encroachment, and wellspring of contaminations on account of the extended proximity of disease passing on vectors. 31,765 m³ of junk and 30,554 m³ of improvement debris is surveyed to be kept along the Riverbank. The clarifications behind this are the nonattendance of fitting workplaces point of confinement of managing the waste created, inefficiency in maintaining the law against littering and dumping junk.

Proposed course of action: Clean up of solid waste and improvement junk alongside all areas of the conduit bank, and familiarizing a layer of soil with giving strong ground to the advancement of greenery. As a preventive measure, the stream will be fenced off. Waste exchange holders will be presented. An impact structure will be acquainted in 10 spots with assemble floating part on the conduit surface.

Soil Testing: Soil was attempted where homes are orchestrated, and the earth was found not risky. The conclusion drawn is that it can be disposed of in dump yards.

Stream Channel: The report says that the conduit channel has encountered huge changes from its typical condition, restricted in light of encroachments in various parts, and interstates in a couple of spots. This result in reduced surge passing on confine causing a back-water affect upstream. Proposed game plan: Desiltation of the Riverbed to improve the surge passing on farthest point of the conduit. Removed soil will not entirely be used along the conduit, while the remaining will be dumped in the landfill yards. Diverse exercises are the regularization of the Riverbed inclination and arrangement of a newborn child channel along part of the conduit and reaching out of the stream bed in various parts. The mouth of the stream is proposed to be oftentimes planned to keep the improvement of sandbars.

Organic Flows: Cooum is an infrequent stream with an exceptionally factor stream. The report sees that to attempt to make the conduit unendingly stable may not be the best characteristic option. The course of action tries to take after the chronicled stream organization with its checked normal illustration. To keep up this a water change is required between the source and use of water. As indicated by a water modify multiplication, for the horizon year 2020, there is a 73% water deficiency. The report deserts it to PWD and Water Resources Control and Review Council to sort out the usage of water.

Biodiversity: The course of plant species was seen at seven goals recognizing trees, herbs, and climbers. For the fauna, a whole outline from Paruthipattu to the mouth was done and found no fish, a couple of bugs, snails, winged creatures, warm-blooded animals, private animals, and limited minute fish. Proposed work: Mangroves and natural trees will be planted. Regardless, since the earth along the stream is dirtied in light of "anthropogenic activities" no vegetables or helpful plants can be created. Or maybe "timber yielding plants of business regard" are proposed to be planted.

Social Impact Assessment: The social effect appraisal depends upon TNSCB's outline of ghettos along Cooum stream banks, the Right of Way line gave by PWD and the Fluvial

Corridor as demonstrated constantly Master Plan. Pillar data was not made open to the guide setting up the report. 14257 families in 58 ghetto districts will be impacted by the Plan, 49 of these inside Chennai and 9 outside Chennai. The issues thought about while making sense of which ghettos are to be impacted are the Right of Way line, the Fluvial Corridor, need of "urban recuperation", need of Riverfront change, flooding threat, and oppositeness with a "proper urban Riverfront". The essential objective communicated is improving the individual fulfillment of those living in easygoing settlements, yet the criteria associated don't think about this objective, other than flooding peril. In light of these criteria three choices were presented as a blend of these three potential results: 1. perceiving regions where in situ change is possible i.e. no flooding danger and immaculate with the generation of a Riverfront. 2. In situ generation to make new neighborhood areas, in 20 perceived exhaust zones. These have been blocked in view of CRZ standards, and CMDA's property use bearings. 3. Removal and resettlement in TNSCB lodging Option 1: Partial resettlement and in situ change would impact 87% of the families i.e. 12459 families Option 2: Partial resettlement, in situ headway and in situ multiplication would impact 47% of 6681 families. Decision 3: Complete resettlement impacting 100% families. Every one of the three decisions were acquainted with TNSCB, which picked elective 3 "as the lofts are developed and arranged for occupation" at Ezhil Nagar and Perumbakkam. All wander affected families are to be circulated a flat in the TNSCB resettlement regions at these two zones. The money related arrangement for resettlement is Rs. 1087.63 crores of a total assignment spending design of Rs.1934.88 crores. Each individual recognized for resettlement is to be given a moving reward of Rs. 5000 and subsistence settlement of Rs. 2500 consistently for multi-year. The notional cost of each flat has been set at Rs 6.5 lakh and 10% of this is beneficiary responsibility that will be borne by CRRT.

Stream Front Development: The game plan proposes 11 upkeep techniques for 9.6kms, 22 walkways of 24 km, 17 cycle tracks of 19kms and 24 parks with recreational spaces, children's play territories, and sustenance courts. Riverfront vegetation will be improved in a couple of locales and fenced off.

Arranging Plan: The entire endeavor work portrayed out above has been secluded into subprojects to be executed by various line workplaces. There are 60 without further ado subprojects, 7 medium term subprojects, and 2 whole deal subprojects.

The above arrangement is made arrangements for the long haul and it has been not executed for quite a while. Mindfulness ought to be conveyed to the overall population about the Cooum River rebuilding venture and government bodies should cooperate to take this forward.

6.2. Functioning of Government bodies

There are many government bodies have been involved in the Cooum restoration project. Some organization namely CMDA, CMWSSB, TNSCB, a Municipal corporation of Chennai are the governing bodies of the Cooum River has not functioning enough to take up the Cooum River project. These bodies should work together like other countries like Korea and the Indian cities like Ahmedabad.

- Pollution control
- Flood management for Covum

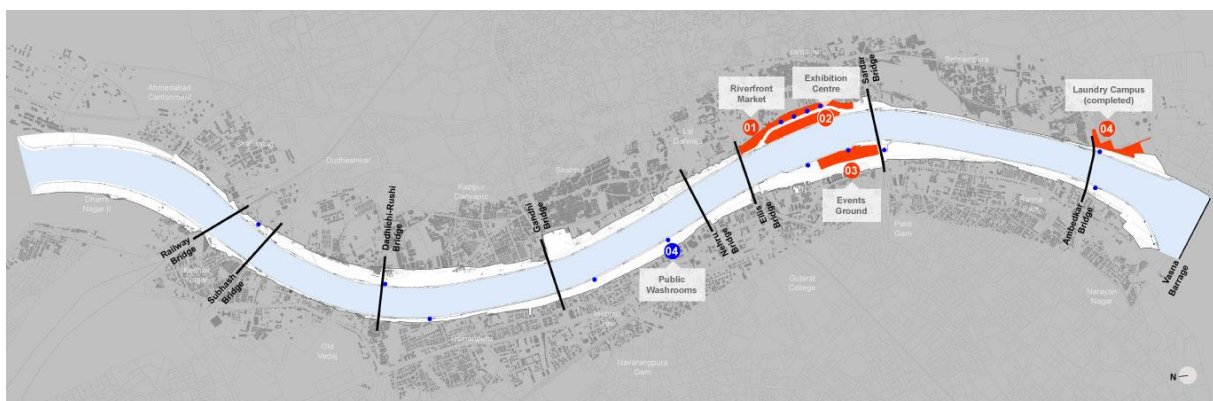
6.3 Comparison between Chennai and Ahmedabad / Inference from Case study

Ahmedabad has framed lot of development control regulations along the Sabarmati River to control the new development which should not impact the river in negative ways. And also it has designed the river stretch in such a way that no encroachments can happen along its periphery and it has lot of tourism proposal which will earn to funds for maintenance and take out the investment for river development

Along with the problems findings following are the design recommendations which has derived from the above study, which will help for the betterment of the public as well the river development.

Following are the key difference between Ahmedabad and Chennai

1. Governance
2. Fund Management
3. Planning and utilization of the river front development
4. Resource optimization to execute the projects



CHAPTER 7: STUDY OF STRATEGIES AND ITS PRINCIPLE

7.1 STRATEGIES AND PRINCIPLE

Vision Statement

To bring back the River's multi-functional quality as flood carrier and provide a secondary source of water to city and to create a vibrant public space to encourage city and River relationship improving socio- cultural, economic value of the city.

Goals and objectives

- To activate city scale public space – Primary Goal
- Bringing Back River as the city's flood carrier – Primary Goal
- Reclaiming the River edge
- To stop the drain line connecting the River
- To activate the River multi-functional quality
- Model that impacts the city development

STRATEGIES AND RECOMMENDATION

7.2 STRATEGY -1: SAFETY AND QUALITY

Past flood in the city



Figure 41 Image showing past flood in Chennai, 2015

Cooom River catchment area

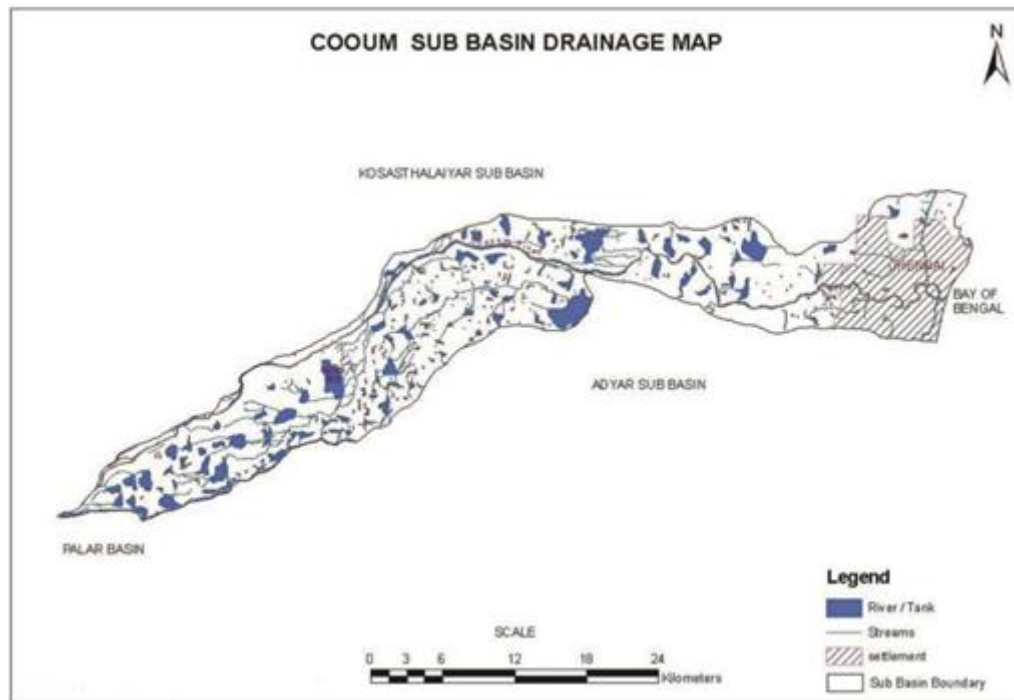


Figure 42 Image showing the Cooom River basin

Flood level

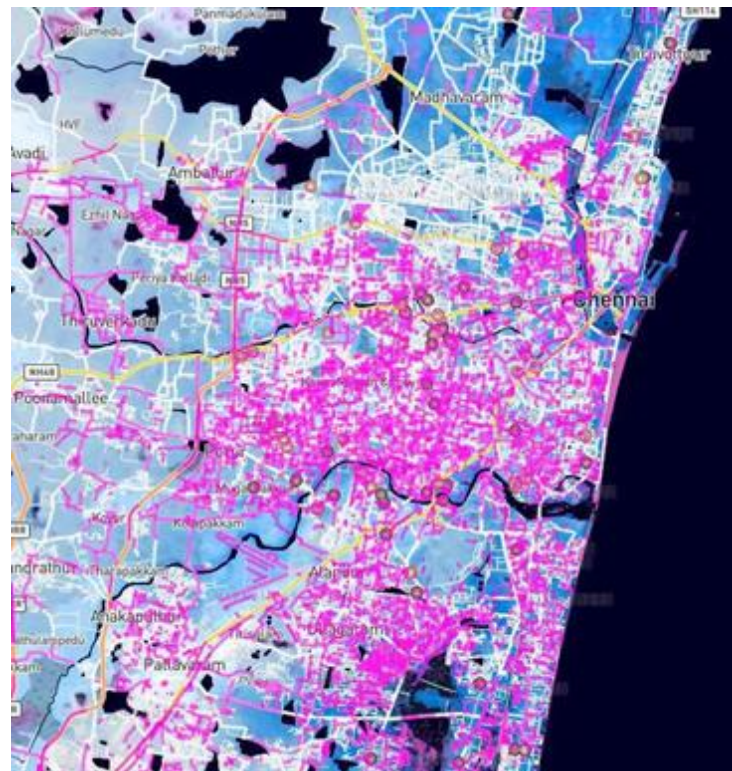


Figure 43 Map showing the flooded area

Existing section

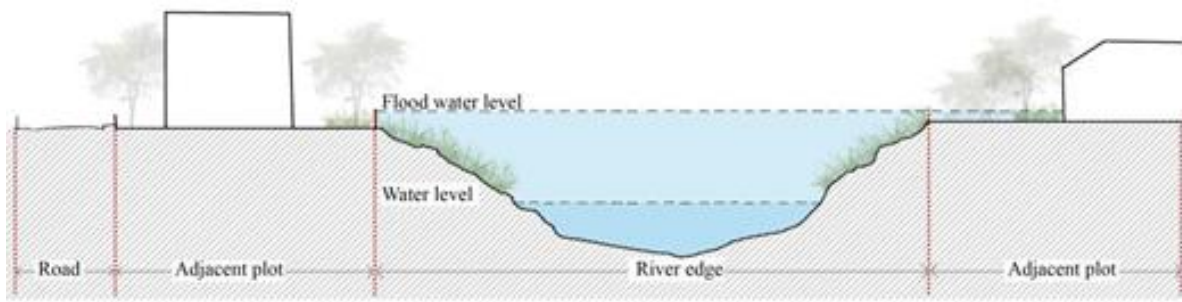


Figure 44 Section showing the existing condition in the River banks

The River embankments are dumped with garbage and the edges are undefined, lacking maintenance. The drainage is discharged directly into the River polluting it making the environment unhealthy. Surrounding land use is washed away due to the flood and people have moved back to their huts recently. The water level fluctuates extremely to the edge of River during monsoon season and discharges storm water into the sea. The importance of River is reducing and turning into a grey water layer, the River edges have to be reclaimed and provided with better drainage system and storm water system.

7.2 1 PRINCIPLES AND RECOMMENDATION

River embankment design:

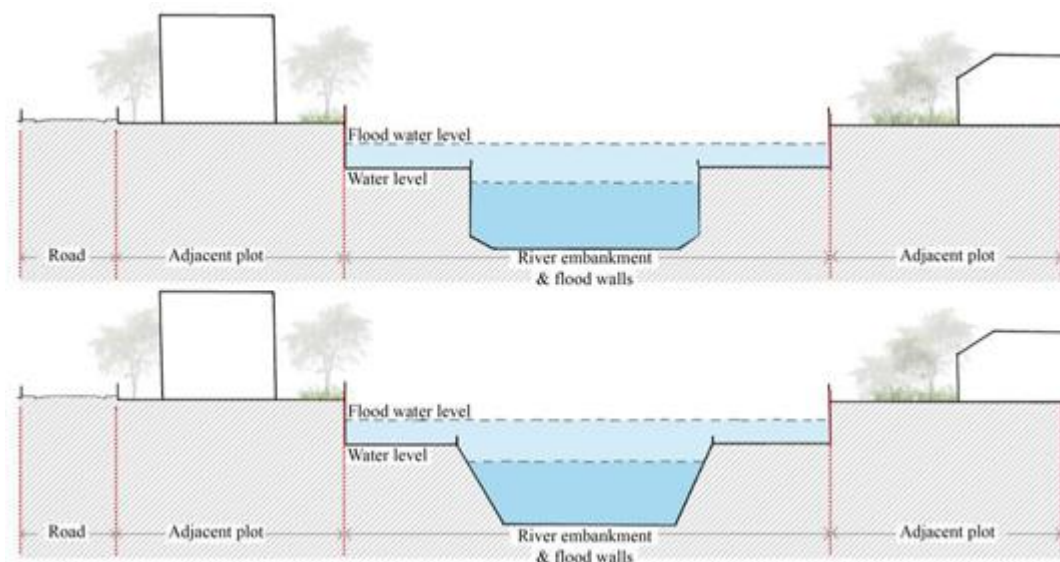


Figure 45 Section showing embankment design

The River edge profile design with maximum carrying capacity, the section shows the fluctuating level of water during summer and monsoon. River profile shape that is effective to hold maximum flow and guide the water flow to the discharge points. The Flood walls safeguard the surrounding areas during a flood and reduce damage to the city.

Storm water collection:

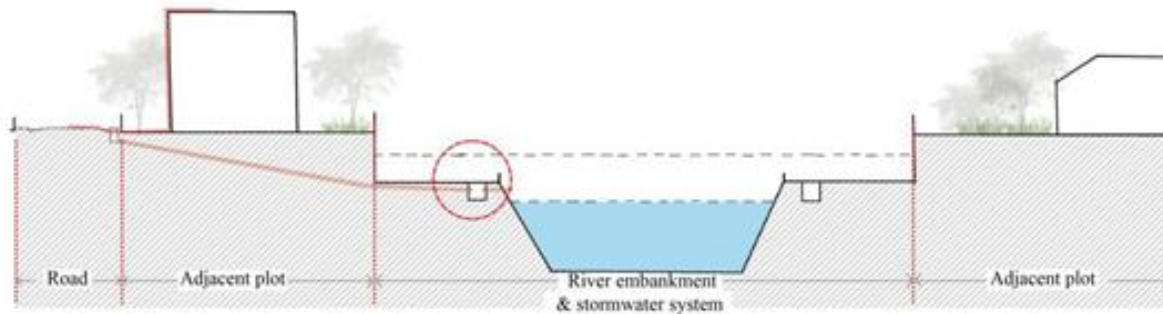


Figure 46 Section showing embankment wall

The River Embankment that supports the city system such as drainage, and infrastructure along the natural topography. This method can control the drainage discharging into the River directly, introducing treatment plants at regular intervals and discharging the treated water into the River. The storm water from open space such as roads, public parks, terraces can be connected to the River edge, treated and used as a secondary source of water.

7.3 STRATEGY -2 ACCESSIBILITY

Existing connection to the River



Figure 47 Image showing the informal access to River edge

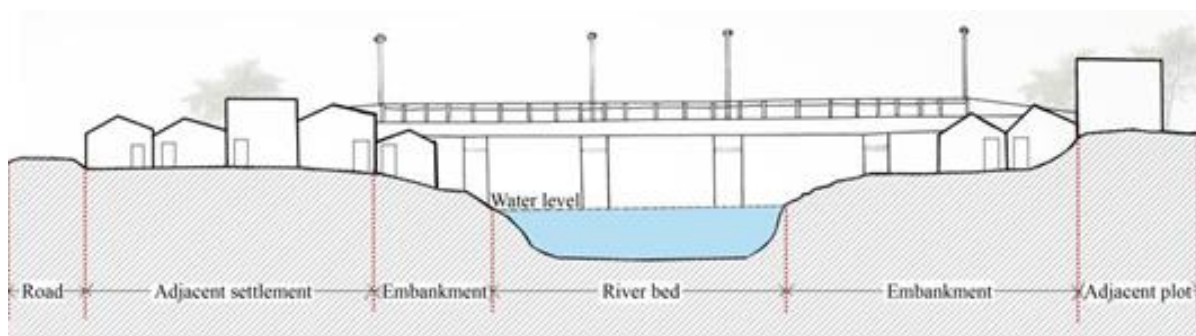
Improving local network

This documentation is an evidence for showing the lack of direct access to the River and River edge, due to encroachment. The possible access to River edge is the bridge points where the River is visually well connected and will help to navigate you. The parallel streets to the River can provide direct access to the River and act as an interaction space. The reclaimed edges can be used for providing continuous corridors for walking and cycling to encourage a healthy lifestyle in the city.

Bridges

Bridge structure along the River is the active spots in the evening. People get a clear view of River at these structures, providing access from the bridge structure can make it easier for people to reach the Riverfront and to reach their destinations. Bridges are the trace to know the level of water flow during the floods. The past flood water level was still the bridge parapet wall creating damage to the bridge structures. Design providing sight-seeing deck along the pedestrian pathway in the bridge.

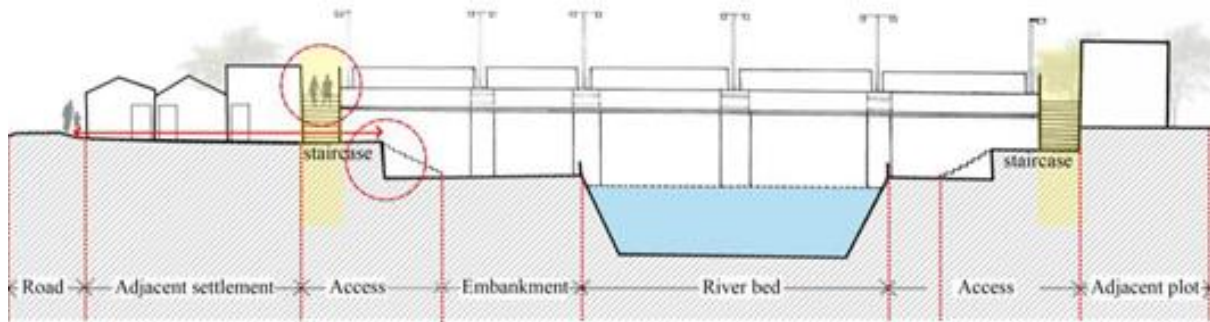
Existing section



The existing section shows a disconnect between the access to the River and the visual connection of the same. The edges are encroached by settlement, the left side settlement with access to River edge from the road and the other has missing linkage. The existing condition lacks need of attraction to the River for any kind of public activities, a good opportunity to develop the edge for various activities and retain the space utilized.

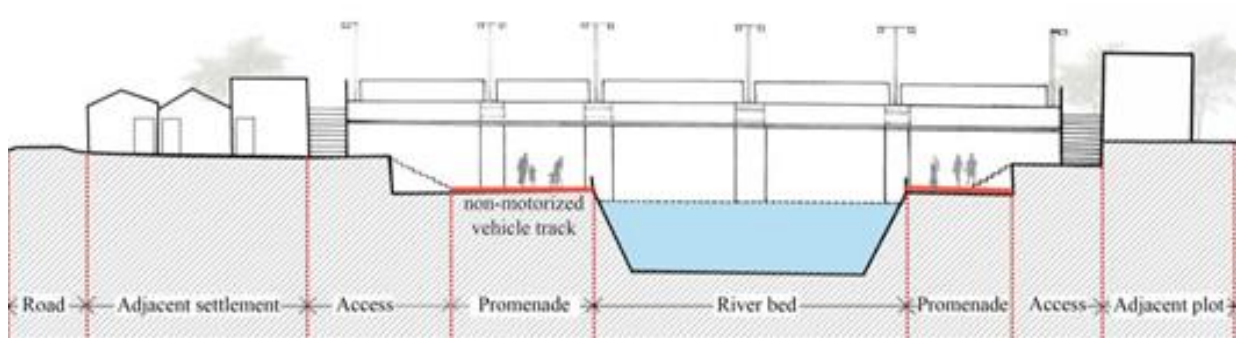
7.3.1 PRINCIPLES AND RECOMMENDATION

Access to the River edge



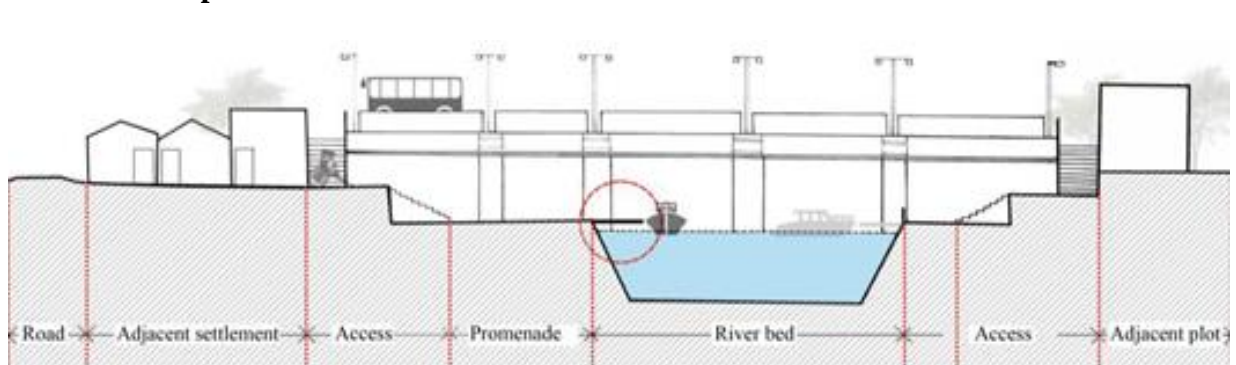
Providing staircase in the bridge edges to reach the different levels of Riverfront development. Development of direct access from the parallel roads a destination points at the perpendicular streets junctions. Different levels of promenades for the user.

Non-motorized vehicle area



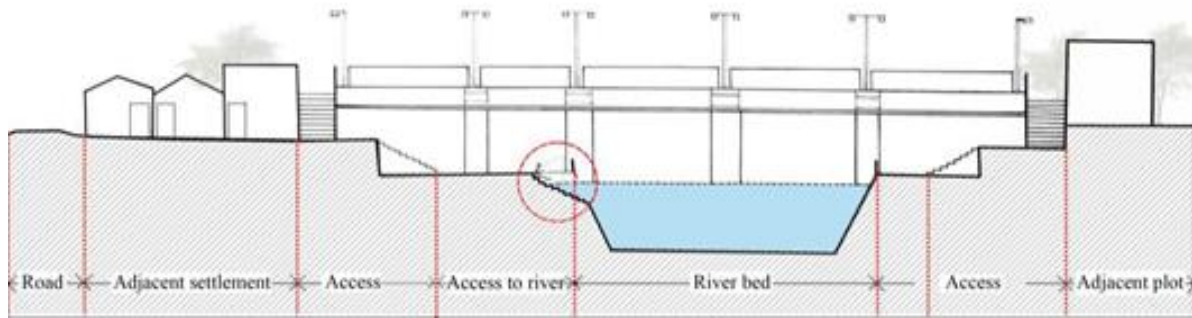
Non- motorized continuous corridors connecting different landmarks and destinations and to encourage a healthy lifestyle in an urban area

Mode of transportation



The River connects major three roads in the city and busy places which attracts commuters every day. Ferry system can be a mode of transportation to reach the destinations faster in heavy traffic and also a new experience for the urban people. This can reduce the traffic during peak hours. This system brings back the sense of River in past decade - how people used water as a mode of transportation.

Access to River



The River was used for bathing and fishing activities before 20 years, today very few are using the River water for their domestic activities. Bringing back the clean River can boost people to access the River for activities like fishing, sightseeing, swimming, bathing and etc... introducing Ghats for people to enjoy the River.

7.4 STRATEGY -3: ENVIRONMENTAL FRIENDLY

Current condition of the River



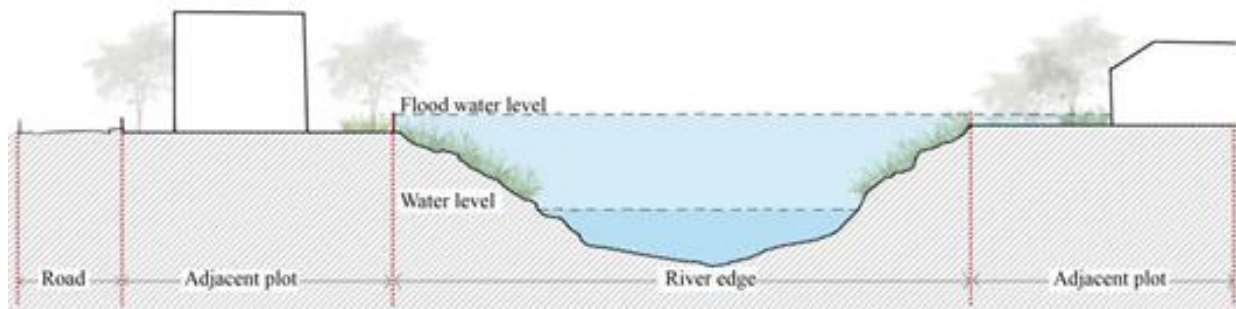
Figure 48 Image showing the River edge dumped with waste in embankments

Natural vegetation



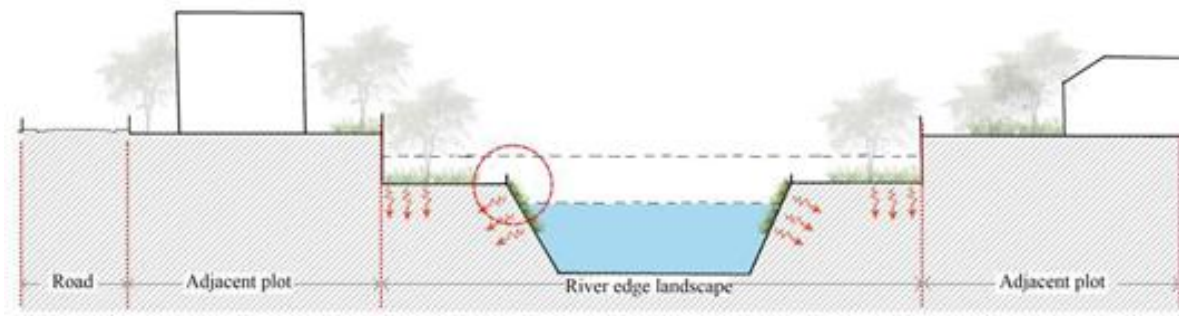
Figure 49 Image section showing River edge vegetation

Existing section



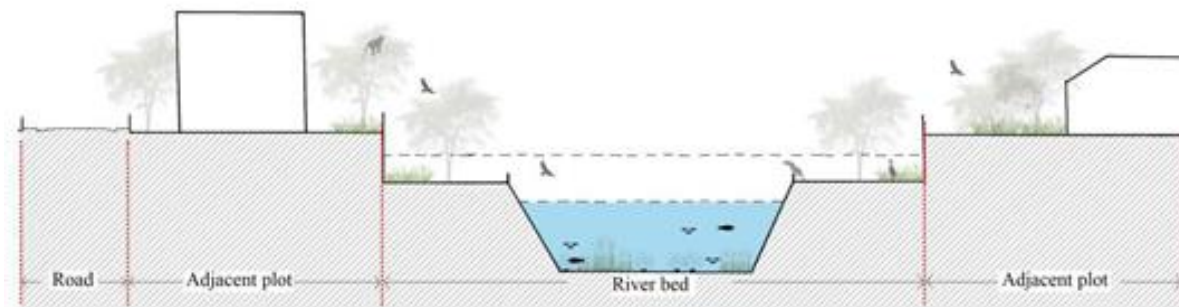
The edges are covered with unplanned vegetation, dumped with construction waste and sandbars under the bridges. This debris pollutes the River and reduces the groundcover of the Riverbed which reduces the groundwater recharge. Reclaiming the edges for landscape can improve water purification and percolate water into the ground.

7.4.1 PRINCIPLES AND RECOMMENDATION: RIVER EDGE LANDSCAPE



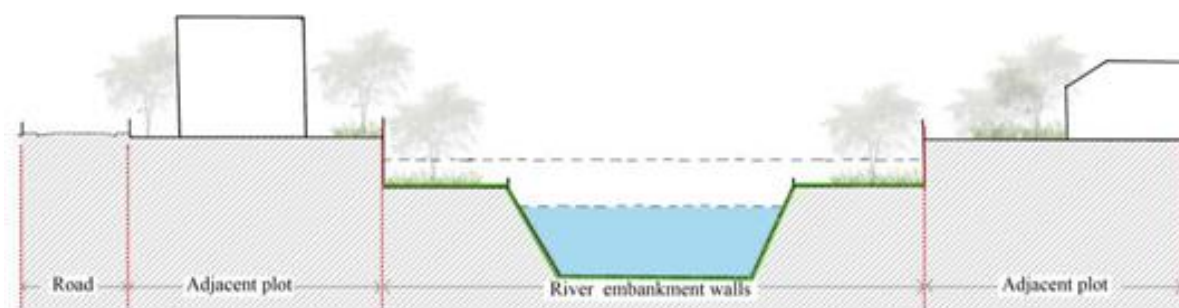
The landscaping of edges will act as the aquifer and reduce pollution. Vegetation has the capacity to hold the water run-off and recharge into the ground. Landscape with utilizes the River edge effectively for the multipurpose situation.

Encouraging bio diversity



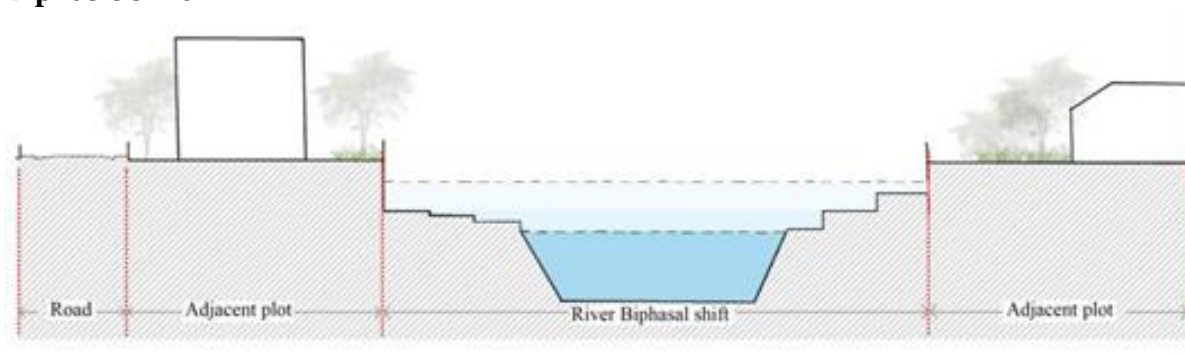
The clean River supports the biodiversity and natural systems, benefit the city and enhance the people attitude on natural water bodies.

Percolating material



Today's technology allows choice of material for the sustainable development of edge conditions. Perforated materials allow the water to percolate in so that before the River reaches the sea it will recharge maximum to the ground. Use of these materials also can act sensitively during the floods.

Biphasic shift



River edge profile that acts as a flood carrier during the heavy flood and works as a public space and promenades during the off seasons. River edge design that responds to the water fluctuations and functions according to the necessity.

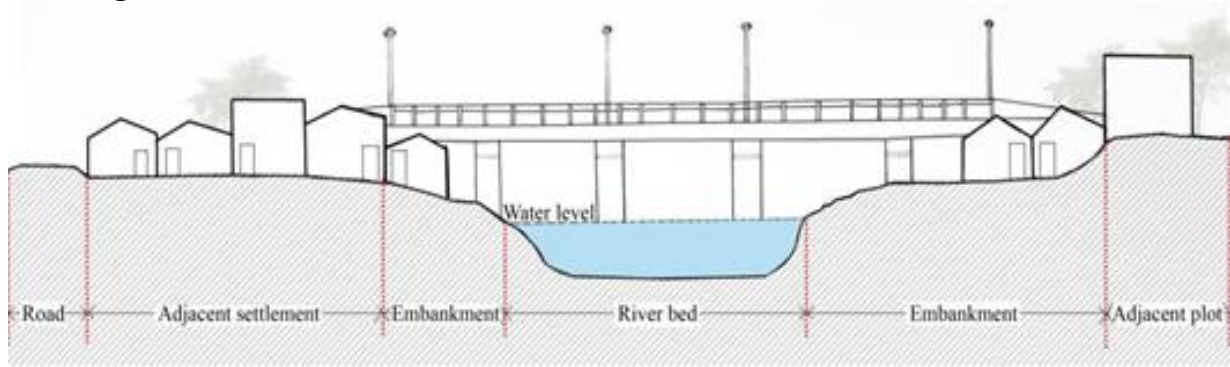
7.5 STRATEGY -4 PLACE MAKING

Urban need

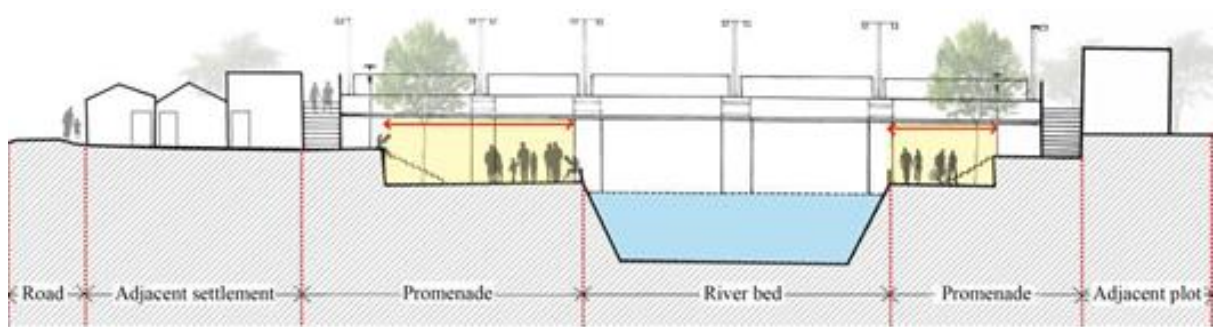


Figure 50 Image showing Activities along the River

Existing section

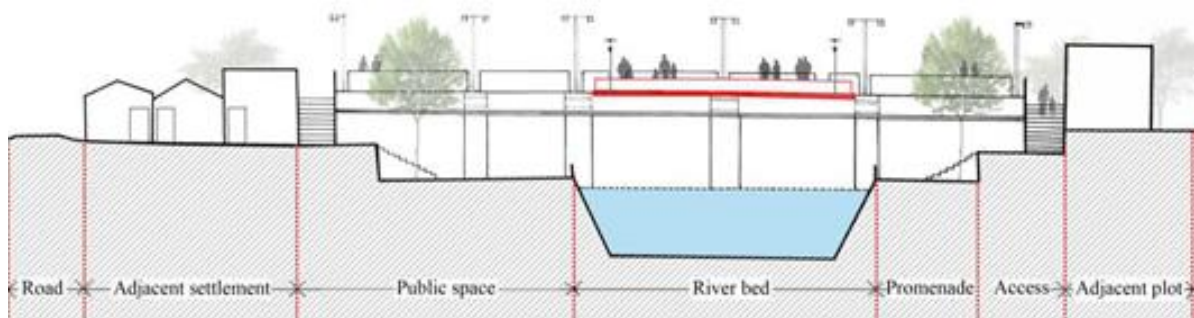


7.5.1 DESIGN PRINCIPLES AND RECOMMENDATION: PROMENADE DESIGN



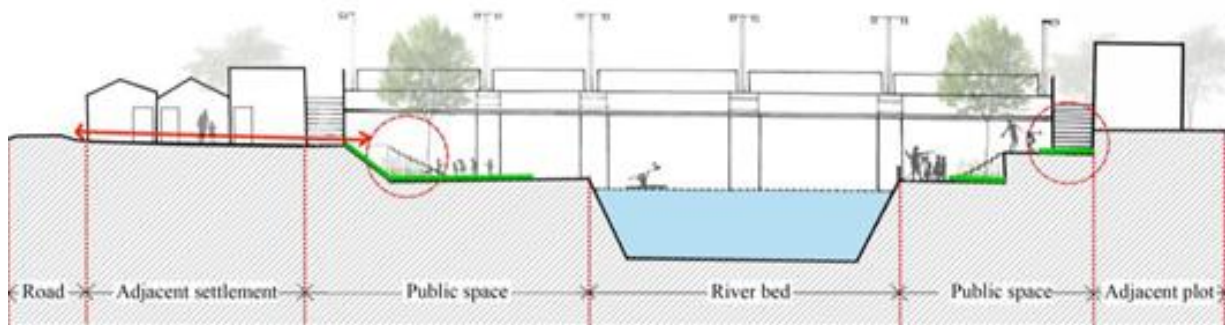
River edge promenade to encourage people interaction. Access provided from adjacent road and bridge to the promenade. Promenade to accommodate various public activities and place for people to relax.

Bridge structures



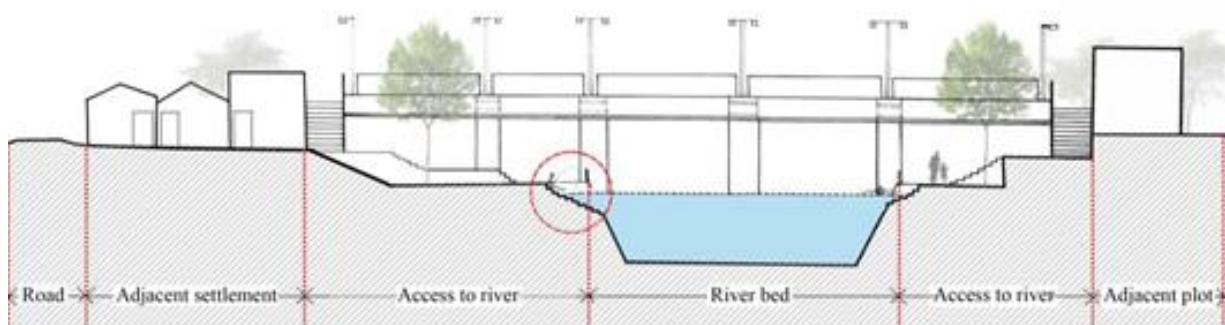
Bridges are the space from where the River is viewed clearly and people stop their vehicle to experience the Riverfront. Providing view decks at the bridge platform to watch the River and sightseeing.

Public space and parks



The documentation concludes the lack of community open parks and Public Square, providing public parks in a different scale. These large pocket in the city core can be the breath in space and landmark for the urban settlement.

Intermediate levels



Providing Ghats and decks in River edge for people to access the water for domestic activity and water sport. To incorporate various scale of activities, different levels of space to be provided.

7.6 TYPICAL SECTION KIT FOR THE RIVER RESTORATION

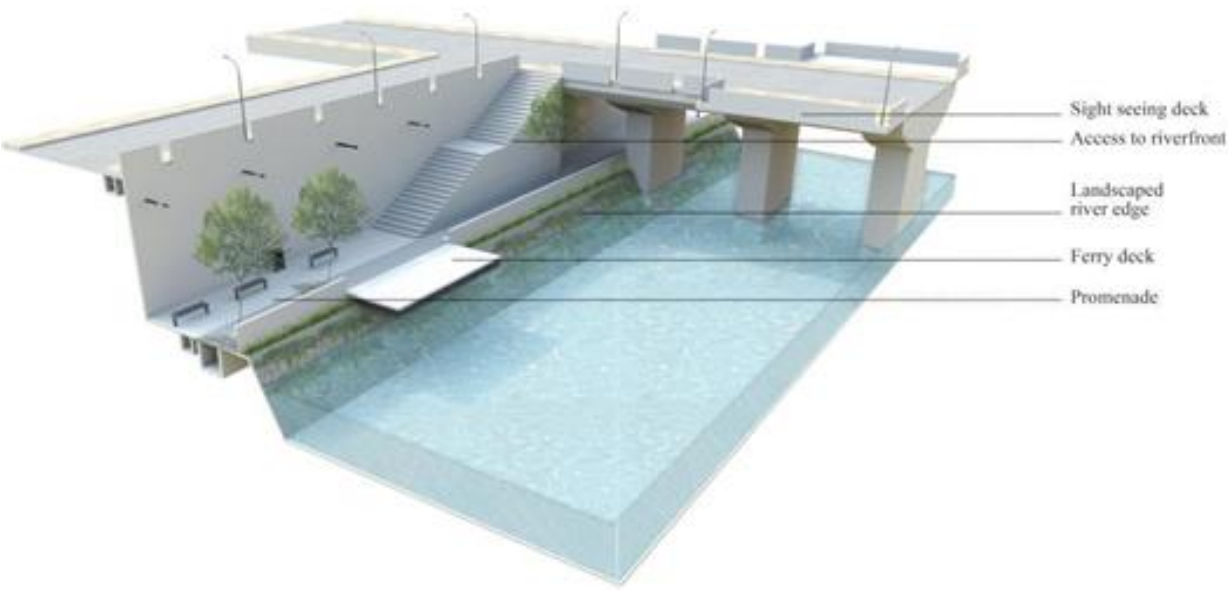


Figure 51 Typical River edge condition near bridge structure

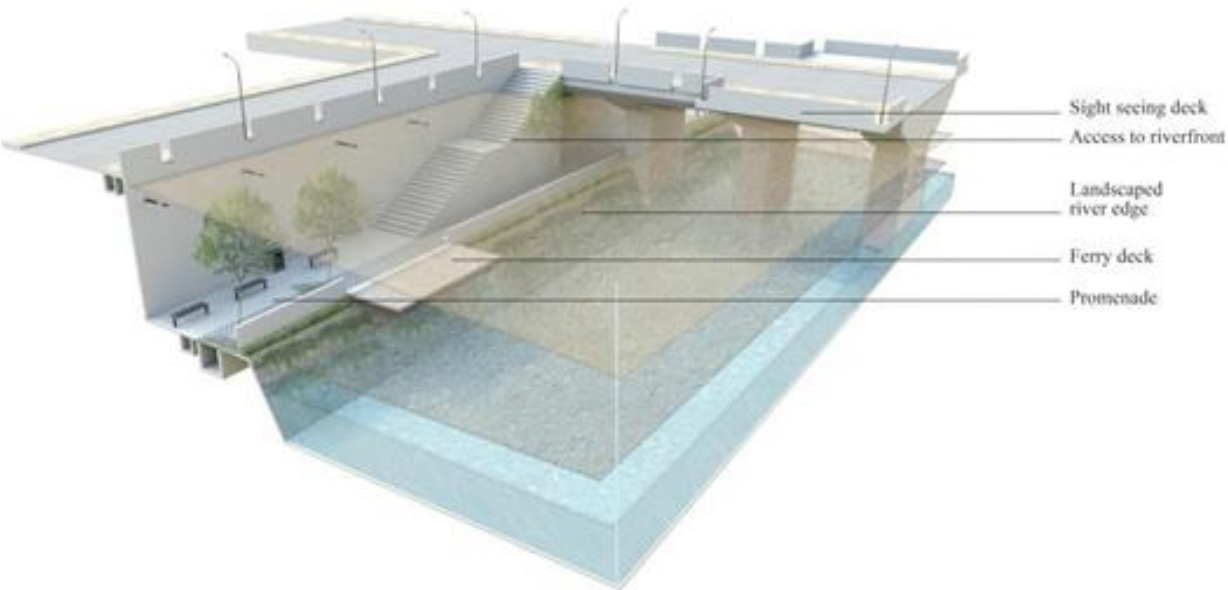


Figure 52 Typical River edge condition near bridge structures :During flood

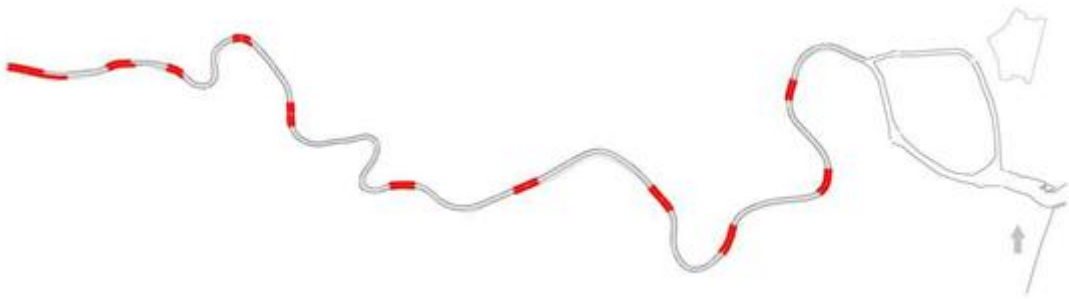


Figure 53 Key plan : Typical edge condition

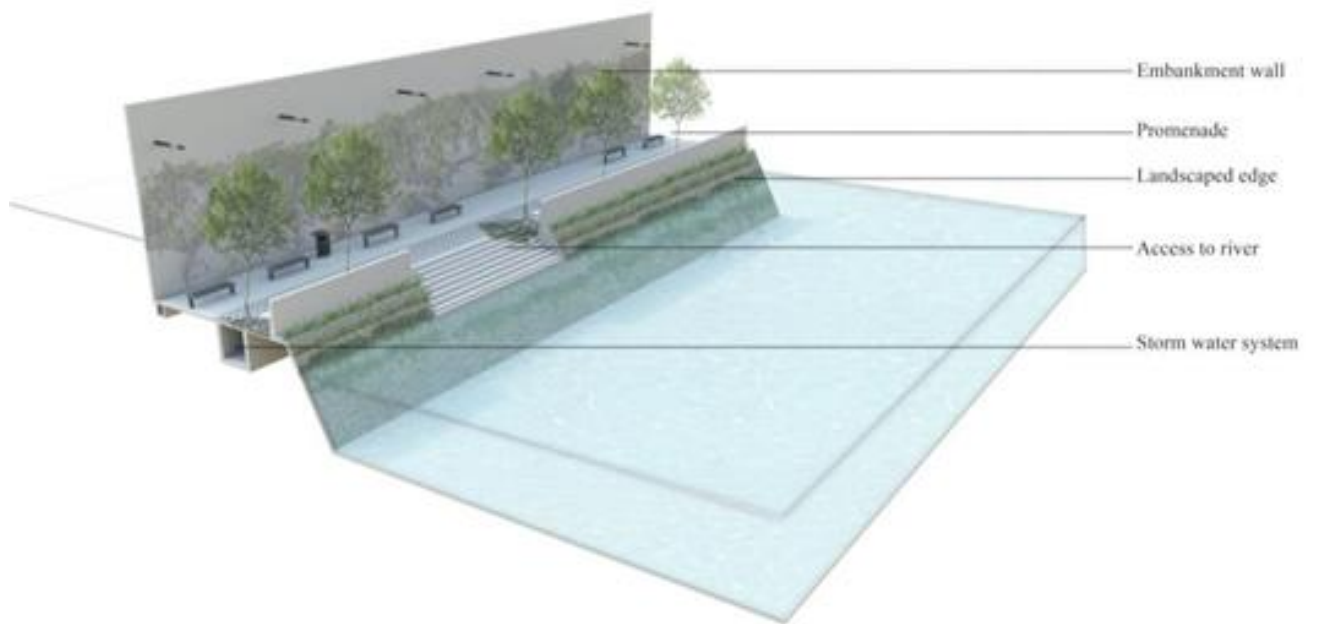


Figure 54 Typical River edge condition along private lands

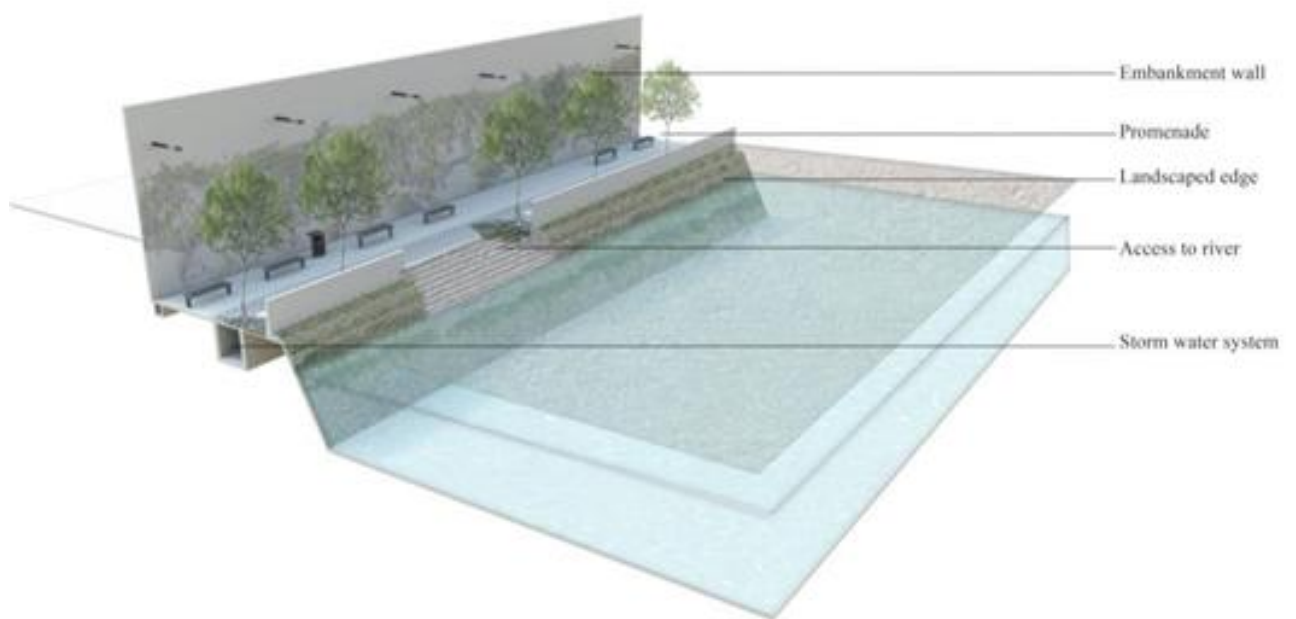
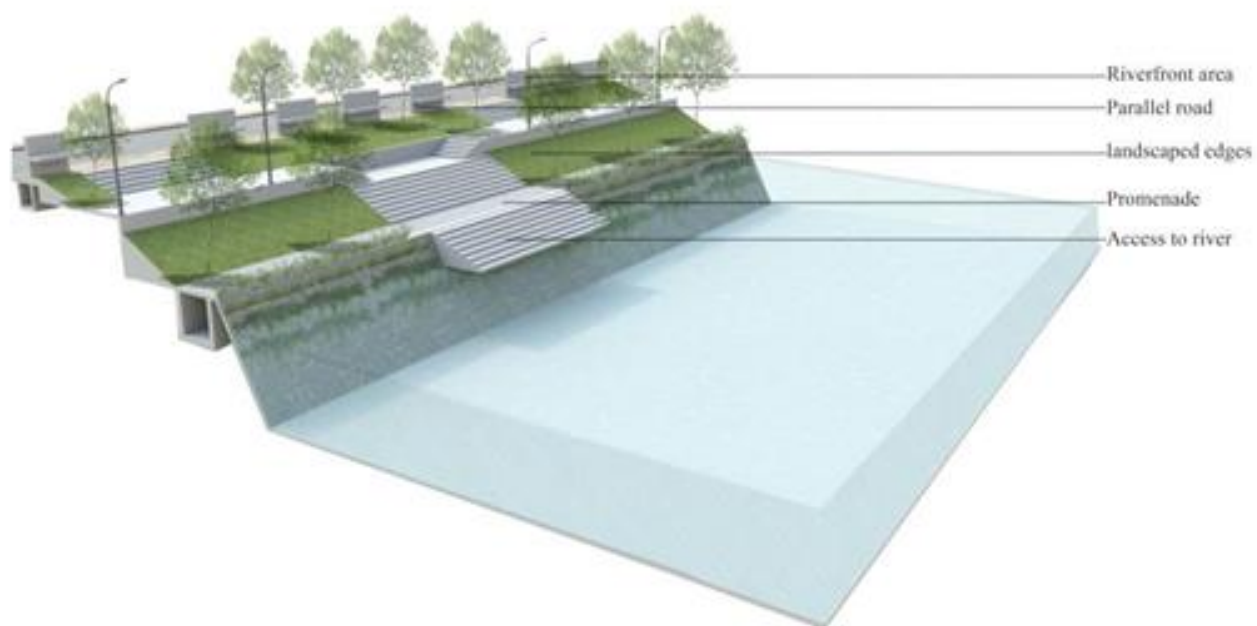


Figure 55 Typical River edge condition along private lands: During flood



Figure 56 Key plan- Typical River edge condition

Typical River edge condition in direct access area



Typical River edge condition in direct access area: During flood

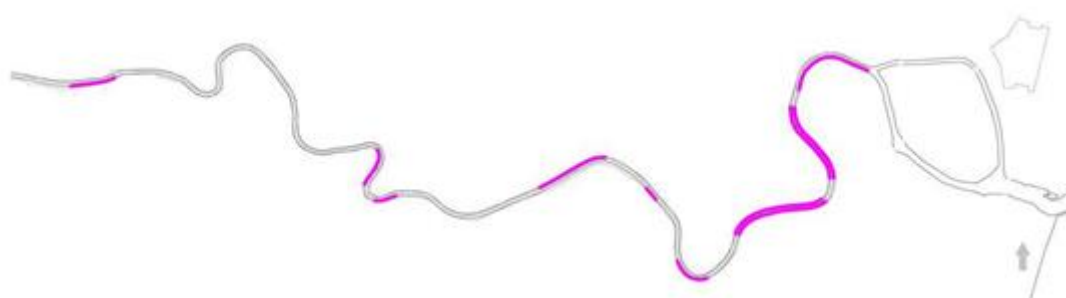
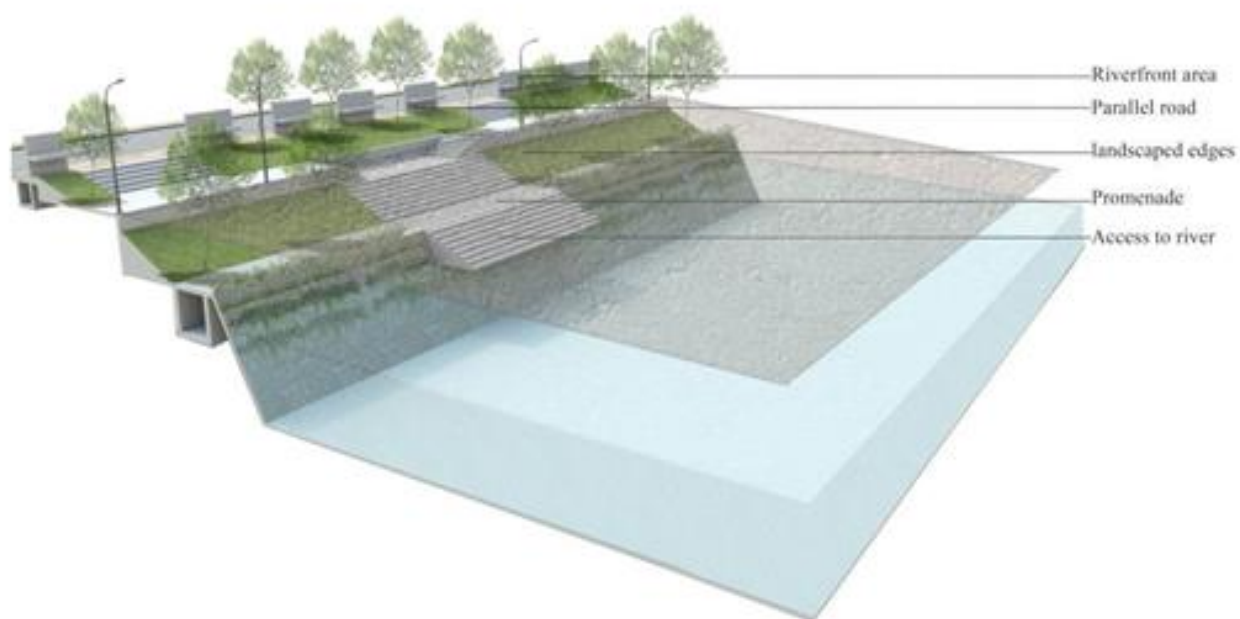


Figure 57 Key plan- Typical River edge condition

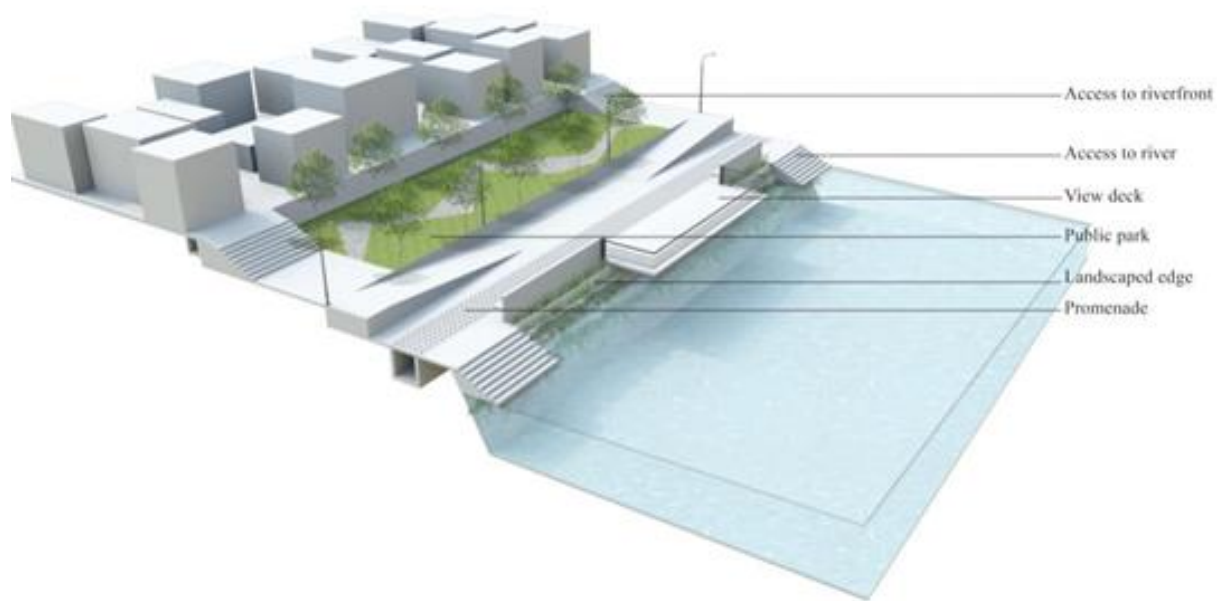


Figure 58 Typical River edge condition along the settlements

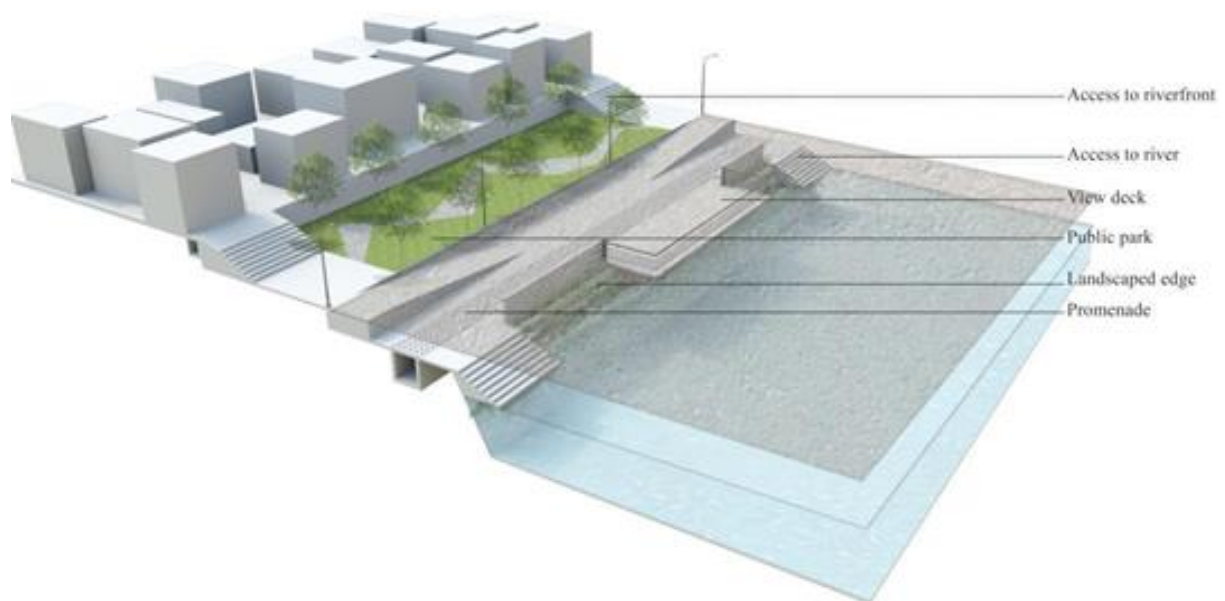


Figure 59 Typical River edge condition in direct access area: During flood

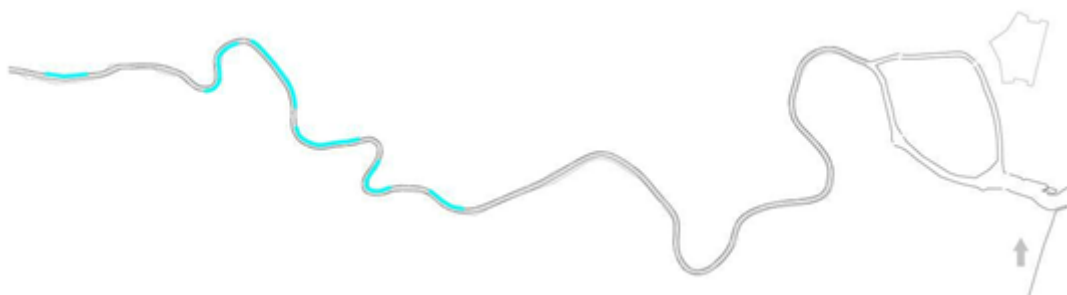


Figure 60 Key plan- Typical River edge condition

CONCLUSION

A study has gone through various levels of data collection and analysis. And it has clearly understood that Cooum faces a lot of problems in various levels. The study identifies various development measures or design recommendations for the governing bodies to incorporate in the Cooum river for the welfare of the public as well as the aspect of the river redevelopment.

Cooum has following problems,

1. Poor Governance

Cooum restoration project was initiated by a lot of chief ministers of the TN starting from 1990 times. But till now it was not executed. It has many reasons interconnected starting from fund management and lack of governance team which very important to execute such important project. For example, design, Built, fund, operate and transfer type of contract will earn more funds and the only thing which the local government body should take care it the project vision and kept in track and project is handed over to the right team to make it work.

2. Urbanization

CMDA is one of the governing authority to approve any development in the city. The development control regulations for the cooum river corridor has been not framed in a way that any development is not affecting the flood path. After the massive flood happened in December 2015. All the slums have been removed along with the river corridor as it got affected by the flood. CMDA should take necessary steps to frame new development controls for the developments of the new buildings

3. Cause for River Flood

There are various reasons has been identified for the cause of the Flood and one of the main reasons for the flood is urbanization along the riverfront and it has strongly agreed by the government of the Tamil Nadu as stated in the above study. After the flood in December 2015, CM has ordered TNSCB to shift the slums along the Cooum River to different locations but due to the voting bank politics, it has been not executed till date. The study clearly states that crowd along Cooum and encroachments along the river to be removed from as soon as possible.

In the same country, Ahmedabad has framed a lot of development control regulations along the Sabarmati River to control the new development which should not impact the river in negative ways. And also it has designed the river stretch in such a way that no encroachments can happen along its periphery and it has a lot of tourism proposal which will earn to funds for maintenance and take out the investment for river development

Along with the problems findings following are the design recommendations which has derived from the above study, which will help for the betterment of the public as well as the river development.

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URBANIZATION AND ITS INFLUENCES ALONG WITH COOUM RIVER: For the situation of Chennai Flood

Abstract:

Chennai is the fourth largest Indian city with a populace today around 4.7 million occupants, which has been developing consistently since Independence metropolitan of 200 km², Situated along the Bengal Sea, India. It has experienced major flooding during 1943, 1976, 1985, 1996, 2005 and 2015. The sewage system in Chennai was originally designed for a population of just over half a million at 114 litres per capita per day of water supply. Today, the population of Chennai is pushing 8 million, that stated poor carrying capacity of water. Cooum River carried 98,000 cusecs of water and the Cooum River does not have that kind of carrying capacity. Cooum River in Chennai the natural spine of the city has got contaminated due to rapid urbanization and industrial edge. So the study started to identify the situation of Cooum and its surroundings and to identify reason behind flood by raising a research question "Does urbanization along the Cooum River reduce carrying capacity of water which leads to the impact of flood and does poor governance forgot to maintenance the urban River and thus results in less carrying capacity of the Cooum River?"

This study has gone through various levels of data collection and analysis. And it has clearly understood that Cooum faces a lot of problems in various levels. Based on a study, Cooum has following problems like poor government, Urbanisation, cause for river flood.

Keywords:

Flood2015, Chennai Cooum River, Urbanisation, Illegal settlements, Governance, Fund Management

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