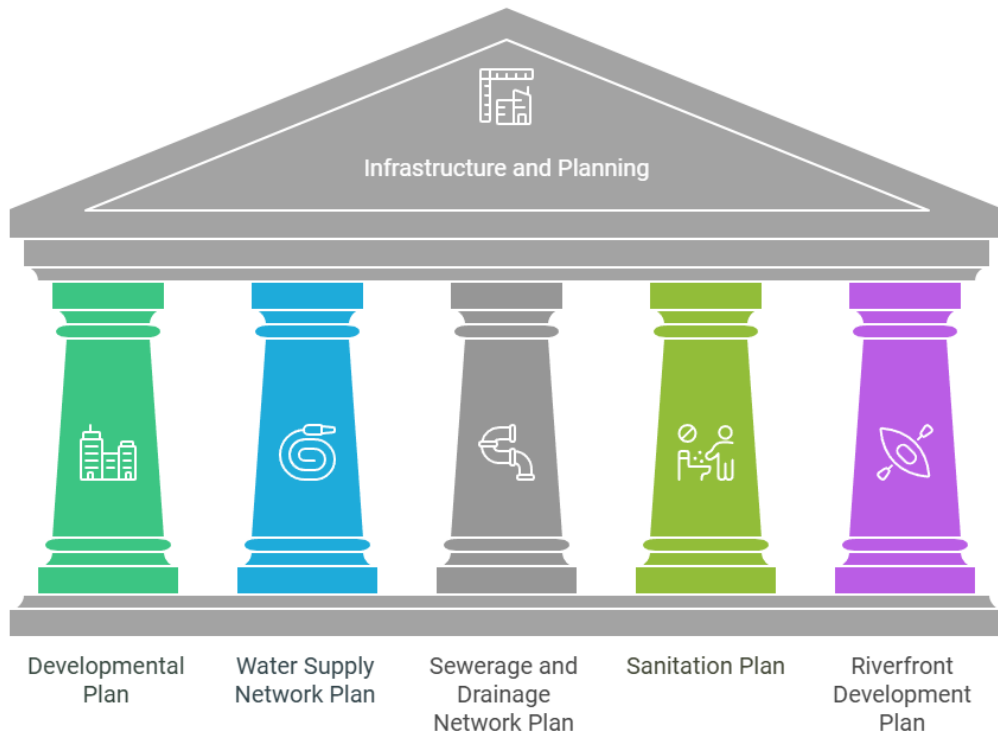




National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development and Ganga Rejuvenation
Government of India

Infrastructure and Planning in Cauvery River Basin



December 2024



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National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development and Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of ‘National River Conservation Plan (NRCP)’. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

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The Centre for Cauvery River Basin Management and Studies (cCauvery) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by IISc Bengaluru and NIT Tiruchirappalli, under the supervision of cGanga at IIT Kanpur, the centre serves as a knowledge wing of the National River Conservation Directorate (NRCD). cCauvery is committed to restoring and conserving the Cauvery River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.ccauvery.org

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cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga’s mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

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This report is a comprehensive outcome of the project jointly executed by IISc Bengaluru (Lead Institute) and NIT Tiruchirappalli (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

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Preface

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

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Abbreviations and Acronyms

%	Percentage
₹	India Rupee
\$	Dollar
&	And
e.g.	For example
km	Kilometre
sq.	Square
AIBP	Accelerated Irrigation Benefits Programme
AMRUT	Atal Mission of Rejuvenation and Urban Transformation
BBMP	Bruhat Bengaluru Mahanagara Palike
BPO	Business Process Outsourcing
BWSSB	Bengaluru Water Supply and Sewerage Board
CETP	Common effluent treatment plant
CRB	Cauvery River Basin
CTR	Catch The Rain
CSOs	Civil Society Organizations
CWSS	Combined Water Supply Schemes
DTCP	Department of Town and Country Planning
ELCOT	Electronics Corporation of Tamil Nadu
EWS	Economically weaker sections
IAMWARM	Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management
IDD	Infrastructure Development Department
iDeCK	Infrastructure Development Corporation (Karnataka) Limited
IHHLs	Individual Household Latrines
IT	Information Technology
IWRM	Integrated Water Resource Management
JnNURM	Jawaharalal Nehru National Urban Renewal Mission
JSA	Jal Shakti Abhiyan
KIIDC	Kerala Irrigation Infrastructure Development Corporation Ltd.
KSIIDC	Karnataka state industrial and infrastructure development corporation
KTCP	Karnataka Town and Country Planning

KUWSDB	Karnataka Urban Water Supply and Drainage Board
LIG	Lower-Income groups
LPA	Local Planning Area
MLD	Million Litres Per Day
MSW	Municipal Solid Waste
MW	Mega Watt
NGOs	Non-Governmental Organizations
NMCG	National Mission for Clean Ganga
ODF	Open Defecation Free
PMAY	Pradhan Mantri Awas Yojana
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PIPDIC	Pondicherry Industrial Promotion Development and Investment Corporation
RDWSD	Rural Drinking Water and Sanitation Department
STPs	Sewage Treatment Plants
SWM	Solid Waste Management
TNIAM	Tamil Nadu Irrigated Agriculture Modernisation
TNIDB	Tamil Nadu infrastructure development board
TNSCB	Tamil Nadu Slum Clearance Board
TNSUDP	Tamil Nadu Sustainable Urban Development Project
TPD	Tons Per Day
TWAD	Tamil Nadu Water Supply and Drainage
UGSS	Underground Sewage System
ULBs	Urban Local Bodies
UT	Union Territory
WRA	Water Resources Assessment
WTP	Water treatment plant

1. Introduction

The Cauvery River Basin (CRB) is a critical geographical and ecological zone in southern India, encompassing significant portions of Karnataka and Tamil Nadu. It serves as a lifeline for agricultural productivity, economic activities, and urban development across the region. Key cities and towns within the basin, such as Bengaluru, Mysuru, Mandya, and Tumakuru in Karnataka, and Coimbatore, Trichy, Thanjavur, and Madurai in Tamil Nadu, rely on its resources for sustenance and growth. The basin supports extensive agricultural activities and is instrumental in meeting the water and energy demands of both rural and urban settlements (Brema et al., 2021; Chidambaram et al., 2018). Urbanization in the CRB, particularly in districts such as Mandya, Mysuru, and Bengaluru in Karnataka, and Coimbatore, Trichy, and Thanjavur in Tamil Nadu, has necessitated advanced urban planning and sustainable infrastructure development. Rapid population growth and industrial expansion in cities like Bengaluru and Mysuru have further intensified the demand for efficient water management, waste disposal systems, and climate-resilient urban designs (Bhave et al., 2018; Brema et al., 2021).

Infrastructure development and urban planning in the CRB are driven by coordinated efforts from government agencies, urban planners, and non-governmental organizations (NGOs). These initiatives aim to address the challenges posed by rapid urbanization while ensuring ecological balance (Brema et al., 2021). Priority areas include integrated water resource management, sustainable housing development, improved urban transportation systems, waste management, and climate adaptation strategies. In Karnataka, specific focus is placed on preserving the ecological integrity of the basin while promoting equitable water sharing and addressing inter-state water disputes with Tamil Nadu.

1.1. Overview of urban planning and infrastructure development in CRB

1.1.1. Urbanization trends in CRB

Karnataka has witnessed significant urbanization, with 38.67% of its population residing in urban areas as per the 2011 Census. The urban population of the state grew by 31.27% between 2001 and 2011, highlighting the rapid pace of urban development, while the rural population grew by only 7.6% during the same period. The average population density in Karnataka in 2011 was 319 persons per sq. km, whereas urban areas exhibited much higher densities, particularly in major cities like Bengaluru, which had a population density exceeding 4,300 persons per sq. km. With a total urban population of approximately 23.6 million, Karnataka ranks eighth in absolute urban population in India and has a steadily increasing share of urban residents among large states. The state's urbanization is largely driven by economic opportunities in cities such as Bengaluru and Mysuru, which have emerged as hubs for information technology, manufacturing, and trade. However, Tamil Nadu has one of the highest urbanization rates in India, with nearly 48.45% of its population residing in urban areas (India Census, 2011). The state's urban population grew by 27% between 2001-2011, compared to only 6% growth in rural areas during the same period. The state's average population density in 2011 was 554 persons per sq. km. However, in urban areas, the density was much higher at 3,521 persons per sq. km. With a provisional urban population of 34.9 million, Tamil Nadu

ranks third in terms of absolute urban population in India, and first in terms of the share of urban population among large states. The government is focused on managing this rapid urbanization to ensure sustainable urban growth, improve living standards, and address the challenges of urban poverty, housing, and infrastructure.

1.1.2. Urban infrastructure development

Urban infrastructure development in CRB aims to improve the quality of life for urban dwellers and promote inclusive growth. This has been supported through various central and state-level programs like the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and AMRUT (Atal Mission for Rejuvenation and Urban Transformation). These programs provide substantial financial assistance for urban infrastructure development, with a focus on:

- Urban Infrastructure and Governance
- Basic Services to the Urban Poor
- Urban Infrastructure Development Scheme for Small and Medium Towns
- Integrated Housing and Slum Development Program

These schemes aim to develop and upgrade the physical and institutional infrastructure, address urban housing needs, and improve governance and financial management at the Urban Local Bodies (ULBs) level.

1.1.3. Key urban infrastructure and governance challenges

- A major challenge is strengthening water supply and sewage systems at the ULB levels, many of which still rely on parastatal agencies for service delivery.
- ULBs need to improve their financial management systems, including better revenue mobilization and property tax collection.
- There is a need for continued professionalization of the municipal workforce, with more efficient governance mechanisms and improved financial management practices.
- Urban planning in Tamil Nadu is still primarily controlled at the state level, with ULBs having limited authority to develop city-level plans.
- The state's ULBs face challenges in revenue generation, particularly in terms of property tax collection, which is often insufficient to meet the growing demands for urban infrastructure and services.

1.2. Government initiatives for urban planning and infrastructure development

1.2.1. Karnataka State Industrial and Infrastructure Development Corporation (KSIIDC)

The Karnataka State Industrial and Infrastructure Development Corporation (KSIIDC) plays a pivotal role in driving urban planning and infrastructure development across Karnataka. As a

nodal agency, KSIIDC is instrumental in the conceptualization and execution of various projects aimed at enhancing the state's industrial and urban infrastructure (Table 1).

a) Industrial Infrastructure Development

KSIIDC is dedicated to fostering industrial growth by developing state-of-the-art industrial parks and zones. These industrial areas are equipped with modern facilities, including transportation links, power supply, water resources, and communication networks. The corporation has developed multiple industrial estates that cater to diverse sectors, promoting balanced regional growth and generating employment opportunities.

b) Urban Infrastructure Projects

KSIIDC also focuses on urban infrastructure development, which includes planning and implementing large-scale projects such as townships, commercial complexes, and transportation hubs. Notable initiatives include the development of integrated townships that combine residential, commercial, and recreational facilities, thus creating self-sustaining urban ecosystems.

c) Public-Private Partnerships

To leverage private sector expertise and investment, KSIIDC actively promotes Public-Private Partnerships in infrastructure projects. This approach has been successful in developing key infrastructure, including highways, airports, and special economic zones, thereby accelerating economic growth and improving the quality of urban life.

d) Infrastructure Financing

KSIIDC also plays a crucial role in providing financial assistance for infrastructure projects. It facilitates funding through loans, equity participation, and joint ventures, enabling the timely completion of critical infrastructure that supports industrial and urban development.

e) Sustainability and Innovation

Emphasizing sustainable development, KSIIDC integrates environmental considerations into its planning processes. It promotes the use of green technologies and sustainable practices in infrastructure projects to minimize ecological impact and ensure long-term benefits for the community.

Through these initiatives, KSIIDC continues to be a key driver of Karnataka's urban planning and infrastructure development, enhancing the state's economic competitiveness and improving the living standards of its residents.

Table 1. Summary of the notable projects undertaken by the Karnataka State Industrial and Infrastructure Development Corporation (KSIIDC) in CRB

Project Name	Description	Status
Mandya Industrial Area Development	Development of industrial estate with facilities for agro-based industries and MSMEs.	Completed
Ramanagara Industrial Area Expansion	Expansion of existing industrial area to accommodate more units, focusing on textiles and handicrafts.	Ongoing
Mysuru Airport Upgradation	Upgradation of the existing airport to handle larger aircraft and increased passenger capacity.	Completed
Channarayapatna Industrial Cluster	Development of a new industrial cluster to boost local manufacturing and logistics industries.	Planned
Srirangapatna Riverfront Development	Integrated development of the riverfront for tourism, including walkways, parks, and recreational areas.	Ongoing
Hassan Growth Centre	Development of a multi-sector growth centre to promote industrial diversification.	Completed
Bannur Textile Park	Establishment of a dedicated textile park to support the region's weaving and garment industries.	Ongoing
Krishnarajasagara Reservoir Tourism Project	Infrastructure development around the reservoir to enhance tourism and recreational facilities.	Completed
Kanakapura Agro-Tech Park	Development of an agro-tech park to promote agriculture-based industries and innovation.	Planned
Mysuru Software Technology Park	Establishment of a technology park to support IT and software industries in the region.	Completed

Source: KSIIDC

1.2.2. Tamil Nadu Infrastructure Development Board (TNIDB)

The Tamil Nadu infrastructure development board (TNIDB) is a key agency involved in planning and executing urban infrastructure projects across the state, including CRB areas (Table 2). TNIDB facilitates the development of critical infrastructure such as water supply, sanitation, and transportation, especially in regions that are urbanizing rapidly due to industrial growth (TNIDB).

- **Water Supply Projects:** In cities like Coimbatore, Trichy, and Thanjavur, TNIDB has supported projects for the 24x7 water supply system aimed at ensuring sustainable access to water, especially considering the Cauvery River’s importance for irrigation and drinking water.
- **Solid Waste Management (SWM):** The board has supported projects focused on solid waste management, including setting up Material Recovery Facilities (MRFs) and Bio-CNG plants in cities like Coimbatore, Tirupur, and Madurai. These projects are designed to reduce waste going to landfills and promote recycling, especially in industrial cities with high waste production.

Table 2 shows some of the projects done by TNIDB in CRB districts.

Table 2. Summary of the notable projects undertaken by the Tamil Nadu infrastructure development board (TNIDB) in CRB

Project Name	Description	Project Status
Implementation of 24x7 Water Supply System for the City of Coimbatore	This project aims to provide a continuous, round-the-clock water supply to the residents of Coimbatore.	Operationalized Project
500 TPD Modern Rice Mill at Thanjavur District	Establishment of a modern rice mill with a capacity of 500 tons per day (TPD) in Thanjavur District.	Study Completed
500 TPD Modern Rice Mill at Tiruvarur District	Establishment of a modern rice mill with a capacity of 500 TPD in Tiruvarur District.	Study Completed
500 TPD Modern Rice Mill at Mayiladuthurai District	Establishment of a modern rice mill with a capacity of 500 TPD in Mayiladuthurai District.	Study Completed
Setting up of 800 TPD Modern Rice Mill at Thiruvarur District	Establishment of a modern rice mill with a capacity of 800 TPD in Thiruvarur District.	Study Completed
Setting up of 800 TPD Modern Rice Mill at Tiruchirapalli District	Establishment of a modern rice mill with a capacity of 800 TPD in Tiruchirapalli District.	Study Completed

Setting up of 800 TPD Modern Rice Mill at Nagappattinam District	Establishment of a modern rice mill with a capacity of 800 TPD in Nagappattinam District.	Study Completed
Setting up of 800 TPD Modern Rice Mill at Madurai District	Establishment of a modern rice mill with a capacity of 800 TPD in Madurai District.	Study Completed
Setting up of 800 TPD Modern Rice Mill at Thanjavur District	Establishment of a modern rice mill with a capacity of 800 TPD in Thanjavur District.	Study Completed
Solid Waste Management-Material Recovery Facility for Madurai Corporation	This project involves setting up a material recovery facility in Madurai to improve solid waste management.	Project under Report Preparation
24x7 Water Supply Project-O&M	Operation and maintenance of a 24x7 water supply project for Madurai Corporation.	Project under Report Preparation
Smart Water Metering Project	Introduction of smart water meters to enhance water usage monitoring and efficiency.	Project under Report Preparation
Development of TN Tech City- Coimbatore	Development of a tech city in Coimbatore to promote technological innovation and growth.	Project under Report Preparation
Development of TIDEL Park at Madurai	Establishment of a TIDEL Park in Madurai to support IT and business process outsourcing (BPO) industries.	Project under Report Preparation
Solid Waste Management-Material Recovery Facility for Coimbatore Corporation	Establishment of a material recovery facility in Coimbatore for better solid waste management.	Project under Report Preparation
Solid Waste Management-Setting up of Bio CNG Plants for Coimbatore	Setting up Bio CNG plants in Coimbatore for sustainable waste management and energy generation.	Project under Report Preparation

Solid Waste Management- Material Recovery Facility for Tirupur Corporation	Setting up a material recovery facility in Tirupur to enhance solid waste management.	Project under Report Preparation
Solid Waste Management- Material Recovery Facility for Trichy Corporation	Establishing a material recovery facility in Trichy for efficient waste management.	Project under Report Preparation
Solid Waste Management- Setting up of Bio CNG Plants for Tiruchirappalli	Setting up Bio CNG plants in Tiruchirappalli to convert waste into energy.	Project under Bid Process Management
Solid Waste Management- Material Recovery Facility for Erode Corporation	Establishment of a material recovery facility in Erode for waste management.	Project under Report Preparation
Solid Waste Management- Setting up of Bio CNG Plants for Madurai	Setting up Bio CNG plants in Madurai to convert organic waste into compressed natural gas.	Project under Bid Process Management
Solid Waste Management- Setting up of Bio CNG Plants for Salem	Establishing Bio CNG plants in Salem for converting organic waste into energy.	Project under Bid Process Management
Solid Waste Management- Setting up of Bio CNG Plants for Tirupur	Setting up Bio CNG plants in Tirupur to enhance waste management practices.	Project under Bid Process Management
Solid Waste Management- Setting up of Bio CNG Plants for Thanjavur	Establishment of Bio CNG plants in Thanjavur to generate renewable energy from waste.	Project under Report Preparation

Source: TNIDB

Moreover, city planners in the CRB focus on sustainable urban development and climate resilience, integrating environmental considerations into urban growth. Their work is particularly important considering the ecological sensitivity of the basin and the need to balance urbanization with resource conservation. They emphasize the need for sustainable development in urban areas like Trichy, Coimbatore, and Thanjavur, where industrialization is growing rapidly, placing strain on infrastructure. Urban master plans are being developed for these cities to provide a clear roadmap for growth. This includes setting aside areas for green spaces, public amenities, and eco-friendly infrastructure. For instance, Coimbatore's Smart City Plan integrates sustainability features such as solar-powered public services, electric vehicle

charging stations, and extensive urban green spaces. Given the crucial role of the Cauvery River in water supply for urban areas, city planners focus on integrated water resource management (IWRM) strategies, integrating urban water supply, wastewater treatment, stormwater management, and agriculture. Urban areas near the river, such as Thanjavur, rely heavily on the river for irrigation and drinking water, and planners aim to balance agricultural and urban demands. The incorporation of rainwater harvesting systems in new buildings and urban spaces is a priority. The planning includes the construction of check dams and water storage tanks to capture rainwater and alleviate pressure on the Cauvery River's water resources. They also focus on transportation infrastructure that supports sustainable growth while minimizing congestion and pollution. In Coimbatore, urban planners are focusing on expanding and modernizing the city's public transport network, including bus rapid transit systems and metro rail proposals. This aims to reduce traffic congestion and pollution. They are also focusing on pedestrian-friendly development, bicycle lanes, and walkways, particularly in urban areas along the river, to reduce dependency on private vehicles. An overview of key infrastructure development efforts led by city planners in Tamil Nadu, highlighting the areas of focus, current initiatives, and the agencies involved is given below:

a) Urban Water Supply and Sanitation

One of the most pressing challenges faced by urban areas in Tamil Nadu is the provision of safe drinking water and the management of wastewater. Many ULBs depend on state-run parastatal agencies to deliver these services. However, city planners are working to improve water supply infrastructure and enhance sewage systems to meet growing demand. Several cities, including Coimbatore, Chennai, Madurai, and Trichy, are working on implementing 24x7 water supply systems, aiming to provide uninterrupted water to urban areas. The Tamil Nadu Water Supply and Drainage Board is leading many of these projects. Wastewater treatment facilities are also a major focus, with cities looking to develop or upgrade sewage treatment plants (STPs) to treat wastewater before discharge. Projects such as the STP projects in Chennai, Madurai, and other urban areas aim to address pollution and environmental degradation.

b) Solid Waste Management

SWM is a critical aspect of urban planning, especially in fast-growing cities with rapidly increasing populations. In Tamil Nadu, city planners are focusing on creating sustainable and efficient waste management systems to handle the growing waste burden. The Directorate of Municipal Administration is working on setting up MRFs in several cities, including Madurai, Coimbatore, Trichy, and Erode. These facilities are designed to sort recyclable waste, reducing the amount of waste that ends up in landfills and increasing recycling rates. In addition to MRFs, Tamil Nadu is investing in Bio-CNG plants to process organic waste and convert it into clean energy. Cities like Madurai, Coimbatore, and Trichy are already in the process of setting up Bio-CNG plants that will not only reduce waste but also generate biofuels for local consumption. Various cities are looking at waste-to-energy technologies to convert non-recyclable waste into electricity. These projects will help reduce the carbon footprint and offer an alternative energy source.

c) Affordable Housing and Slum redevelopment

Urbanization has increased the demand for affordable housing in Tamil Nadu, especially in its major cities. City planners are working on projects that provide low-income housing and improve living conditions in slums through redevelopment efforts. The Tamil Nadu Slum Clearance Board (TNSCB) is working on various housing projects to provide affordable housing for the urban poor, especially in cities like Chennai, Coimbatore, Madurai, and Trichy. The Pradhan Mantri Awas Yojana (PMAY) is one of the central schemes under which the state is constructing low-cost homes for the economically weaker sections (EWS) and lower-income groups (LIG). The state is also investing in the redevelopment of slums, offering better infrastructure, sanitation, and access to basic services. The Tamil Nadu Slum Clearance Board has been instrumental in rehabilitating slum dwellers through the construction of modern residential complexes equipped with water, sewage, and electricity connections.

d) Transportation Infrastructure

City planners in Tamil Nadu are focusing on improving both urban mobility and public transportation systems to ease traffic congestion and improve air quality. Major cities like Chennai and Coimbatore are investing in modernizing transportation systems to accommodate growing urban populations. One of the most significant urban mobility projects is the Chennai Metro, which is expanding in phases. Once completed, it will provide a reliable and efficient public transport option for Chennai's growing population, reducing congestion on roads and improving air quality. Proposals are also underway for metro rail systems in Coimbatore and Madurai, where planners are envisioning rapid transit solutions to meet the future transportation needs of the cities. Coimbatore and Chennai are looking at Bus Rapid Transit (BRT) systems to improve road transport. These projects aim to provide high-quality, efficient public transport with dedicated lanes to reduce traffic congestion and improve commuter experience. Cities like Coimbatore and Trichy are adopting Intelligent Traffic Management Systems (ITMS) to optimize traffic flow and reduce congestion. These systems use sensors and real-time data to manage traffic lights, improve road safety, and reduce traffic jams.

e) Smart City Initiatives

Tamil Nadu is also focusing on smart city initiatives, particularly in Chennai, Coimbatore, and Madurai, where planners are working on digital solutions to improve urban services. Under the Smart Cities Mission, cities like Trichy and Coimbatore are integrating advanced technologies to improve urban living. Initiatives include the deployment of smart meters, Wi-Fi hotspots, and surveillance systems to enhance safety, energy efficiency, and service delivery. The state has made strides in e-governance with the implementation of digital services for citizens, such as online property tax payments, water bill payments, and land record management.

f) Environmental Sustainability and Green Infrastructure

City planners in Tamil Nadu are increasingly focusing on sustainable urban development to mitigate the environmental impact of urbanization. Key initiatives include the promotion of green buildings, rainwater harvesting, and afforestation programs. Tamil Nadu is encouraging the adoption of green building practices, with several private and public sector buildings being constructed using eco-friendly materials and energy-efficient designs. The state has made rainwater harvesting compulsory for new buildings, and existing buildings are encouraged to retrofit systems to capture and store rainwater. Planners are also focusing on the development of urban parks and green spaces to improve air quality and provide residents with recreational areas.

g) Technology Parks and Industrial Growth

Tamil Nadu is making efforts to boost industrial and technological growth in urban areas, creating job opportunities and reducing pressure on urban infrastructure. This includes the development of technology parks and industrial zones in cities like Chennai, Coimbatore, and Madurai. TIDEL Park is a hub for information technology (IT) and business process outsourcing (BPO) industries, helping to position Chennai as an IT and tech services destination. The Electronics Corporation of Tamil Nadu (ELCOT) is also developing a tech city in Coimbatore, aimed at fostering innovation and creating jobs in the IT sector.

1.2.3. Kerala Irrigation Infrastructure Development Corporation Ltd. (KIIDC)

The Kerala Irrigation Infrastructure Development Corporation Ltd. (KIIDC) is a government-owned company in Kerala responsible for developing and managing irrigation infrastructure projects across the state. While KIIDC undertakes various projects, specific details about their involvement in CRB are limited (Table 3).

Table 3. Summary of the notable projects undertaken by the Kerala Irrigation Infrastructure Development Corporation Ltd. (KIIDC) in CRB

Project Name	Description	Current Status
Kabini River Irrigation Project	Development of canals and irrigation infrastructure in the Kabini basin.	Ongoing
Integrated Watershed Management	Sustainable water resource management in tributary regions.	Planning
Drinking Water Supply Scheme	Expansion of drinking water facilities in rural areas near the basin.	Partially Completed
Cauvery Tributary Canal Works	Maintenance and expansion of canal systems for efficient water flow.	Ongoing

Dam Rehabilitation Program	Structural and operational safety enhancements for dams.	Initiated
Eco-Tourism Development	Developing sustainable tourism opportunities along riverbanks.	Proposed
Hydropower Generation Initiative	Installation of small hydropower plants on tributaries.	Planning

Source: KIIDC

1.2.4. Pondicherry Industrial Promotion Development and Investment Corporation (PIPDIC)

The Pondicherry Industrial Promotion Development and Investment Corporation (PIPDIC) is responsible for promoting industrial and infrastructure development within the Union Territory of Puducherry (Table 4). The Union Territory comprises four regions: Puducherry, Karaikal, Mahe, and Yanam. Among these, the Karaikal region is situated within CRB. While specific information on PSIDC 's projects in CRB is limited, here is a summary of notable projects and initiatives in the Karaikal region:

Table 4. Summary of the notable projects undertaken by the Pondicherry Industrial Promotion Development and Investment Corporation (PIPDIC) in CRB

Project Name	Description	Status
Industrial Estate Development	Establishment of industrial estates to promote small and medium-scale industries in Karaikal.	Ongoing
Infrastructure Enhancement	Upgrading roads, drainage systems, and other essential infrastructure to support industrial growth.	Ongoing
Port Development	Development of the Karaikal Port to facilitate maritime trade and support industrial activities.	Completed
Tourism Infrastructure	Initiatives to boost tourism in Karaikal, including development of facilities and amenities.	Ongoing

Source: PIPDIC

1.3. NGOs' role in urban planning and infrastructure development

Non-governmental organizations (NGOs) in Tamil Nadu, particularly those focused on environmental conservation and sustainable urban development, play an essential role in raising awareness about the environmental impacts of urbanization and promoting sustainable practices in urban planning.

a) Environmental conservation

Many NGOs, including the Cauvery River Protection Movement, focus on river conservation and the prevention of pollution caused by industrialization and urbanization. These NGOs work to advocate for policies that protect the river and its ecosystem while promoting sustainable urban growth. NGOs like The Coimbatore Green Movement and The Madurai Green Foundation work on raising awareness about solid waste management and recycling. They actively engage with local communities, encourage waste segregation, and promote zero-waste lifestyles.

b) Community-based urban planning

NGOs also play an important role in community-driven planning. They assist local governments in engaging communities to ensure that urban development is inclusive and benefits all sections of society. NGOs often collaborate with the Tamil Nadu Slum Clearance Board (TNSCB) to provide improved housing and community facilities for urban poor populations. In cities like Coimbatore and Madurai, NGOs are working to restore public parks, develop urban forests, and create more green spaces for residents, which are essential for improving the quality of life in rapidly growing urban areas.

Several NGOs in Tamil Nadu are actively involved in promoting sustainable development, environmental conservation, and infrastructure development within CRB. These NGOs play crucial roles in raising awareness, advocating for policy changes, and directly working on ground-level interventions related to water resource management, river conservation, waste management, and community development.

2. Developmental plan for CRB

CRB, a significant water resource in southern India, spans multiple states and is characterized by its intricate network of administrative boundaries. Understanding these administrative delineations at various levels (e.g., state, district, tehsil, and village) is crucial for effective water resource management, inter-state collaboration, and regional development. Overview of the administrative delineation at various levels within CRB is given below.

2.1. Land use zoning and master planning

Land use zoning in CRB is a critical aspect of urban planning and development, aimed at managing the state's rapid urbanization while ensuring sustainable growth. The key components of Land Use (Fig. 1) zoning are explained below:

a) Residential Zone

This zone is designated for single-family homes, apartments, schools, and parks. It aims to provide a conducive environment for living while maintaining necessary amenities.

b) Commercial Zone

This area accommodates retail shops, offices, hotels, and restaurants. The regulations allow for a higher Floor Area Ratio to promote denser development in business districts.

c) Industrial Zone

Reserved for factories and manufacturing units, this zone is designed to support industrial activities while minimizing their impact on residential areas.

d) Mixed-Use Zone

This category combines residential and commercial uses, allowing for a blend of activities that can enhance community interaction and reduce travel needs.

e) Agricultural Zone

Strictly regulated to preserve agricultural land from non-farm activities, this zone aims to protect farming areas from encroachment due to urban development.

f) Open Space and Recreational Use Zone

Specific to the Chennai Metropolitan Area, this zone includes parks, playgrounds, and other recreational facilities.

Several government agencies are involved in the land use management processes described below.

a) Revenue Department

It oversees the process of land acquisition and provides guidelines for land use changes.

b) Town and Country Planning Department

It develops master plans for urban areas, ensuring that land is used effectively while considering urbanization needs.

c) Forest Department

It regulates land use in forest areas to prevent deforestation and promote sustainable practices.

d) Public Works Department

It oversees construction projects that may alter land use, such as roads, bridges, and public buildings.

However, a master plan is a comprehensive document which provides the broad framework and direction for the growth and development of the city. A master plan aims to integrate the various sectoral plans taking into consideration the overall requirements in terms of land, infrastructure services, physical and social amenities, environmental aspects etc. over a 10 – 20-year time frame. The plan aims to project the population, lay down the overall space,

and provide direction for the future growth and development of the city keeping in view the larger perspective. Besides, it aims to provide a clear circulation network and, assess the demand and gap in the facilities and amenities for the present and projected population while also reserving land requirements for future amenities and services (which may be totally uninhabited currently) together with planning for new residential areas, new work centres, new business/commerce areas, new educational and institutional areas, including the amenities and services.

In Karnataka, under the Karnataka Town and Country Planning (KTCP) Act,1961, the master plan shall consist of a series of maps and documents indicating the manner in which the development and improvement of the entire planning area within the jurisdiction of the planning authority are to be carried out and regulated, such a plan shall include proposals for the following, viz -

- Zoning of land use for residential, commercial, industrial, agricultural, recreational, educational and other purposes together with Zoning Regulations.
- A complete street pattern, indicating major and minor roads, national highways, and state highways, and traffic circulation pattern, for meeting immediate and future requirements with proposals for improvements.
- Areas reserved for parks, playgrounds, and other recreational uses, public open spaces, public buildings and institutions and area reserved for such other purposes as may be expedient for new civic developments.
- Areas earmarked for future development and expansion.
- Reservation of land for the purposes of Central Government, the State Government, Planning Authority or public utility undertaking or any other authority established by Law, and the designation of lands being subject to acquisition for public purposes or as specified in Master Plan or securing the use of the land in the manner provided by or under this Act.
- Declaring certain areas, as areas of special control and development in such areas being subject to such regulations as may be made regarding building line, height of the building, floor area ratio, architectural features and such other particulars as may be prescribed; and
- Stages by which the plan is to be carried out.

2.1.1. Extent of local planning area of Bengaluru Development Authority

The Notifications/ Government Orders issued by Government that define the Local Planning Area of Bengaluru Development Authority (BDA) are as follows:

- Govt. Notification No. S.O.3446 dated 1st November 1965, declaring the Local Planning Area (LPA) for Bengaluru City.
- Govt. Notification No. HUD 496 TTP 83 dated 15th March 1984 declaring the Local Planning Area for the environs of Bengaluru.
- Govt. Notification No. HUD 167 MNJ 87 dated 1st March 1988 specifying the areas of BDA.

- Govt. Notification No. Na Aa Ee130 Bem Ru Pra 2001 dated 20th November 2001 declaring the LPA for BMICAPA.
- Govt. Notification No. UDD/118/Bem Ru Pra 2003 dated 3rd March 2006 declaring the extent of Hoskote Local Planning Area.
- Govt. Notification No. UDD 36N BMR 2009 dated 26th September 2012 specifying exclusion of 8 villages from LPA of BDA, which were overlapping with Hoskote LPA.

2.1.1.1. Bengaluru Master Plan: Key highlights from 2015

The highlights of the Bengaluru Master Plan 2015 are being discussed below:

- A structure plan was created in the Bengaluru Master Plan 2015 with a two-fold aim - strengthening existing urban areas and extending development to already developed areas.
- Five concentric belts were created and divided into – the core area, peri-central area, recent extensions, new layouts, and green belt and agricultural regions.
- A focus point was also the development along major radial roads with a concentration of industrial and commercial activities.
- Residential areas with high-density populations were planned to be served by city centres and mixed land usage to support urban development.
- The Master Plan 2015 also included plans to improve the transportation infrastructure for the people of the city.

2.1.1.2. Bengaluru Master Plan: Key proposed revisions for 2031

The proposed revisions as per the Bengaluru Master Plan 2031 are being discussed below:

- The Bengaluru Master Plan 2031 aims to improve the transit systems in the city through transport hubs, metro development, and suburban rail lines.
- Creation of different zones for specific development instead of concentric circles - Zone A (development through new stores and offices), Zone B (better roads and infrastructure), and Zone C (assisting farmers to generate more income).
- Development of higher buildings for mixed-land usage around transportation corridors.
- Infrastructural development in the form of flyovers to reduce travel time for the residents.

In Tamil Nadu, Department of Town and Country Planning (DTCP) develops master plans for urban areas, ensuring that land is used effectively while considering urbanization needs. It also manages reclassification of land use zones under the Tamil Nadu Town and Country Planning Act, 1971. Master plan is prepared for town and cities giving emphasize for zoning regulation for judicious use of urban land. Thus a Master Plan is a key development plan to provide land use allotment for residential, commercial, industrial, public and semi-public, traffic and transportation, parks, play fields and open spaces, etc., taking into consideration the

existing land uses. The plans while suggesting for broader land use restrictions, will also identify the problem areas in traffic and transport, location for education, recreation site etc., and propose for provision of infrastructure facilities based on the projected population for that area. Programmes are drawn and funding agencies are identified to take up such projects. 114 Local Planning Areas (108 Local Planning Areas and 6 New Town Development Areas) have been declared, and master plans and new town development plans have been prepared for these urban areas. This department has so far prepared Master Plan/New Town Development Plan for 117 towns. Master Plan has to be prepared for the newly upgraded 50 Municipalities (DTCP).

2.2. Urban expansion

Karnataka's urban growth is at a critical juncture, with towns having populations of less than 100,000 emerging as significant wealth generators. The definition of "urban" needs reconsideration, particularly in terms of the percentage of people engaged in agriculture and allied activities, as well as population density. Both urban and rural areas aim for equal basic services. Between 2021-2031, Karnataka is expected to see 18 new Class I cities and 24 Class II cities, with "RURBAN" towns blending urban and rural characteristics.

Emerging urban areas in coastal, hilly, and eco-sensitive regions have been neglected due to low population density; these areas need recognition and urban status. A "Town Commissionerate" for towns with populations under 50,000 should be formed to ensure better governance and sustainable development. Additionally, a "New Township Act" should facilitate large developments and satellite towns. Bengaluru's Master Plan expired in 2015, and a new plan for 2031 is urgently needed. The Ministry of Urban Development should extend the Master Plan limits to include the Satellite Town Ring Road jurisdiction. Across Karnataka, out of 312 Urban Local Bodies, Master Plans exist for only 114 areas, City Mobility Plans for just 14 cities, and there is no regional plan except the Bengaluru Structure Plan. To ensure sustainable urbanization, Karnataka should prepare regional and eco-regional plans, especially in eco-sensitive regions. The state should also conduct a "Water Resource Audit" in every settlement to rationalize water use, in line with the NGT's 2021 order on RO plant regulations.

Tamil Nadu's urban flagship investment program focuses on water supply, sewerage, and drainage infrastructure development in at least 10 cities within strategic industrial corridors. This initiative aims to address acute infrastructure deficits, water scarcity due to climate change, and environmental pollution, with an estimated investment need of \$42.7 billion. The Asian Development Bank supports part of this investment with a commitment of \$1.268 billion. The Tamil Nadu Sustainable Urban Development Project (TNSUDP) seeks to empower select municipalities to deliver sustainable urban services, focusing on water supply, sewerage, drainage, solid waste management, and urban transportation networks. The Integrated Urban Development Mission, launched in 2011, addresses the infrastructure needs of urban local bodies across Tamil Nadu, allocating over ₹1309 crore for essential infrastructure works from 2011 to 2017. These programs are crucial for managing urban growth sustainably and improving the quality of life in CRB.

While Kerala and Puducherry are smaller in comparison, they play a significant role in the urban dynamics of CRB. Kerala's urban expansion is characterized by dispersed settlements with a high population density, necessitating careful planning to balance development and ecological preservation. Puducherry, with its unique administrative status, focuses on integrating sustainable urban development practices, emphasizing water management and infrastructure improvements to cope with the growing urban demands.

2.3. Smart city initiatives in CRB

CRB, encompassing regions in Karnataka and Tamil Nadu, has been the focus of various initiatives aimed at enhancing urban infrastructure and water management. It includes Belagavi, Mangaluru, and Tumakuru districts in Karnataka, while Coimbatore, Erode, Madurai, Salem, Thanjavur, Tiruchirappalli, Tirunelveli, and Tiruppur districts in Tamil Nadu, which are the part of India's Smart Cities Mission, launched in 2015, which aims to enhance urban infrastructure, promote sustainable development, and improve the quality of life for citizens. The primary objectives of the smart cities mission include:

- Upgrading urban infrastructure
- Enhancing public services
- Promoting sustainable urban development

The key areas of development are:

- **Infrastructure Development:** Construction of new roads, bridges, and improvements to public transportation systems.
- **Public Services:** Enhancements in e-governance systems, healthcare, and educational facilities.
- **Sustainability:** Projects aimed at promoting environmental sustainability through waste management and energy conservation initiatives.
- **Citizen Engagement:** Improving citizen participation in urban governance through technology.

Some of the notable projects include:

- **Hogenakkal Integrated Drinking Water Project**

This project, initiated by the Tamil Nadu Water Supply and Drainage Board, addresses fluorosis mitigation by providing safe drinking water to the drought-prone and fluorosis-affected districts of Dharmapuri and Krishnagiri in Tamil Nadu. Utilizing Tamil Nadu's share of Cauvery River water, the project benefits approximately 3 million people across multiple municipalities and rural habitations.

- **Bengaluru's Water Management Challenges**

Despite being designated as a smart city, Bengaluru faces significant water scarcity issues. The city relies heavily on the Cauvery River for its water supply. However, challenges such as muddy water from the Cauvery basin requiring filtration and delayed water supply have

been reported. Additionally, borewells have dried out, exacerbating the water scarcity problem.

- **Nature-based Solutions for Urban Water Security**

In response to water security challenges, initiatives promoting nature-based solutions have been implemented. For instance, Bengaluru has faced groundwater depletion due to rainfall shortages in CRB. To address this, efforts are being made to enhance groundwater recharge and develop sustainable water management practices.

- **River Revitalization Efforts**

The Isha Foundation's "Rally for Rivers" campaign, including the "Cauvery Calling" initiative, focuses on revitalizing rivers like the Cauvery. These efforts aim to address water scarcity and environmental degradation through large-scale tree plantation along riverbanks and promoting sustainable agricultural practices.

These initiatives reflect ongoing efforts to address water scarcity and enhance urban infrastructure within CRB, contributing to the broader objectives of smart city development in the region.

3. Water supply network plan

3.1. Water source management

Water source management, also known as Water Resources Management (WRM) refers to the process of overseeing and regulating the use, distribution, and protection of water resources to ensure their sustainability and accessibility for both human consumption and environmental needs. It is a comprehensive process that involves planning, developing, distributing, and managing surface water (rivers, lakes, and reservoirs) and groundwater resources effectively to meet the needs of various stakeholders while ensuring sustainability and maintaining ecological health. It addresses both the quantity and quality of water to balance human, environmental, and economic needs. Water resource management also entails managing water-related risks, including floods, drought, and contamination. Water resources classified based on type of water resources into –

- a) Natural sources such as rain, snow, hail or sleet which are precipitated on the surface.
- b) Surface water accumulates because of direct runoff from precipitation in the form of streams, lakes and ponds which are natural or artificial storage sites.
- c) Ground water which is precipitated water that infiltrates into the ground.

3.1.1. Objectives of water source management

- a) Promote Environmental, Economic and Social Sustainability
- b) Improve water supply reliability and quality
- c) Protect and improve watershed health and function and Bay water quality
- d) Improve Regional Flood Management
- e) Create, protect, enhance and maintain environmental resources and habitats

3.1.2. Water management principles

- a) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
- b) Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels.
- c) Women play a central part in the provision, management and safeguarding of water.
- d) Water has an economic value in all its competing uses and should be recognised as an economic good as well as a social good.

3.1.3. Components of water source management plan

a) Water resources assessment (WRA)

It is the process of measuring, collecting and analysing relevant parameters on the quantity and quality of water resources for the purpose of a better development and management of water resources. The WRA depends on understanding the water flows and storages, their interrelationship over time and their relation to human impact or demand within the defined boundary.

b) Demand management

It focuses on effectively controlling the demand for water resources for various purposes and efficiently managing and using the available resources. The purpose of implementing an effective water demand management strategy include:

- Reduced water usage in terms of both average and peak demands.
- Reduced water leakage or loss.
- Reduced wastewater flows.
- Improved financial performance of the ULBs through deferment of infrastructure investments and reduced operational costs.
- Generating greater awareness for consumers on the financial and environmental value of water.

c) Water resource management strategies

Based on the findings from the Water Resource Assessment, strategies can be adopted focusing on key priorities and engaging all stakeholders to ensure sustainability and viability of the interventions.

3.1.4. Major water conservation schemes by government

3.1.4.1. AMRUT

Atal's Mission of Rejuvenation and Urban Transformation (AMRUT) covers all cities and towns with a population of over 1 lakh as per 2011 census and 1 Heritage city under HRIDAY Scheme. Sub-Scheme on "Formulation of GIS based Master Plan for 500 AMRUT Cities" was launched to support States for preparation of master plans in AMRUT towns. Final GIS

database has been created for 443 towns, draft GIS based Master Plan prepared for 330 towns and final GIS based Master Plans has been notified for 180 towns.

3.1.4.2. AMRUT 2.0

AMRUT 2.0 scheme was launched on 1 October 2021, aims to provide a universal water supply with regular functional taps and ensure better distribution to urban areas. This includes strengthening infrastructure to ensure equitable access to clean water, reducing wastage, and improving the efficiency of water distribution networks. It focusses on water supply, treatment, drainage, and pollution management could support the rejuvenation of rivers like the Cauvery by implementing sustainable water practices and improving the overall health of urban water ecosystems. Under this scheme, 385 projects are implemented in 18 Corporations and 7 Municipalities under the administrative control of Directorate of Municipal Administration (DMA), at an estimated cost of Rs. 9,977.37 crore. The main components of AMRUT 2.0 include:

- Universal coverage of water supply at all ULBs.
- Ensure 100% coverage of sewage/ septage management in 500 AMRUT cities.
- Rejuvenation of water bodies and formation of green space.

3.1.4.3. Jal Shakti Abhiyan

Jal Shakti Abhiyan (JSA) was launched in 2019 in 26 water-stressed districts of the country. Later, in 2021 the second series of this scheme came up with the theme ‘Catch the rain (CTR) - where it falls when its falls’. Fast forward in 2024 Jal Shakti Abhiyan’s fifth series was implemented in March with the theme ‘Nari shakti se Jal shakti’ highlighting the important role of women in water conservation. Five focused interventions include (i) water conservation and rainwater harvesting; (ii) enumerating, geo-tagging & making inventory of all water bodies; preparation of scientific plans for water conservation based on it; (iii) setting up of Jal Shakti Kendras in all districts; (iv) intensive afforestation; and (v) awareness generation. Apart from the five focused interventions, JSA: CTR 2024 has distinctive emphasis on following key aspects:

- De-silting and cleaning water bodies.
- Revitalizing Abandoned/Defunct Borewells for groundwater recharge and rejuvenating small rivers.
- Geo-tagging water bodies coupled with meticulous mapping and regular updates.
- Snow harvesting in hilly areas to conserve water, like stupas in Ladakh.
- Setting up of Jal Shakti Kendra in all districts.
- Tamil Nadu Irrigated Agriculture Modernization Project

3.1.4.4. Tamil Nadu irrigated agriculture modernization project

The World Bank Supported Tamil Nadu Irrigated Agriculture Modernisation (TNIAM) Project is a follow up of IAMWARM (Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management) Project which made significant development impacts in the state by modernising irrigation infrastructure, improving water use efficiency, enhancing yields and productivity of agriculture in a climate resilient production systems, diversification towards

high value crops, strengthening the institutional reforms through Participatory Irrigation Management (PIM) and Water Users Association (WUA). The main objective of TNIAMP is to improve irrigation and water management, covering both supply and demand aspects. It consists of four inter-related subcomponents as:

- Institutional Strengthening and Capacity Building for water management
- Irrigation Systems Modernization
- Participatory Irrigation Management
- Convergence for improved service delivery

Institutional Strengthening and Capacity Building for water management aims to assist the Government of Tamil Nadu in addressing the need for (i) an integrated water resources planning, decision making and management in a sub basin context (ii) an enhancing knowledge base and (iii) an improving sustainability of water sector assets.

3.1.4.5. Kudimaramathu scheme

The Kudimaramathu scheme is a water management initiative in Tamil Nadu that aims to rejuvenate the state's water bodies, including those along the Cauvery River. The scheme aims to restore the storage level in tanks, strengthen bunds, maintain the water bodies and help overcome floods and droughts. It was announced by the Tamil Nadu government in 2017. The scheme focuses on rejuvenating traditional water systems, ensuring sustainable water management, and enhancing water availability for agriculture and rural communities. The scheme includes maintenance work on canals, tanks, shutters, and supply channels. It also involves strengthening and reconstructing surplus weirs and sluices.

3.1.4.6. PMKSY - Modernisation of grand anicut canal under AIBP

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) is an ambitious initiative launched by the Government of India to ensure the availability of irrigation water to every farm in the country. It aims to enhance irrigation facilities, reduce dependency on rain-fed water sources, and increase agricultural productivity. Under PMKSY, the Accelerated Irrigation Benefits Programme (AIBP) plays a crucial role in the creation of irrigation infrastructure. The modernization of the Grand Anicut Canal involves upgrading its infrastructure, improving water distribution efficiency, and expanding its reach to enhance the irrigation coverage in the region. The project will also make the canal more resilient to climate change, reducing the risk of flooding and breaches. The project include:

- Lining the canal's bed and side walls
- Repairing or replacing water regulating structures
- Desilting tanks
- Introducing a canal automation system
- NAM Neer Program

3.1.4.7. NAM Neer Program

In line with the JSA Mission of Government of India, the Karaikal District administration has launched the “Nam Neer” project in August 2019 to save the water resources on high priority.

The mission Nam Neer focuses on better management of Cauvery water and rainwater by digging, cleaning and de-silting ponds and wells that have traditionally stored water. The objective includes:

- To enhance the development of Minor Irrigation infrastructure
- To strengthen community-based irrigation management in a decentralized manner
- To adopt a comprehensive programme for restoration of tanks and sources of water to effectively utilize Cauvery water and rainwater.

3.1.5. Water resource projects in CRB

CRB is home to several major and medium irrigation projects that support agriculture, the primary livelihood in the region (Table 5). These projects are designed to harness the river's waters for irrigating vast stretches of agricultural land. These water resource projects collectively play a crucial role in agricultural, industrial, and domestic water supply, as well as in energy generation, contributing to the overall development of Karnataka, Kerala, Tamil Nadu and Puducherry.

Table 5. Major medium irrigation projects in CRB

Sr. No.	Name	State	Type
1	Amaravathy Medium Irrigation Project	Tamil Nadu	Medium
2	Arkavathi Medium Irrigation Project	Karnataka	Medium
3	Badanavalu Medium Irrigation Project	Karnataka	Medium
4	Banahalli Hundi Lift Irrigation Project	Karnataka	Medium
5	Banasurasagar Medium Irrigation Project	Kerala	Medium
6	Byramangala Medium Irrigation Project	Karnataka	Medium
7	Cauvery Anicut Channels Major Irrigation Project	Karnataka	Major
8	Cauvery Delta Major Irrigation Project Puducherry	Puducherry	Major
9	Cauvery Delta Major Irrigation Project Tamilnadu	Tamil Nadu	Major
10	Cauvery Mettur Major Irrigation Project	Tamil Nadu	Major
11	Chickahole Medium Irrigation Project	Karnataka	Medium
12	Chiklihole Medium Irrigation Project	Karnataka	Medium
13	Chinnar Medium Irrigation Project	Tamil Nadu	Medium
14	Gundal Medium Irrigation Project	Karnataka	Medium
15	Gunderipallam Medium Irrigation Project	Tamil Nadu	Medium
16	Harangi Major Irrigation Project	Karnataka	Major
17	Hebballa Medium Irrigation Project	Karnataka	Medium

18	Hemavathy Major Irrigation Project	Karnataka	Major
19	Hucchana - Koppalu Medium Irrigation Project	Karnataka	Medium
20	Iggalur Medium Irrigation Project	Karnataka	Medium
21	Kabini Major Irrigation Project	Karnataka	Major
22	Kachnahalli Lift Irrigation Project	Karnataka	Medium
23	Kalingarayan Major Irrigation Project	Tamil Nadu	Major
24	Kama Samundra Lift Irrigation Project	Karnataka	Medium
25	Kanva Medium Irrigation Project	Karnataka	Medium
26	Karapuzha Medium Irrigation Project	Kerala	Medium
27	Kattalai Major Irrigation Project	Tamil Nadu	Major
28	Kodaganar Medium Irrigation Project	Tamil Nadu	Medium
29	Kodivery Anicut System Major Irrigation Project	Tamil Nadu	Major
30	Krishnarajasagar Major Irrigation Project	Karnataka	Major
31	Kuthiraiyar Medium Irrigation Project	Tamil Nadu	Medium
32	Lower Bhavani Major Irrigation Project	Tamil Nadu	Major
33	Lower Coleroon Anicut Major Irrigation Project	Tamil Nadu	Major
34	Manchanabele Medium Irrigation Project	Karnataka	Medium
35	Mangala Medium Irrigation Project	Karnataka	Medium
36	Marconahalli Medium Irrigation Project	Karnataka	Medium
37	Mettur Canal Major Irrigation Project	Tamil Nadu	Major
38	Nallur Amanikere Medium Irrigation Project	Karnataka	Medium
39	Nandhiyar Channel Medium Irrigation Project	Tamil Nadu	Medium
40	Nanganjiar Medium Irrigation Project	Tamil Nadu	Medium
41	Nanjapura Medium Irrigation Project	Karnataka	Medium
42	Noyyal Medium Irrigation Project	Tamil Nadu	Medium
43	Nugu Medium Irrigation Project	Karnataka	Medium
44	Orathupalayam Medium Irrigation Project	Tamil Nadu	Medium
45	Palar Porandalar Medium Irrigation Project	Tamil Nadu	Medium
46	Parambikulam Aliyar Major Irrigation Project	Kerala, Tamil Nadu	Major
47	Parappalar Medium Irrigation Project	Tamil Nadu	Medium
48	Pelandhurai Anicut Medium Irrigation Project	Tamil Nadu	Medium
49	Ponnaniar Medium Irrigation Project	Tamil Nadu	Medium
50	Pullambadi Canal Medium Irrigation Project	Tamil Nadu	Medium

51	Siddhamalli Medium Irrigation Project	Tamil Nadu	Medium
52	Suvarnavathy Medium Irrigation Project	Karnataka	Medium
53	Taraka Medium Irrigation Project	Karnataka	Medium
54	Thoppaiyar Medium Irrigation Project	Tamil Nadu	Medium
55	Uduthorehalla Medium Irrigation Project	Karnataka	Medium
56	Varattupallam Medium Irrigation Project	Tamil Nadu	Medium
57	Vattamalai Karai Odai Medium Irrigation Project	Tamil Nadu	Medium
58	Votehole Medium Irrigation Project	Karnataka	Medium
59	Yagachi Major Irrigation Project	Karnataka	Major

Source: India-WRIS

Several dams have been constructed in the CRB to manage water resources effectively. These dams play a crucial role in irrigation, flood control, and water supply. Some significant dams in the CRB are listed in Table 6.

Table 6. Dams in CRB

Sr. No.	Name	Purpose	River	District	State	Length (m)
1	Alalur Dam	Irrigation	Lakshmanathir tha	Mysuru	Karnataka	939.6
2	Albur Kere Dam			Tumkuru	Karnataka	
3	Amaravathi Dam	Hydroelectric, Irrigation	Amaravati	Tiruppur	Tamil Nadu	1095
4	Arkavathy Dam	Irrigation	Arkavathy	Ramanagara	Karnataka	720
5	Avalanche Dam	Hydroelectric	Avalanche & Emerald Streams	The Nilgiris	Tamil Nadu	366
6	Byramangala Dam	Irrigation	Vrishabhavath y	Ramanagara	Karnataka	2286
7	Chakena Hally Dam	Irrigation	Hemavathy River	Hassan	Karnataka	886.75
8	Chickkahole Dam	Irrigation	Chickkahole	Chamarajanagar	Karnataka	756
9	Chikkagondanahally Dam	Irrigation	Arkavathy	Ramanagara	Karnataka	516
10	Chiklihole Dam	Irrigation	Chiklihole	Kodagu	Karnataka	464.8
11	Deepambudikere Dam	Irrigation	Nagini	Tumkuru	Karnataka	600
12	Doddaladahalli Dam	Irrigation	Arkavathy	Ramanagara	Karnataka	330
13	East Varahapallam		East	The Nilgiris	Tamil	173

	dam		varahapallam		Nadu	
14	Emerald Dam	Hydroelectric	Emerald	The Nilgiris	Tamil Nadu	323
15	Glenmorgan	Hydroelectric	Glenmorgan St	The Nilgiris	Tamil Nadu	80
16	Glenmorgan Forbay Dam	Hydroelectric		The Nilgiris	Tamil Nadu	80
17	Gopinatham Dam	Irrigation	Cauvery Basin	Chamarajanagar	Karnataka	402
18	Gowdahally Dam	Irrigation	K.K.Halla	Chamarajanagar	Karnataka	731.5
19	Gundal Dam	Irrigation	Gundal	Chamarajanagar	Karnataka	1219
20	Gunderipallam Dam		Gunderipallam	periyar	Tamil Nadu	627
21	Harangi Dam	Hydroelectric, Irrigation	Harangi	Kodagu	Karnataka	845.8
22	Hebbahalla Dam	Irrigation	Hebballa	Mysuru	Karnataka	996.65
23	Hemavathy Dam	Irrigation	Hemavathy	Hassan	Karnataka	4692
24	Hesaraghatta Dam	Drinking / Water Supply	Arkavathy	Bengaluru	Karnataka	1560
25	Hosahalli Dam	Irrigation	K.K.Halla	Chamarajanagar	Karnataka	868.68
26	K.Honnamachanahalli Dam	Irrigation	Local Halla	Tumkuru	Karnataka	630
27	Kabini Dam	Hydroelectric, Irrigation	Kabini	Mysuru	Karnataka	2732.4
28	Kachavanahalli Dam	Irrigation	Karigale & Hebbahalla	Mysuru	Karnataka	722
29	Kadaba Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	1680
30	Kalikatte Dam	Irrigation	Kalikattehalla	Chamarajanagar	Karnataka	1122
31	Kamarahalli Dam	Irrigation	K.Hallihalla	Chamarajanagar	Karnataka	1020
32	Kamraju Sagar (Sandy Nalla) Dam		Sandynallah	The Nilgiris	Tamil Nadu	107
33	Kanva Dam	Irrigation	Kanva	Ramanagara	Karnataka	1422
34	Karapuzha (Id) Dam	Irrigation	Karapuzha	Wayanad	Kerala	625
35	Karimuddenahalli Dam	Irrigation	Lakshman Theertha	Mysuru	Karnataka	422.25

36	Kesarigulihalla Dam	Irrigation	K.gulihalla	Dharmapuri	Tamil Nadu	1672
37	Kodaganar Dam	Irrigation		Dindigul	Tamil Nadu	2893
38	Kothagere Dam			Tumkuru	Karnataka	
39	Kowlihalla Dam	Irrigation	Cauvery Basin	Chamarajanagar	Karnataka	393
40	Krishnarajasagar Dam	Irrigation	Cauvery	Mandya	Karnataka	2621
41	Kundah Palam Dam	Hydroelectric	Kundah	The Nilgiris	Tamil Nadu	152
42	Kunigal Dodakere Dam	Irrigation	Nagini	Tumkuru	Karnataka	2000
43	Kuppareddy Dam			Bengaluru	Karnataka	
44	Kuthiraiyar Dam	Irrigation	Kuthiraiyar	Dindigul	Tamil Nadu	899.9
45	Kuttiyadi Spillway Dam	Hydroelectric, Irrigation	Panamarampu zha	Wayanad	Kerala	56.38
46	Lower Bhavani Dam	Hydroelectric, Irrigation	Bhavani	Erode	Tamil Nadu	8797
47	Maidal Amanikere Dam	Irrigation	Agasarahalli nala	Tumkuru	Karnataka	810
48	Mallaghatta Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	750
49	Manchanabele Dam	Irrigation	Arkavathy	Ramanagara	Karnataka	362.2
50	Mangala I Dam	Irrigation	Nagini River	Tumkuru	Karnataka	610
51	Mangala II Dam	Irrigation	Cauvery	Chamarajanagar	Karnataka	661.4
52	Maralvadi Dam	Irrigation	Arkavathy	Ramanagara	Karnataka	480
53	Maravakandi Forbay Dam	Hydroelectric	Aravarihalla	The Nilgiris	Tamil Nadu	415
54	Marconahally Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	1609
55	Marudhanadi Dam	Irrigation	Maurdhanadhi	Dindigul	Tamil Nadu	808
56	Mayasandra Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	1410

57	Mettur Dam	Hydroelectric, Cauvery Irrigation		Salem	Tamil Nadu	1615.44
58	Moyar Forebay Dam	Hydroelectric		The Nilgiris	Tamil Nadu	731
59	Mukurthy Dam		Mukurthi	The Nilgiris	Tamil Nadu	162
60	Muthurayanakere Dam	Irrigation	Local Nala	Tumkuru	Karnataka	1140
61	Nagavathi Dam	Irrigation	Nagavathy	Dharmapuri	Tamil Nadu	306
62	Nallathangal Odai Dam		Nallathangal Odai	Tiruppur	Tamil Nadu	3450
63	Nallur Amanikere Dam	Irrigation	Gundlu	Chamarajanagar	Karnataka	1802
64	Nanganjiyar Dam	Irrigation	Nanganjiyar	Dindigul	Tamil Nadu	2680
65	Near Kottagiri Saddle Dam	Hydroelectric		Wayanad	Kerala	86.5
66	Nelligudda Dam	Irrigation	Bidadi Halla	Ramanagara	Karnataka	740
67	Neralatti Kere Dam			Ramanagara	Karnataka	
68	New Amachawadi Dam	Irrigation	Yennehole Stream	Chamarajanagar	Karnataka	540
69	Nidasale Dam	Irrigation	Nagini	Tumkuru	Karnataka	870
70	Nittur Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	1350
71	Nonavinakere Lake Dam			Tumkuru	Karnataka	
72	Noyyal Athupalayam Dam	Irrigation	Noyyal	Karur	Tamil Nadu	2850
73	Noyyal Orathupalayam Dam	Irrigation	Noyyal	Tiruppur	Tamil Nadu	2290
74	Nugu Dam	Hydroelectric, Nugu Irrigation		Mysuru	Karnataka	637.65
75	Obichudanahally Dam	Irrigation	Arkavathy	Bengaluru	Karnataka	637
76	Palar Porundalar Dam	Irrigation	Palar Porundalar	Dindigul	Tamil Nadu	2451

77	Parappalar Dam	Irrigation	Parappalar	Dindigul	Tamil Nadu	81.07
78	Parsons Valley Dam	Hydroelectric	Parson Valley Stream	The Nilgiris	Tamil Nadu	146
79	Pegumbahallah Forebay Dam	Hydroelectric	Pengumbahallah	The Nilgiris	Tamil Nadu	181
80	Perumpallam Dam		Perumpalam	Erode	Tamil Nadu	2060
81	Pillur Dam	Hydroelectric	Bhavani	Coimbatore	Tamil Nadu	357
82	Ponnaniar Dam	Irrigation	Ponnaniyar	Karur	Tamil Nadu	246.81
83	Porthimund Dam	Hydroelectric	Porthimund St	The Nilgiris	Tamil Nadu	335
84	Pykara Dam			The Nilgiris	Tamil Nadu	193.5
85	Sarigehally Dam	Irrigation	Shimsha	Tumkuru	Karnataka	1200
86	Siddhamalli Dam	Irrigation		Ariyalur	Tamil Nadu	5050
87	Siruvani (ID) Dam	Drinking / Water Supply	Siruvani	Palakkad	Kerala	224
88	Suvarnavathy Dam	Irrigation	Suvarnavathy	Chamarajanagar	Karnataka	1170.4
89	Taraka Dam	Irrigation	Taraka	Mysuru	Karnataka	1272.5
90	Thonnur Dam	Irrigation	Hebballa Valley	Mandya	Karnataka	118.8
91	Thoppaiyar Dam	Irrigation	Thoppaiyar	Dharmapuri	Tamil Nadu	435
92	Tippagondana Hally Dam	Drinking / Water Supply	Arkavathy & Kumudavathy	Bengaluru	Karnataka	451.104
93	Turuvekere Dam	Irrigation	Shimsha Valley	Tumkuru	Karnataka	870
94	Uduthorehalla Dam	Irrigation	Uduthorehalla	Chamarajanagar	Karnataka	1530
95	Uppar (Erode) Dam		Uppar	Tiruppur	Tamil Nadu	2256
96	Upper Bhavani Dam	Hydroelectric	Bhavani	The Nilgiris	Tamil Nadu	419

97	Varattupallam Dam	Irrigation	Varattupallam	Erode	Tamil Nadu	1798
98	Vattamalaikarai Odai Dam	Irrigation	V.K. Odai	Tiruppur	Tamil Nadu	1820
99	Votehole Dam	Irrigation	Votehole	Hassan	Karnataka	900
100	West Varahapallam Weir Dam		W.V.Pallam	Nilgiri	Tamil Nadu	92
101	Yagachi Dam	Irrigation	Yagachi	Hassan	Karnataka	1280

Source: India-WRIS

The CRB also includes several powerhouses that generate electricity to support the state's power requirements. These powerhouses are typically associated with dams and reservoirs. Some of the important powerhouses are considered in Table 7.

Table 7. Powerhouses in CRB

Sr. No.	Name	State	Total Installed Capacity (MW)
1	Bhavani Kattalai Barrage - II Powerhouse	Tamil Nadu	30
2	Bhavani Kattalai Barrage - I Powerhouse	Tamil Nadu	30
3	Bhavani Kattalai Barrage - III Powerhouse	Tamil Nadu	30
4	Harangi Powerhouse	Karnataka	9
5	Kabini	Karnataka	20
6	Kundah - I Powerhouse	Tamil Nadu	60
7	Kundah - II Powerhouse	Tamil Nadu	175
8	Kundah - III Powerhouse	Tamil Nadu	180
9	Kundah - IV Powerhouse	Tamil Nadu	100
10	Kundah - V Powerhouse	Tamil Nadu	40
11	Kundah - VI Powerhouse	Tamil Nadu	30
12	Lower Bhavani Powerhouse	Tamil Nadu	8
13	Lower Bhavani RBC Powerhouse	Tamil Nadu	7.5
14	Lower Mettur Barrage - I Powerhouse	Tamil Nadu	30
15	Lower Mettur Barrage -II Powerhouse	Tamil Nadu	30
16	Lower Mettur Barrage -III Powerhouse	Tamil Nadu	30
17	Lower Mettur Barrage -IV Powerhouse	Tamil Nadu	30
18	Mettur Dam Powerhouse	Tamil Nadu	40
19	Mettur Tunnel Powerhouse	Tamil Nadu	200

20	Moyar Powerhouse	Tamil Nadu	36
21	Pykara Singara Powerhouse	Tamil Nadu	70
22	Pykara Ultimate (Pushe) Powerhouse	Tamil Nadu	150
23	Seshadhri Iyer (Sivasamudram) Powerhouse	Karnataka	42
24	Simshapura Powerhouse	Karnataka	17.2

Source: India-WRIS

The CRB is home to several hydroelectric projects that harness the river's flow for power generation. These projects are vital for meeting the state's energy demands and promoting sustainable development. Some of the important hydroelectric projects are labelled in Table 8.

Table 8. Hydroelectric projects in CRB

Sr. No.	Name	District	State	River
1	Bhavani Kattalai Barrage - I Hydroelectric		Tamil Nadu	Cauvery
2	Bhavani Kattalai Barrage - II Hydroelectric	Erode	Tamil Nadu	Cauvery
3	Bhavani Kattalai Barrage - III Hydroelectric		Tamil Nadu	Cauvery
4	Harangi Hydroelectric Project	Kodagu	Karnataka	Hrangi Cnl
5	Kabini		Karnataka	Kabini
6	Lower Bhavani Hydroelectric Project		Tamil Nadu	Bhavani
7	Lower Mettur Barrage - I Hydroelectric Project		Tamil Nadu	Cauvery
8	Lower Mettur Barrage - II Hydroelectric Project		Tamil Nadu	Cauvery
9	Lower Mettur Barrage - III Hydroelectric Project		Tamil Nadu	Cauvery
10	Lower Mettur Barrage - IV Hydroelectric Project		Tamil Nadu	Cauvery
11	Mettur Hydroelectric Project	Erode	Tamil Nadu	Cauvery
12	Pykara Moyar Hydroelectric Project	Nilgiris	Tamil Nadu	Pykara and Mukurthy
13	Seshadhri Iyer (Sivasamudram) Hydroelectric	Mandya	Karnataka	Cauvery
14	Simshapura Hydroelectric project	Mandya	Karnataka	Cauvery

Source: India-WRIS

3.2. Pipeline networks

The Karnataka Urban Water Supply and Drainage Board (KUWSDB) is the implementing body for drinking water supply and underground drainage schemes in 316 urban areas of the Karnataka State except Bangalore city. The Board aims to provide adequate water supply from assured and safe sources of supply and proper sanitation to all the urban areas. For instance the water distribution network in Somwarpet region is described in Fig. 1.

The board has taken up remodelling of existing distribution network, Automation and Integrated Management System of Mysore city under the Jawaharalal Nehru National Urban Renewal Mission (JnNURM) centrally sponsored project at an estimating cost of Rs.179.18 Crores and approved Revised Est Cost is RS. 229.93 Crores. The work is completed and handed over to Mysore City Corporation for further maintenance. Augmentation of water supply project from Kabini river has been taken up at an estimated cost of Rs. 108.81 crores under JnNURM and the project has been commissioned and handed over to Mysore City Corporation for further maintenance. A Project for providing 24x1 water supply to uncovered areas of Mysore city has been Administratively approved by the Government for Rs. 214 crores. The project has been taken up for implementation and completed 23 district metered areas (DMA' S).

The action plan for the year 2023-24, consisting of 286 projects (116 Water Supply and 170 UGD projects) which includes projects commissioned during previous years and to be completed, projects targeted for commissioning during 2023-24, on-going projects and New Projects proposed during the year 2023-24. The Board has made the budget for plan schemes (GOK) for the year 2023-24 is amounting to Rs.1400.00 crores and the Action Plan was submitted to Government vide this office letter No. 278 dated 11-07-2023 for approval. The Grant of State Budget for the year 2023-24 is Rs. 900.00 Crores (KUWSDB APR).

The Tamil Nadu Water Supply and Drainage (TWAD) Board is entrusted with the development of Water Supply and Sewerage facilities in the State of Tamil Nadu, except Chennai Metropolitan Development Areas. TWAD Board further expanded their horizon of service to include maintenance of major Combined Water Supply Schemes (CWSS) also into their domain. During the year 2021-22 & 2022-23, 8 CWSS covering 6 town panchayats, 1014 rural habitations have been completed at an estimated cost of Rs. 266.79 crore to supply 28.37 MLD of safe potable water in Cuddalore, Krishnagiri, Tiruppur, Trichy, Nilgiris and Tirunelveli Districts, benefitting a population of 8.13 lakh. Further, 5 Combined Water Supply schemes covering and 1,388 Rural habitations in Thanjavur, Nagapattinam, Perambalur, Krishnagiri, and Tiruppur, Districts are under various stages of implementation at an estimated cost of Rs. 257.86 crore which on completion will supply designed quantity of 32.57 MLD (Ultimate stage) of potable water to a population of 10.75 lakh (TWAD Board).

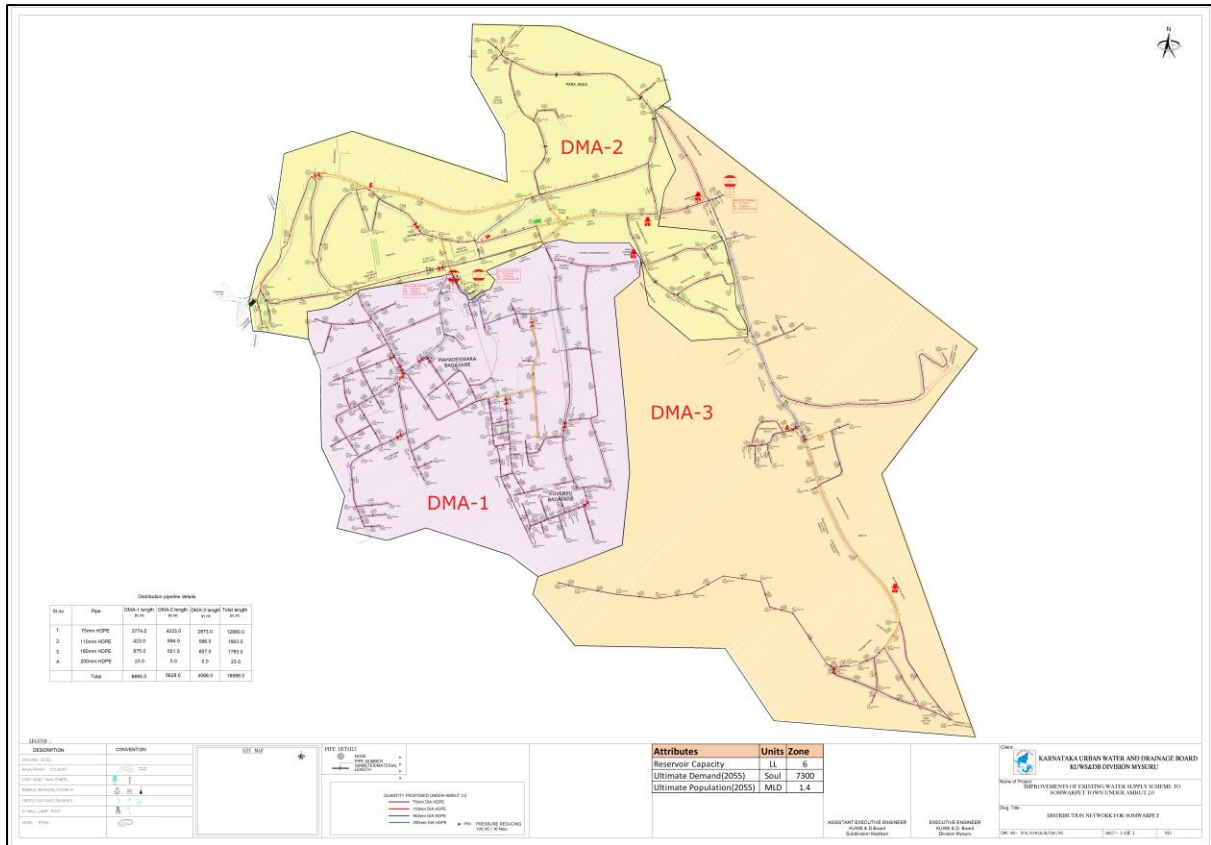


Fig. 1. Water distribution network in Somwarpet region, Karnataka
(Source: KUWSDB)

3.3. Water treatment plant

A water treatment plant (WTP) is a facility designed to treat raw water (from rivers, lakes, wells, or other natural sources) to make it suitable for human consumption, industrial use, and other purposes (Fig. 2). The main goal of a WTP is to ensure that the water provided meets the required quality standards for safety and health, free from contaminants like pathogens, chemicals, and impurities. Water treatment processes can vary depending on the quality of the source water, but they typically involve several stages to purify the water. A brief description of WTP in CRB is given in Table 9.

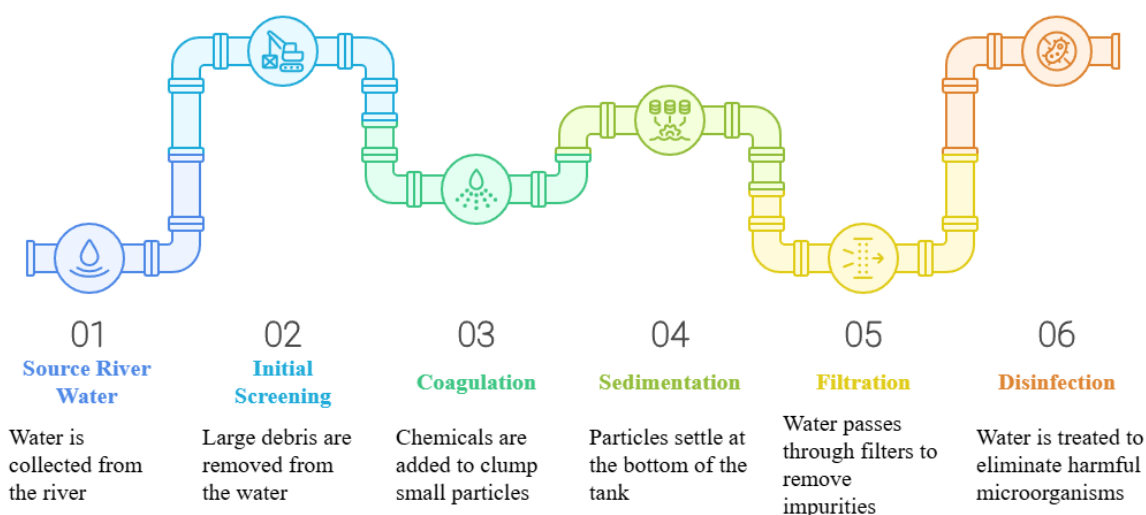


Fig. 2. Schematic diagram of water treatment plant process

Table 9. Water treatment plants in CRB

Sr. No.	Name of Town	WTP Capacity		Water Source	Type of Treatment	LPCD
		Installed MLD	Water Treated MLD			
1	Tiruchirappalli	88	88	Cauvery River	Bleaching Powder	118
2	Thanjavur	-	-	Vennar River and Coleroon River	Bleaching Powder	
3	Kumbakonam	15	15	G/W	Liquid Chlorine	107.1
4	Erode	30	20	Cauvery River	Sedimentation, Filtration, Disinfection	132
5	Tiruppur	46	44	Bhavani River	Sedimentation, Filtration, Disinfection	125.2
6	Dindigul	10	10	Lake	Sedimentation, Filtration, Disinfection	50.9
7	Bengaluru	1350	1350	Cauvery River	Sedimentation, Filtration, Disinfection	150

8	Mysuru	175	175	Cauvery River	Sedimentation, Filtration, Disinfection	135
9	Mandya	70	70	Cauvery River	Sedimentation, Filtration, Disinfection	120
10	Hassan	40	40	Hemavathi River	Sedimentation, Filtration, Disinfection	110
11	Tumkuru	30	30	Hemavathi River	Sedimentation, Filtration, Disinfection	100

Source: CPCB

4. Sewerage and drainage network plan

Pollution refers to the contamination of the environment with harmful substances that disrupt the natural balance of ecosystems and pose risks to the health of living organisms, including plants, animals, and human beings. River pollution has become a crucial environmental issue because of its significant impact on the major rivers in Tamil Nadu. The main sources of contamination in these rivers include Industrial discharges, sewage pollution, and poor waste management practices. Domestic wastewater is primarily organic but still has a high concentration of substances that can lead to serious environmental impacts. The release of this wastewater into open water bodies or groundwater can cause oxygen-depletion due to the chemical and biochemical reactions that occur when organic matter is broken down. This process depletes dissolved oxygen levels, which are critical for aquatic life, leading to Eutrophication.

In eutrophic conditions, excessive nutrients like nitrogen and phosphorus fuel the rapid growth of algae, which further reduces oxygen levels and disrupts aquatic ecosystems. They harm the aquatic life of the receiving water and affect humans through the food chain. Sewage from residential and commercial buildings that frequently don't have enough underground sewer connections runs directly into the rivers, further degrading the water quality. Sewage treatment plants that aren't working properly make the problem even worse. Using contaminated water for irrigation reduces the fertility of the land, creating new difficulties for agriculture. The considerable amount of solid residue generated by the common effluent treatment plant (CETP) needs adequate treatment and reclamation before ending up in the environment as solid waste.

4.1. Sewerage system mapping

Sewerage system mapping in Karnataka and Tamil Nadu is crucial for efficient urban planning, sanitation management, and environmental protection. Both states have undertaken initiatives to map their sewer networks using GIS and modern surveying techniques. In Karnataka, cities like Bengaluru have implemented digital mapping to track underground drainage systems,

aiding in reducing waterlogging and improving maintenance. Tamil Nadu, particularly in Chennai, has also adopted GIS-based mapping to manage stormwater drains and prevent urban flooding. These efforts help authorities monitor sewage flow, detect leaks, and enhance wastewater treatment, ultimately improving public health and water quality. However, challenges such as aging infrastructure, unauthorized sewage connections, and rapid urbanization necessitate continuous updates and technological advancements in sewerage system mapping.

The Underground Sewage System (UGSS) covers the Tiruchirappalli Corporation and 2 Town Panchayats (Fig. 3). The corporation is covered by UGSS through old schemes. The total sewage generated from Tiruchirappalli Corporation, Municipalities, Town Panchayat and Villages is 118 MLD, 5 MLD, 5 MLD and 19 MLD. 71% of the Tiruchirappalli Corporation area is covered by a sewer network. 54% of Manachanallur and S.Kannanoor Town Panchayat area is covered through sewer network (Directorate of Town and Country Planning).

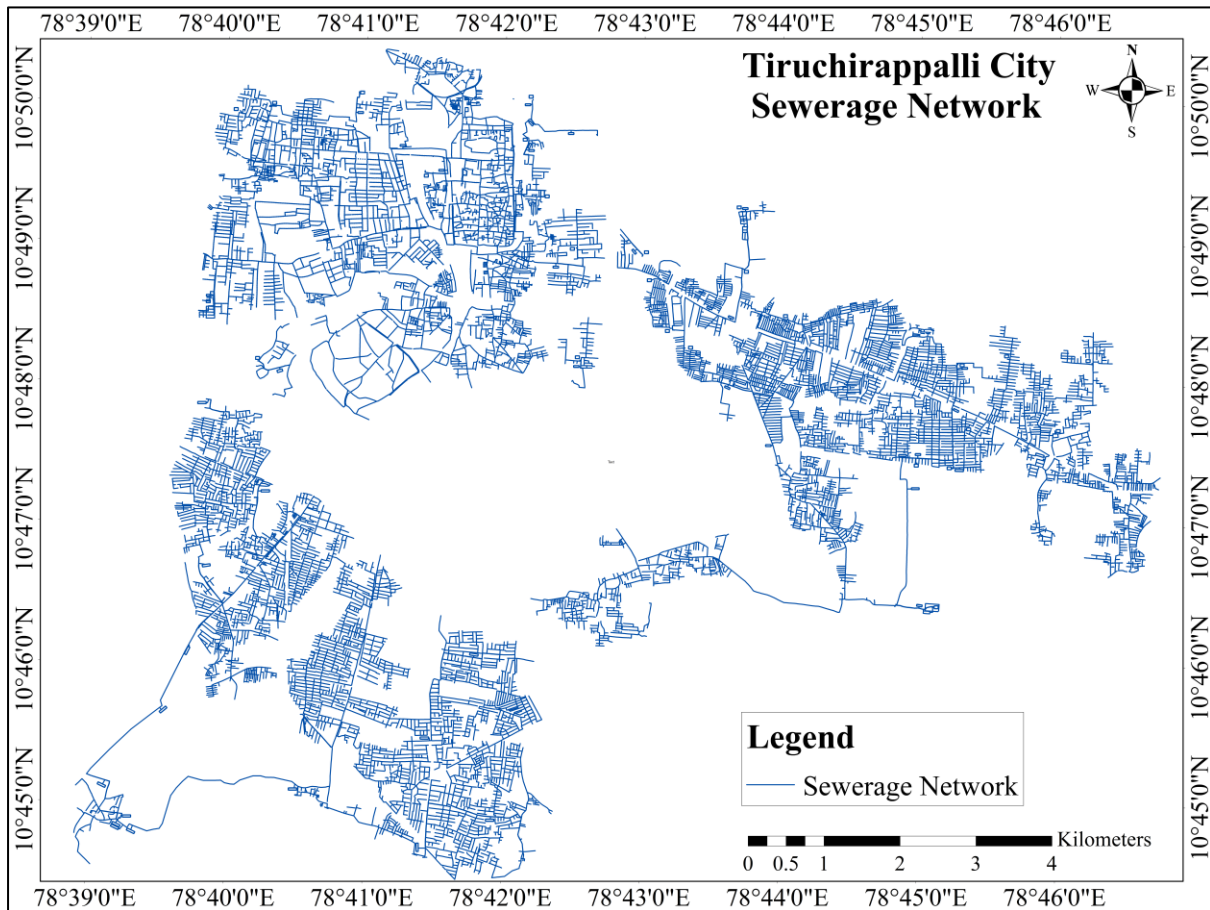


Fig. 3. Sewerage network map of Tiruchirappalli city, Tamil Nadu
(Source: Tiruchirappalli City Municipal Corporation)

4.2. Stormwater drainage

Storm water is that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility. Storm

water management is the control and use of storm water runoff. It includes planning for runoff, maintaining storm water systems, and regulating the collection, storage, and movement of storm water. Storm water management should also factor in drainage in the design of cities and housing developments. The drainage system should best preserve or mimic the natural hydrologic cycle and fit within the capacity of the existing infrastructure.

Bruhat Bengaluru Mahanagara Palike (BBMP) spread over an area of 741 sq km is demarcated into eight zones. As per the records of the Chief Engineer, Storm Water Drains, BBMP has a total drain network (primary and secondary drains only) of 842 km. However, as per the master plan of drains also prepared by BBMP, the total length of drains was 856.74 km which includes the length of drains that are outside the jurisdiction of BBMP but are considered for hydraulic analysis purposes only. BBMP did not have on records the length of the tertiary drains under its jurisdiction. Even the drainage network map of BBMP has no mention/sketch of the tertiary drains.

4.3. Wastewater treatment facilities

Effective wastewater treatment within CRB is crucial to maintain water quality and support the diverse needs of the population. In Karnataka, the Bengaluru Water Supply and Sewerage Board (BWSSB) is responsible for managing sewage disposal and water supply in Bengaluru. The city operates several sewage treatment plants (STPs) to treat wastewater before its release or reuse. These facilities are essential for mitigating pollution in the Cauvery River, as untreated sewage can significantly degrade water quality. In Tamil Nadu, cities like Erode and Tiruchirappalli have established STPs to manage urban wastewater. These plants are designed to handle the sewage generated by the urban population, ensuring that the treated effluent meets environmental standards before being discharged into the river system.

Additionally, community-based initiatives like Cauvery Calling aim to restore the river basin's health by promoting agroforestry among farmers. By planting trees, these projects enhance soil health, increase water retention, and reduce runoff, thereby improving the overall water quality in the basin. Collectively, these efforts in establishing and maintaining wastewater treatment facilities, along with community engagement in sustainable practices, are pivotal in preserving the ecological balance of CRB. The details of various STPs installed in CRB are summarized in Table 10.

Table 10. Summary of various STPs installed in CRB

Sr. No.	Location	STP Installed Capacity (MLD)	STP capacity utilization (MLD)	Technology (UASB/ ASP/ OP/ SBR/ MBR/ FAB etc.)
1	Bengaluru Urban	35	25.79	SBR
2	Bengaluru Urban	90	93.69	ASP
3	Bengaluru Urban	5	4.74	SBR

4	Bengaluru Urban	5	1.98	MBBR
5	Bengaluru Urban	4	3.25	MBBR
6	Bengaluru Urban	40	40.5	SBR
7	Bengaluru Urban	20	19.27	SBR
8	Bengaluru Urban	2	1.67	SBR
9	Bengaluru Urban	100	49.01	FBR
10	Bengaluru Urban	60	0	FBR
11	Bengaluru Urban	20	20.86	SBR
12	Bengaluru Urban	10	7.27	SBR
13	Bengaluru Urban	15	15.28	MBBR
14	Bengaluru Urban	218	186.5	ASP
15	Bengaluru Urban	30	32.17	EA
16	Bengaluru Urban	60	60.39	ASP
17	Bengaluru Urban	150	107.55	FBR
18	Bengaluru Urban	20	6.15	UASB
19	Bengaluru Urban	20	10.51	SBR
20	Bengaluru Urban	50	43.18	ASP
21	Bengaluru Urban	6	3.24	SBR
22	Bengaluru Urban	1	0.78	ASP
23	Bengaluru Urban	60	31.21	ASP
24	Bengaluru Urban	1.5	1.41	ASP
25	Bengaluru Urban	75	69.08	ASP
26	Bengaluru Urban	5	3.5	SBR
27	Bengaluru Urban	20	10.84	SBR
28	Bengaluru Urban	20	8.18	EA

29	Bengaluru Urban	40	41.75	ASP
30	Bengaluru Urban	40	15.56	EA
31	Bengaluru Urban	5	4.63	SBR
32	Bengaluru Urban	180	10	BTF
33	Bengaluru Urban	15	13.8	SBR
34	Bengaluru Urban	10	7.8	ASP
35	Hubballi-Dharwad	20	16	SBR
36	Hubballi-Dharwad	40	20	SBR
37	Vijayapura	31	25	FAL
38	Jamkhandi	7.6	2	FAL
39	Raichur	20	12	FAL
40	Raichur	8	5	FAL
41	Chamarajanagar	9	5	FAL
42	Tiptur	6	3	SBR
43	Doddaballapur	12	7	WSP
44	Chikkaballapur	10	7	WSP
45	Bhatkal	1.5	1.5	WSP
46	Mangaluru (Pachanady)	8.75	4.5	ASP
47	Mangaluru (Kavoor)	43.5	22	UASB
48	Mangaluru (Surathkal)	16.5	1.5	ASP
49	Mangaluru (Bajal)	20	8	ASP
50	Kalaburgi	40	40	SBR
51	Guledgudda	4	0	OP
52	Karwar	1.5	1.5	AL
53	Udupi	12.5	5	FAL

54	Bidar	17.26	5	AL
55	Gokak	8.7	1.5	FAL
56	Hunagund	3.5	0	WSP
57	Davangere	20	20	SBR
58	Davangere	5	2.5	SBR
59	Davangere	20	15	SBR
60	Harihara	18	3.5	FAL
61	Jewaragi	3.25	0	WSP
62	Ranebannur	7.5	7.5	FAL
63	Hubballi-Dharwad	3	0.5	Phytorid
64	Hubballi-Dharwad	1	0.5	Phytorid
65	Hubballi-Dharwad	10	2	SBR
66	Hubballi-Dharwad	0.25	0	MBBR
67	Chikkodi	5.8	2.2	WSP
68	Davangere	14.8	14.8	WSP
69	Badami	4.3	3.63	WSP
70	Mudhol	9.06	6.16	WSP
71	Bilagi	3.5	2.2	WSP
72	Harapanahalli	7.92	0	WSP
73	Bailhongal	8.28	4	AL
74	Huvin Hadagali	4.27	3	WSP
75	Ballari	15	15	FAL
76	Ballari	30	30	FAL
77	Kanakapura	6.29	4	WSP
78	Magadi	3.7	1.5	WSP

79	Anekal	3.3	1	SBR
80	Anekal	3.1	1	SBR
81	Kollegal	9	5	EA
82	Gundlupet	2.5	1.5	WSP
83	Gundlupet	1.5	1	WSP
84	Chikmagalur	20	6	MBBR
85	Birur	2.64	0.3	WSP
86	Chitradugra	20	5	SBR
87	Honnali	3.3	0	WSP
88	Sulia	2	0.5	OP
89	Belur	2.4	2.4	WSP
90	Belur	0.3	0.3	WSP
91	C.R Patna	4.6	4.6	WSP
92	Hassan	10	10	WSP
93	H. N Pura	3	3	OP
94	Arasikere	12	5	SBR
95	Kalaburgi	20	18	SBR
96	Kalaburgi	25	8.5	SBR
97	Chittapura	5.1	1	WSP
98	Kolar	10.16	10	WSP
99	Srinivasapura	3	3	WSP
100	Chintamani	2	2	WSP
101	Siddlaghatta	3.1	3	WSP
102	Malur	4	1	SBR
103	Gangavathi	14	14	WSP

104	Maddur	3.5	3.5	WSP
105	Mandya	9.62	7.5	OP
106	Mandya	8.9	7.5	WSP
107	SR Patna	1.39	1.39	WSP
108	SR Patna	2.21	1.63	WSP
109	Nagamangala	3	1	WSP
110	Malavalli	5.65	0.5	WSP
111	K.R Pet	5	2	WSP
112	Mysore	60	39	FAL
113	Mysore	67.5	51	FAL
114	Mysore	8	8	MBR
115	Mysore	30	15	FAL
116	T. Narasipura	5.5	2	SBR
117	Nanjangud	7	2.35	AL
118	Bannur	2.5	1	WSP
119	Hunsur	3.9	3.9	AL
120	K.R.Nagar	1.45	1.45	WSP
121	Shikaripura	5	0	SBR
122	K.R.Nagar	2.5	2.5	WSP
123	Turuvekere	1.95	0	UASB
124	K.R.Nagar	1.44	1.44	WSP
125	Ramanagar	7.56	7.56	AL
126	Bhadravathi	5.83	2	WSP
127	Bhadravathi	7.2	2	WSP
128	Bhadravathi	1	0.2	SBR

129	Shivamogga	35.58	20	AL
130	Shivamogga	5.13	0.2	SBR
131	Rabkavi Banahatti	9.2	0	SBR
132	Tumkur	25	18	AL
133	Sira	10.6	1.5	SBR
134	Karkala	3	0.25	OP
135	Sadalga	3.72	0	AL
136	Basavana Bagewadi	4.02	4.4	WSP
137	Indi	4.02	4.52	WSP
138	Talikote	4.24	3.74	WSP
139	Humnabad	6	0	WSP
140	Gadag-Betageri	10.8	0	WSP
141	Bagalkot	12.5	6.5	OP
142	Naragund	4.18	0	WSP
143	Gurmitkal town	3	0.64	WSP
144	Laxmeshwar	5.5	0	AL
145	Gadag-Betageri	13.88	8	WSP
146	Hubballi-Dharwad	0.25	0	MBBR
147	Subramanya	2.6	1	AL
148	Hubballi-Dharwad	3	1	SBR
149	Haveri	4.71	0	FAL
150	Ranebannur	7.5	0	FAL
151	Mulbagal	6.3	3	SBT
152	Ilkal	8	0	FAL
153	Srinivasapura	0.11	0	DEWATS

154	Srinivasapura	0.11	0	DEWATS
155	Srinivasapura	0.11	0	DEWATS
156	Srinivasapura	0.06	0	DEWATS
157	Basavana Bagewadi	0.25	0.1	MBBR
158	Chintamani	6.4	2	SBR
159	Gadag-Betageri CMC	13.88	6.97	WSP
160	Ballari City Corporation	10	5	SBR
161	Raichur CMC	5.5	2.2	SBR
162	Coimbatore-1 Sewage Treatment Plant Ukkadam	70	35	SBR
163	Coimbatore- 2 60MLD STP Coimbatore	60	5	SBR
164	Dindigul Sewage treatment plant, Dindigul municipality	13.65	3	ASP
165	Thanjavur Sirajudeen Nagar Sewage Treatment Plant	28.05	14.15	ASP
166	Tiruppur MWUL Sewage Treatment Plant	15	8.5	EASP
167	Karur	15	6.5	EAP
168	Namakkal	5	5	ASP
169	Nagapattinam STP-1	2.69	1	EASP
170	Nagapattinam STP-2	9.63	4.1	ASP
171	Tiruvarur	6.92	4.1	ASP
172	Perambalur	4.2	3.6	ASP
173	Udhagamandalam Ooty STP	5	4	ASP

174	Udumalaipet underground sewage treatment plant, Udumalpet municipality	7.81	3.75	EASP
175	Tiruchirappalli	58	58	WSP
176	Erode	50.55	27	MBBR
177	Salem - Vellakuttai STP	13	7	ASP
178	Salem - Anaimeedu STP	6	4	MBBR
179	Salem - Mankuttai STP	35	1.5	FAB
180	Salem - Vandipettai STP	44	1	FAB
181	Mettur STP-1	0.82	0.5	ASP
182	Mettur STP-2	0.92	0.14	ASP
183	Mettur STP-3	5.45	2.1	ASP
184	Kumbakonam	17	12.5	ASP
185	Mayiladuthurai	5.85	5.85	WSP
186	Chidambaram	9.44	3.65	ASP
187	Rasipuram	6.96	2.6	ASP
188	Ariyalur	4.16	1	ASP

Source: NMCG

AL: Aerated Lagoon, ASP: Activated Sludge Process, BTF: Biological Trickling Filter, DEWATS: Decentralized Wastewater Treatment Systems, EAP: Effluent Application Process, EASP: Extended Aeration Sludge Process, EA: Extended Aeration, FAB: Fluidized Aerobic Bed, FAL: Facultative Aerated Lagoon, FBR: Fluidized Bed Reactor, MBBR: Moving Bed Biofilm Reactor, MBR: Membrane Bioreactor, OP: Oxidation Pond, Phytorid: Phytoremediation Integrated Design (a constructed wetland system), SBR: Sequencing Batch Reactor, SBT: Soil Biotechnology, UASB: Upflow Anaerobic Sludge Blanket, WSP: Waste Stabilization Pond.

5. Sanitation plan

Sanitation planning refers to the strategic process of ensuring safe, equitable, and sustainable sanitation services, including waste collection, transportation, treatment, and disposal. A sanitation plan (Fig. 4) aims to identify, assess, and mitigate risks related to public health and the environment by establishing systems that provide clean water, adequate waste management,

and proper sanitation. This plan involves a holistic approach to managing sanitation systems across urban and rural areas, with an emphasis on health, hygiene, environmental sustainability, and social equity. Sanitation planning is a preventive risk management approach that identifies the risks associated with waste management, focusing on the entire sanitation service chain:

- Waste collection and transportation
- Waste treatment and disposal
- Water and wastewater treatment
- Reuse and resource recovery (e.g., composting, biogas production)



Fig. 4. Workflow of sanitation plan

The plan involves local authorities, government bodies, NGOs, communities, and private sector participants, working together to ensure effective waste management and sanitation. In India, with its large population, rapid urbanization, and rural-urban disparities, sanitation is a critical issue. Managing sanitation systems is essential for public health, reducing disease burden, and protecting the environment.

Open defecation has been a common issue especially in rural India. Historically, it wasn't considered a shame or looked at from a sanitary perspective. Over the past few decades, Karnataka has seen the implementation of various sanitation projects under centrally sponsored schemes, externally aided programs and Government of Karnataka sponsored programs such as Nirmal Grama Yojana, Swachh Grama Yojana, etc. According to the Baseline Survey of 2012, out of 70.32 lakh rural households in Karnataka, 35% households had toilets, while the majority 65% were without toilets. To achieve the desired goal of accelerating sanitation coverage across rural India, "Swachh Bharat Mission" was launched on 2nd October 2014 by the Government of India. From 2nd October 2014 to 19th November 2018, 48 lakh Individual Household Latrines (IHHLs) were constructed across the state (RDWSD).

5.1. Public toilets

Under this scheme, every BPL household, SC / ST households belonging to restricted APL sector, small and micro families, landless families, differently abled families and household headed by women can construct individual toilets with a subsidy of Rs.12000/- which consists of Rs.7200/- from central government and Rs.4800/- from state government. The SC/ST family can get a benefit of Rs.15000/- where the state government provides an additional Rs.3000/- under SCP/TSP. Focus is also given for the construction of Community Toilets wherever needed (Fig. 5).



Fig. 5. Public toilets

(Source: RDWSD)

Sustainability of Open Defecation Free (ODF) status is the main objective of SBMG Phase-2. Central Ministry of Jal Shakti has instructed to construct community toilets (Fig. 6) if there is no availability of space to build individual toilets, and where there are maximum of 35 households. In the state, 905 community toilets are in use (as of August 2020), and the construction of 1862 community sanitary complexes are in progress. SBM (G) compensates up to 70% of the total fund and the remaining 30% can be covered under the 15th finance commission.



Fig. 6. Community toilets

(Source: RDWSD)

In Tamil Nadu, the responsibility for maintaining public toilets (Fig. 7) in districts outside of Chennai lies primarily with the local urban bodies (ULBs), which include municipal corporations, municipalities, and town panchayats. Each of these entities is tasked with planning, constructing, operating, and maintaining public sanitation facilities within their respective jurisdictions.

- **Local Urban Bodies:** Each district's municipal corporation or municipality is responsible for the upkeep of public toilets. This includes cities like Coimbatore, Madurai, Tiruchirappalli, and others where local bodies manage the sanitation facilities.
- **Public Health Department:** The Public Health Department at the local level also plays a role in overseeing sanitation standards and ensuring that public toilets meet hygiene requirements.
- **Private Partnerships:** In some cases, local bodies may outsource maintenance to private contractors to improve service efficiency. However, this has sometimes led to challenges regarding the quality of maintenance, as highlighted by public complaints in various districts.
- **Swachh Bharat Mission:** The central government initiative encourages ULBs to enhance public sanitation facilities, and it provides guidelines for effective management of public and community toilets. This mission emphasizes the importance of adequate maintenance and cleanliness to combat open defecation and improve overall public health.

The maintenance of public toilets in Tamil Nadu's districts is primarily managed by local urban bodies, with support from state health departments and potential private sector involvement.



Fig. 7. Public toilets in Tiruchirappalli
(Source: TNUSSP)

5.2. Waste management

Solid waste generation is an inevitable consequence of rapid urbanization, population explosion, changing lifestyle and modernization. SWM is efficient collection, transportation, processing, recycling and disposal and monitoring of waste and its impact on environment. SWM is one of the major challenges all over the world and in India. About 72 million Tons of SW is generated in the country, of which 43 million Tons are collected and only 12 million Tons of waste is scientifically treated. Balance quantity of 31 million Tons is dumped in landfills without any treatment. Un-scientific landfilling of municipal solid waste (MSW) generates huge quantity of leachate, which contaminates water. Most of the ULBs adopt landfilling as the option for disposal of SW, which is linked to water contamination, generation of greenhouse gases beside odour nuisance.

5.2.1. Objectives of waste management

- **Environmental Protection:** Prevent pollution of air, water, and soil by ensuring proper waste treatment and disposal.
- **Public Health:** Minimize the risk of disease transmission by managing waste in sanitary ways.
- **Resource Conservation:** Promote recycling and reusing waste materials to conserve natural resources.

- **Energy Recovery:** Harness energy from waste materials through processes like incineration or anaerobic digestion.
- **Compliance with Regulations:** Adhere to environmental laws and waste management standards set by governments and international organizations.

5.2.2. Waste generation in CRB

The data reveals considerable variability in MSW generation across districts within the same state, underscoring the influence of population density, economic activity, and urbanization levels (Fig. 8). For instance, Bengaluru Urban district in Karnataka records the highest MSW generation at 4,593 tons per day (TPD), reflecting its status as a major metropolitan hub. In contrast, districts such as Chamarajanagar generate significantly lower quantities, around 75 TPD, due to their rural and less densely populated nature. In Tamil Nadu, Coimbatore (1249 TPD), as one of Tamil Nadu's major urban and industrial hubs, it generates high MSW due to its dense population, thriving IT and textile industries, and urban sprawl. Smaller districts like Ariyalur (29 TPD) generate less waste due to their rural nature, smaller populations, and lack of extensive industrialization.

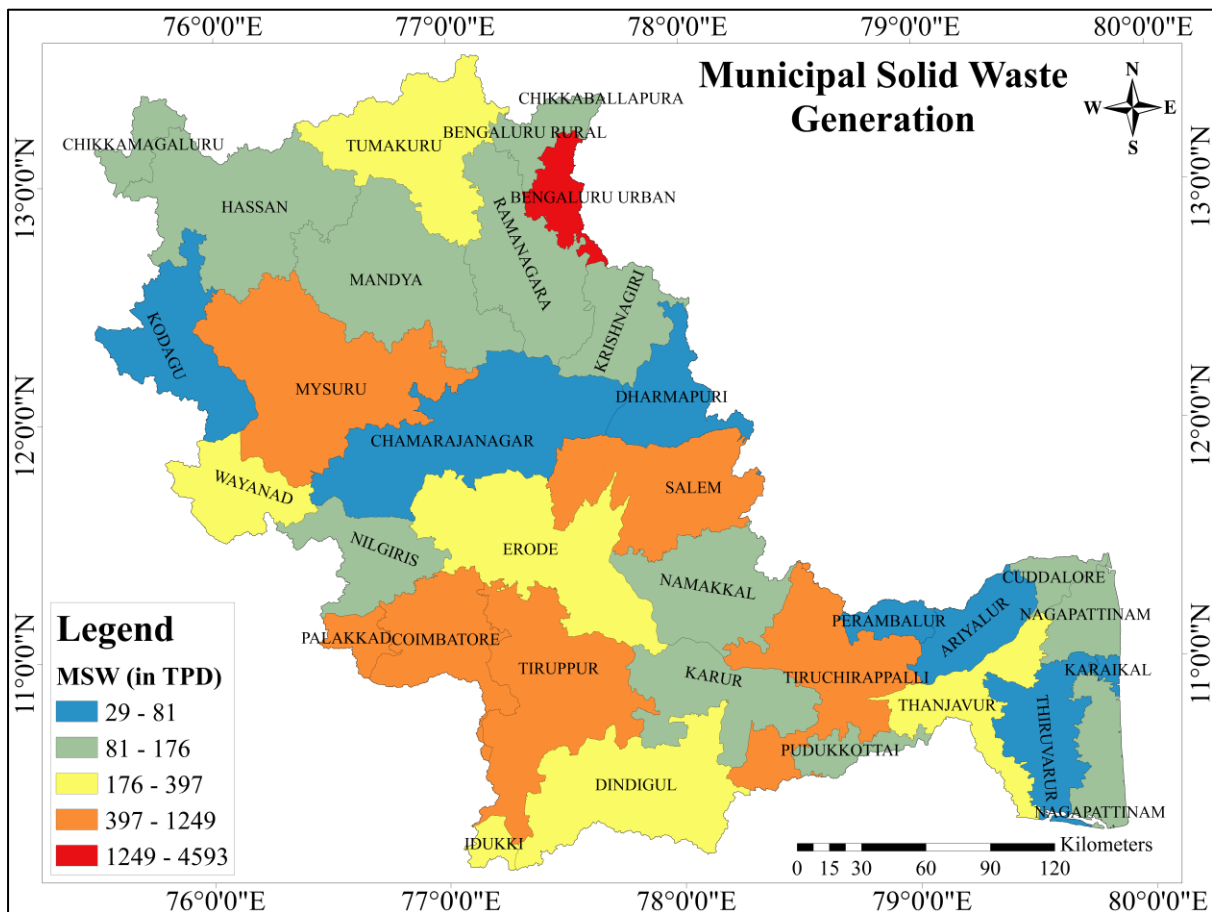


Fig. 8. Municipal solid waste generation map of CRB

District-wise analysis of municipal solid waste generation highlights the pressing need for tailored waste management strategies. Urban centres with high waste generation require immediate interventions to prevent environmental and public health crises, while rural districts

need support to establish efficient waste processing systems. Policymakers, municipal authorities, and citizens must collaborate to build a sustainable framework for managing solid waste effectively. By adopting innovative practices and fostering a culture of responsibility, districts can transition towards a cleaner, more sustainable future.

5.2.3. Government initiatives for solid waste management

In the context of CRB, which is one of the most important river systems in southern India, waste management plays a critical role in preserving the health of the river and the surrounding environment. The river basin is vital for drinking water supply, agriculture, industry, and the livelihoods of millions of people. However, pollution, particularly from industrial, agricultural, and domestic waste, threatens the quality of water and overall ecosystem health in the region. The various government initiatives taken for waste management are described below:

a) Swachh Bharat Mission

The central government's cleanliness mission, aimed at improving waste management practices across urban and rural areas, is being implemented in different districts under CRB. The mission emphasizes clean cities, waste segregation, and the elimination of open defecation.

b) State Policy on Solid Waste Management

The state government has adopted a comprehensive policy that sets goals for reducing waste generation, promoting segregation, recycling, and composting, and minimizing the impact of waste on the environment.

c) Public Awareness Campaigns

NGOs, local bodies, and the state government are also involved in running awareness campaigns to encourage waste segregation, reduce plastic use, and promote recycling.

5.2.4. Efforts and challenges in effective solid waste management

While there are waste treatment plants in some urban areas, they are often insufficient or underperforming due to outdated technology or lack of proper maintenance. In some places, sewage continues to be discharged untreated into the Cauvery. Several government and non-governmental organizations have been working to reduce pollution in the Cauvery, such as the Cauvery Calling initiative by the Isha Foundation, which focuses on reforestation and watershed management. However, more targeted efforts are required to address the root causes of industrial, domestic, and agricultural waste.

5.3. Community sanitation programs

Community sanitation programs in CRB are critical for improving water quality, ensuring public health, and promoting sustainable management of the river's resources. Here's an outline of how such programs can be implemented and their potential impact:

5.3.1. Current challenges in CRB

- a) Water Pollution:** Untreated sewage, agricultural runoff, and industrial effluents are major contaminants.
- b) Public Health Issues:** Lack of proper sanitation leads to waterborne diseases.

- c) **Social Inequity:** Rural and underprivileged communities often lack access to basic sanitation infrastructure.

5.3.2. Objectives of community sanitation programs

- a) Reduce the inflow of untreated wastewater into the river.
- b) Enhance access to sanitation facilities in rural and urban areas.
- c) Raise awareness about the importance of sanitation for river health and community well-being.
- d) Promote behavioural changes through education and participation.

5.3.3. Key components of the programs

a) Infrastructure Development

- Construction of toilets in rural and peri-urban areas.
- Establishment of decentralized wastewater treatment systems.
- Building community-managed solid waste management units to prevent garbage from entering the river.

b) Capacity Building and Training

- Training community members in sanitation maintenance and waste management.
- Forming local self-help groups to monitor sanitation activities.

c) Awareness Campaigns

- Conducting workshops on the linkage between sanitation and river health.
- Creating culturally relevant messages that incorporate local traditions and values, including references to the sacred significance of the Cauvery River in Hinduism.

d) Policy and Institutional Support

- Collaborating with local government bodies and NGOs for funding and implementation.
- Ensuring compliance with the National Water Policy and Swachh Bharat Mission initiatives.

e) Monitoring and Evaluation

- Utilizing GIS and remote sensing tools to track pollution hotspots and sanitation facility distribution.
- Regular water quality monitoring to measure the impact of sanitation programs.

f) Role of Stakeholders

- **Government:** Formulate policies and provide funding.
- **Local Communities:** Actively participate in the planning, implementation, and monitoring processes.

- **NGOs and CSOs:** Facilitate capacity building, awareness, and technical support.
- **Academia and Researchers:** Provide evidence-based solutions and evaluate program impacts.

g) Expected Outcomes

- **Improved Water Quality:** Reduction in contaminants entering the river.
- **Public Health Benefits:** Decrease in diseases like cholera and dysentery.
- **Community Empowerment:** Enhanced participation and ownership of sanitation initiatives.
- **Sustainability:** Long-term benefits through integrated water and sanitation management.

h) Integrating River Conservation with Sanitation

Sanitation programs can complement river conservation by:

- Reducing non-point and point-source pollution.
- Encouraging nature-based solutions, such as wetland restoration, to treat wastewater naturally.
- Strengthening community-centric river management models, supported by traditional knowledge and cultural practices.

6. Riverfront development plan

Riverfront development is a transformative urban planning initiative aimed at revitalizing and enhancing riverfronts, fostering economic growth, improving public access, creating recreational spaces, and preserving environmental integrity. By leveraging the potential of rivers as key natural assets, these developments can provide sustainable and vibrant spaces for communities. The focus of such projects is not only on improving the aesthetics and functionality of riverfronts but also on creating an integrated approach that balances ecological, economic, and social goals.

6.1. Initiatives on riverbank protection

To safeguard the banks of the Cauvery River, a combination of structural and bioengineering measures will be implemented. Native vegetation, such as Vetiver grass, will be planted to stabilize the soil and prevent erosion, while riprap and gabion walls will be installed in areas prone to high water flow to deflect and absorb the energy of the river. Terracing will be employed to reduce the slope of the riverbanks, slowing down water velocity and minimizing erosion. These initiatives will be complemented by regular monitoring and maintenance to ensure the long-term stability of the riverbanks.

6.2. Recreational spaces

Creating recreational spaces along the Cauvery River will provide the community with areas for leisure and outdoor activities while maintaining the ecological balance of the region. Parks

with landscaped green spaces, playgrounds, and sports facilities will be established to cater to people of all ages. Additionally, cultural spaces such as open-air venues and amphitheatres will host events, fostering community engagement. Designated zones for water activities like kayaking, boating, and fishing will be developed to promote safe interaction with the river.

6.3. Walkways

Pedestrian walkways along the river will offer scenic routes for walking, jogging, and cycling, promoting healthy lifestyles. These paths will be designed to be continuous and accessible, ensuring inclusivity for all, including those with mobility challenges. Bicycle lanes will run alongside the walkways, encouraging eco-friendly transportation. Viewing decks at strategic locations will provide panoramic views of the river and its surroundings, while tree-lined paths will offer shade and enhance the aesthetic appeal of the riverfront.

6.4. Ecological restoration

Restoring the natural habitat along the Cauvery River is crucial for maintaining biodiversity and improving water quality. Reforestation with native trees will help rebuild the forest cover, while the creation of wetlands will support diverse flora and fauna. Enhancing the aquatic habitat with structures like submerged logs or artificial reefs will provide shelter for fish and other species. Efforts will also focus on controlling pollution by reducing industrial discharge, managing agricultural runoff, and promoting waste management practices. Community involvement will be encouraged through awareness programs and volunteer activities, ensuring collective responsibility for the river's health.

6.5. Implementation plan

The implementation of these initiatives will follow a phased approach (Fig. 9). Initially, a comprehensive assessment of the current state of the riverbank and surrounding areas will be conducted. This will be followed by the development of detailed project designs and securing the necessary permissions, involving all stakeholders in the planning process. The subsequent phase will involve the construction and implementation of the protection measures, recreational spaces, walkways, and ecological restoration projects. Finally, ongoing monitoring and maintenance will ensure the sustainability of these efforts, addressing any emerging challenges and adapting to changing conditions. This holistic plan aims to harmonize development with environmental conservation, preserving the Cauvery River's natural and cultural heritage for future generations.

The Infrastructure Development Department (IDD), Government of Karnataka (GoK) has identified various projects in the State for development through Public Private Partnership (PPP) frameworks. One such project identified is the development of waterfronts in the State. As a preliminary step in the project development activities, IDD intends to undertake a pre-feasibility study to ascertain the Project's amenability for development under PPP. Moreover, Infrastructure Development Corporation (Karnataka) Limited (iDeCK) has been awarded the mandate for undertaking the pre-feasibility study for the above-mentioned project. The Report also discusses the various options for implementation of the project and sets out the next steps in the study.

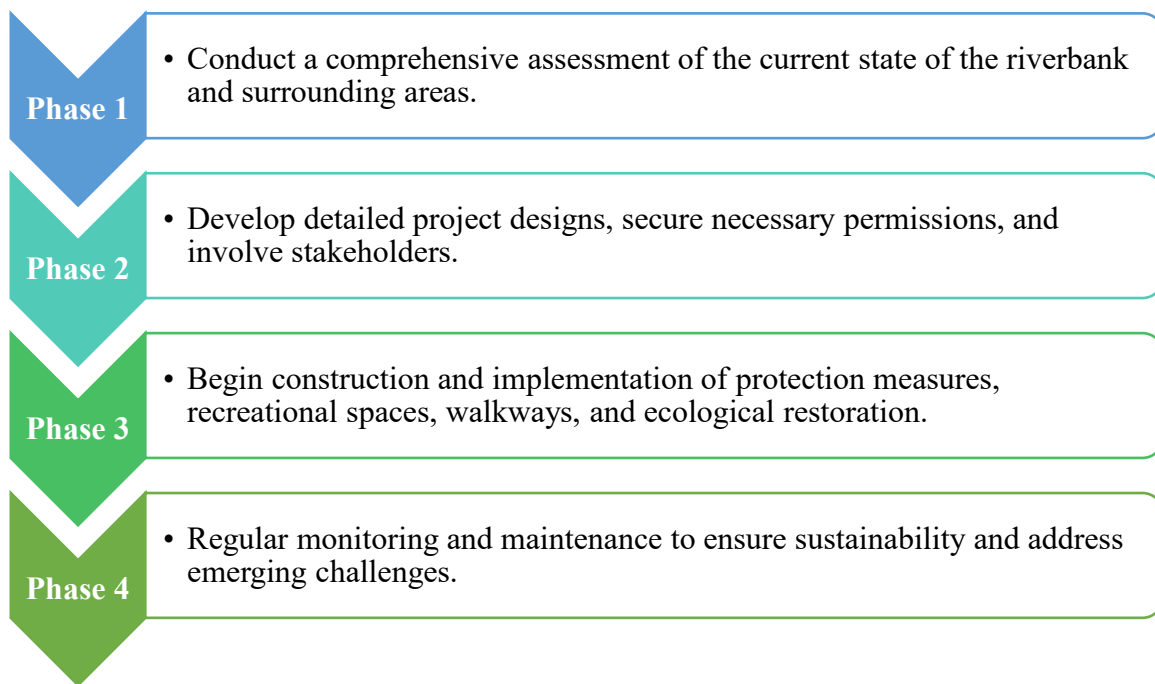


Fig. 9. Implementation plan for infrastructure development

The Karnataka government has initiated several projects aimed at developing and rejuvenating the Cauvery River and its surroundings. Some of the riverfront development plans are described below:

a) Cauvery Stage V Project

Launched on October 16, 2024, this project aims to supply 775 million litres per day (MLD) of water to Bengaluru, increasing the city's total water intake to 2,225 MLD. This expansion is expected to provide approximately 15 lakh new water connections.

b) Cauvery Stage VI Project

Announced concurrently with Stage V, this proposed project plans to extract an additional 500 MLD from the Cauvery River to meet Bengaluru's growing water demands. The estimated cost is around ₹7,200 crore, with funding anticipated through international loans.

c) Mekedatu Dam Project

The state government is set to acquire approximately 5,096 hectares of forest land in the Cauvery basin for the construction of the Mekedatu dam. This project aims to enhance water storage and supply capabilities.

d) Waterfront Development Initiatives

A pre-feasibility study has been conducted for waterfront development in Karnataka, focusing on balanced land use and sustainable planning along rivers, including the Cauvery. This initiative aims to enhance tourism, environmental conservation, and local livelihoods.

e) Cauvery Calling Campaign

Spearheaded by the Isha Foundation, this campaign supports farmers in planting 242 crore trees to revitalize the Cauvery River ecosystem. The initiative focuses on sustainable agriculture and environmental conservation.

The Tamil Nadu government has also initiated several projects aimed at developing and rejuvenating the Cauvery River and its surroundings. Some of the riverfront development plans are described below:

a) Tiruchirappalli's first riverfront development

The project plans to develop a 250-meter stretch along the Cauvery River. The plan includes a riverside walking track, a 30-foot watchtower, an amphitheatre, a kids' play area, bathing ghats, planters with seating, a sundial, and public toilets (Fig. 10). The Trichy Corporation will oversee the project, with an estimated cost of Rs. 14 crores.

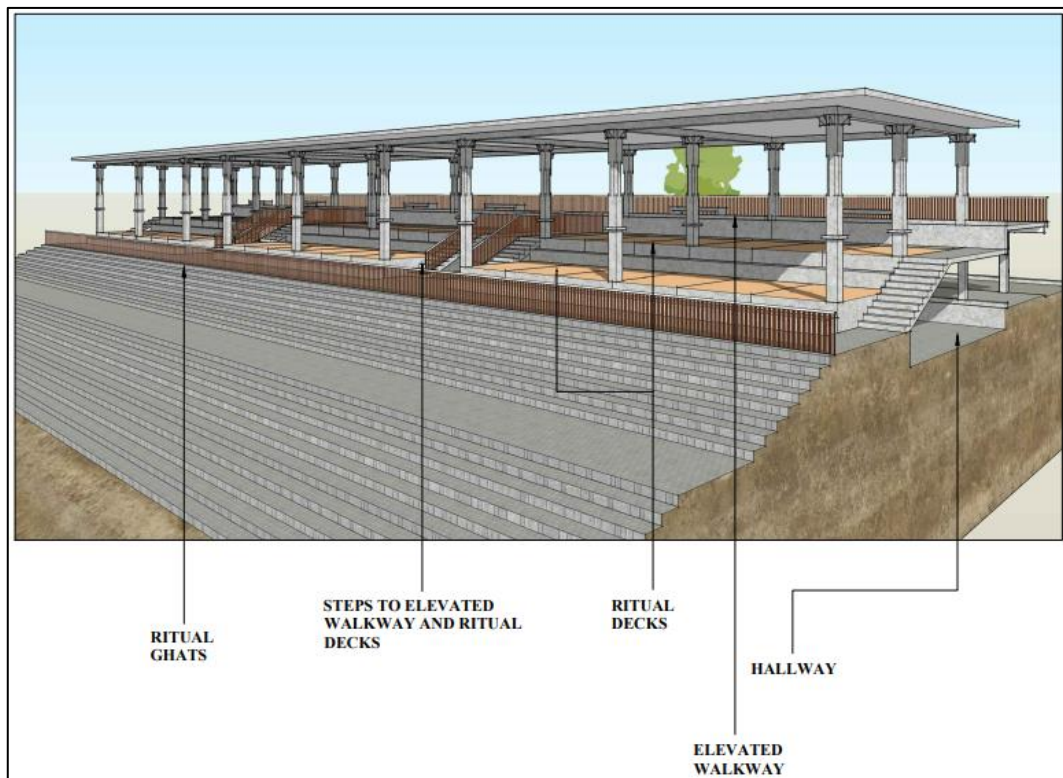


Fig. 10. Tiruchirappalli's riverfront development

(Source: WRD - Nadanthai Vaazhi Cauvery Project)

b) Nadanthai Vaazhi Cauvery Project

To rejuvenate the Cauvery River and its tributaries, the project aims to construct new check dams, sewage treatment plants, and implement a real-time water quality monitoring system. The project is being executed in phases, with an estimated cost of Rs 11,250 crore, funded by both the centre and state (Fig. 11).



Fig. 11. Riverfront development in Mettupalayam
 (Source: WRD - Nadanthai Vaazhi Cauvery Project)

c) Cauvery River eco-park in Trichy

This development focuses on eco-tourism by creating an eco-park and a riverfront walkway. Efforts are also underway to restore the natural beauty of the river and improve access to Srirangam Island, a key historical location in Trichy.

d) Cauvery riverfront development in Karur

The plan focuses on pedestrian-friendly areas, recreational spaces, improved waste management, and river conservation efforts to enhance the aesthetic value of the riverfront while promoting tourism.

e) Mettur dam & surrounding area development

Plans include upgrading infrastructure around Mettur Dam to improve access to tourist sites, adding promenades, viewpoints, and facilities for boating. The project focuses on eco-tourism while preserving the ecological balance of the region.

f) Sustainable development along the Cauvery River

Sustainable riverfront development aims at flood control, water management, waste treatment, and tree planting along the riverbanks to reduce erosion and enhance biodiversity (Fig. 12).

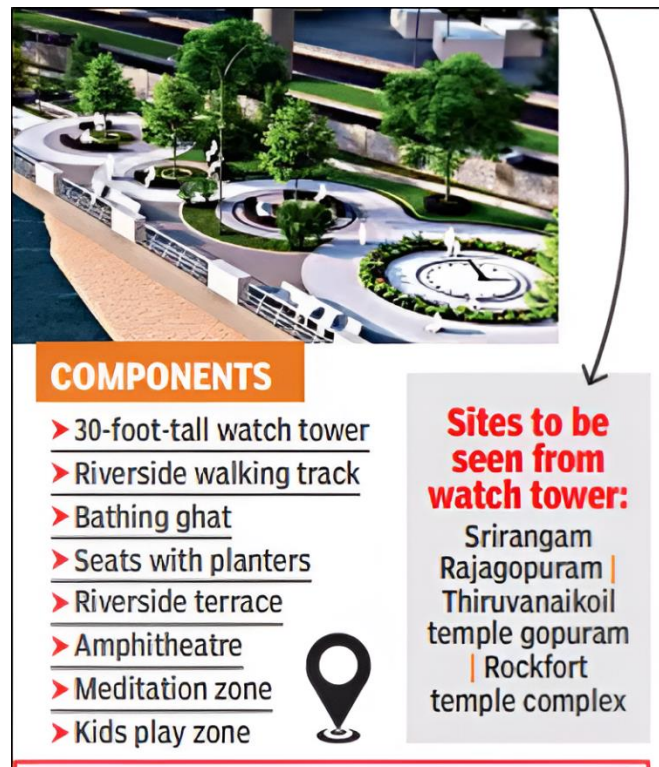


Fig. 12. Proposal of riverfront development plan

(Source: Times of India)

These efforts reflect a comprehensive approach to managing the Cauvery River's resources, balancing developmental needs with environmental sustainability.

6.6. Goals of Cauvery Riverfront development

a) Ecological Conservation

Protect and restore the river's ecosystem by reducing pollution, improving water quality, and preserving biodiversity.

b) Tourism Promotion

Develop the Cauvery region as a prominent eco-tourism and heritage tourism destination by building recreational and cultural spaces.

c) Urbanization & Infrastructure

Improve urban spaces along the riverfront with pedestrian walkways, green spaces, transportation access, and enhanced public utilities.

d) Sustainable Development

Ensure that all developments respect environmental sustainability, balancing modern infrastructure with ecological preservation.

e) Cultural Heritage

Emphasize and preserve the cultural and historical importance of the Cauvery River to local communities, while integrating new development with existing heritage sites.

6.7. Need for riverfront development

The increasing pace of urbanization and industrialization has left many towns/ cities with minimum avenues for recreation and open green spaces. A developed waterfront trail would provide residents access to new recreation opportunities and an expanded awareness of the natural aspects of river life. The waterfront would attract a growing legion of morning walkers and after-work runners. Added to this, public access sites connected by linear greenways will tie developments together, eliminating barriers, both real and imagined and animate the waterfront with the light and life of the city.

This form of urban redevelopment can pull the waterfront areas from marginal use and neglect into the mainstream of public activity and private investment. Cities enjoy increased tourism, employment and growth. This amenity would attract significant new high-quality investment and encourage people once again to approach the water—an instinct lost during a century of industrialization. Most importantly, a vital and vibrant waterfront serves to unite residents and visitors in a shared experience of the city. It is in that daily exchange of ideas and points of view that a city finds the energy and desire to continually improve and remake itself.

6.8. Advantages of riverfront development

The advantages of developing river front are manifold ranging from economic benefits, environmental benefits to social/ community benefits. These benefits are detailed below.

- a) With the development of waterfront there would be creation of jobs in developing the front, jobs as it gives way to starting up of a host of commercial activities in that region and indirect job creation associated with the set of activities.
- b) Source of revenue for government – government would be able to earn revenue in terms of taxes from the commercial activities in the region. The commercial activities include shops, restaurants, sport activities, transportation, boating etc which can be leased out or giving to private players to operate.
- c) Development of tourism in the region – with the development of waterfront the tourism in the region can be increased by offering a variety of attractions like water sports, entertainment arenas, parks, shopping areas, etc.
- d) Economic spin-off's – rise in the value of properties in and around the region, acting as a catalyst for redevelopment and renewal of nearby places.
- e) Habitat protection and restoration.

7. Other initiatives or plans

Accompanying the major activities directed towards the management of river basins, a few more activities are also important in the context of development and improvement of the infrastructure in the territories (Table 11). These activities are concerned with managing water resources which calls for meeting the requirements of agriculture, industry, and domestic use and at the same time protecting the ecosystem. Such modern irrigation systems, flood control features, and sewage treatment plants are developed for improvement of water efficiency and environmental conservation.

Additionally, constructing multipurpose dams and reservoirs for the development of hydroelectricity generation and recreational activities, as well as water supply is also being considered. There are also people-oriented approaches aimed at developing capacity of the community in engaging local water management, ownership and responsibility of the stakeholders. The capacity building and technological programs suggested works to empower the local authorities and the people in effective resource use.

Also, the other proposed activities include restoration of tree cover along the riverbanks for water purification, preservation of vector biodiversity and curtailing soil erosion. There is a marked and planned synergy with academia and research institutions to support evidence based decision-making and new approaches. All in all, these activities seek to provide the river basin enhancement approaches with a diversified and flexible base to promote sustainable environmental management and economic prosperity objectives.

Table 11. News articles related to other development plans

Sr. No.	Title	Description	Year	Source
1.	NRCD approves ₹934.3 crore for first phase of 'Nadanthai Vaazhi Cauvery' project.	A project proposed by the Tamil Nadu government for the conservation and rejuvenation of Cauvery River. The National River Conservation Directorate (NRCD), a wing of the Union Ministry of Jal Shakti, has approved ₹934.3 crore for the first phase of the 'Nadanthai Vaazhi Cauvery'. The Union and State governments would share the project cost as ₹560.58 crore and ₹373.72 crore respectively on a 60:40 basis. The components of the project include sewage management at ₹577.151 crore, riverfront development activities at ₹176.98 crore, river surface cleaning at ₹27 crore, solid waste management at ₹30.89 crore and people participation and awareness creation at ₹6 crore. Among the other items would be rehabilitation and resettlement for the high-risk area, flood-prone zone and	June, 2024	https://www.thehindu.com/news/national/tamil-nadu/nrcd-approves-9343-crore-for-first-phase-of-nadanthai-vaazhi-cauvery-project/article68317112.ece

intervention required area along with real-time monitoring system to ensure water quality (₹27.58 crore), a museum at Grand Anicut (Kallanai) at ₹36.7 crore and biodiversity at ₹52 crore. In the first phase, the project would cover the river from downstream of the Mettur dam up to Tiruchi and in the second, the remaining part of the river from Tiruchi to Poompuhar, the river's confluence points with the sea.

2. CWC gives nod for Rs 11K crore Cauvery rejuvenation project in Tamil Nadu.
- Central Water Commission (CWC) has given its approval for the Rs 11,250 crore Nadanthai Vaazhi Cauvery project which aims to rejuvenate hundreds of water bodies linked to the Cauvery River and its tributaries across the state to prevent them from pollution and effluents. The rejuvenation programme is executed in two phases at a cost of Rs 1,958 crore and Rs 8,753 crore. The project aims to conserve, rejuvenate, and enhance water resources in the Cauvery basin on the lines of Namami Gange Programme, a flagship scheme of the Union Government implemented with the objectives of effective abatement of pollution, conservation and rejuvenation of Ganga. The Cauvery project proposes to address pollution concerns by identifying sewage and effluent inflow into water bodies through setting up of Sewage Treatment Plants (STPs) and ecological conservation of
- June, 2024 <https://www.newindianexpress.com/states/tamil-nadu/2024/Jun/08/cwc-gives-nod-for-rs-11k-crore-cauvery-rejuvenation-project-in-tn>

the Cauvery River and its tributaries. Ten common effluent treatment plants for textile units will be built at a cost of Rs 119.56 crore under the project in Erode and Namakkal regions and 65 sewage treatment plants (209.30 MLD combined capacity) will be built in areas from Mettur to Tiruchy under the project. Riverfront development will also be taken up at Bhavani Kooduthurai, Karur, Kodumudi, Mettupalayam, Mettur, Pallipalayam, Sathyamangalam Bridge site and upper anicut.

3. Rs 7,700-crore project to modernise irrigation infrastructure in Cauvery basin to be ready by 2024.

The Project aims to the Cauvery Basin's irrigation infrastructure January, 2022 would be extended, renovated and modernised by the end of year in a few parts and the rest of the works would be completed before 2024. The Cauvery basin has hundreds of rivers and rivulets and more than 10,000 canals of various sizes and categories. Most of the irrigation infrastructure, including canal lines and water pathways, was built during the Chola and British eras, they have been severely damaged.

Moreover, tail-end areas of Cauvery basin haven't been getting enough water, affecting agricultural activities. Also, due to inter-state water disputes, there are roadblocks in undertaking renovation works in areas around Cauvery River and its tributaries. After the green signal by Cauvery Water Regulation Committee, the State

<https://www.newindiaexpress.com/states/tamil-nadu/2022/Jan/21/rs-7700-crore-project-to-modernise-irrigationinfrastructure-in-cauvery-basin-to-be-ready-by-2024-2409454.html#:~:text=Tamil%20Nadu-,Rs%207%2C700%2Dcrore%20project%20to%20modernise%20irrigation%20infrastructure%20in%20Cauvery,i>

government had planned to extend, renovate and modernise irrigation infrastructure in the Cauvery basin at Erode, Namakkal, Tiruchy, Thanjavur and nearby districts at an estimated cost of Rs 7,705.75 crore in 2019. Though a few works are nearly complete, most of them are still on. Under this project, 95 per cent of works have been finished at Erode, Namakkal, Tiruppur and Karur districts. "The State government sanctioned Rs 933 crore for Lower Bhavani project in Erode, Rs 335 crore for Kattalai High-Level Canal in Karur and Tiruchy, Rs 3,384 crore for Cauvery sub-basin in Tiruvarur, Myladuthurai Nagapattinam, and Karaikal districts, as well as Rs 1,038 for the Grant Anicut in Thanjavur," the official added. Water from Mettur dam is released between June 12 and January 28 every year for irrigation. Hence, WRD officials temporarily stop works in Cauvery basin during this period. Occasionally, rivers and canals might have water till February and work is stopped during this period as well. Works start when riverbeds are dry. As part of the project, in all districts where the Cauvery flows, concrete linings would be made in all damaged sluices, check dams, drainage inlets, cross masonries and regulators. Works will be undertaken along nearly 2,000 km as part of the project.

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The official assured that, after completion of works, tail-end regions will get more water and 8.83 lakh acres of ayacut lands are likely to benefit.

4. Cauvery Calling drive to stop river from drying up

The Isha Foundation launched the Cauvery Calling campaign in Bengaluru on July 21, 2019. The Cauvery Calling campaign aims to revitalize the Cauvery River and help farmers by planting 242 crore trees. The campaign's goals include improving soil and water conditions, improving farmers' economic situation, increasing farmers' income, and retaining water in the soil. Cauvery Calling is a first of its kind campaign, setting the standard for how India's rivers – the country's lifelines – can be revitalized. It will initiate the revitalization of Cauvery River and transform the lives of 84 million people. Cauvery Calling follows a tree-based agricultural approach that not only multiplies farmers' income through diversified tree-based agriculture practices but also enhances soil organic matter. This facilitates better water absorption, which in turn replenishes underground reserves and sustains the river's flow throughout the year. Agroforestry will revive the dying soil, increase water retention as well as river water levels. Agroforestry means farmers will dedicate one-third of their farm to growing fruit or timber trees. While 'Cauvery Calling', along with citizen

July, 2019 <https://timesofindia.indiatimes.com/city/bengaluru/cauvery-calling-drive-to-stop-river-from-drying-up/articleshow/70314308.cms>

volunteers and corporate bodies, will crowdfund saplings for these trees, the organisation plans to ask the government to incentivise farmers' decision to shift from conventional crops to fruit trees.

5. Short stretch of canal construction work along Tiruchi-Pudukottai border nears completion.

The construction of a canal along a short stretch, as part of Phase-I of the Cauvery-Vaigai-Gundar intra-State river linking project, is nearing completion. Launched in 2021, the project aims to divert surplus flows from the Cauvery to water-scarce regions of the State, including Pudukottai, Sivaganga, Ramanathapuram, and Virudhunagar, by constructing a canal connecting the Cauvery to the Vaigai and the Gundar. The barrage across the Cauvery at Mayanur in Karur district serves as the starting point of the new 262-km link canal, designed to transport surplus water from the Cauvery to the South Vellar, the Vaigai, and ultimately the Gundar. The canal is designed to carry approximately 6,000 cusecs of water.

November, 2024 <https://www.thehindu.com/news/cities/Tiruchirappalli/short-stretch-of-canal-construction-work-along-tiruchi-pudukottai-border-nears-completion/article68915820.ece>

8. Gaps/shortcomings in initiatives and plans

8.1. Identification of inefficiencies in current infrastructure

The current infrastructure across CRB exhibits several inefficiencies, particularly in the provision of water supply and sanitation services. Many ULBs depend on state-run parastatal agencies for delivering these services, which are often unable to meet the growing demand due to outdated infrastructure and insufficient capacity. Furthermore, the solid waste management systems, though improving, still face challenges in processing capacity and coverage, particularly in expanding urban areas.

8.2. Misalignment with urban growth

Urban growth in CRB regions such as Karnataka and Tamil Nadu have been rapid and often unplanned, leading to misalignment between the available infrastructure and the needs of the population. Many master plans are outdated, and there is a lack of integration in planning efforts, particularly in eco-sensitive regions. For instance, several urban areas have exceeded their infrastructure capacities, and new developments have not been adequately supported by corresponding expansions in infrastructure.

8.3. Inadequacy of resources

The inadequacy of financial and technical resources is a significant challenge in CRB's infrastructure development. The financial resources allocated for urban infrastructure projects are often insufficient to cover the expansive and rapidly growing needs of the urban population. Despite significant investment programs such as the Tamil Nadu Sustainable Urban Development Project, the estimated funding requirements far exceed the available budget, leading to delays and partial implementations. Additionally, there is a shortage of skilled personnel and modern technology to manage and maintain the infrastructure efficiently.

9. Significance of the infrastructure and planning report

The Infrastructure and Planning Report is crucial for the condition assessment and planning of CRB, as it provides a comprehensive analysis of the existing infrastructure, including dams, canals, irrigation systems, and reservoirs (Fig. 13). This report identifies areas needing maintenance, upgrades, or new infrastructure to optimize water resource management. It also assesses the ecological health of the basin, highlighting issues like sedimentation, pollution, and biodiversity loss, which are essential for planning sustainable development projects that minimize environmental damage. Moreover, the report plays a vital role in flood and drought mitigation by helping design effective control measures and early warning systems, improving water storage and distribution networks. By evaluating current water usage patterns across sectors, the report supports equitable water allocation and identifies socio-economic opportunities where investments can enhance agricultural productivity, industrial growth, and living standards. Additionally, it serves as a key input for policymakers to make informed decisions regarding water governance and basin management, ensuring a balance between development and conservation. Importantly, the report also addresses climate change adaptation by identifying vulnerabilities in the basin's infrastructure and aiding in planning resilient solutions to cope with changing environmental conditions. Overall, the report is essential for sustainable development, water security, and the long-term health of CRB.

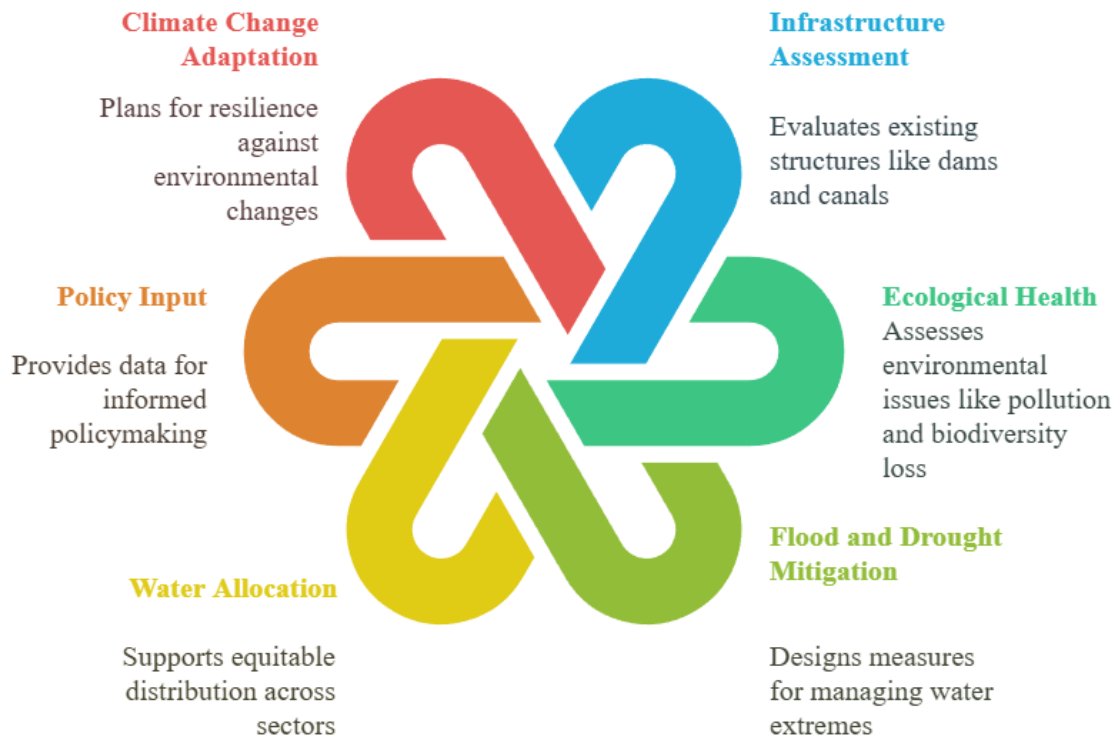


Fig. 13. Significance of the infrastructure and planning report

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