Tamil Nadu Climate Change Mission

MAYILADUTHURAI

DISTRICT CLIMATE ACTION PLAN

2024

Under

CLIMATE STUDIO

Prepared by

Centre for Climate Change and Disaster Management,
Department of Civil Engineering, Anna University, Chennai

Supported by

Department of Environment and Climate Change, Government of Tamil Nadu

Dr. P. Senthilkumar, I.A.S.,
Principal Secretary to Government,
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PREFACE

A climate action plan is not merely a response to environmental threats but a forward-looking strategy that leverages opportunities for innovation and collaboration to address local vulnerabilities while aligning with global sustainability goals. Integrating scientific research, community insights and data-driven solutions provides a roadmap for reducing greenhouse gas emissions, safeguarding natural resources and enhancing adaptive capacity. With a strong focus on regional priorities, they lay the groundwork for a sustainable future, ensuring that every action contributes to building resilience at both local and global levels.

The Mayiladuthurai District Climate Action Plan underscores the district's steadfast commitment to tackle the pressing challenges of climate change with a targeted approach to its key sectors—Greenhouse gas (GHG) emissions, water resources, agriculture, forests and coastal ecosystems. In an era of growing climatic uncertainty, this plan reflects our resolve to ensure that future generations thrive in a sustainable and secure environment.

This action plan, developed through extensive research and stakeholder collaboration under the "Operationalization of Climate Studio" addresses Mayiladuthurai climate challenges with targeted strategies. It provides a detailed analysis of the district GHG emissions and the effects of climate change on water, agriculture, forests and coastal ecosystems. The plan focuses on reducing emissions through transition to clean energy, energy efficient practices, and climate-smart agriculture. Water resources are protected with rainwater harvesting, improved efficiency, and flood-resilient infrastructure. Agriculture is strengthened by promoting tolerant crop varieties, agroforestry and soil health. Mangrove restoration, sustainable fisheries, and resilient infrastructure safeguard coastal areas, offering a clear path to a sustainable and climate-resilient future.

Let us collectively rise against the challenge, being united in our commitment to create a future that is secure, sustainable and prosperous for the residents of Mayiladuthurai. With determination and foresight, we can lead the way towards a climate-resilient district and inspire other districts to follow this footsteps.

(P.Senthilkumar)

Thiru. A. R. Rahul Nadh I.A.S.,
Director
Department of Environment and Climate Change
Government of Tamil Nadu
Chennai – 600 015

FOREWORD

Tamil Nadu with its rich cultural heritage, dynamic urban and rural landscapes stands at the forefront in tackling climate challenges and tapping the opportunities. The Mayiladuthurai District Climate Action Plan encapsulated in this document is a significant step forward in our collective commitment to create a sustainable and climate resilient future for Tamil Nadu.

This comprehensive plan serves both as a strategic roadmap and a call for action, offering a deep dive into the district vulnerabilities, adaptive capacities and pathways for climate resilience. It highlights the interconnection between climate systems and human activities providing actionable insights for balancing development imperatives with ecological stewardship.

The adaptation strategies proposed in this plan emphasize nature-based solutions, green infrastructure and community-driven resilience programs. These initiatives reflect the district's vision of harmonizing technological innovation with traditional wisdom to ensure equitable and inclusive growth. By prioritizing sustainability and resilience, the plan aims to protect and enhance the livelihoods of the people of Mayiladuthurai, securing the well-being of generations to come.

Let us transform this blueprint into climate action, fostering resilience, equity and sustainability for Mayiladuthurai and beyond. Let this document serve as a guiding beacon as we build a future that honours both the aspirations of our people and the integrity of our environment.

(A.R. Rahul Nadh)

Thiru. A.P. Mahabharathi., IAS
District Collector
Mayiladuthurai - - 609 001

FOREWORD

Mayiladuthurai District, a region endowed with rich natural resources, agricultural heritage, and vibrant coastal ecosystems, stands at a critical juncture in addressing the pressing challenges posed by climate change. Tamil Nadu, with its diverse agro-climatic zones and economic reliance on sectors like water resources, agriculture, forestry, and coastal ecosystems, has recognized the urgent need for adaptive strategies to safeguard livelihoods, ensure food security, and sustain its biodiversity.

The **Mayiladuthurai District Climate Action Plan**, encapsulated in this report, represents a pivotal step toward building a climate-resilient future for our district and the state at large. This plan emerges from a comprehensive sector-specific and district-level climate risk assessment, conducted with the support of the advanced analytical capabilities of the Climate Studio at the Centre for Climate Change and Disaster Management (CCCDM). It highlights actionable strategies to address climate vulnerabilities and harness opportunities for resilience and sustainability.

This document offers a detailed analysis of the district's vulnerabilities across critical sectors, including agriculture, water resources, coastal ecosystems, and sustainable habitats. The Climate Studio team has provided actionable insights and evidence-based adaptation strategies. These strategies prioritize nature-based solutions, community-driven initiatives, and sustainable practices that balance development imperatives with ecological integrity.

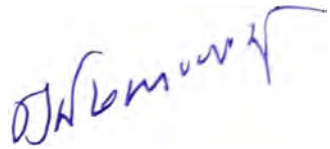
I am deeply grateful to **Dr. P. Senthil Kumar, IAS., Principal Secretary to Government, Environment, Climate Change and Forest Department** for his visionary leadership and unwavering commitment to addressing climate change. His steadfast support for pioneering initiatives like the Climate Studio has been instrumental in empowering districts like Mayiladuthurai to undertake evidence-based and community-centered climate action.

My profound gratitude also extends to **Thiru A.R. Rahul Nadh, IAS., Director, Department of Environment and Climate Change**, for his valuable guidance and support throughout the operationalization of the Climate Studio. His leadership has been pivotal in ensuring the success of this initiative and in advancing climate resilience across the state.

My heartfelt thanks to Dr. Kurian Joseph, Professor & Director, CCCDM, Dr. A. Ramachandran, Emeritus Professor, CCCDM, and the entire Climate Studio research team for their dedicated efforts in compiling this report. Their expertise and collaboration have ensured that this document serves as a strategic roadmap for informed decision-making and sustainable development in the district.

I also extend my gratitude to all the Government Line Departments, academic institutions, and other stakeholders for their invaluable contributions in providing critical data and insights. This collaborative endeavor underscores the shared responsibility of government, academia, and communities in creating a sustainable and resilient Mayiladuthurai District.

As we release this report, I urge all stakeholders to actively engage with its recommendations and transform its vision into tangible actions. Together, let us chart a course toward a future that not only meets the aspirations of our people but also preserves the integrity of our natural environment for generations to come.



(A.P. Mahabharathi)

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We humbly acknowledge Prof. Dr. R. Velraj, the Honourable Vice Chancellor, Dr. J. Prakash, Registrar, Anna University, Prof. Dr. K.P. Jaya, Head of the Department, Department of Civil Engineering, Dr. R. Saravanan, Professor, CWR and the adjunct faculty of CCCDM, Anna University, for their valuable inputs and expertise. A special mention of thanks to Ms. R.S. Sivaranjani, Green Fellow, Mayiladuthurai for district level support on data collection and stakeholder's meetings. Further, we acknowledge the support from the following departments for providing the necessary data for the completion of District Climate Action Plan for the key sectors of Mayiladuthurai:

- Department of Environment, Climate Change and Forests, Government of Tamil Nadu
- Indian Meteorological Department (IMD), Ministry of Earth Sciences, Government of India
- Central Ground Water Board, SECR, Ministry of Jal Shakthi, Department of Water Resources
- District Rural Development Agency, Mayiladuthurai
- Water Resources Department, Mayiladuthurai
- Tamil Nadu Water Supply and Drainage Board, Mayiladuthurai
- Department of Agriculture, Mayiladuthurai
- Department of Animal Husbandry, Mayiladuthurai
- Department of Horticulture, Mayiladuthurai
- Department of Fisheries and Fishermen Welfare, Mayiladuthurai
- Department of Rural Development, Mayiladuthurai
- Tamil Nadu Electricity Board, Mayiladuthurai
- Transport Department, Mayiladuthurai
- District Industrial Centre, Mayiladuthurai
- Department of Municipal Administration, Mayiladuthurai
- Department of Town Panchayat, Mayiladuthurai
- Tamil Nadu e-Governance Agency, Chennai
- Institute of Remote Sensing, Anna University

We sincerely thank other project staff and administrative staff of CCCDM for their continuous support towards the successful execution of the project.

EXECUTIVE SUMMARY

Climate change poses significant risks to local communities, necessitating urgent adaptation and mitigation efforts. A District Climate Action Plan provides a tailored response to these environmental challenges, promoting sustainable practices, coordinating resources, engaging stakeholders, and implementing policies aimed at reducing emissions and enhancing resilience. Such plans are vital to protecting ecosystems, infrastructure, and public health at the regional level.

In alignment with its Nationally Determined Contribution (NDC), Tamil Nadu has emerged as a leader in developing adaptation and mitigation strategies across various sectors. The Government of Tamil Nadu, using the IPCC's "Climate Change Risk Assessment" framework, has established the 'Climate Studio' at the Centre for Climate Change and Disaster Management (CCCDM), Department of Civil Engineering, Anna University. This is supported by Department of Environment and Climate Change (DoE&CC) with Rs. 3.80 crores. It is supported by GIZ, Germany, this state-of-the-art facility is equipped with high-performance computational resources and digital learning tools. The Climate Studio analyzes global climate data at the cadastral level, provides high-resolution regional climate scenarios, assesses climate change impacts on natural resources, and develops multi-sectoral spatial information for dissemination. To date, over 250 sectoral officials and thousands of participants have been trained, fostering a climate-resilient future for Tamil Nadu.

The comprehensive climate risk assessment for Tamil Nadu evaluated sectoral risks in water resources, agriculture, forests, coastal ecosystems, and sustainable habitats. Mayiladuthurai district ranks among the highest in climate risk, necessitating immediate district-level climate action. As a newly formed district, challenges range from data collection to developing a robust mitigation and adaptation framework. Despite these hurdles, a detailed District Climate Action Plan has been developed with data collected at the village level to ensure precision.

Mayiladuthurai faces increasing climate risks, with flood intensity projected to rise by 1.3 times in coastal villages and drought severity by 1.5 times in the Sembanarkoil and Kuthalam Block villages. Of the district's 247 villages, 75 are classified as high-risk for flooding and 129 for drought. Coastal villages are particularly vulnerable to flooding, exacerbated by groundwater over-extraction.

Mayiladuthurai is in the Cauvery Delta, and water management and sustainable agricultural practices are critical for ensuring long-term resilience and development. Rice is the primary crop grown during the Kuruvai and Samba seasons, alongside pulses, cotton, and groundnut. Irrigation methods vary, with inland areas relying on borewells and coastal blocks having lower cultivation. Climate change is expected to significantly affect rice varieties, with declines projected for Kuruvai season varieties ADT 43 (8.02-10.86%) and CO-51 (7.02-10.51%), and Samba season variety ADT 54 (9.78-14.20%). However, CR1009 Sub-1 shows resilience, with only a 3.67-4.96% reduction.

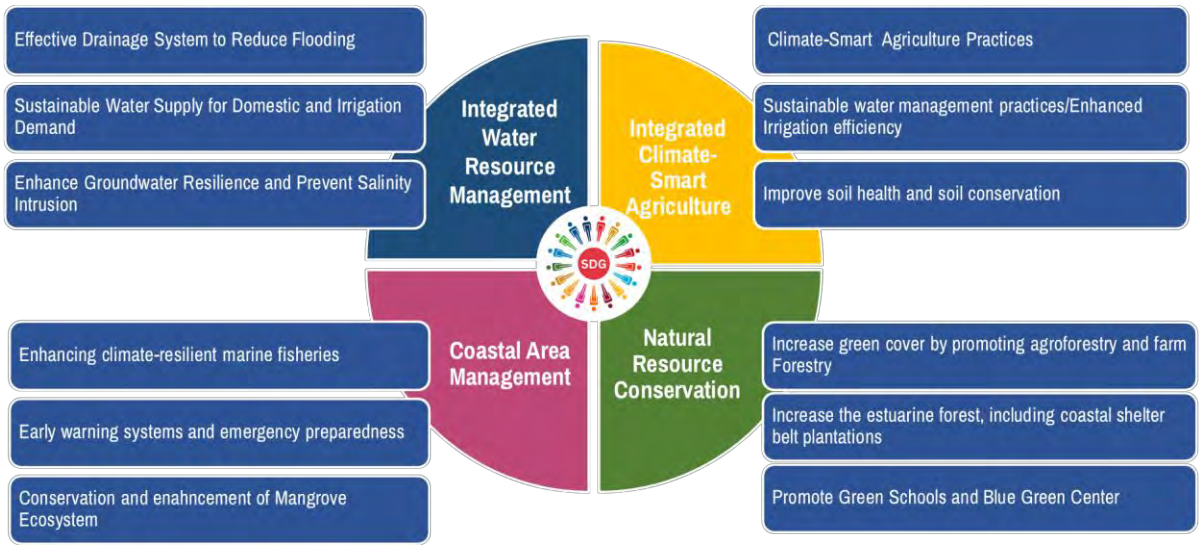
The Discomfort Index (DI), based on temperature and humidity data from 1985-2014, reveals that Mayiladuthurai experiences an average of 180 days of discomfort annually, with an increasing trend in the southern interior regions. This contrasts with northern coastal Tamil Nadu, where discomfort days range from 100 to 125, primarily during the summer and monsoon seasons. Rising discomfort levels pose health risks and increase energy consumption. Mayiladuthurai district has 4,255 hectares of tree cover, representing 3.63% of its land. This includes mangroves, Trees Outside Forests (TOF), and reserved forests. Riverside plantations account for 33%, while TOF covers 31%, contributing to agroforestry and carbon sequestration. Kollidam block has the highest tree cover, sequestering 2.02 Tg of CO_2, with the district's total at 4.55 Tg. Under the Green Tamil Nadu Mission, tree cover has increased to 4.27% (5,014 hectares), though a 25% deficit remains. Expanding native tree plantations on fallow land and enhancing mangroves offer further ecological benefits.

The Mayiladuthurai coastal stretch, part of the Coromandel Coast, spans 70.9 km across Kollidam, Sirkali, and Sembanarkoil blocks. This area includes diverse landscapes such as beaches, swamps, estuaries, and mangroves, with key fishing harbors in Poompuhar, Tharangambadi, and Pazhayar. Over 30 years (1992-2022), 3.69 km of the coast has experienced high erosion, 5.49 km moderate erosion, and 8.73 km low accretion, with an erosion rate of 2.7 m/year and accretion at 1.1 m/year. Sea level rise, projected at 20.3 cm by 2100 (SSP2 4.5 scenario), could inundate 398 ha of coastal ecosystems, including lagoons, creeks, and agricultural lands.

Village-level climate risk assessments reveal that Sembanarkoil block is the most vulnerable in Mayiladuthurai, primarily due to its coastal proximity, climate hazards (e.g., sea-level rise, erosion), water flow gaps, population density, and weak infrastructure. Twenty-four Gram Panchayats (GPs) are classified as very high climate risk, while 78 are high risk. Major climate risk drivers include floods, droughts, soil fertility, proximity to rivers, tree cover, water access, and agricultural productivity.

Greenhouse Gas (GHG) emissions are a major contributor to climate change, impacting global temperatures, weather patterns, and ecosystems. In Mayiladuthurai, GHG emissions for 2023 totaled 2.26 MtCO2e, with the energy sector responsible for 71% (1.3 $MtCO_2e$). Emissions from natural gas-based electricity generation accounted for 0.04 MtCO2e, and electricity consumption for 1.2 $MtCO_2e$, with agriculture consuming 65.3% of electricity. Transport emissions totaled 0.17 $MtCO_2e$, while solid waste (111 TPD) and wastewater emissions reached 0.06 $MtCO_2e$. The agricultural sector contributed 0.46 $MtCO_2e$ through rice cultivation, livestock, and urea fertilization. Industrial emissions, mainly from natural gas and crude oil production, were 0.01 $MtCO_2e$.

The climate action plan focuses on four key elements: integrated water resource management, climate-smart agriculture, natural resource conservation, and coastal area management. Key strategies for water management include sustainable water supply for domestic demand at 93.2% of households and 13161 households tap water connection by 2025, connecting the field channels (C & D) to improve water flow and storage, constructing 6 tail end regulators to ensure groundwater recharge and prevent salinity intrusion in the agricultural field, 1481 number of channels to be desilted annually before monsoon period.



Key element for climate adaptation action plan

For agriculture, strategies include promoting adaptive resilient rice varieties (e.g., CR1009 Sub-1, BPT 5204), promoting horticulture crop cultivation, Integrated water management strategies which are constructing the 7081 farm ponds, enhancing water use efficiency through cultivation and irrigation practices, and improving soil health to cultivate the green manure and green leaf manure. These interventions are vital for food security and sustainable livelihoods in the face of climate variability. For sustainable habitat, strengthen the health infrastructure, develop climate-responsive urban planning to reduce the heat stress in Mayiladuthurai, enhance the tourism infrastructure to support climate resilience and eco-tourism, and enhance wastewater management systems to prevent contamination and pollution. Reduce the impact of sea level rise and shoreline change as coastal management strategies.

Installation of 5 KW of solar-powered pumps for 24000 farmer fields, 3 KW of rooftop solar installations at 90000 households. The adoption of electric vehicles (EVs) will significantly reduce GHG emissions and contribute to a sustainable, low-carbon future for Mayiladuthurai. Implementing this District Climate Action Plan is crucial for safeguarding ecosystems, infrastructure, and public health against the impacts of climate change.

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CAP	Climate Action Plan	MFI	Mean Rainfall Intensity
CDD	Consecutive Dry Days	MLD	Million Liters Per Day
CERES	Crop Environment Resource Synthesis	mm	Mili meter
CROPGRO	Crop Growth Simulation Model	MT	Metric Tons
CWD	Consecutive Wet Days	MtCO2e	Metric Tons of CO2 Equivalent
DI	Discomfort Index	MSL	Mean Sea Level
DSSAT	Decision Support System for Agrotechnology Transfer	NCRC	National Coastal Restoration Committee
FHTC	Functional Household Tap Connections	NRCB	National Research Centre for Banana
GCM	Global Climate Model	PHC	Primary Health Centre
GA	Grand Anicut	Rx5	Maximum 5-day Precipitation
GDP	Gross Domestic Product	RX1	Maximum One-Day Rainfall
GHG	Greenhouse Gas	SDG	Sustainable Development Goals
GIS	Geographic Information System	SDI	Streamflow Drought Index
GP	Gram Panchayat	SLR	Sea Level Rise
ha	Hectares	SPI	Standard Precipitation Index
HSDO	High-Speed Diesel Oil	SPEI	Standard Precipitation Evapotranspiration Index
IMD	India Meteorological Department	SSP	Shared Socioeconomic Pathways
IPCC	Intergovernmental Panel on Climate Change	SWAT	Soil and Water Assessment Tool
lpcd	Litres Per Capita Per Day	TOF	Trees Outside Forests
LULC	Land Use Land Cover	TPD	Tons Per Day
LRR	Linear Regression Rate	TWAD	Tamil Nadu Water Supply and Drainage Board
MCM	Million Cubic Meters	%	Percentage
MCu.ft	Million Cubic Feet	°C	Degrees Celsius

1. INTRODUCTION

Mayiladuthurai, a district with a rich cultural heritage and vital agricultural base, faces significant challenges due to climate change. These include increased flooding, rising temperatures, and shifts in seasonal patterns, impacting agriculture, water resources, and local livelihoods. The district needs a comprehensive Climate Action Plan (CAP) that integrates climate mitigation and adaptation strategies to address these issues and achieve climate-compatible growth. This plan aims to position Mayiladuthurai towards a trillion-dollar economy by fostering sustainable development and resilience.

Vision and Goals

The vision of the Mayiladuthurai Climate Action Plan is to build a resilient, low-carbon economy that thrives amid climate change impacts (Figure.1). The goals include:

Climate Adaptation: Enhancing resilience to climate impacts by improving water management, agricultural practices, and infrastructure,

Climate Mitigation: Reducing greenhouse gas (GHG) emissions through energy efficiency, renewable energy, and sustainable practices.

Economic Growth: Promoting green technologies and sustainable practices to drive economic growth and move towards a trillion-dollar economy

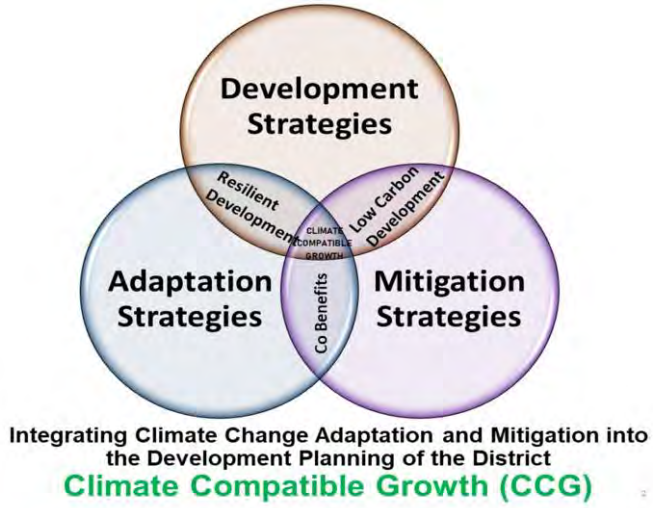


Figure 1 Climate Compatible Growth (CCG)

(Source: CCCDM, Anna University, Chennai)

1.1 DISTRICT AT A GLANCE

Mayiladuthurai became Tamil Nadu's 38th district following its bifurcation from Nagapattinam district on December 28, 2020, as per G.O.(Ms). No.796. The district is located between latitudes 10° 57' 00" N and 11° 26' 00" N and longitudes 79° 31' 00" E to 79° 55' 00" E, covering a geographical area of 1,181 sq. km. Positioned along the Coromandel Coast, it has a coastal stretch of 70.9 km, characterized by diverse coastal features, including beaches, beach ridges, mud flats, swamps, and backwaters (NCRC, 2007). Mayiladuthurai district is bordered by Cuddalore district to the north, Thanjavur district to the west, and the Bay of Bengal to the east. It has an average elevation of 10 meters (33 feet) above mean sea level (MSL). Often referred to as the "Land of Temples," the district's economy is largely driven by fishing and agriculture, benefiting from its long coastline and fertile lands. Administratively, the district is divided into two revenue divisions—Mayiladuthurai and Sirkali—and further subdivided into four taluks: Mayiladuthurai, Kuthalam, Sirkali, and Tharangambadi, which together encompass 287 revenue villages, as shown in Figure 2. The district has two municipalities—Mayiladuthurai and Sirkali—and includes four town panchayats: Vaitheeswaran Koil, Tharangambadi, Manalmedu, and Kuthalam. It is also organized into five blocks—Mayiladuthurai, Kuthalam, Sirkali, Kollidam, and Sembanorkoil—with 241 village panchayats. The district is characterized by mostly flat terrain with a slope of less than 1%, gently inclining towards the east and southeast. It boasts a 70.9 km coastline along its eastern edge and lies within the Cauvery River basin. Major rivers like the Cauvery, Kollidam, and Veerachozhanar flow through the district, making it a part of the Cauvery River Delta. The port town of Tharangambadi, noted for its historical importance, features architecture from the Danish era, reflecting the town's colonial past. The district's administrative, physiographic, and demographic details are summarized in Table 1.

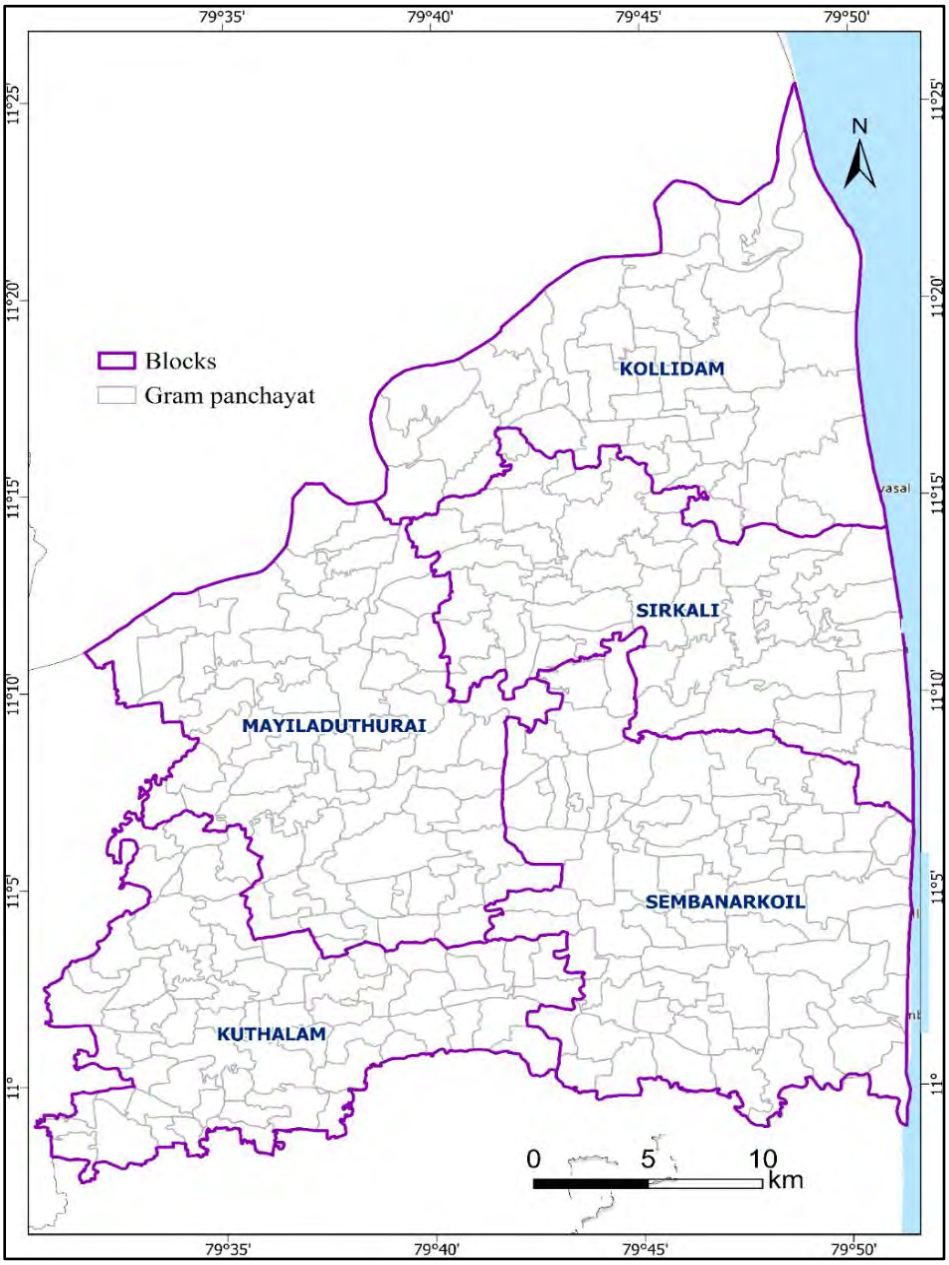


Figure 2 Base Map of Mayiladuthurai District

(Source: CCCDM, Anna University, Chennai)

Table 1 Mayiladuthurai District at a glance

Geographical Profile			
Latitude	11.1013	Area (sq. km)	1181
Longitude	79.6501	Elevation (Above MSL in m)	0 - 10
Administrative units			
Revenue Divisions (no's)	2	Taluk (no's)	4
Revenue Villages (no's)	287	Block (no's)	5
Firkas (no's)	15	Village Panchayats (no's)	241
Municipalities (no's)	2	Town Panchayats (no's)	4
Demography			
Total Population	918356	Population Density (per sq. km)	785
Population (Urban)	176568	Number of Household	230493
Population (Rural)	741788	% Urban	19.2
Climate			
Annual Average Rainfall (mm)	1238.1	Annual Average Temperature (°C)	33.3
Agriculture			
Agro-climatic zone	Cauvery delta Zone		
Soil Type	Alluvial, Sandy Loam and Sandy Clayey Loam		
Major crops	Paddy, Green gram, Black gram, Sugarcane, Banana, Cotton, Groundnut, Cashew nut and Coconut		
Water Resources			
Availability of canals (no's)	54 (A) & 170 (B)	Availability of Ponds (no's)	2000
Availability of tanks (no's)	2	Net Annual Groundwater Availability (MCM)	108.7
Availability of wells (no's)	13	Annual Groundwater Draft (MCM)	152.83
Per capita availability of water (LPCD)	55	Stage of Ground Water development (%)	130
Major Rivers	Cauvery and Kollidam		
Forest & Biodiversity			
Total Tree Cover (sq. km)	42.25	Percentage of District area under tree cover (%)	3.63
Reserved Forest Area (sq. km)	9.2	Tree outside the forest and Riverside Forest (sq. km)	27.44
Coastal			
Coastal Length (km)	70.9	Area covered by mangroves (sq. km)	560
Major Fishing Harbors	Poompuhar, Tharangambadi, Pazhayar	Marine Fish Production (Quantity in Tons)	8512
Sustainable Health & Urban Habitat			
Primary Health Centres (PHCs)	48	District Government Hospital	10

(Sources: Statistical Handbook of Mayiladuthurai,2023; Census of India, 2011)

1.2 DEMOGRAPHIC PROFILE

As per the Census of India 2011, the district has a population of 9.18 Lakh, which accounts for 1.3 percent of Tamil Nadu's population. The female population is marginally higher than the male population in all the five blocks of the district. The share of the rural population in the district is 80.8 percent, whereas the share of the urban population is 19.2 percent. The coastal village population of the district is 41278, which is 4.49 percent of the district's total population (Figure 3).

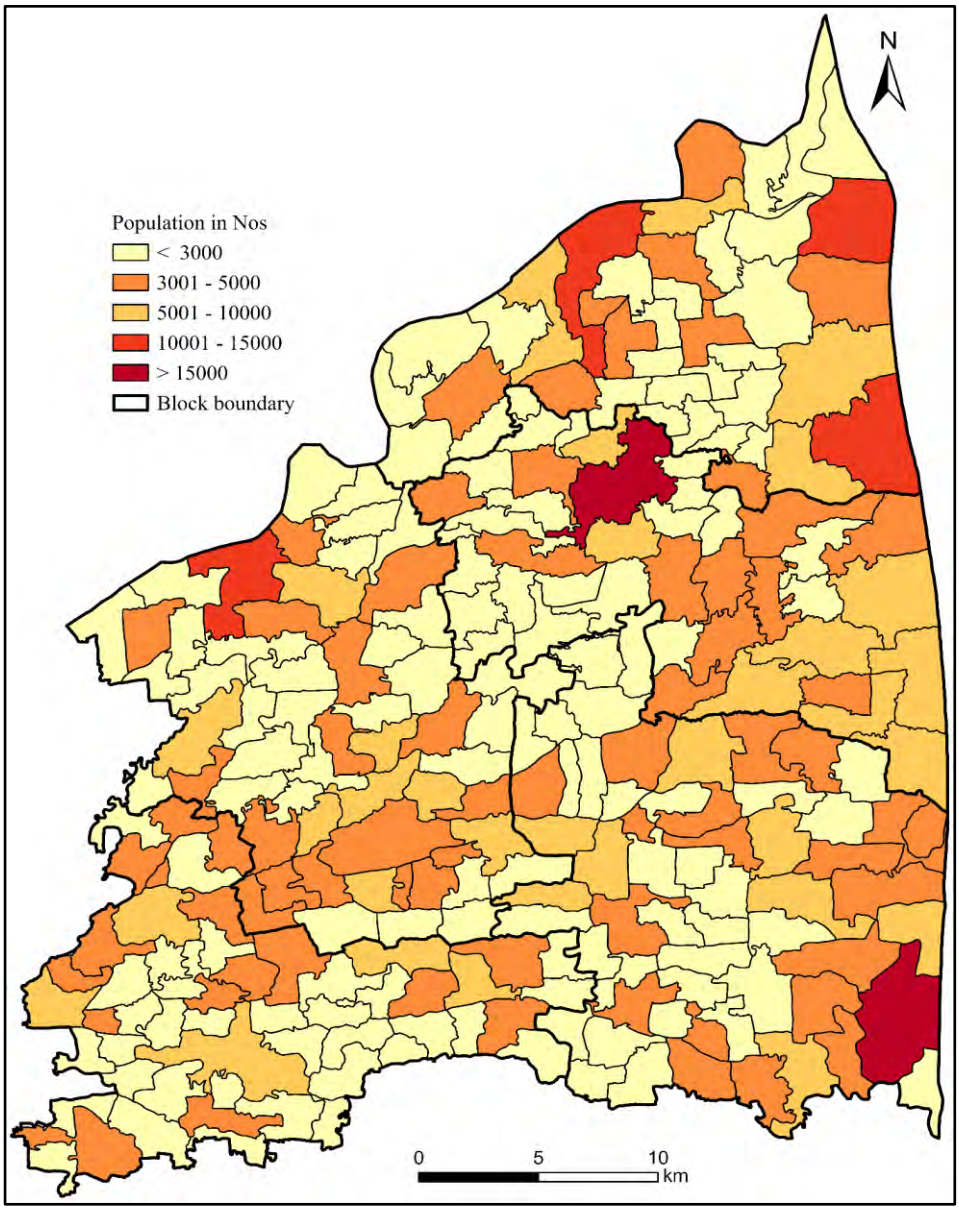


Figure 3 Population Distribution in Mayiladuthurai

The district has a population density of 785 people per sq. km, whereas the state has only 555 persons per sq. km. In 2011, out of the total population, the Scheduled Caste population constituted 32 percent, and the Scheduled tribe population constituted 0.2 percent of the district's total population. The effective literacy rate of the district is 75 percent (Male:39 percent, Female:36 percent) as per Census 2011. The sex ratio of the district is 1029 Female/1000 Male, which is against the state sex ratio of 996F/1000M. Also, the block-level demographic profile of the district is outlined in Table 2.

Table 2 Demographic profile of Mayiladuthurai (block level)

Indicators	Block Name					District Total
	Mayiladuthurai	Sembanarkoil	Sirkali	Kuthalam	Kollidam	
Population (Persons)	259634	200634	171371	148846	137871	918356
Rural Population (%)	64	88	75	89	100	80.8
Urban Population (%)	36	12	25	11	0	19.2
Population Density (person per sq.km)	1000	742.55	818	750.57	587	785
No. of Households	65163	50583	43256	32952	41894	230493
% of Scheduled Caste Population	29	31	35	32	38	32
% of Scheduled Tribe Population	0.4	0.03	0.3	0.05	0.4	0.2
Sex Ratio (per 1000 Males)	1024	1038	1017	1034	1033	1029
Literacy Rate (%)	78	75	74	75	70	75
Male Literacy Rate (%)	41	39	39	40	37	39
Female Literacy Rate (%)	37	36	35	35	33	36

(Source: Census of India, 2011)

1.3 LAND USE LAND COVER PROFILE

Mayiladuthurai district, located in Tamil Nadu, primarily consists of agricultural land, with paddy fields dominating due to irrigation from the Cauvery River and its tributaries. Other crops include sugarcane, pulses, cotton, and groundnut, along with plantations of coconut and banana. The district has limited forest cover but features riparian vegetation along riverbanks. It also has a network of canals, tanks, and wetlands that support agriculture and wildlife. Urban areas are small, with Mayiladuthurai town being the primary urban center. The district's coastline supports fishing villages and small patches of mangroves. Overall, agriculture, water bodies, and coastal ecosystems shape the region's land use and cover, as shown in Figure 4.

From Table 3, the Land Use and Land Cover (LULC) data for the Mayiladuthurai district shows that agricultural land dominates, covering 85,544.27 hectares (72.4% of the total area), reflecting the district's reliance on farming. Built-up areas, including urban settlements, account for 16,302.07 hectares (13.8%). Wastelands cover 9,249.99 hectares (7.8%), indicating unused or degraded land, while water bodies such as rivers and lakes span 6,469.30 hectares (5.5%). Forested areas are minimal, occupying only 620.58 hectares (0.5%), highlighting limited forest cover in the district.

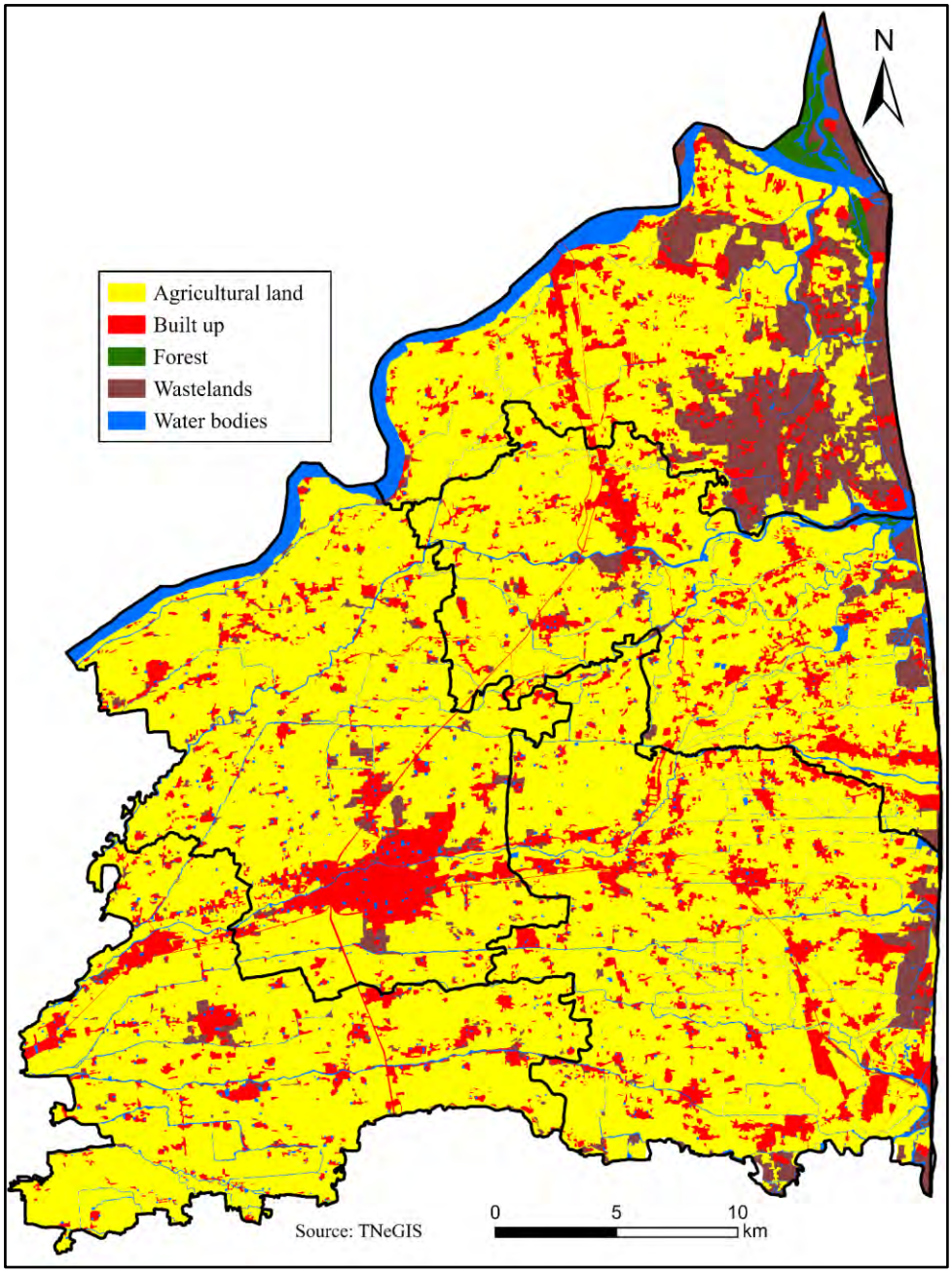


Figure 4 Land use and Land cover (LULC) of Mayiladuthurai

Table 3 Level-1 Classification of LULC - Mayiladuthurai

S. No	NRSC LULC (Level 1) Classification	Area (ha)	Percentage
1.	Agricultural land	85544.27	72.38
2.	Built up	16302.07	13.79
3.	Forest	620.58	0.53
4.	Wastelands	9249.99	7.83
5.	Water bodies	6469.30	5.47
	Total	118186	

Figure 5 shows the nine-fold classification of Mayiladuthurai, which is a land use pattern. The net cultivated area is 72899 ha, the non-agricultural use is 23661 ha, and the fallow land is 14101 ha.

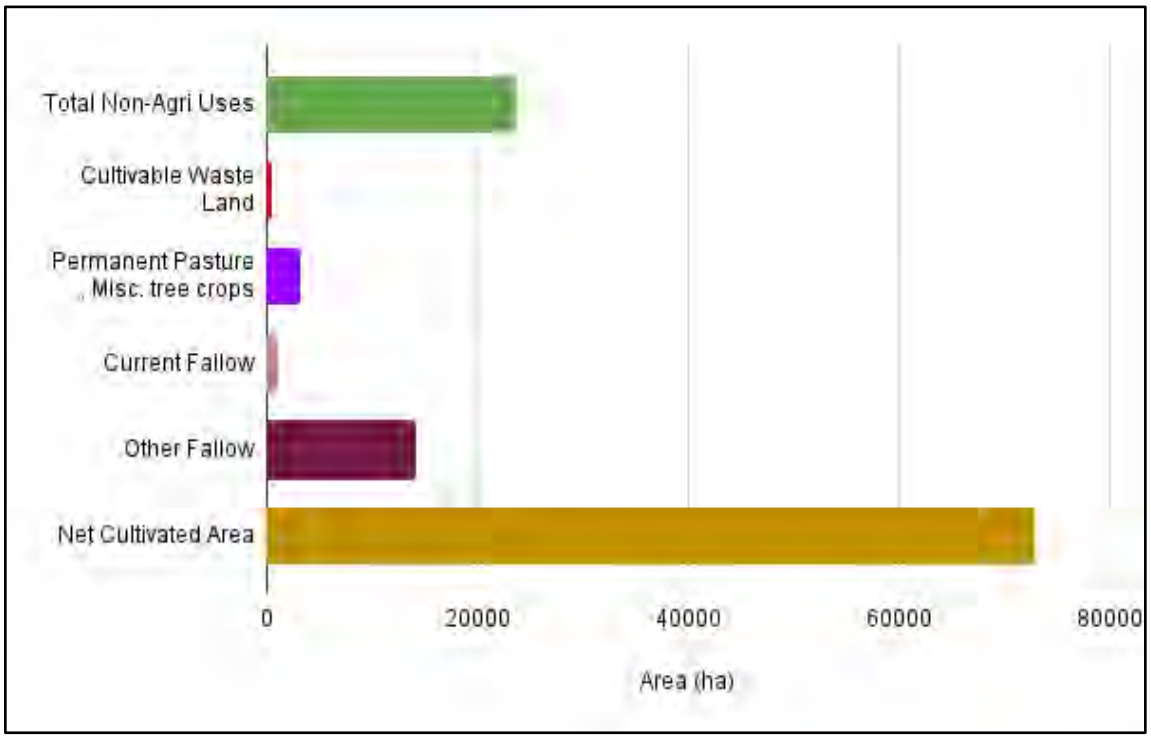


Figure 5 Nine-fold LULC classification

(Source: G Return of Mayiladuthurai)

1.4 ECONOMIC PROFILE

The economy is primarily driven by agriculture, with rice as the predominant crop, followed by pulses such as black gram and green gram. The district also grows cotton, groundnut, bananas, coconuts, and other horticultural products. The Cauvery Delta plays a vital role in supporting agricultural activities. Fishing is another important occupation, especially in the coastal villages. Handloom weaving, particularly saree production, is also a traditional industry.

a. Socio-Economic Aspects: Mayiladuthurai district, primarily agricultural, has a population of 918,356, with the majority residing in rural areas. Agriculture remains the backbone of the economy, with paddy, sugarcane, and pulses as the major crops. The district also has a small yet notable industrial presence, including small-scale industries and fisheries, contributing to local employment and income.

b. Tourism: The district is rich in historical and cultural heritage, housing several significant temples and shrines, such as the Mayuranathar and Vaithiyanathar. The Tharangambadi Danish Port and Poombukar Art Gallery also attract tourists interested in the region's colonial history and art.

1.5 NATURAL RESOURCES

Mayiladuthurai district, Tamil Nadu, is rich in agricultural resources with fertile soils and extensive irrigation from the Cauvery River. Key crops include rice, sugarcane, and pulses, supported by canal and groundwater systems. The district also has a strong fisheries sector due to its coastal access. Limited forestry and small-scale sand mining contribute to the local economy. Coastal ecosystems and agriculture dominate the district's natural resource base.

1.5.1 Water Resources

Mayiladuthurai district, situated in the Cauvery Delta region of Tamil Nadu, is a predominantly agricultural area with a rich water resource network vital to its economy and livelihood. The Cauvery River, flowing through the district, is the principal water source, supporting extensive paddy fields and other crops that depend on its seasonal flow. The river's distributaries, such as the Kollidam and numerous canals within the district, play a crucial role in distributing water across the region. This intricate network of waterways not only sustains agriculture but also serves as a critical source of drinking water and supports a variety of local industries, including fisheries and traditional handicrafts.

1.5.1.1 Surface Water Resources

Mayiladuthurai district, located at the tail end of the Cauvery River within the Cauvery basin, encompasses the subbasins of the Cauvery Delta and Coleroon. The district's catchment area begins at the Grand Anicut (GA) Canal on the Cauvery River, which distributes water flow as illustrated in Figure 6. The water resources of Mayiladuthurai are supported by 13 distributary rivers, also known as seasonal rivers, including the Cauvery, Veeracholanar, Manjalar, Mahimalayar, Vikramanar, Ayyavaiyanar, Manniar, Palavar, Odaiyar, Pudumanniyar, Nandalar, K.K. Manniar, and Southrajan Channel. Additionally, the significant Kollidam River runs parallel to the district's northern boundary, providing water for agricultural, domestic, and commercial needs. These distributaries are interconnected by canals and regulated by control structures to ensure an efficient water supply throughout the district, meeting the irrigation demands. The river flow and geotagged locations of these regulators within the Mayiladuthurai district are mapped in Figure 7. During the southwest monsoon season, river flow begins in July and is driven by releases from the GA canal. This flow continues and reaches its peak during the northeast monsoon, maintaining full river flow until January.

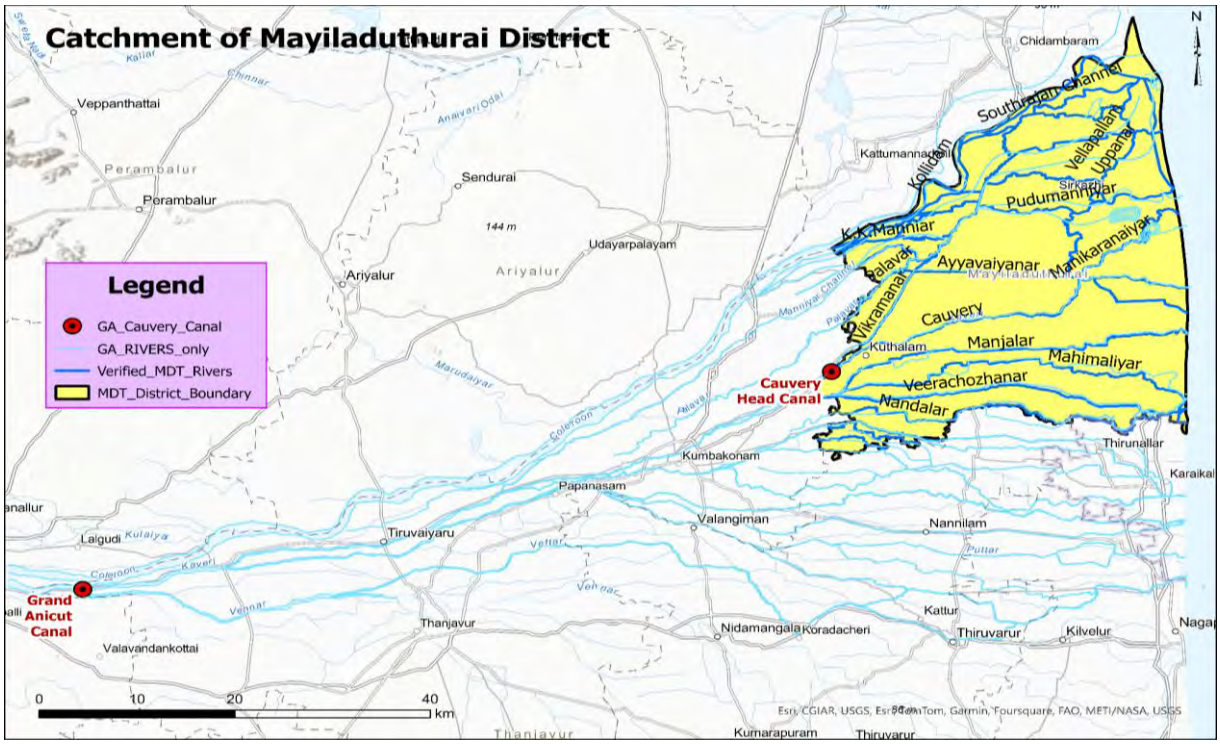


Figure 6 Catchment area of Cauvery River for the Mayiladuthurai district

Figure 7 River Profile of Mayiladuthurai

1.5.1.2 Groundwater Resources

In addition to the surface water from the Cauvery, Mayiladuthurai district relies heavily on groundwater resources. It lies at a low elevation, generally from 0 to 15 meters above sea level. The terrain is relatively flat, with a gentle slope towards the Bay of Bengal, facilitating the flow of rivers and distribution channels across the district. Therefore, the groundwater is primarily stored in shallow alluvial aquifers, which consist of sand, silt, and clay deposits. These aquifers are typically unconfined, and the groundwater depth can vary but is usually found at shallow levels (< 20m), making it accessible for agricultural and domestic use (Figure 8). The district has many open and bore wells, essential for irrigation, especially during dry spells (February to May) when river water is scarce. However, this reliance on groundwater has led to significant challenges. Over-extraction of groundwater has resulted in declining water tables in some areas (Figure 9), raising concerns about the long-term sustainability of these resources. Groundwater extraction and contamination are severe problems in the Mayiladuthurai district due to the lesser availability of surface water and difficulty meeting water demand.

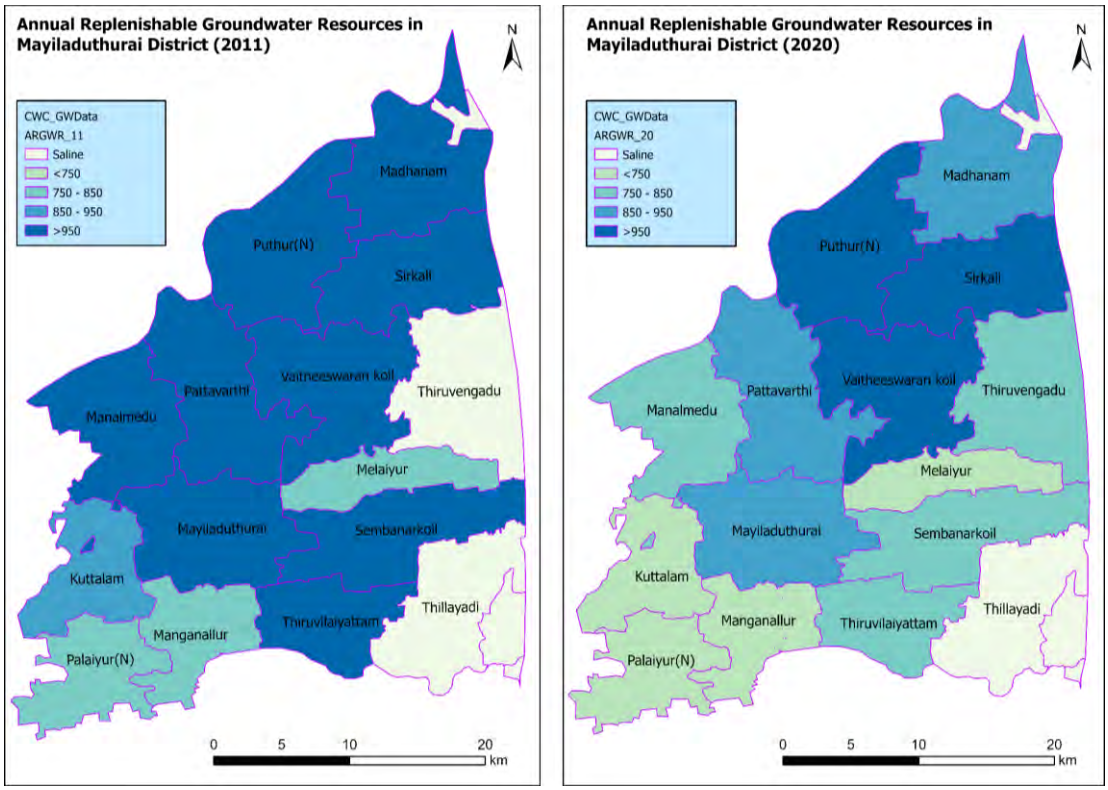


Figure 8 Annual replenishable groundwater resources status of Mayiladuthurai district during 2011 and 2020

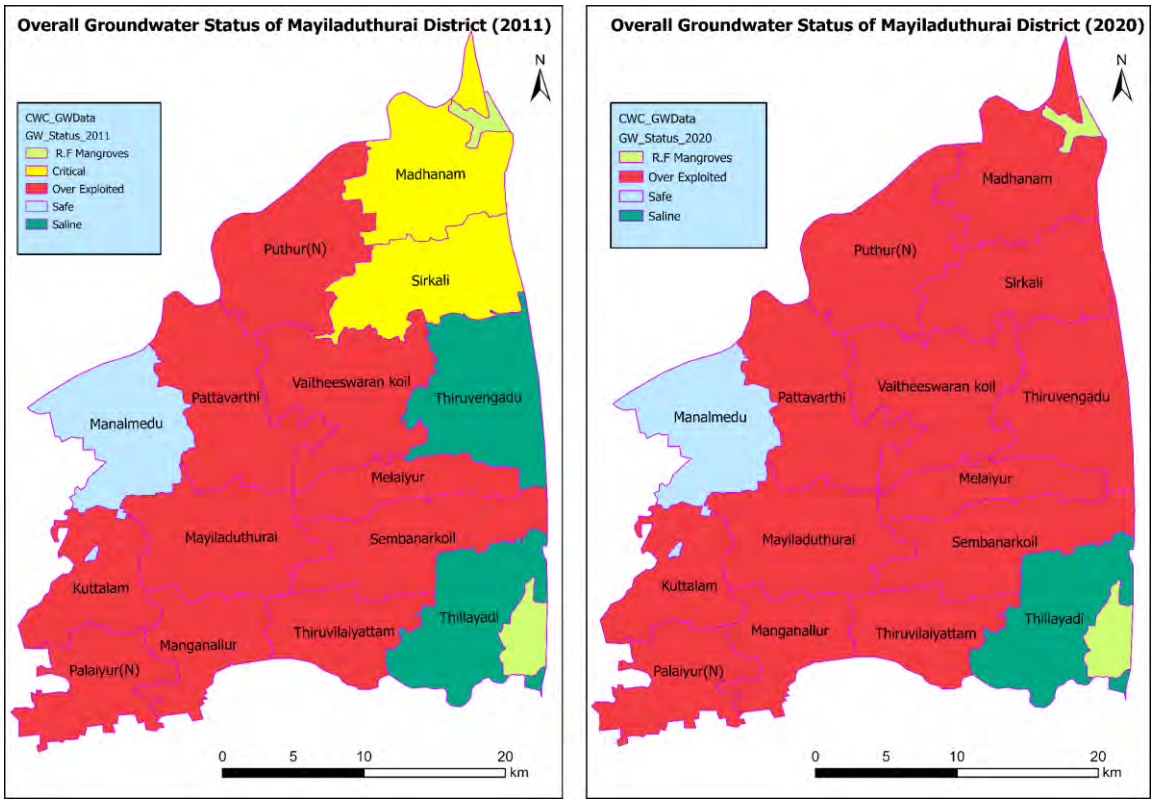


Figure 9 Groundwater Status of Mayiladuthurai District - 2011 vs 2020

1.5.2 Sustainable Agriculture

Mayiladuthurai district has a rich and diverse agricultural landscape, with approximately 71.9% of its land area dedicated to farming activities. The district's favorable climate, extensive irrigation infrastructure, and varied cropping patterns shape the district's agriculture. The agricultural landscape of the Mayiladuthurai district is distinguished by a diverse cropping pattern (Table 4), with rice (Oryza sativa L.) serving as the predominant crop. Paddy cultivation is the primary agricultural activity, with the Samba season (August to January) contributing to 41% of the total cultivated area and the Kuruvai season (June to August) accounting for 23%. This bimodal cropping strategy optimizes land utilization and leverages the region's favorable climatic conditions. Pulses, mainly black gram (Vigna mungo L.) and green gram (Vigna radiata L.), are critical in enhancing crop diversification, covering 13% of the cultivated area. Additionally, cotton (Gossypium spp.) is a significant component of the agricultural system, occupying 7% of the land area, while other crops, including groundnut (Arachis hypogaea L.), comprise the remaining 3% (Table 4).

Table 4 Cultivable Crop Area of Mayiladuthurai

S. No	Crop classification	Area (ha)
	Cultivable Area	72899
1.	PADDY	
	Kuruvai	37901
	Samba/ Thaladi	68510
	Summer	126
	Total	106538
2.	MILLET	
	Sorghum	10.68
	Maize	21
	Ragi	0.5
3.	PULSES	
	Black gram	24304
	Green gram	24740
	Total	49045
4.	OILSEED	
	Groundnut	1018
	Gingelly	322
	Soyabean	106
	Total Oilseed	1446
5.	COTTON	6871
6.	SUGARCANE	468
7.	HORTICULTURE	1547

(Source: Department of Agriculture, TN, G-return, Mayiladuthurai)

The Samba/Thaladi cultivation dominates, ranging from 53% to 83% of the total rice-growing area, with Kollidam block leading at 83%. Kuruvai cultivation is significant in Kuthalam (47%) and Mayiladuthurai (44%) blocks, suggesting favorable conditions for early-season rice (Table.5). While Samba's prevalence underscores its critical role in local agriculture and food security, the substantial Kuruvai cultivation in some blocks highlights its importance in diversifying production and mitigating mono-seasonal risks.

Table 5 Block-level paddy cultivable area

Block	Mayiladudurai	Sirkali	Kollidam	Sembanarkoil	Kuthalam
Kuruvai	11786	4117	2551	7557	12209
Samba/Thaladi	14845	11890	12602	15715	13539
Summer		14.425	99.05	13.375	13
Total	26632	16021	15252	23285	25762

(Source: G Return of Mayiladuthurai)

The agroecosystem of the Mayiladuthurai district exhibits a heterogeneous distribution of irrigated (22,974 ha) and rainfed (9,813 ha) cultivation systems. Within the irrigated regime, Rice predominates, occupying 21,308 ha, with tri-seasonal cultivation: Kuruvai (7,580 ha), Samba/Thaladi (13,702 ha), and a minor summer crop (25 ha). Secondary irrigated crops include cotton 1,374 ha, groundnut, 203 ha, and Sugarcane, 84 ha. The rainfed agroecosystems are primarily allocated to leguminous (Pulse) crops, specifically black gram, 4,861 ha, and green gram, 4,948 ha. This spatial distribution underscores the district's dependence on irrigation for its principal cereal crop while demonstrating the adaptation of drought-tolerant legumes to non-irrigated conditions. The diverse cropping pattern across hydrological regimes reflects an agricultural strategy to optimize productivity while efficiently managing water resources.

1.5.3 Forest Ecosystem

In Mayiladuthurai district, the tree cover extends across 4,255 hectares, representing 3.63% of the total land available for utilization. Reserved Forests account for a significant portion of the tree cover, comprising 22%, or 922 hectares. These areas are legally protected and managed to conserve biodiversity and maintain ecological balance. Mangrove forests are vital to the region's ecosystem, contributing 13% (560 hectares) to the district's tree cover. These coastal forests provide essential services such as shoreline protection and support to fisheries and act as crucial carbon sinks in mitigating climate change.

A substantial 31% (1,342 hectares) of the tree cover is categorized as Trees Outside Forests (TOF). These trees are found in agricultural lands, urban areas, and along roadsides, forming a key element in agroforestry systems, enhancing biodiversity and carbon sequestration outside formally designated forest lands. TOF represents an essential resource in improving livelihoods, providing timber, fruit, and other products while enhancing non-forest lands' ecological value. Although bamboo plantations cover a relatively small area of just 29 hectares (0.7%), they contribute to economic activities and the region's environmental health. Bamboo is a fast-growing species essential in soil conservation and flood control and provides raw materials for various industries. Riverside plantations contribute the largest share, making up 33% of the district's tree cover, a total of 1,402 hectares (Figure 10). These plantations are natural buffers against soil erosion, particularly in areas susceptible to flooding. They also provide habitats for wildlife and contribute to the overall biodiversity of the region.

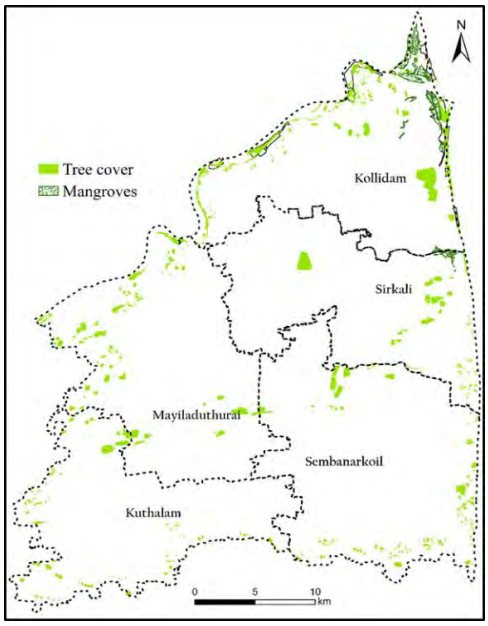


Figure 10 Tree Cover Spatial Extent of Mayiladuthurai District

(Source: Sentinel 2A data, 2024)

Dry deciduous forests are the principal forest type found in the Mayiladuthurai district. These forests are characteristic of the region's semi-arid climate, with trees shedding their leaves during dry seasons to conserve water. These forests, combined with managed vegetation like TOF and riverside plantations, are tabulated in Table 6. They play a crucial role in sustaining the district's tree cover and enhancing its environmental resilience.

Table 6 Categorize wise Tree cover Area of Mayiladuthurai District

S. No	Tree Cover Categorization	Area (ha)	Percentage of Tree Cover (%)
1.	Reserved Forest	922	22
2.	Mangroves	560	13
3.	Trees Outside Forests (TOF)	1342	31
4.	Bamboo	29	01
5.	Riverside plantation	1402	33
Total		4255	

(Source: Forest Department, Mayiladuthurai District)

1.5.4 Coastal Management

The coastal stretch of Mayiladuthurai district, part of the Coromandel Coast, extends 70.9 km and encompasses three blocks: Kollidam, Sirkali, and Sembanarkoil. It is located between the Kollidam River to the north and Karaikal to the south (Figure 11). The Mayiladuthurai coastal plain predominantly covers the district and features a variety of landscapes, including beaches, beach ridges, mud flats, swamps, and backwaters (NCRC, 2007). The district's Key fishing harbors are in Poompuhar, Tharangambadi, and Pazhayar. There are 28 coastal villages with a total population of 41,278, accounting for 4.49 percent of the district's overall population.

The coastal region exhibits diverse topography: beach terraces, low cliffs, sandy beaches, dunes, estuaries, and mangrove and casuarina forests. The district has a mangrove cover of 560 hectares, primarily located in Pazhayar and Thirumulaivasal. It also features two estuaries: Uppanar and Pazhayar. The coastline serves as a shelterbelt for the olive ridley turtle nesting site. Additionally, 402 registered shrimp farmers are along the coastline, utilizing an area of 738 hectares.

Figure 11 Coastal profile map of Mayiladuthurai District

1.5.5 Environment and Health

Environment and health in the Mayiladuthurai district are pivotal aspects of the region's development, focusing on creating resilient communities while preserving environmental integrity. The district, known for its rich cultural heritage and agricultural prominence, is increasingly prioritizing sustainable practices to address the challenges of climate change and rapid urbanization.

a. Status of Wastewater and Water Quality: The district faces challenges in wastewater management, with many areas relying on untreated water discharge into local water bodies. Only a few large-scale reservoirs and tanks suggest limited infrastructure for comprehensive wastewater treatment (District Statistical Handbook of Mayiladuthurai, 2022-2023).

b. Air Quality: While detailed air quality data for Mayiladuthurai is not readily available, the district's rural nature and absence of significant industrial pollution sources suggest that air quality remains largely within safe limits (District Statistical Handbook of Mayiladuthurai, 2022-2023). However, seasonal agricultural activities and vehicular emissions may contribute to fluctuations in air quality, particularly during peak seasons.

c. Waste Management: Waste management in Mayiladuthurai district is mainly dependent on sanitary workers and vehicles engaged in garbage and sewage disposal, with an organized system in place across the municipalities and town panchayats (District Statistical handbook of Mayiladuthurai, 2022-2023).

d. Health: Mayiladuthurai has a network of healthcare facilities, including ten government hospitals, 48 primary health centers, and 157 health sub-centers. With a bed strength of 1,146, the district faces a moderate burden of diseases but is equipped with essential healthcare services. Infant mortality data was unavailable, highlighting a gap in health-related statistics.

Efforts in Mayiladuthurai include promoting eco-friendly construction techniques, enhancing green cover, and improving waste management systems to create sustainable habitats. Health initiatives in the district are equally vital, aiming to ensure access to clean water, sanitation, and healthcare services, which are essential for improving public health outcomes. Integrating traditional knowledge with modern practices is crucial in fostering a healthy environment, contributing to the population's overall well-being. Collaborative

efforts between government bodies, local communities, and non-governmental organizations are key to advancing sustainable habitat and health initiatives, ensuring that the Mayiladuthurai district can thrive in a sustainable and healthy future.

1.6 APPROACH AND METHODOLOGY - DISTRICT CLIMATE ACTION PLAN

The Mayiladuthurai District Climate Action Plan is developed using a comprehensive methodology that aligns local needs with state, national, and international climate policies and commitments. This approach ensures that our district's efforts contribute meaningfully to broader climate action goals while addressing specific local challenges and opportunities. The Methodology Framework and its description are shown in Figure 12. The Development of District Climate action plan is built on four key pillars:

1) Establishing baseline emissions and carbon neutrality strategy
2) Assessing climate risks and developing adaptation plans
3) Defining governance structures and partnerships
4) Engaging the community and highlighting co-benefits

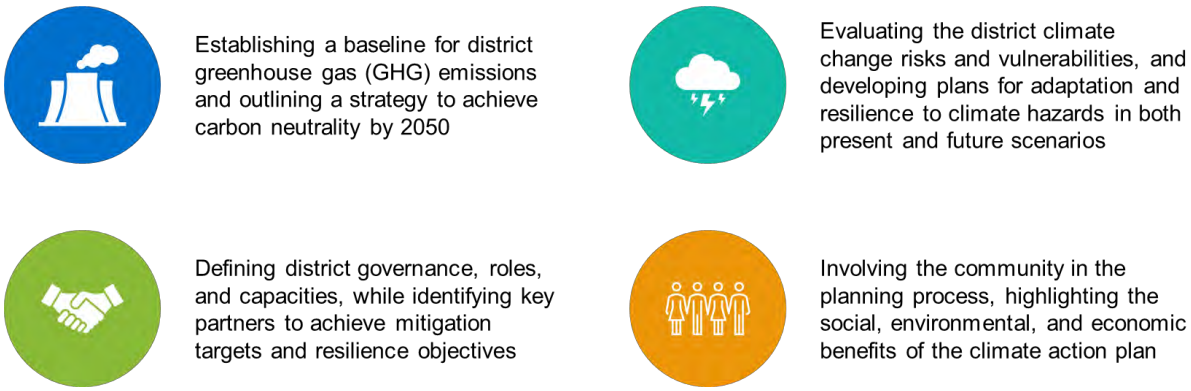


Figure 12 District Climate Action Plan Framework

Each pillar is designed to integrate with relevant frameworks, including the Tamil Nadu State Action Plan on Climate Change (TNSAPCC), India's Nationally Determined Contributions (NDCs), the Paris Agreement, and the Sustainable Development Goals (SDGs).

1.6.1 Establishing Baseline GHG Emissions and Carbon Neutrality Strategy

Conduct comprehensive GHG inventory across key sectors. Set 2023 as the baseline year. Align reduction targets with India's NDCs and India's 2050 net-zero goal

a. District-wide GHG Inventory

A comprehensive greenhouse gas (GHG) inventory for Mayiladuthurai District using methodologies aligned with the Intergovernmental Panel on Climate Change (IPCC) guidelines. The emission calculation methodology for evaluating the policies has been derived from the 2006 IPCC Guidelines, peer-reviewed papers on policy impact evaluation, briefing papers, and Phase III work of GHGPI. This inventory covers key sectors, including (Figure 13)

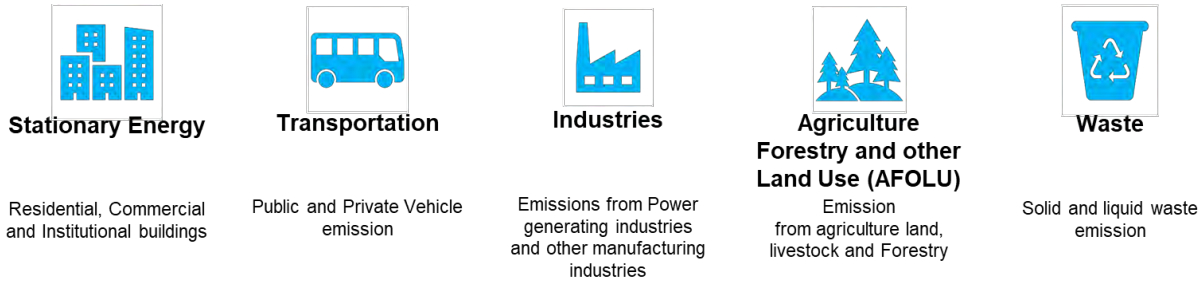


Figure 13 Major Sectors Addressing GHG Inventory

The inventory provides a baseline year (2023) assessment of our district's emissions, serving as a foundation for target-setting and progress monitoring.

b. Alignment with National and State Goals

Our emissions reduction targets are set by India's revised NDCs, which aim for net-zero emissions by 2050. We've established interim targets aligning with national goals and the TNSAPCC, ensuring our district contributes proportionally to state and national climate objectives.

c. Sector-specific Strategies

Based on the baseline inventory results, sector-specific strategies for emissions reduction have been developed. These strategies consider local contexts while drawing inspiration from best practices outlined in India's Long-Term Low Emission Development Strategy (LT-LEDS).

1.6.2 Climate Risk Assessment and Adaptation Planning

The IPCC risk assessment framework (Figure 14) was adopted to analyze village hazard and vulnerability in Mayiladuthurai District. This risk assessment consists of hazard, exposure, vulnerability (sensitivity and adaptive capacity), and responses

a. Risk Assessment

- Climate Hazard Assessment (Flood, Drought, Climate Extremities)
- Vulnerability Assessment (Biophysical, Institutional and Socio-economic)

Figure 14 Risk assessment framework

b. Adaptation Strategy Development

We developed a comprehensive adaptation strategy for the Agriculture, Water Resources, Forestry, and Coastal sectors based on climate risk assessment. This strategy:

- Aligns with the National Adaptation Fund for Climate Change guidelines
- Integrates with relevant SDGs, National and State Schemes
- Considers both short-term resilience and long-term adaptive capacity

The identified adaptation strategies are integrated into broader district development plans to ensure climate resilience is mainstreamed across all sectors.

1.6.3 Governance, Roles, and Partnerships

Effective governance and robust partnerships are crucial for implementing a Climate Action Plan. The following are the team's roles and responsibilities.

a. Institutional Structure

A District Climate Change Cell will oversee the implementation of the Climate Action Plan.

- Reports directly to the District Collector
- Includes representatives from key government departments
- Liaises with state-level climate change authorities

b. Stakeholder Mapping and Engagement

A comprehensive stakeholder mapping to identify key partners for enabling the climate action plan, from:

- Government departments
- Industry and business associations
- Academic and research institutions
- Civil society organizations
- Community groups

Each stakeholder's role in plan implementation is clearly defined, with mechanisms for regular engagement and feedback.

1.6.4 Community Engagement and Co-benefits

Community engagement is central to the success of the district's Climate Action Plan, and This approach ensures local ownership, strengthens resilience and promotes long-term sustainability.

- Develop a participatory planning process.
- Highlight linkages between climate action and other SDGs
- Emphasize local benefits of climate action

2. CLIMATE PROFILE OF MAYILADUTHURAI

2.1 TEMPERATURE PROFILE

2.1.1 Observed Maximum Temperature

The annual mean maximum temperature of Mayiladuthurai for the baseline period (1985 to 2014) is 33.3°C, and the trend indicates an increase in maximum temperature by 0.3°C (Figure 15).

Figure 15 Maximum Temperature Trend of Mayiladuthurai (1985 -2014)

2.1.2 Observed Minimum Temperature

The annual mean minimum temperature of Mayiladuthurai for the baseline period (1985 to 2014) is 23.9°C, and the trend indicates an increase in minimum temperature by 0.3°C (Figure 16).

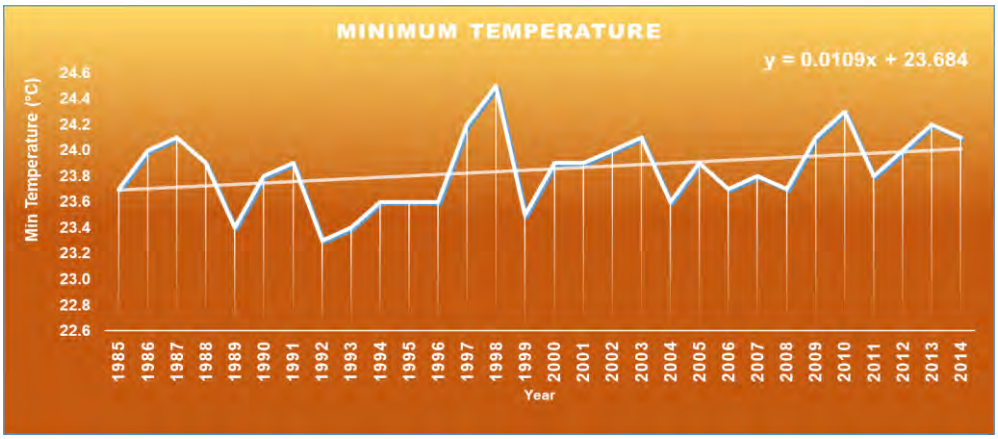


Figure 16 Minimum Temperature Trend of Mayiladuthurai (1985 -2014)

To assess scientific, technical, and socio-economic information relevant to the understanding of climate change impacts, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly established IPCC in 1988. The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical, and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. The latest IPCC AR6 report projects socio-economic global changes using Shared Socioeconomic Pathways (SSPs) Scenarios (IPCC 2016). The SSPs provide five distinctly different pathways (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5) about future socio-economic developments as they might unfold in the absence of explicit additional policies and measures to limit climate forcing or to enhance adaptive capacity- adopted by IPCC-AR6.

The IPCC in collaboration with the global scientific community has developed General or Global Circulation Models (GCMs) based on the latest assessment reports to understand present climate and future climate under different scenarios of IPCC. GCMs are most widely used for projecting the future of the Earth's climate. The limitation of GCMs is that spatial resolution is generally quite coarse, with a grid size of about 100–500 kilometres and it is generally unsuitable for simulating local climate since many important phenomena occur at spatial scales less than 50 km. Thus, downscaling techniques have been developed that take the large-scale predictions provided by a GCM and apply methods to extract implied climate change information at more regional/local scales. Downscaling techniques can be either Statistical Downscaling or Dynamical Downscaling to get the regional/local scale information at a high resolution. The future climate projections generated by regional climate models are primary for the assessment of climate change impacts on sectors such as Water Resources, Agriculture, Forestry, and Coastal ecosystems.

The GCMs from the Coupled Model Intercomparison Project Phase 6(CMIP6) repository are selected based on the previous research and with the nominal resolution of (100 x 100) sq. km to downscale it to the probable highest resolution. The selected models are spatially and statistically evaluated using Root Mean Square Error (RMSE) and spatial correlation coefficient(R) for the ranking of the best model. Based on the statistical and spatial evaluation, the EC-Earth3 model is selected as the best model for downscaling to the higher resolution. The GCM model is statistically downscaled from 100×100 sq. km spatial resolution to 25×25 sq.km for Tamil Nadu for the shared socio-economic pathway scenario SSP2-4.5 and SSP5-8.5 of IPCC AR6 and the projections were analysed from 2015-2100. The detailed methodologies are available at: https://www.annauniv.edu/cccdm/img/event/reports/draft/modelling.pdf

The downscaled climate parameters such as maximum temperature, minimum temperature and precipitation, have been projected for Mayiladuthurai district for the near century (2021-2050), mid-century

(2051-2080), and end-century (2081-2100) with reference to the baseline (1985-2014). Further, the projected data are utilized for the impact assessment of each sectors such as Water resources, Agriculture, Coastal and Forestry.

2.1.3 Maximum Temperature Projections

The maximum temperature projections imply that by the end of the century, the maximum temperature will increase by 1.6°C and 4.1°C under the SSP2-4.5 and SSP5-8.5 scenarios (Table 7).

Table 7 Maximum Temperature Projections of Mayiladuthurai

Projection period	Increase in Annual Average Maximum Temperature (°C)	
	SSP2-4.5	SSP2-8.5
Near Century (2021-2050)	0.4	0.7
Mid Century (2051-2080)	1.1	2.0
End Century (2081-2100)	1.6	4.1

2.1.4 Minimum Temperature Projections

The projections of minimum temperature imply that by the end of the century, minimum temperature will be increased by 2.1°C and 4.3°C under SSP2-4.5 and SSP5-8.5 scenarios (Table 8).

Table 8 Minimum Temperature Projections of Mayiladuthurai

Projection period	Increase in Annual Average Maximum Temperature (°C)	
	SSP2-4.5	SSP2-8.5
Near Century (2021-2050)	0.7	0.8
Mid Century (2051-2080)	1.4	2.2
End Century (2081-2100)	2.1	4.3

2.2 RAINFALL PROFILE

2.2.1 Observed Rainfall

The annual average rainfall of Mayiladuthurai for the baseline period (1985 to 2014) is 1238.1 mm. The rainfall trend indicates an increase of 14.3 mm/year from 1985 -2014 (Figure 17).

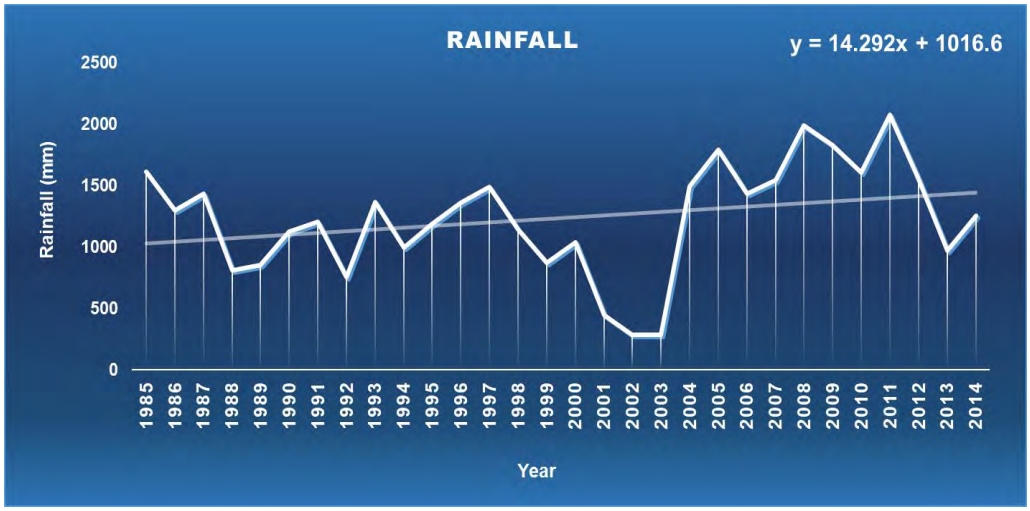


Figure 17 Rainfall Trend of Mayiladuthurai (1985 -2014)

2.2.2 Rainfall Projections

The rainfall projections imply an increase of 25.4% and 34.7% by the end of the century under SSP2-4.5 and SSP5-8.5 scenarios (Table 9).

Table 9 Rainfall Projections of Mayiladuthurai

Projection period	Percentage change in annual average rainfall (%)	
	SSP2-4.5	SSP2-8.5
Near Century (2021-2050)	0.7	0.8
Mid Century (2051-2080)	1.4	2.2
End Century (2081-2100)	2.1	4.3

2.3 Climate Extremities

2.3.1 Observed and Projected Heatwave Days (4.5°C above Normal)

Heatwaves (HW) are prolonged episodes of extreme temperature over any region. The temperature threshold may vary depending on the physiography and climate of the area and the different durations considered. HW days are calculated if the maximum temperature is above 4.5 °C from the average value for 1985-2014. The heatwave days during the baseline period (1985 – 2014) is one day per year. The average projected Heatwave days for the Mayiladuthurai district is 40 days per year by the end of the century (Table 9).

2.3.2 Observed and Projected Intense Rainfall Days (above 64.5 mm)

Extreme events such as heat waves and intense rainfall have become a fundamental issue due to climate change significantly impacting society. Based on the IMD classification, the rainfall above 64.5 mm per day is classified as Intense Rainfall. The intense rainfall above 64.5mm in the district for the baseline period (1985-2014) is two days per year. The future projections of Intense Rainfall above 64.5mm in Mayiladuthurai are expected to increase by five days per year by the end of the century (Table 10).

Table 10 Heatwave days and Intense Rainfall events of Mayiladuthurai

Projection Period	Heatwaves (days/year)		Intense Rainfall (days/year)	
	SSP2-4.5	SSP5-8.5	SSP2-4.5	SSP5-8.5
Near Century (2021-2050)	12	26	3	4
Mid Century (2051-2080)	29	55	4	5
End Century (2081-2100)	40	80	5	8

(Source: CCCDM, Anna University, Chennai)

3. GREENHOUSE GAS INVENTORY

Greenhouse Gas (GHG) emissions are a critical driver of climate change, significantly impacting global temperatures, weather patterns, and ecosystems. Understanding and managing GHG emissions has become increasingly important as nations, regions, and organizations strive to meet international climate commitments and pursue sustainable development. A comprehensive GHG inventory provides a foundation for a detailed account of emissions sources, trends, and potential mitigation opportunities.

3.1 Energy

The energy sector encompasses emissions from stationary activities such as fuel combustion for electricity generation, electricity consumption, and residential heating. The total energy sector emits 1.3 $MtCO_2e$, which is 71% of the total emission of the Mayiladuthurai district.

The GHG emissions from electricity generation using natural gas is 0.04 MtCO2e by 2023 and the emission from the electricity consumption is 1.2 MtCO2e. The trend in electricity consumption in each sector is shown in Figure 18. It indicates that the agriculture sector consumes the maximum by 65.3%. The emission from Domestic or residence for the consumption of liquefied petroleum gas (LPG) and kerosene is 0.06 MtCO2e.

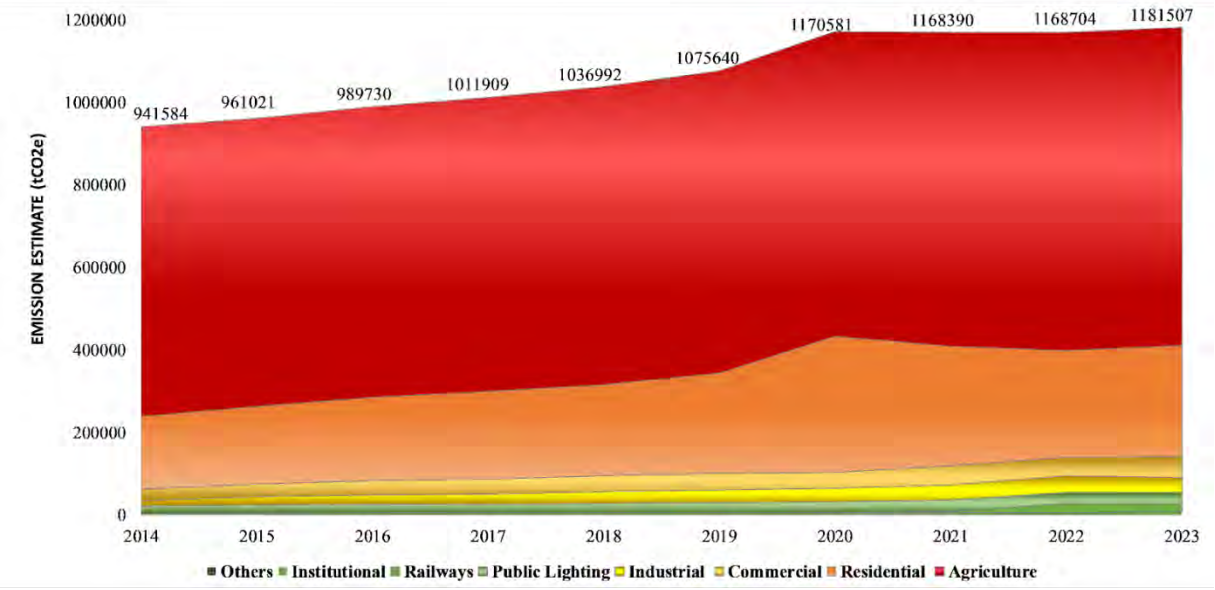


Figure 18 GHG emissions from electricity consumption of each sector and its percentage contribution of Mayiladuthurai

3.2 Transport

Increasing disposable income and expanding road transport infrastructure have steadily increased demand for two and four-wheelers (Gupta, Huddar, Iyre, & Moller, 2018). Consequently, petrol (motor spirit) and Diesel (HSDO) consumption has also increased. The GHG emission from transport is 0.17 Mt CO2e. The GHG based on fuel sales and its emission share is shown in Figure 19 & Figure 20 and Table 11.

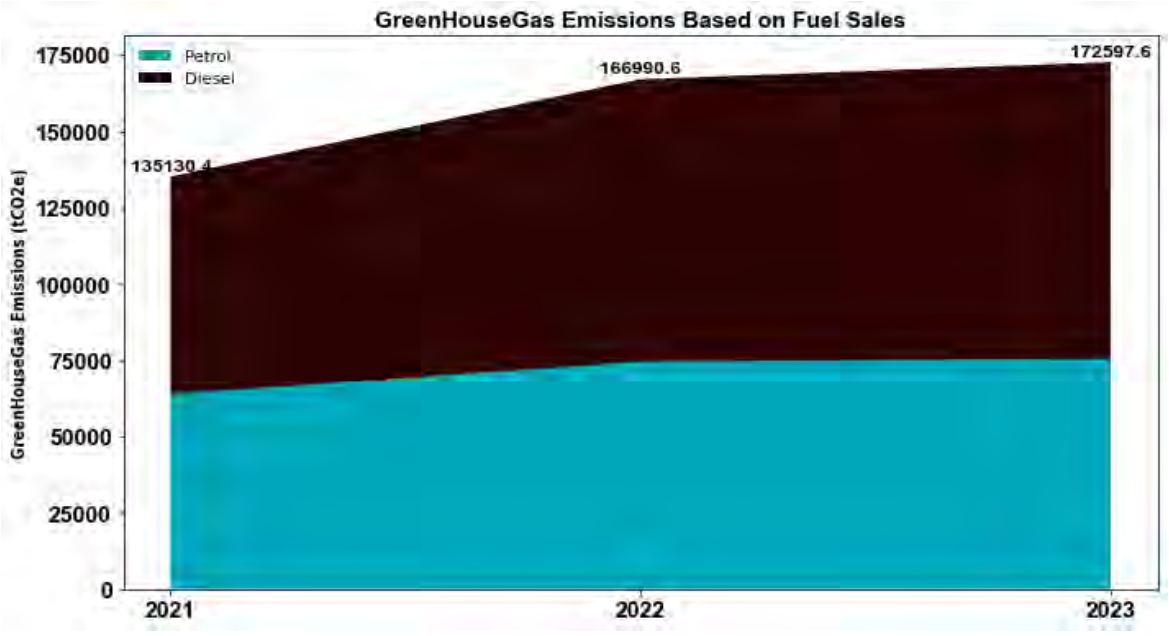


Figure 19 Green House Gas Emissions Based on Fuel Sales of Mayiladuthurai district

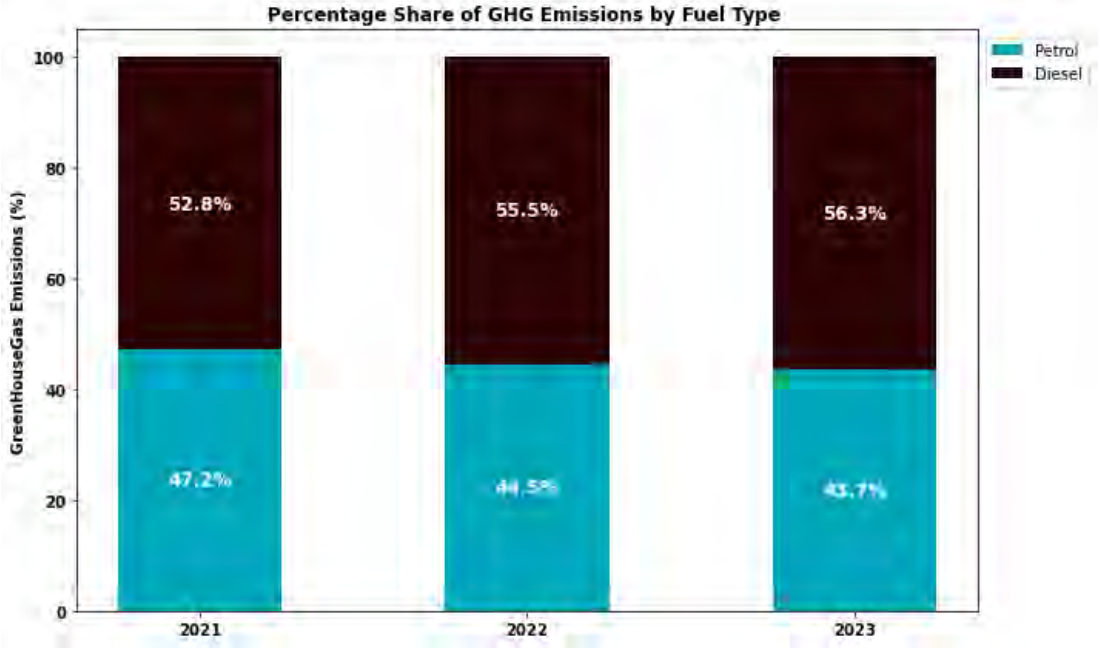


Figure 20 GHG based on fuel sales and percentage shares of emissions in Mayiladuthurai district

Table 11 GHG emissions from Transport

Year	Green House Gas Emissions (t CO_2e)		
	Diesel (A)	Petrol (B)	Total (A+B)
2023	97151.9	75445.7	172597.6

3.3 Solid Waste and Wastewater

The emission from 111 TPD-generated solid waste is 54,567 tCO2e. Table 12 details wet and dry waste generated in the Mayiladuthurai district.

Table 12 Waste Generation in Mayiladuthurai District

S. No	Waste Management	Gram Panchayat		Municipality		Town Panchayat		Total (TPD)
		Dry waste	Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	
1.	Waste Generated	18	79	13.4	19.1	5.1	8.3	142.9
2.	Waste Treated	3.9	1.9	9.7	12	1.7	2.5	31.7

The emission generated from household wastewater is 14,085 tCO2e. The total emission from Solid waste and wastewater is 0.06 $MtCO_2e$.

3.4 Industries

The GHG emission from industries producing Natural Gas and Crude oil is 0.1$MtCO_2e$.

3.5 Agriculture, Forestry, and Other Land Use

The three major sources of emissions from the agricultural sector are domestic livestock, agricultural rice cultivation, and urea fertilization. The aquaculture in Mayiladuthurai district also contributes to the emission of N_2O. The total emission from AFOLU is 0.46 $MtCO_2e$.

The overall GHG inventory for Mayiladuthurai indicates the emission of 2.26 M tCO2e for 2023. Table 13 and Figure 21 show the emissions from each sector. The Energy sector contributes to the maximum emission of 71%.

Table 13 GHG Emission Profile of Mayiladuthurai district

Sectors	tCO_2e
A. ENERGY	
ELECTRICITY	
Public Electricity Generation	58408
Electricity Consumption from thermal	1322125
Domestic	69941
B. TRANSPORT	172598
C. INDUSTRIES	130480
D. SOLID WASTE	68652
E. AGRICULTURE	
Livestock	11805
Rice Cultivable Land	394012
Fertilizers	57302
F. AQUACULTURE	5535
G. GROSS EMISSION (A+B+C+D+E+F)	2290858
H. FOREST (CO_2 CAPTURE)	(-21297)
NET EMISSION (G-H)	2269561

(Source: CCCDM, Anna University, Chennai)

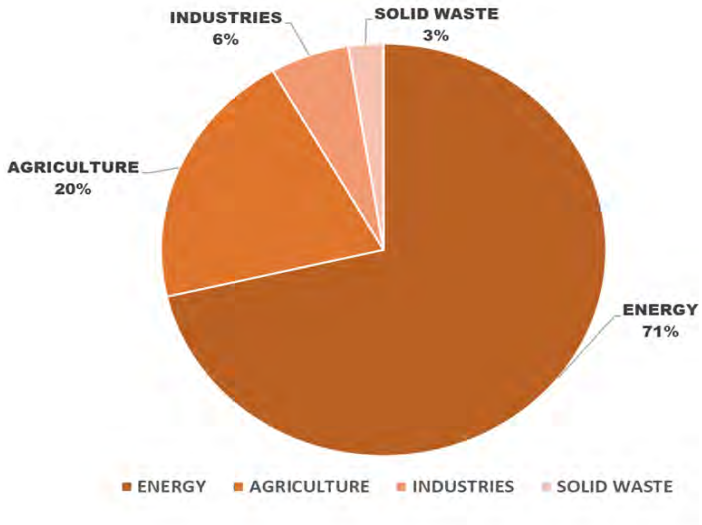


Figure 21 Sectoral contribution of GHG emissions

4. SECTORAL CLIMATE RISK ASSESSMENT AND ADAPTATION

4.1 Water Resources

Mayiladuthurai district, situated in Tamil Nadu's Cauvery Delta, faces floods and droughts due to its location and climatic conditions. Floods, primarily during the northeast monsoon (October to December), are caused by intense rainfall, river overflow, and cyclonic activity, leading to waterlogging and damage to agriculture and infrastructure. Conversely, drought occurs when the southwest monsoon (June to September) fails, leading to water scarcity, groundwater depletion, and challenges in sustaining agricultural activities. The district's dependency on the Cauvery River for irrigation makes it particularly vulnerable to these extreme weather events, significantly impacting its farm productivity and local livelihoods.

4.1.1 Flood and Drought Impact on Water Resources

The impact of floods and droughts on water resources in the Mayiladuthurai district was evaluated from a hydro-climatic perspective. Using the Soil and Water Assessment Tool (SWAT), the watershed hydrology of the Cauvery River in the district was modeled, focusing on critical hydrological variables such as surface runoff and evapotranspiration. In addition to these variables, climatic extreme events were assessed through various indices. For flood events, indices like maximum one-day rainfall (RX1), rainfall exceeding 25 mm (R25), rainfall intensity (MFI), and consecutive wet days (CWD) were utilized. For drought assessment, indices such as consecutive dry days (CDD), standard precipitation index (SPI), standard precipitation evapotranspiration index (SPEI), and streamflow drought index (SDI) were considered. The flood and drought hazard assessments were conducted for two key agricultural seasons of Mayiladuthurai district: Kuruvai (May to August) and Samba/Thaladi (September to January).

The flood hazard indicator (Table 14) highlights the flood risk during the Samba season, particularly in October, November, and December during the Northeast Monsoon. The assessment suggests that, for a 5-year return period, one-day extreme rainfall is most likely in the coastal villages of Mayiladuthurai. In contrast, rainfall events exceeding 25mm are moderately distributed across the entire district. According to the Modified Fournier Index (MFI), the risk of soil erosion is low throughout the district. However, consecutive wet days (CWD) indicate prolonged periods of rainfall, especially in

the coastal zones, where the intensity and duration of rainfall are notably higher than inland areas. As a result, coastal regions are at a higher risk of flooding. In contrast, inland areas, despite experiencing moderate rainfall and wet conditions, are less susceptible to severe flooding. Although rainfall intensity is generally low, which mitigates the risk of soil erosion, the extended rainy periods, particularly in coastal areas, remain a significant factor contributing to the overall flood hazard. Table 15 shows a flood-affected village of Mayiladuthurai. Sembanarkoil block in Mayiladuthurai has affected many villages.

Table 14 Flood Hazard Indicators of Mayiladuthurai District

FHI Variables	30-years Average		5-year return period		
	Minimum	Maximum	Coastal Zone	Inland Area	Classification
Maximum 1-day rainfall in mm (RX1)	89	139	139	128	High rainfall
Rainfall intensity (MFI)	39	42	50	45	Low Erosivity
Rainfall events >=25mm (R25)	287	325	70	65	Moderate rainfall
Consecutive Wet Days (CWD)	17	21	90	60	Long-term wet days

Table 15 Flood Affected Villages of Mayiladuthurai District

Name of the Blocks	Flood Affected Villages				
	Very Low	Low	Moderate	High	Very High
Kollidam	0	3	5	10	22
Sirkali	0	0	16	10	20
Sembanarkoil	0	0	5	18	33
Mayiladuthurai	18	26	10	0	0
Kuthalam	34	10	5	2	0
Overall District	52	39	41	40	75

The district has a substantial number of villages (110) categorized under the "Very High and High" class of drought hazard, making up 46.56% of the total. These severe conditions are predominantly concentrated in the coastal blocks of Kollidam, Sirkali, and Sembanarkoil. In contrast, the inland blocks of Mayiladuthurai and Kuthalam experience a low class of drought hazard.

The drought hazard indicators (Table 16) illustrate the drought risk during the summer season, particularly in April, May, and June, marking the onset of the southwest monsoon (Kuruvai season). The analysis for a 2-year return

period suggests that both the Standard Precipitation Index (SPI) and the Standard Precipitation Evapotranspiration Index (SPEI) will reflect moderately dry conditions across both inland and coastal areas, primarily due to reduced precipitation and increased evapotranspiration. A significant concern for Mayiladuthurai District is the streamflow, as highlighted by the Streamflow Drought Index (SDI), which indicates severe drought conditions in inland areas. These regions are expected to experience long-term dry days (CDD), signifying prolonged periods without rainfall, further intensifying the drought conditions. Inland areas are particularly vulnerable, with more extended dry spells and higher drought severity than coastal regions. In summary, inland areas of Mayiladuthurai District are at a greater risk of experiencing severe drought conditions, marked by extended dry spells and significant water deficits. At the same time, coastal regions face moderately dry conditions with persistent but less extreme drought episodes across the district.

Table 16 Drought Hazard Indicators of Mayiladuthurai District

DHI Variables	30-years Average		2-year return period		
	Minimum	Maximum	Inland Area	Coastal Zone	Classification
Streamflow Drought Index (SDI)	1.7	-1.3	-1.67	-1.18	Severely Dry
Standard Precipitation Index (SPI)	-0.42	-3.4	-1.3	-1.13	Moderately dry
Standard Precipitation Evapotranspiration Index (SPEI)	-0.32	-2.05	-1.28	-1.25	Moderately dry
Consecutive Dry Days (CDD)	39	93	65	63	Long-term dry days

Table 17 infers that the block Kuthalam has the highest number of villages experiencing the most severe drought conditions (very high & high), with 51 villages. The district has 188 villages in this category, accounting for 76% of the total. Sembanarkoil and Mayiladuthurai also report that many villages are affected by very high drought conditions. Kollidam and Sirkali have fewer villages in the Very High and High categories. The resulting flood and drought hazard maps were spatially distributed for the Mayiladuthurai district in Figure 22.

Table 17 Drought Affected Villages of Mayiladuthurai District

Name of the Blocks	Drought Affected Villages				
	Very Low	Low	Moderate	High	Very High
Kollidam	18	13	7	2	0
Sirkali	0	7	14	20	0
Sembanarkoil	0	0	0	11	47
Mayiladuthurai	0	0	0	26	31
Kuthalam	0	0	0	0	51
Overall District	18	20	21	59	129

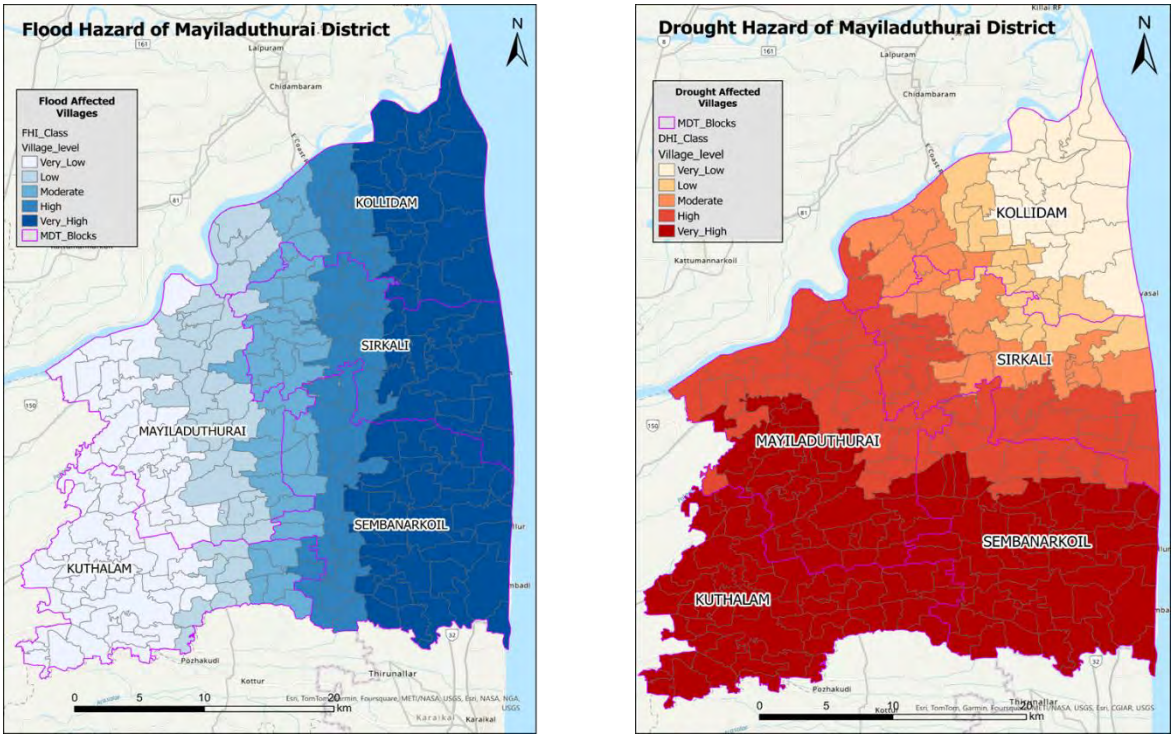


Figure 22 Flood and Drought Hazard Map of Mayiladuthurai District

4.1.2 Domestic Water Supply and Demand in Mayiladuthurai District: Present and Future Scenarios

Mayiladuthurai district faces significant challenges in meeting its domestic water demand in the present and projected future scenarios. Currently, out of 239 villages, only 4 have a water surplus, while 235 are in a deficit state. It is expected to increase, with future projections indicating only three villages maintaining a surplus by 2050.

The district-wide supply-demand gap is projected to increase by 31.2%, from 37.1 MLD in 2023 to 48.7 MLD by 2050, assuming an 8% decadal population growth rate (POPULATION RESEARCH CENTRE, 2018). Among the five blocks, Mayiladuthurai block shows the highest current deficit of 9.2 MLD, expected to reach 11.9 MLD by 2050. Other blocks also show substantial gaps, ranging from 6.4 to 8.2 MLD presently, with projections indicating increases to 8.6-10.8 MLD by 2050 (Table 18). The village-level spatial variation of supply, demand, and supply-demand gap is shown in Figures 23 for the present and future scenarios. The highest supply-demand gap is exhibited in the coastal villages.

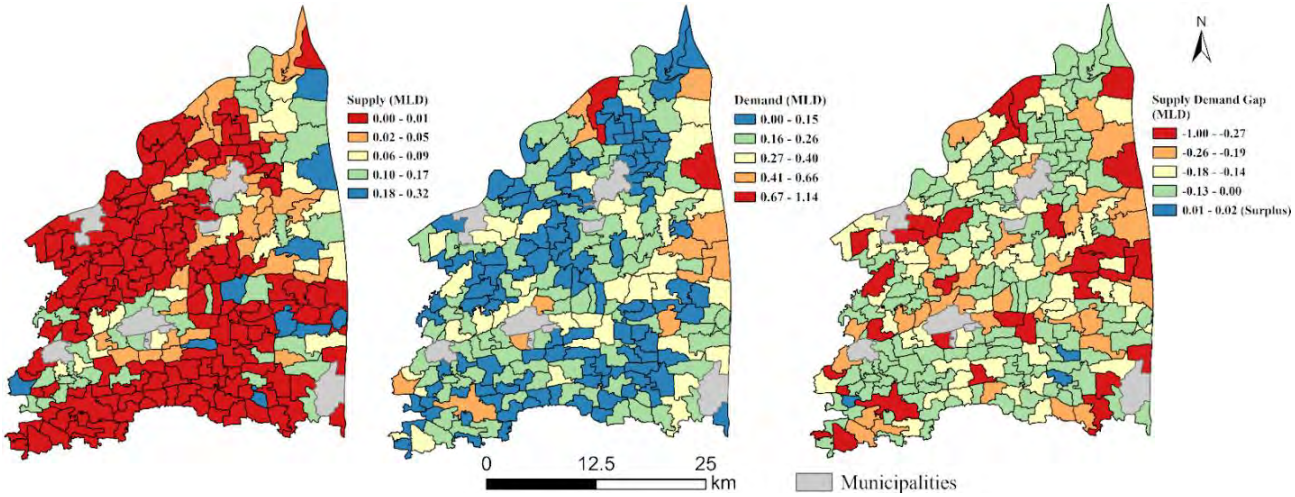


Figure 23 Domestic Supply, Demand, and Deficit of Mayiladuthurai District at village-level

4.1.3 Irrigation Canal Water Supply and Demand in Mayiladuthurai District: Current and Projected Scenarios

Irrigation Supply-Demand Gap refers to the imbalance between the water available for irrigation and the amount demanded by agricultural activities. This gap can arise due to various factors: Water Scarcity, Increasing Agricultural Demand, Inefficient Water Use, and Climate Change. The irrigation supply-demand gap significantly impacts agricultural productivity, food security, and environmental sustainability in the Mayiladuthurai district. Addressing this gap requires a comprehensive and integrated approach that considers the specific needs and challenges of the water and agricultural sectors (Figure.24).

The irrigation supply-demand gap was evaluated based on water releases from the Cauvery head, Mahimalaiyar head, and Manjalar head canals, along with the crop water requirements for conventional and SRI (System of Rice Intensification) methods. This assessment was conducted for the Kuruvai (May to August) and Samba/Thaladi (September to January) crop seasons. The current supply-demand gap for the 2023 scenario. Additionally, scenario assessments were performed to explore ways to meet irrigation demand. These scenarios considered integrating existing water harvesting

structures, particularly ponds, in three aspects: 1 in 4 ponds, 1 in 2 ponds, and all ponds in each village, as potential solutions for improving water management efficiency (Figures 25 - 29).

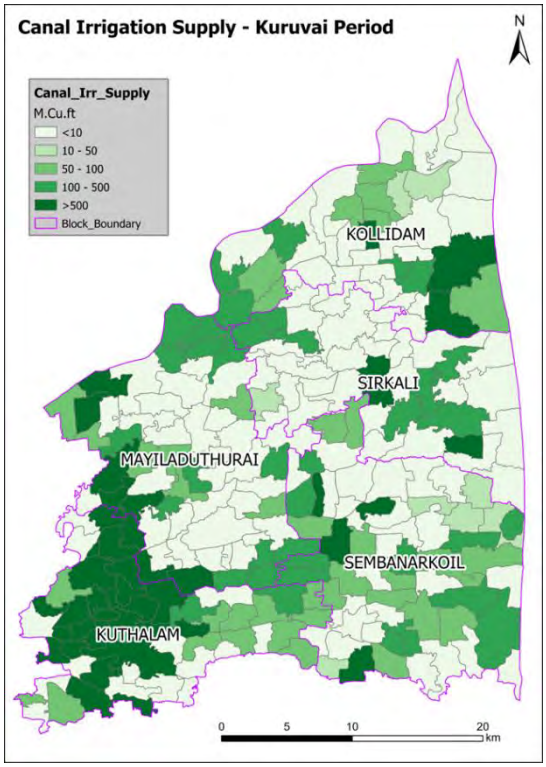
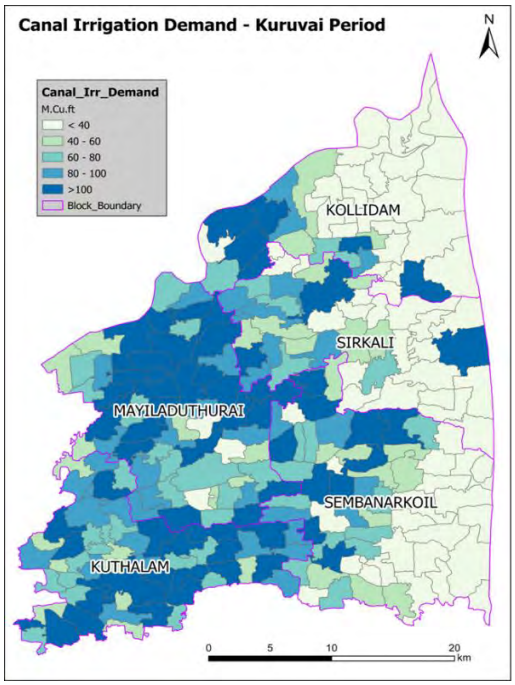
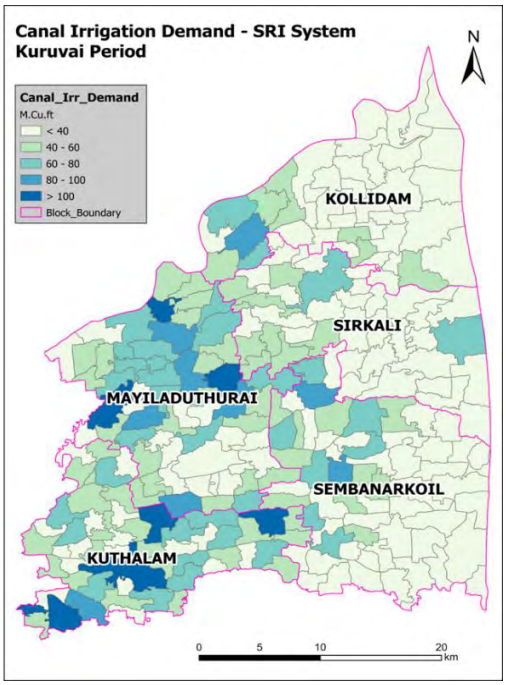


Figure 24 Canal Irrigation Supply of Mayiladuthurai District at Village-level for Kuruvai Cropping

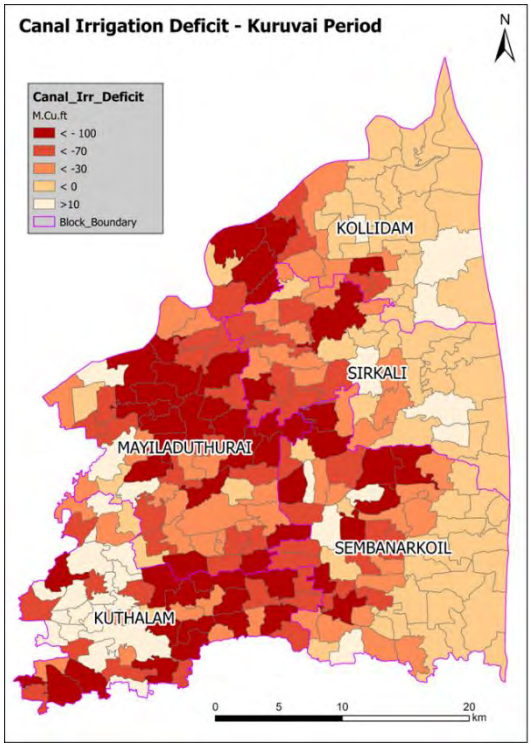


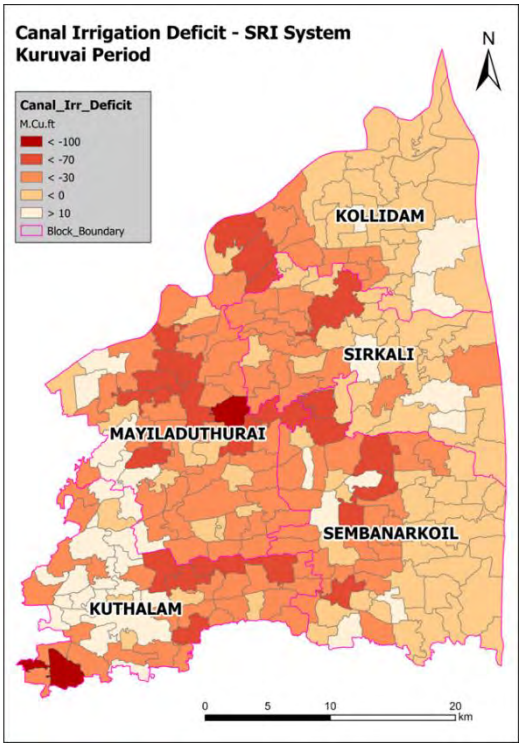
(a) Conventional Method



(b) SRI Method

Figure 25 Canal Irrigation demand of Mayiladuthurai District at village-level for Kuruvai Cropping





(a) Conventional Method (b) SRI Method

Figure 26 Canal Irrigation deficit of Mayiladuthurai District at village-level for Kuruvai Cropping

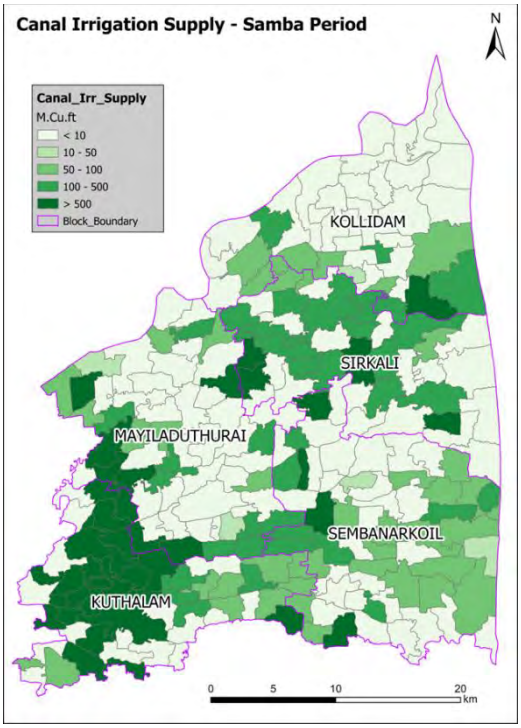
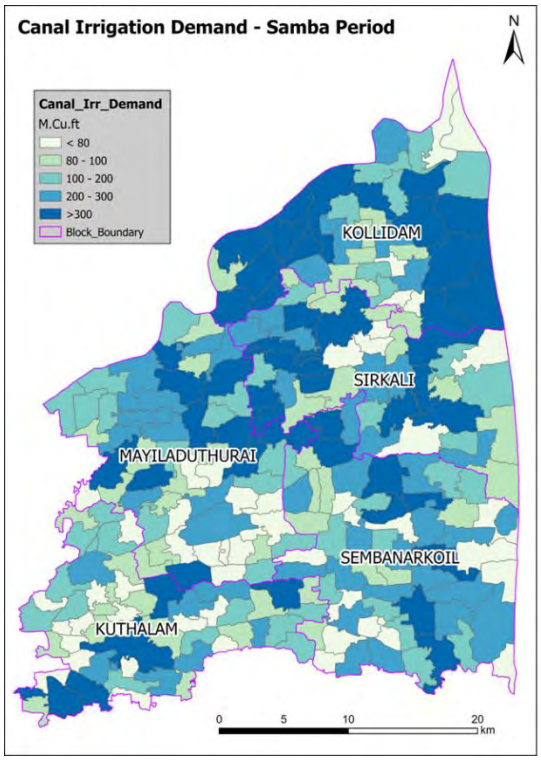
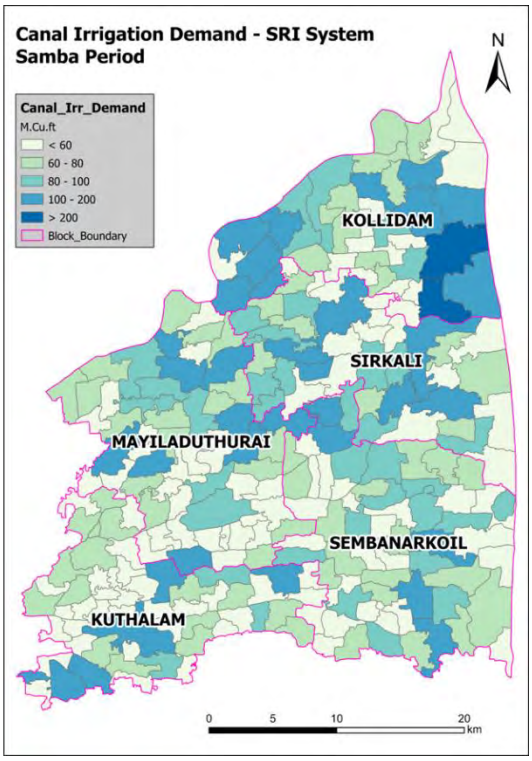


Figure 27 Canal Irrigation Supply of Mayiladuthurai District at Village-level for Samba Cropping Period

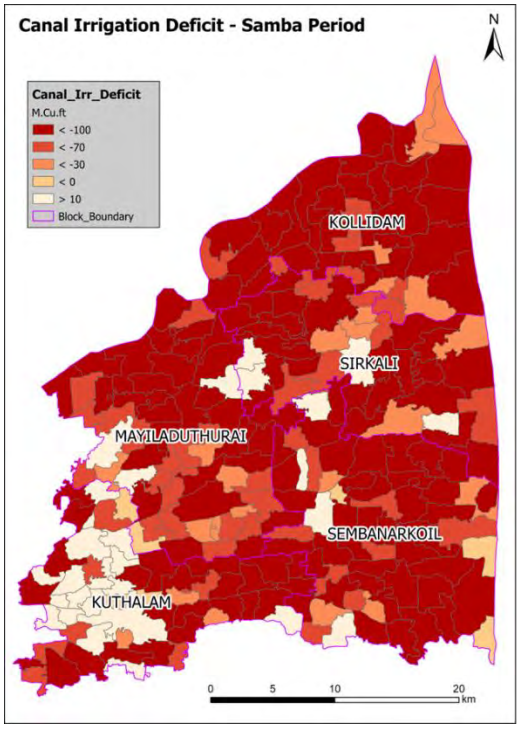


(a) Conventional Method

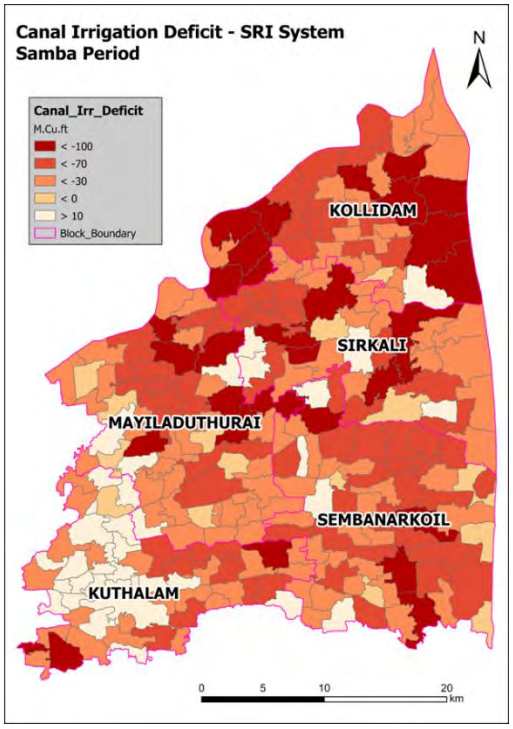


(b) SRI Method

Figure 28 Canal Irrigation demand of Mayiladuthurai District at village-level for Samba Cropping



(a) Conventional Method



(b) SRI Method

Figure 29 Canal Irrigation deficit of Mayiladuthurai District at village-level for Samba Cropping

4.2 Sustainable Agriculture

Mayiladuthurai is predominantly an agricultural district where rice cultivation forms the backbone of the local economy. The agricultural practices in this region are characterized by distinct patterns of crop cultivation and water source utilization, which significantly influence the district's agricultural vulnerability. The farm landscape of Mayiladuthurai district is characterized by two primary rice cultivation patterns: Kuruvai and Samba/Thaladi. Kuruvai rice cultivation heavily relies on Cauvery canal irrigation and is predominantly practiced in areas with access to borewells, particularly in the Kuthalam and Mayiladuthurai blocks. However, minimal Kuruvai cultivation is observed at the tail end of Mayiladuthurai.

In contrast, Samba/Thaladi rice cultivation is widespread across all blocks and employs fine and bold rice varieties. The district exhibits notable geographical variations in its agricultural practices. The Kuthalam and Mayiladuthurai blocks demonstrate a significant dependence on borewells for irrigation, highlighting the importance of groundwater resources in these areas. Conversely, the coastal blocks of Sirkali, Sembanarkoil, and Kollidam exhibit markedly less cultivation, suggesting potential challenges or different land use patterns in these regions. This diverse agricultural profile underscores the complex interplay between water sources, geographical factors, and crop choices in shaping the district's farming practices.

Climate variability plays a crucial role in shaping the sustainability of agricultural sector growth. According to the IPCC (2014), frequent droughts, extreme heat stress, floods, cyclones, and monsoon unpredictability have adverse effects on crop production. The Decision Support System for Agrotechnology Transfer (DSSAT) crop simulation model was employed to assess these impacts. Specifically, the CERES (Crop Environment Resource Synthesis) models within DSSAT were utilized to evaluate the effects of climate change on cereals. The modules CERES-RICE and CROPGRO within DSSAT simulated Rice, Black gram, and Greengram yields, respectively.

The DSSAT model requires a range of input data, including weather parameters, genetic characteristics of crop varieties, soil properties, and crop management practices, to simulate crop yields accurately. Future climate projections from the EC-Earth Global Climate Model (GCM) were used as inputs for the CROPGRO

model, incorporating data such as maximum and minimum temperatures, rainfall, and solar radiation for both the baseline period (1985-2014) and near-century projections (2021-2050). Climate data were extracted under the SSP2 4.5 scenario and included daily precipitation (mm), solar radiation, and temperature data, which were formatted for DSSAT using the Weatherman tool.

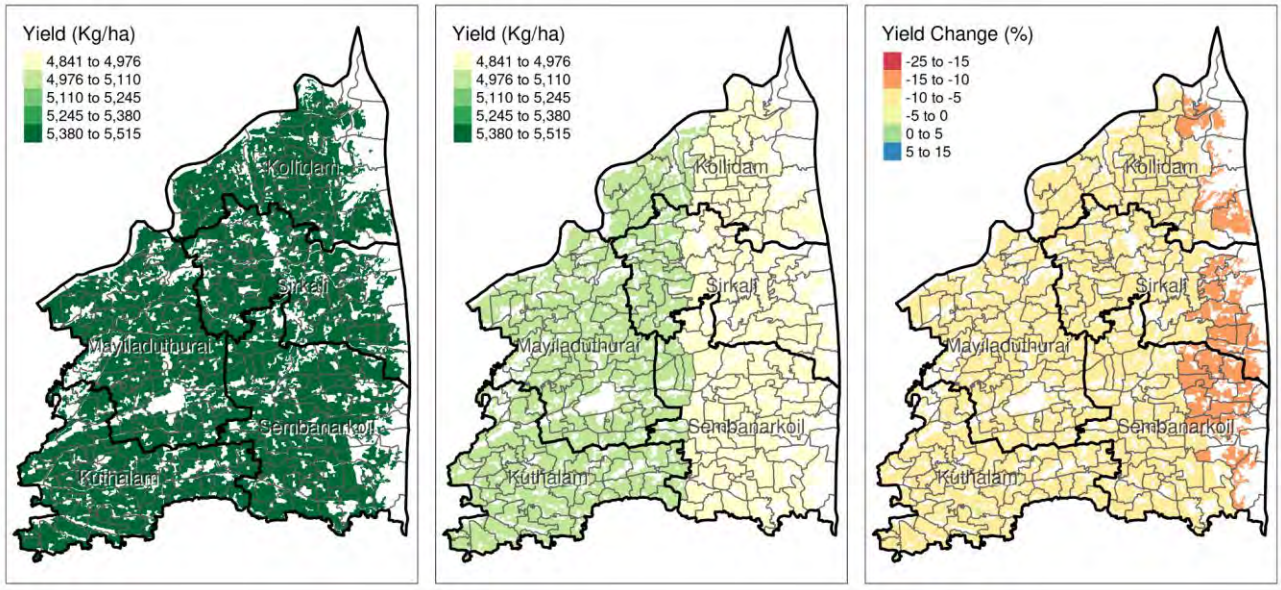
Various soil texture layers and bulk densities were set up in the DSSAT S-build tool in the soil module and customized to reflect local conditions. A detailed soil database for Tamil Nadu, available at a 1: 50,000 scale from the Department of Remote Sensing and GIS at Tamil Nadu Agricultural University (TNAU), was employed to generate soil profiles. These profiles were extracted using ArcGIS software and integrated into DSSAT's S-Build tool. Crop management details, including harvest timing, irrigation management, organic material treatments, and fertilizer application for Rice (Kuruvai and Samba), Black gram, and Greengram, were configured in DSSAT's X-Build tool. These files were developed based on standard agronomic practices followed in Mayiladuthurai. Experimental conditions, including weather station data, soil descriptions, planting patterns, irrigation practices, and fertilizer usage, were integrated into DSSAT through the X-Build tool to provide a detailed simulation environment.

4.2.1 Climate change impact on Rice yield in Mayiladuthurai district

Mayiladuthurai district has two main rice cultivation patterns: Kuruvai (Canal and borewell-dependent) and Samba (widespread), with notable geographical variations in agricultural practices. Climate change impacts rice yield needs assessment using DSSAT, considering the district's diverse irrigation sources and cultivation methods. The evaluation would involve data collection, model setup, climate scenario analysis, and developing adaptation strategies for different blocks and cultivation patterns. The rice varieties ADT 43 and CO-51 are widely cultivated across all five blocks of Mayiladuthurai during the Kuruvai season. For the Samba season, ADT 54, CR1009 Sub1, Swarna Sub-1, and BPT-5204 are the predominant varieties grown in all five blocks, with cultivation from May to August. The assessment of climate change impacts on rice crop yields in the Mayiladuthurai area reveals significant variations among different varieties over time. The study focuses on two rice varieties commonly grown in the Kuruvai season: ADT 43 and CO-51. Using the CERES-Rice model for projections, ADT 43 is expected to experience a yield decline of 8.02% to 10.86% in the Near Century (Figure 30).

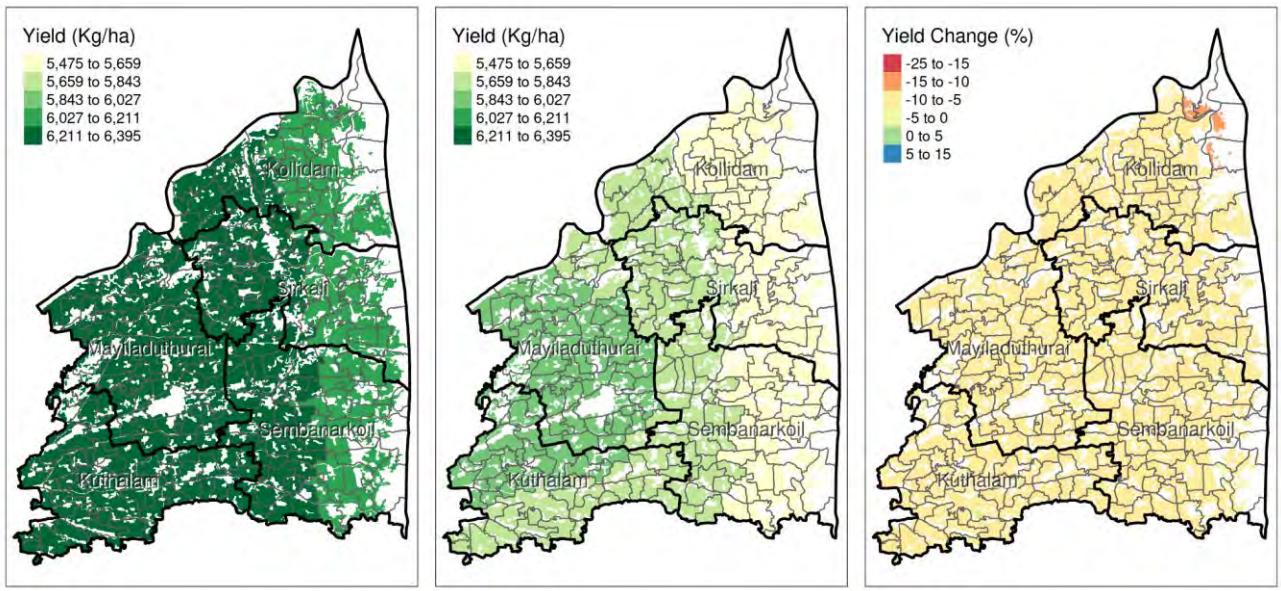
Similarly, CO-51, with a baseline yield of 6,107 to 6,395 kg/ha, is projected to see yields ranging from 5,475 to 5,946 kg/ha in the future, representing a decline of 7.02% to 10.51% (Figure 31). Both varieties are vulnerable in coastal

blocks such as Kollidam, Sirkali, and Sembanarkoil. The study also highlights that farmers in the Kuthalam and Mayiladuthurai blocks heavily depend on borewell irrigation, which could pose additional challenges in the face of climate change. The varying impacts across blocks emphasize the importance of localized adaptation measures to ensure the long-term sustainability of rice production in the region.



a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

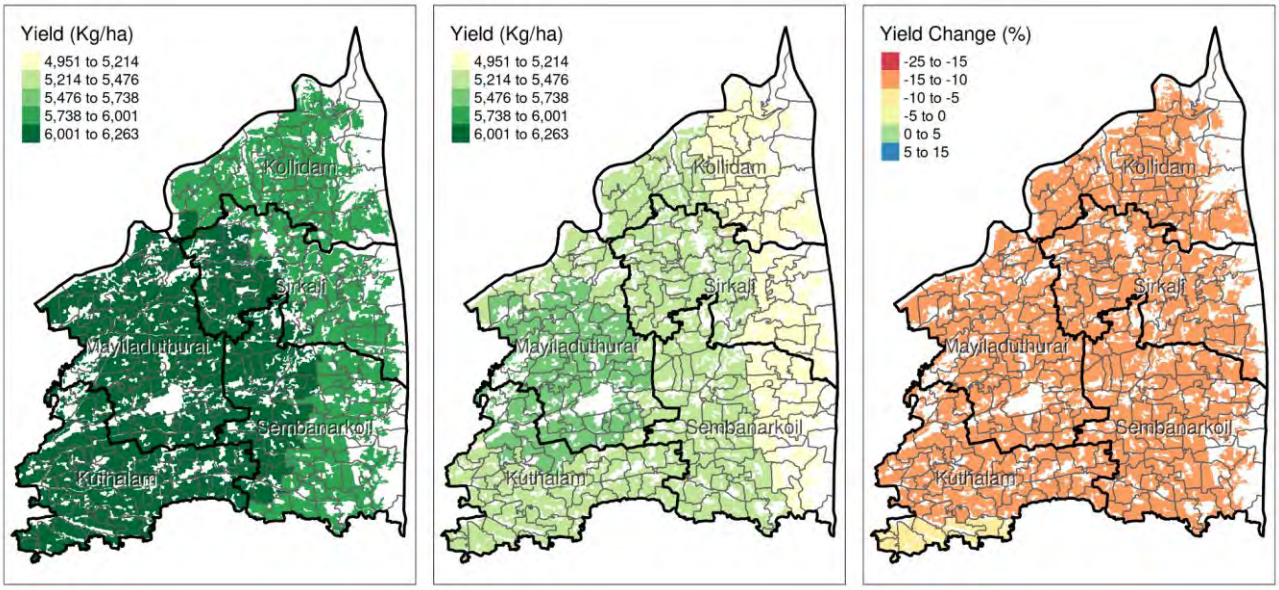
Figure 30 Climate Change impact on ADT43 rice yield of Mayiladuthurai



a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 31 Climate Change impact on CO-51 rice yield of Mayiladuthurai

The samba cultivation in the Mayiladuthurai area utilizes several rice varieties, including ADT54, CR1009 Sub1, BPT5204, and Swarna sub-1. This variety diversity likely helps farmers adapt to different growing conditions and market demands. The current yield of ADT54 ranges from 5,771 to 6,263 kg/ha. Under future climate change scenarios, the projected yield of ADT54 is expected to range from 3,375 to 4,951 kg/ha. This significant decrease in yield highlights the potential negative impact of climate change on rice production in the region. The relative yield change for the ADT54 variety is projected to decline by approximately 9.78% to 14.20% (Figure 32). This range represents a significant reduction in productivity, which could have severe implications for food security and farmers' livelihoods in the region. The projected decline in ADT54 yield is concerning and highlights the need for climate change adaptation strategies in rice cultivation. The varying impact across different areas, particularly the higher vulnerability of coastal blocks, suggests that adaptation measures may need to be tailored to specific local conditions. A significant yield reduction may necessitate the development or adoption of more climate-resilient rice varieties for the samba cultivation season. Farmers and agricultural planners may need to consider diversifying crops or implementing advanced farming techniques to mitigate the potential loss in rice productivity.

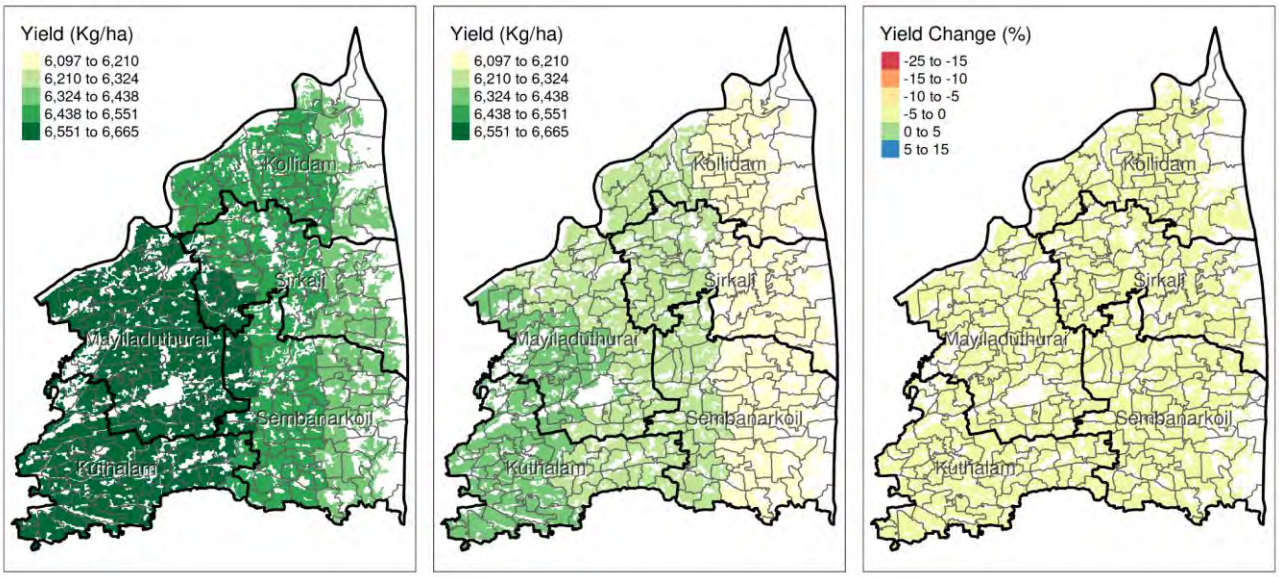


a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 11 Climate Change Impact on ADT54 Rice Yield of Mayiladuthurai

The baseline yield of CR1009 Sub1 ranges from 6,352 to 6,665 kg/ha. Under future climate change scenarios, the projected yield of CR1009 Sub1 is expected to range from 6,000 to 6,367 kg/ha. The relative yield change for CR1009 Sub1 is projected to decline by approximately 3.67% to 4.96% (Figure 33). CR1009 Sub1 varieties are noted to be highly suitable for coastal regions. They can withstand flooding for up to two weeks, a valuable trait in areas prone to waterlogging

or flooding. The better performance of CR1009 Sub1 under projected climate change scenarios suggests it might be a more suitable variety for future cultivation, especially in coastal areas.

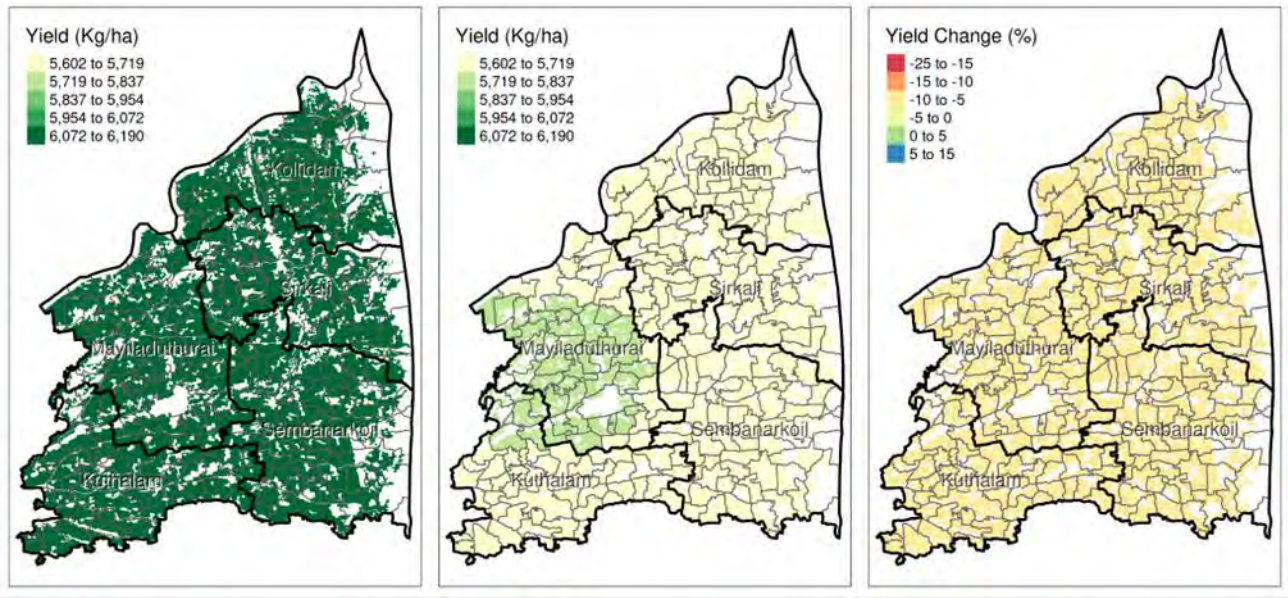


a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 33 Climate Change impact on CR1009 Sub1 sub1 rice yield of Mayiladuthurai

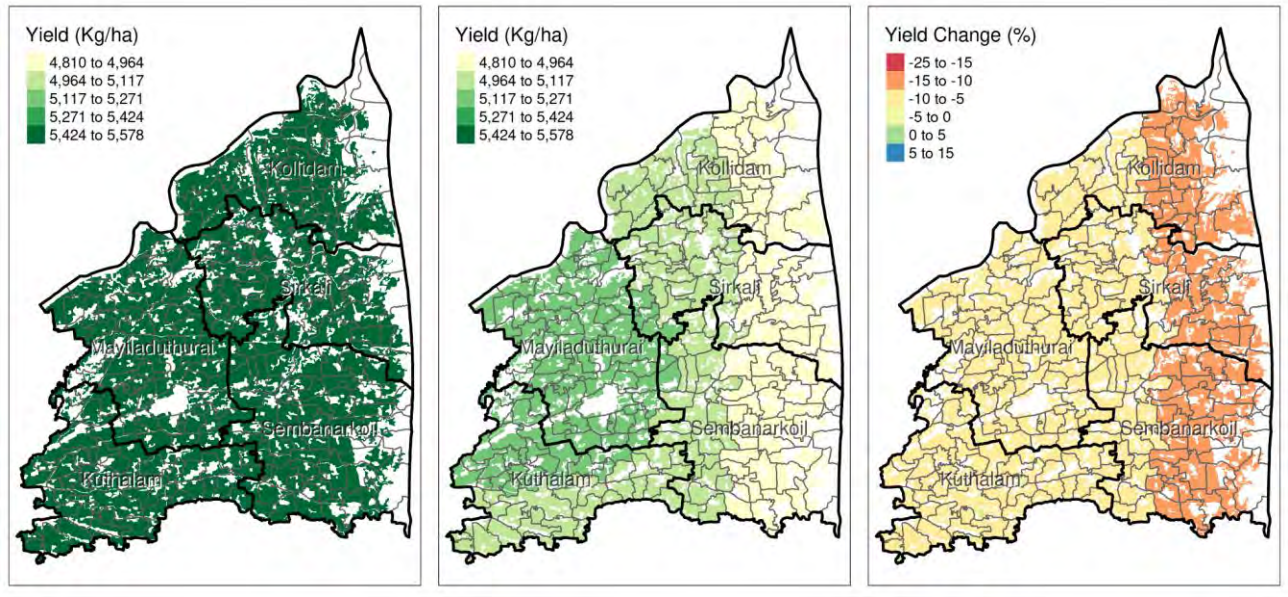
The baseline yield of BPT 5204 ranges from 6,009 to 6,190 kg/ha. Under future climate change scenarios, the projected yield of BPT 5204 is expected to range from 5,602 to 5,738 kg/ha. The relative yield change for BPT 5204 is projected to decline by approximately 7.14% to 8.28%. For BPT 5204, the coastal blocks of Kollidam and Mayiladuthurai are projected to see yield declines of 7.83% to 8.28% (Figure 34). The overall projected decline range for this variety confirms the greater vulnerability of coastal areas. BPT 5204 appears to be a moderately climate-resilient variety, which could make it a good option for farmers looking to balance yield potential with climate adaptation.

The baseline yield of Swarna Sub-1 ranges from 5,511 to 5,578 kg/ha. Under future climate change scenarios, the projected yield is expected to range from 4,810 to 5,241 kg/ha. This represents a moderate decrease compared to its current yield. The relative yield change for Swarna Sub-1 is projected to decline by approximately 6.03% to 12.99% (Figure 35). In coastal blocks (Kollidam, Sirkali, and Mayiladuthurai), the yield is projected to decline more severely, by 10.20% to 12.99%. Swarna sub-1 demonstrates moderate resilience to climate change impacts. The wide range of potential yield declines suggests that Swarna sub-1's performance may depend more on specific local conditions or management practices than some other varieties.



a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 34 Climate Change impact on BPT 5204 rice yield of Mayiladuthurai



a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 35 Climate Change Impact on Swarna sub-1 rice yield of Mayiladuthurai

The average yield change of CR1009 Sub-1, BPT5204, Swarna Sub-1, and ADT 54 is 4.32%, 7.71%,9.51%, and 11.99% respectively (Figure 36). CR1009 Sub1 shows the highest resilience to climate change, with the most minor projected yield decrease. There's a notable gap between the top three varieties (CR1009 Sub1, BPT5294, Swarna sub-1)

and ADT54 yield. Swarna sub-1 performs better than ADT54 when looking at average yield change, though it has a broader range of potential impacts (Table 18)

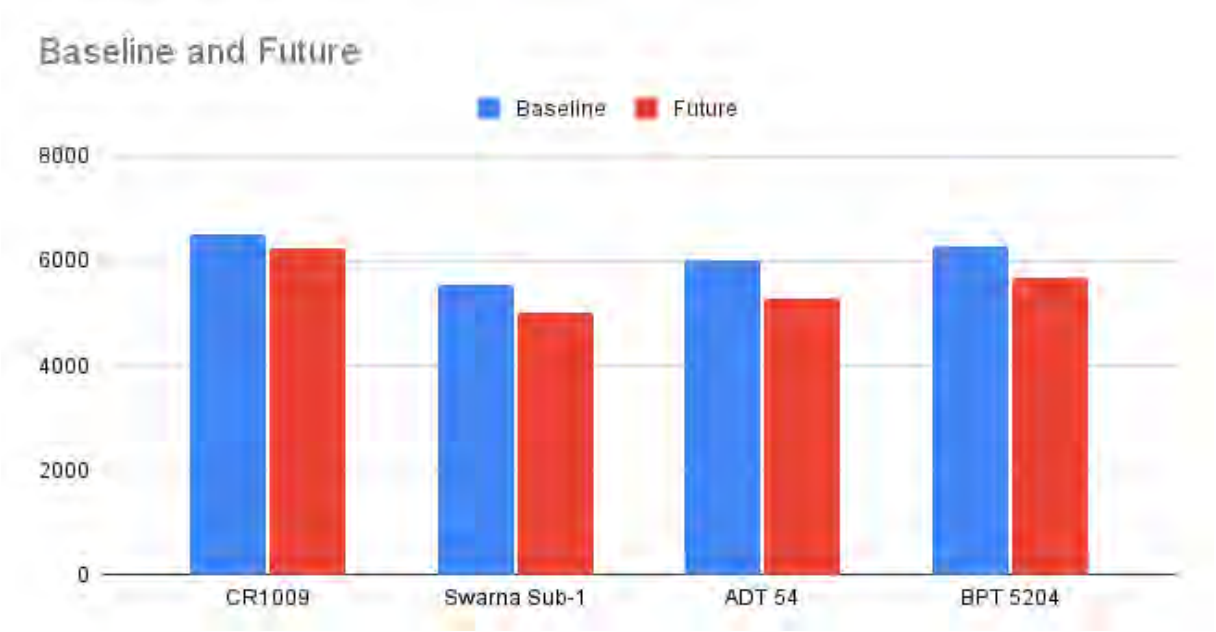


Figure 36 Relative yield change of Samba varieties used in Mayiladuthurai

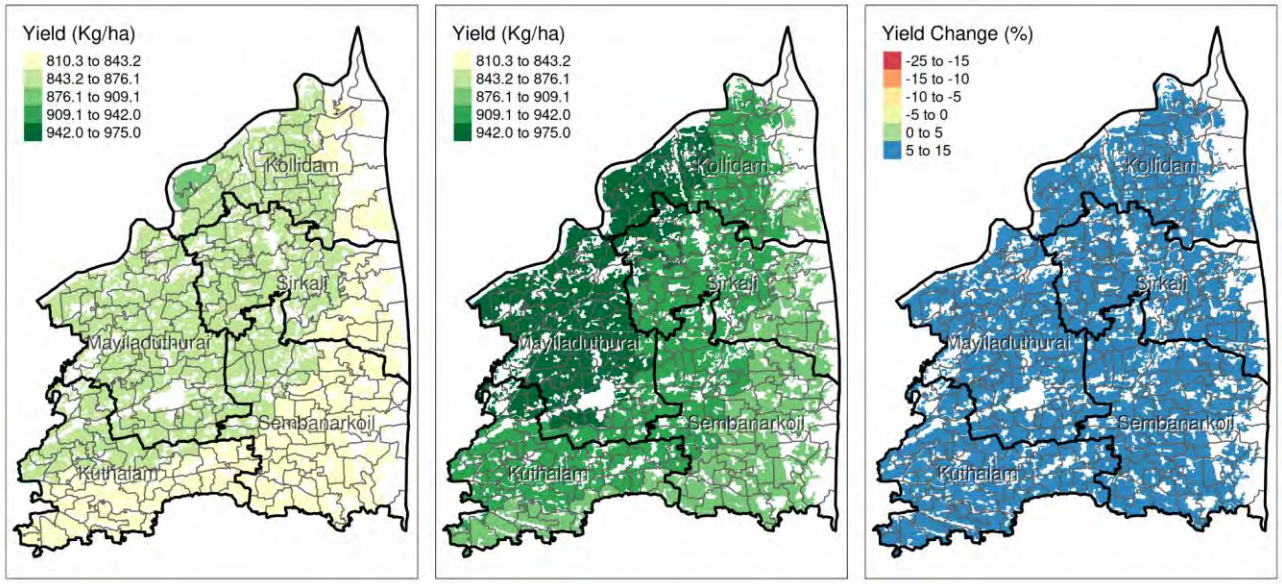
Table 18 Yield Change of samba rice varieties for the future period (2021-2050)

Varieties	Baseline yield (kg/ha)	Future yield (Kg/ha)	Yield Change (%)
CR1009 Sub1	6510	6230	-4.3
Swarna Sub-1	5545	5025	-9.4
ADT 54	6025	5275	-12.4
BPT 5204	6293	5870	-6.7

4.2.2 Climate Change Impact on Pulses of Mayiladuthurai

In the delta region of the Mayiladuthurai district, cultivating rice fallow pulses, specifically black gram and green gram, is an essential agricultural strategy following the samba rice season. This method utilizes residual moisture and nutrients in the soil after the rice harvest, making it a cost-effective and sustainable approach to pulse cultivation. The baseline yield of black gram in this district has been recorded between 810.3 to 880.2 kg/ha. Projections for the future suggest a potential increase in yield, with figures expected to range between 886 to 975 kg/ha, which indicates a promising relative yield growth of 6.18% to 10.77% (Figure 37). Despite this positive outlook overall, a geographical

variation in yield performance is notable across different blocks. The coastal blocks, particularly Sirkali and Sembanarkoil, are witnessing a decline in yield compared to the more inland blocks, such as Kollidam, Mayiladuthurai, and Kuthalam, which are experiencing relatively higher yields.

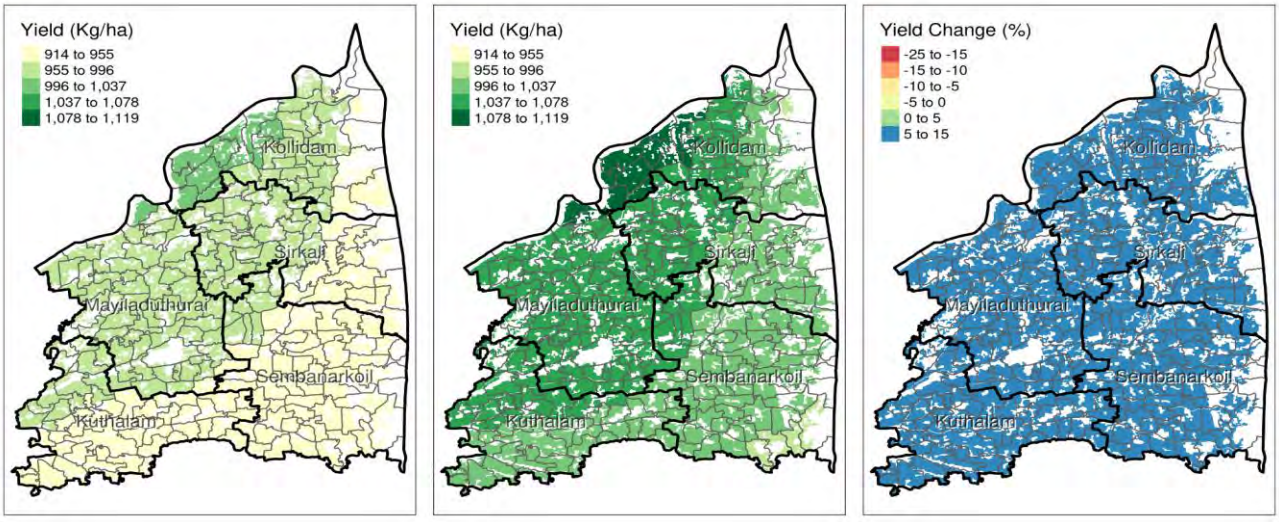


a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 37 Climate Change impact on Black gram yield of Mayiladuthurai

The baseline yield of green gram in the Mayiladuthurai district ranges from 914 to 935 kg/ha, with the Kollidam block achieving the highest yields, followed by Mayiladuthurai and Kuthalam. Projections suggest that future yields will continue to rise, reaching between 886 and 975 kg/ha, mirroring the baseline trends. The relative yield increase is expected to range from 5.73% to 10.03%, indicating steady growth (Figure 38). However, coastal blocks like Sirkali and Sembanarkoil show a decline in yield compared to the inland blocks of Mayiladuthurai and Kuthalam, where yield remain consistently higher.

The trend shows that inland areas such as Kollidam, Mayiladuthurai, and Kuthalam benefit from more favorable environmental conditions, including better soil quality, less exposure to salt stress, and fewer impacts from extreme coastal weather. On the other hand, coastal areas are more susceptible to factors that inhibit yield growth, such as salinity, waterlogging, and possible cyclonic activities.



a) Baseline period (1985 -2015) b) Future (2021-2050) c) Yield change of future period

Figure 38 Climate Change Impact on Green gram yield of Mayiladuthurai

Both crops perform better in inland blocks such as Kollidam, Mayiladuthurai, and Kuthalam, while coastal blocks like Sirkali and Sembanarkoil experience lower yields. This pattern is likely due to environmental factors such as soil salinity, waterlogging, and coastal weather influences, which negatively impact crop growth.

4.3 Forest Ecosystem

4.3.1 Block-level tree cover in Mayiladuthurai District

The distribution of tree cover across various blocks in the Mayiladuthurai district reveals the different contribution levels to the district's overall forested area. Kollidam block, which includes mangroves, has the highest tree cover with 1,891 hectares, significantly contributing to the district's greenery. Mayiladuthurai block follows with 774 hectares, while Sembanarkoil adds 627 hectares. Kuthalam and Sirkali blocks account for 422 hectares and 542 hectares of tree cover, respectively. This pattern highlights the critical role of Kollidam and Mayiladuthurai blocks in maintaining the district's ecological balance, with their substantial tree cover essential for supporting local biodiversity and environmental health (Figure 39).

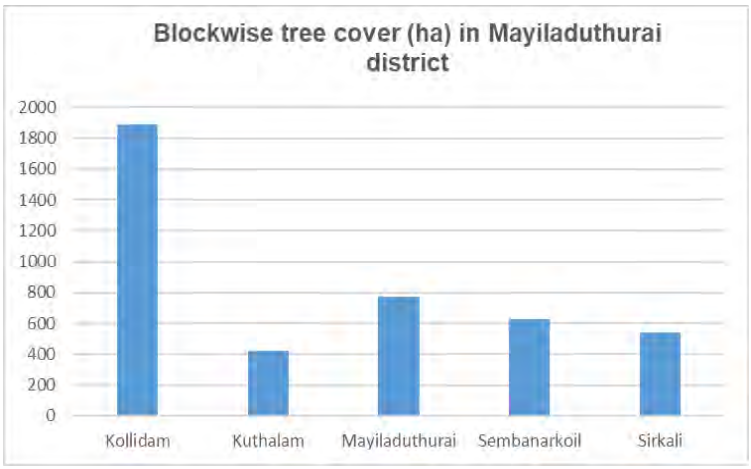


Figure 39 Block-level Tree Cover of Mayiladuthurai

4.3.2 Present CO_2 Sequestration Potential in Mayiladuthurai District

The CO2 sequestration potential across the blocks of Mayiladuthurai district is directly linked to the extent of tree cover in each area. Kollidam block, with the most significant tree cover of 1,891 hectares, sequesters 9602 MT of CO2, making it the most substantial contributor to the district's carbon sequestration efforts. Then, Mayiladuthurai block sequesters 3313 MT of CO2 with 774 hectares of tree cover. Sembanarkoil and Sirkali blocks contribute 2683 MT and 2318 MT of CO2 sequestration, respectively, with 627 hectares and 542 hectares of tree cover. Kuthalam block, with 422 hectares of tree cover, sequesters 1804 MT Tg of CO2. In total, the district's tree cover sequesters 19719 MT of CO2, underscoring the significant role of these blocks in contributing to climate change mitigation through carbon sequestration (Figure 40).

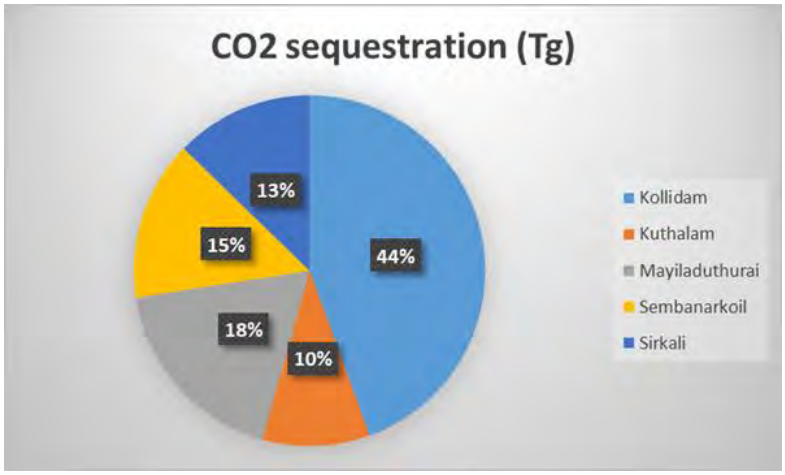


Figure 40 CO_2 Sequestration in Mayiladuthurai District

4.3.3 Green Cover Status and Enhancement of tree cover and CO_2 sequestration possibilities in Mayiladuthurai District

The current green cover in Mayiladuthurai district stands at 3.63%, covering 4,255 hectares. As part of the Green Tamil Nadu Mission, the district has increased its green cover to 4.27%, encompassing 5,014 hectares. However, this still falls short of the Tamil Nadu government's target, leaving a significant green cover deficit of 25%. There are several opportunities to enhance the district's green cover further. One of the most promising avenues is the plantation of native trees on fallow land, which could increase green cover by an additional 11% (12,851 hectares). Another potential area for improvement is planting native trees in schools, colleges, and government buildings, which could contribute 0.3% (319 hectares) to the overall green cover. Additionally, expanding mangrove plantations offers a possibility to enhance green cover by 0.04% (46 hectares). These initiatives highlight the district's potential to significantly boost its green cover, contributing to environmental sustainability and ecological balance.

4.4 Coastal Ecosystem

4.4.1 Shoreline Change along the coast of Mayiladuthurai

The results obtained from the LRR analysis show that within 30 years (1992–2022), about 3.69 km of coastal length under high erosion, 5.49 km of coastline under moderate erosion, 19.9 km of coastline under low erosion while 8.73 km under low accretion (Table 19). High and moderate erosion was observed only in the Kollidam Sirkali and Sembanarkoil Blocks, indicating vulnerability to shoreline changes. The erosion rate is 2.7 m/year, while the accretion rate is 1.1 m/year. The eroding hotspot villages were identified, and the length was calculated (Figure 41).

Pudhupattinam, Keezhaiyur, Kattur, Perunthottam, Kaalamanallur, Marudampallam, and Vanagiri villages are eroded, while Sathangudy villages have high accretion. The study revealed that about 205 ha of land loss and 67 ha of land gain were observed in the Mayiladuthurai district area over 30 years.

Table 19 Shoreline Change Assessment of Mayiladuthurai

District Name	Block Name	Coast Length (km)	High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
			(km/year)						
Mayiladuthurai	Kollidam	21.32	2.92	2.60	3.80	4.32	6.96	0.71	0.00
	Sirkali	13.91	0.62	2.77	7.46	2.40	0.66	0.00	0.00
	Sembanarkoil	14.54	0.15	0.13	8.64	4.35	1.11	0.17	0.00
	Total	49.77	3.69	5.49	19.90	11.07	8.73	0.89	0.00

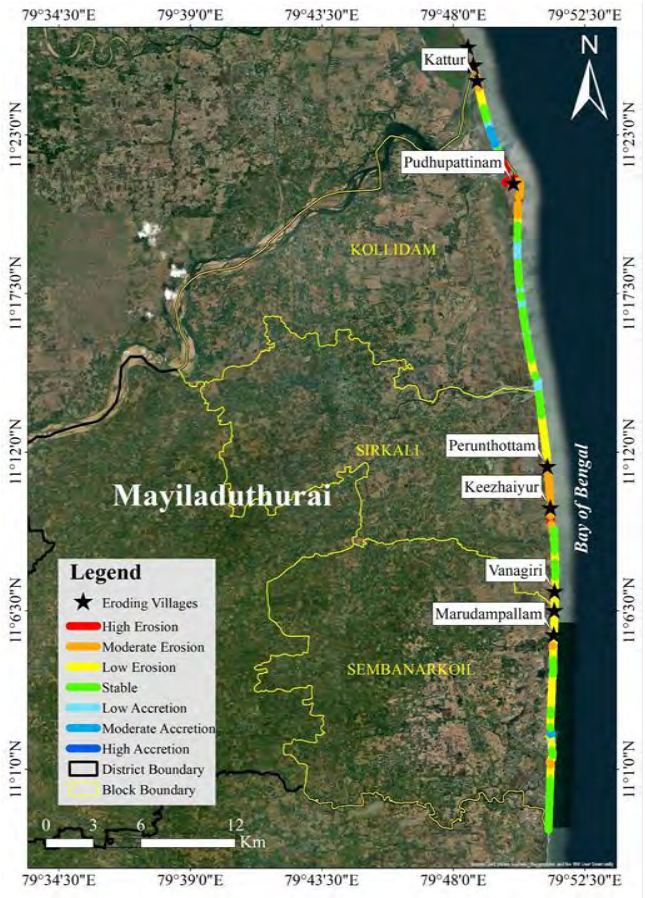


Figure 121 Shoreline Change Map of Mayiladuthurai District from 1992-2022

4.4.2 Observed and Projected Sea-Level Rise

The relative sea level trend is 0.18 millimeters/year with a 95% confidence interval of +/- 0.68 mm/yr based on monthly mean sea level data from 1971 to 2021, which is equivalent to a change of 0.06 feet in 100 years (Figure 42).

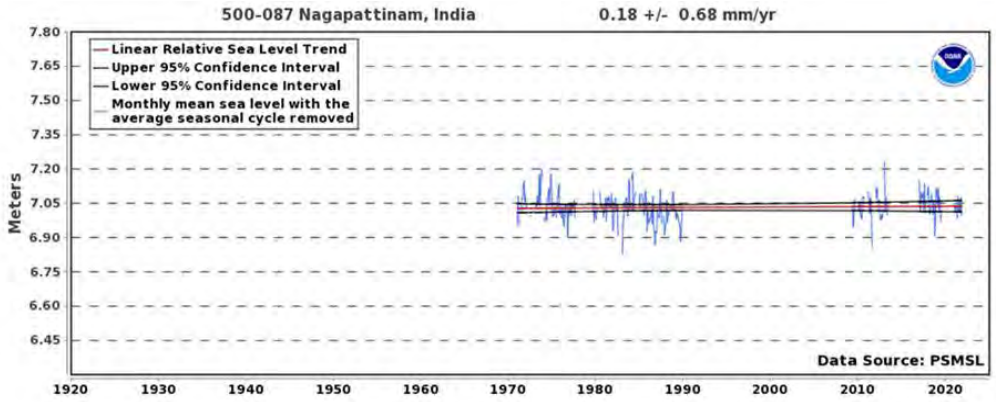


Figure 42 Observed Sea Level at Nagapattinam Tide Gauge Station

The projection of the total trend of sea level rise (SLR) for the Mayiladuthurai coast based on the SSP2 4.5 scenario (medium projection) for the near century is estimated to be an average of 20.3 cm (Figure 43). The coastal inundation due to rising sea levels is projected to be about 398 ha from 2021 to 2050. The Lagoon, Creeks, Mudflats, Swamps, Agricultural land, and Waterbody Sandy Beaches are at high risk due to inundation (Figure 44).

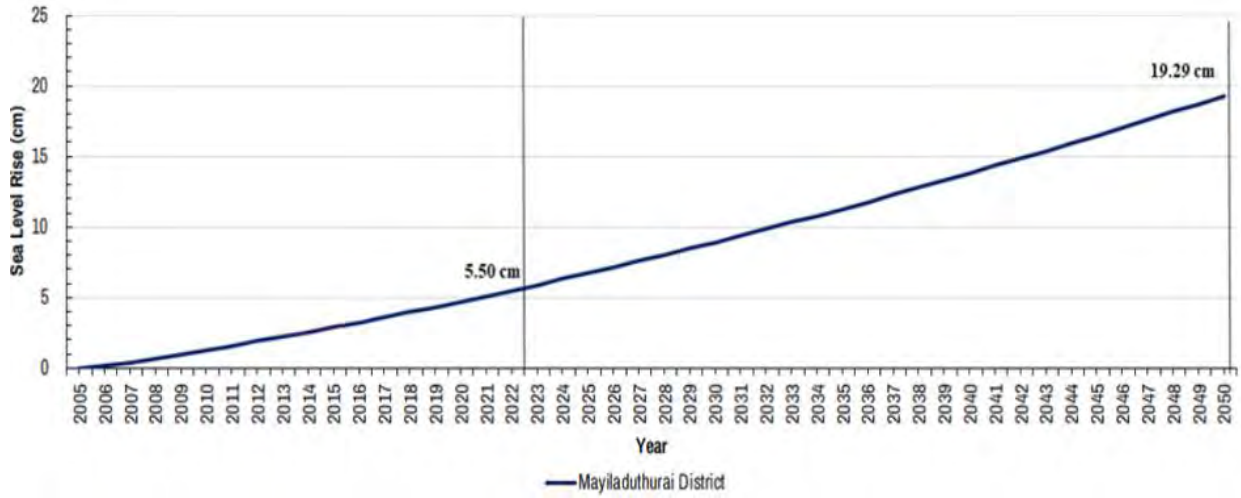


Figure 43 Projection of Sea Level Rise under SSP2 4.5 Scenario

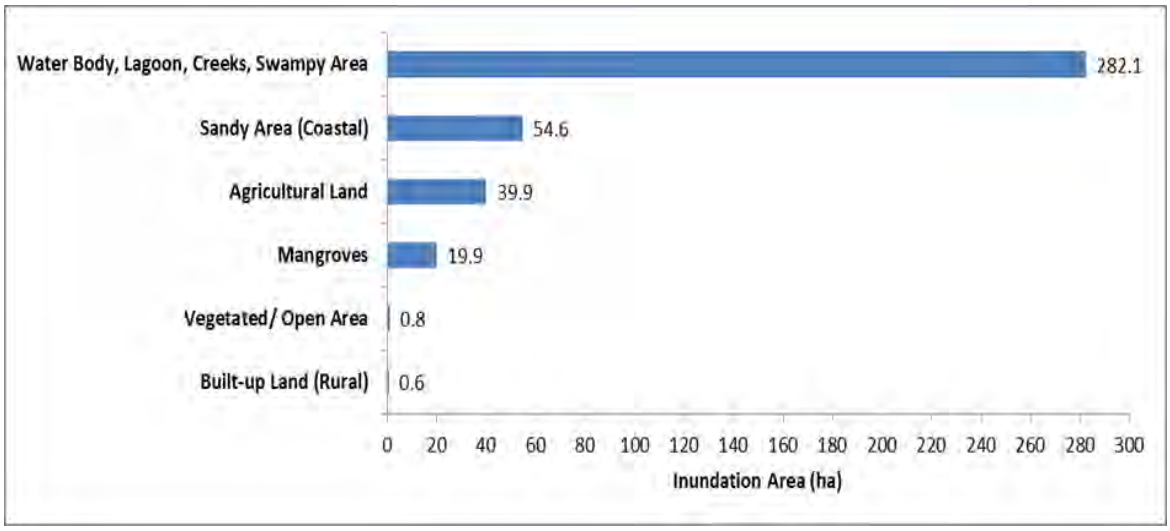


Figure 44 Inundation area due to Sea Level Rise under SSP2 4.5 Scenario

4.4.3 Annual Fish Catch

The annual fish catch of Mayiladuthurai is 8512 tons. The major fish-producing villages are Thoduvai, Thirumulaivasal, Poompuhar, Vanagiri, and Tarangambadi. The results show that towns with good infrastructure and facilities like harbors, storage, cold storage, and fish landing centers produce a greater quantity of fish than villages with fewer facilities. Figure 45 describes the detailed fish production of the 28 villages.

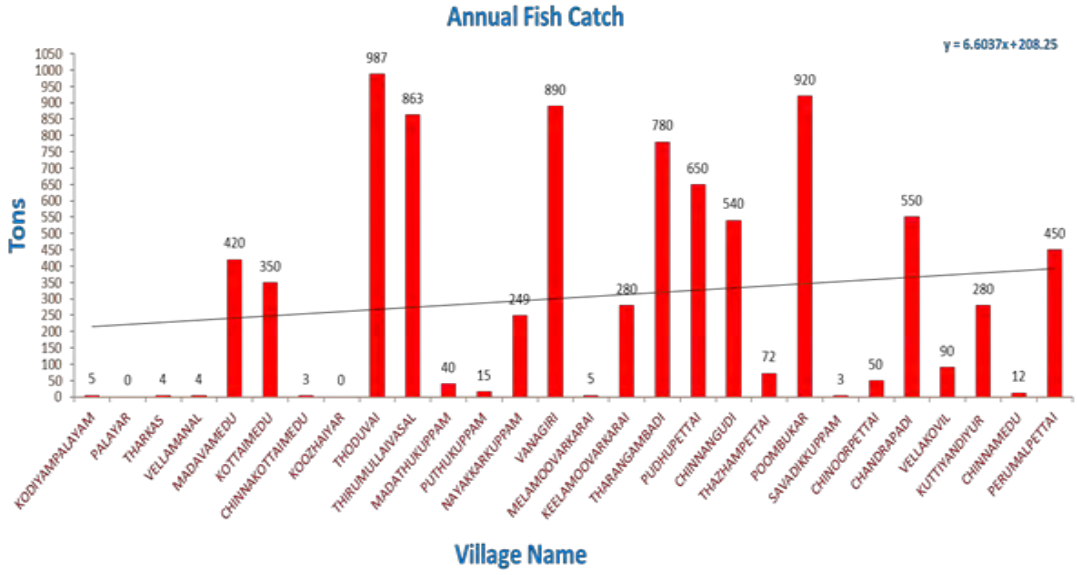


Figure 45 Annual Fish Catch of Mayiladuthurai (2023)

There are seven permanent and temporary Olive Ridley nesting centers along the coast of Mayiladuthurai. A detailed egg collection and eggs hatched from 2019 to 2004 are shown in Figure 46.

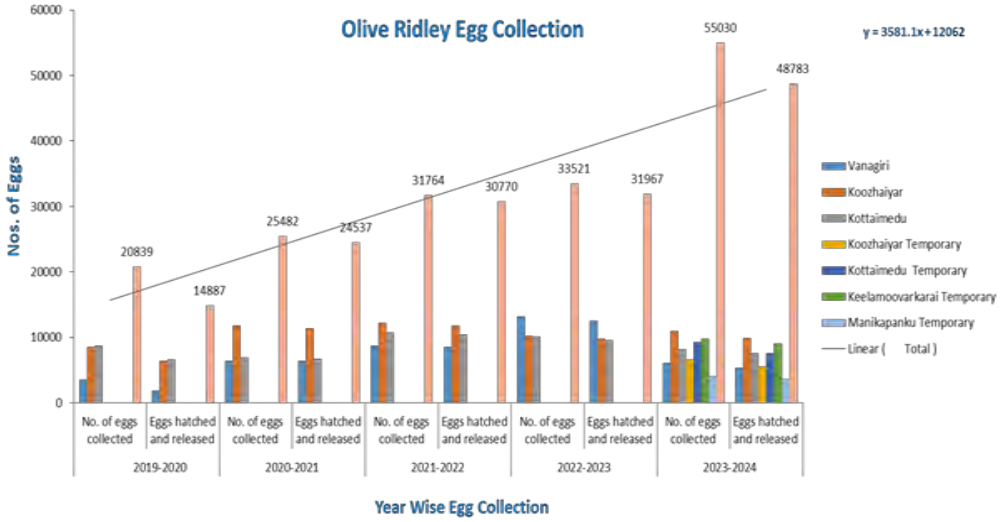


Figure 46 Olive Ridley Population (2019-2024)

4.5 Climate Change Impact on Sustainable Habitat

4.5.1. Thermal Discomfort

The Discomfort Index (DI) measures thermal comfort by considering temperature and humidity levels. Daily mean temperature and relative humidity from the regionally downscaled climate data were used to compute the discomfort indices across Tamil Nadu for the baseline period (1985-2014). Throughout these computations, Thom's formula [Thom 1959; Yousif and Tahir 2013] was applied and formulated as follows:

$$DI = T - (0.55 - 0.0055RH) (T - 14.5)$$

Here:

DI represents the Discomfort Index in degrees Celsius.

T denotes the mean monthly temperature (in degrees Celsius).

RH signifies the mean monthly relative humidity of the air (as a percentage).

The discomfort conditions and their trend are essential since they have been associated with a greater risk of morbidity and mortality and increased electricity consumption. The Discomfort Index (DI) is analyzed based on the daily average temperature and relative humidity. Figure 47 illustrates the Annual Average days of the discomfort conditions (DI 27-29) experienced by most people in the Mayiladuthurai district in the baseline period (1985-

2014). It is observed that, on average, the Mayiladuthurai district experiences 180 days of discomfort days. The pattern of discomfort days is increasing across the southern parts of the Mayiladuthurai district. The number of thermal discomfort days is higher in the district's interior than in the coastal stretch. This pattern differs from the overall trend of thermal discomfort observed in Tamil Nadu, where the number of discomfort days increased across the northern coastal regions of Tamil Nadu to more than 100-125 days every year, especially during the summer and southwest monsoon season.

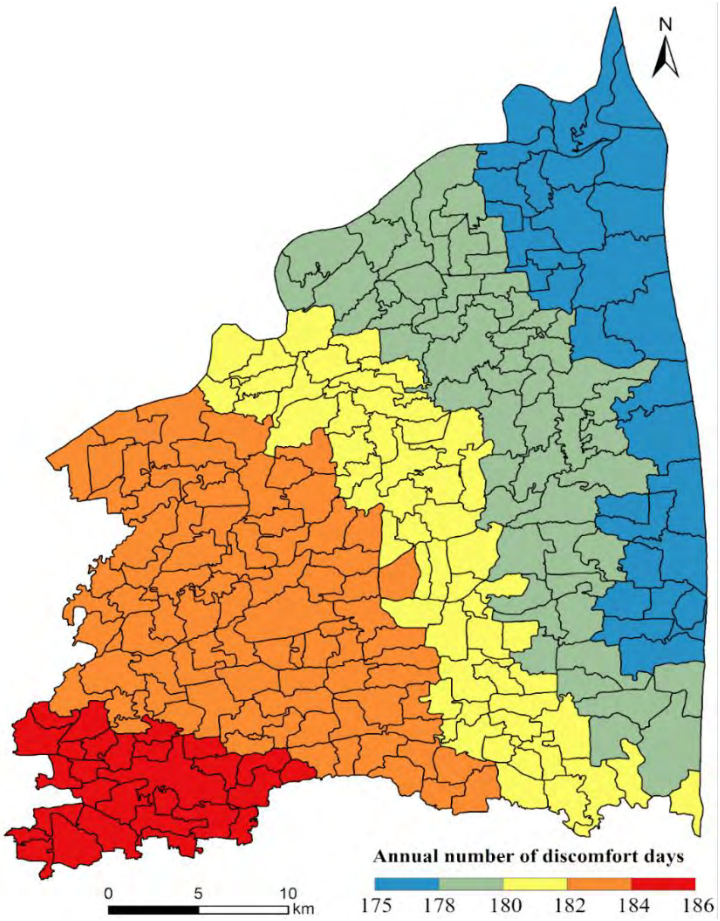


Figure 47 Number of Discomfort Days in Mayiladuthurai District

4.6 Comprehensive Climate Risk Assessment (CCRA) of Mayiladuthurai

Mayiladuthurai, located in the Cauvery Delta region of Tamil Nadu, is highly vulnerable to the impacts of climate change due to its dependence on agriculture and proximity to the coast. The region faces significant climate risks, including rising temperatures, erratic rainfall, cyclones, and sea-level rise. These changes pose threats to agriculture, water resources, and local livelihoods.

A set of 30 risk indicators was used in the assessment to capture the hazards, exposure 'sensitivity', and 'adaptive capacity' of the Mayiladuthurai district. Table 20 presents the construction of these indicators, their relationship with risk, and the rationale. The village-level values of all indicators and data sources are provided in the Appendix

Table 20 List of Indicators used for climate risk assessment

S. No	Indicators	Category	Relationship to Risk
	Climate Hazard		
1	Drought	Hazard	Directly Proportional ⬆
2	Flood	Hazard	Directly Proportional ⬆
3	Rx5 day (mm) - (maximum 5-day precipitation)	Hazard	Directly Proportional ⬆
4	Sea level Rise (Area Inundation)	Hazard	Directly Proportional ⬆
	Biophysical		
5	Kuruvai Supply-Demand Gap	Sensitivity	Directly Proportional ⬆
6	Samba Supply-Demand Gap	Sensitivity	Directly Proportional ⬆
7	Distance to river	Sensitivity	Directly Proportional ⬆
8	Water Yield	Adaptive capacity	Inversely proportional ⬇
9	Proportion of Kuruvai, samba, Black gram, Green gram, and cotton Cultivable area	Exposure	Directly Proportional ⬆
10	Soil Fertility Index (Indexing the soil nutrient)	Adaptive Capacity	Inversely proportional ⬇
11	Proportion of cultivable wasteland	Exposure	Directly Proportional ⬆
12	Percentage of Tree cover	Adaptive Capacity	Inversely proportional ⬇
			(Continued…)
13	Proportion of Horticulture Cultivable area	Adaptive Capacity	Inversely proportional ⬇

S. No	Indicators	Category	Relationship to Risk
14	Coastal Salinity	Exposure	Directly Proportional ↑
15	Coastal Erosion	Exposure	Directly Proportional ↑
16	Number of Thermal Discomfort Days	Exposure	Directly Proportional ↑
Infrastructure & Institutional			
17	Number of wells	Adaptive capacity	Inversely proportional ↓
18	Number of farm ponds	Adaptive capacity	Inversely proportional ↓
19	Mgnerga jobs card	Adaptive capacity	Inversely proportional ↓
20	Number of Pumpsets	Adaptive capacity	Inversely proportional ↓
21	Road density	Adaptive capacity	Inversely proportional ↓
Socio-economic			
22	Proportion of Small & Marginal Farmers	Sensitivity	Directly Proportional ↑
23	Number of Agriculture labourers	Sensitivity	Directly Proportional ↑
24	Number of Livestock Per Thousand Population	Adaptive capacity	Inversely proportional ↓
25	Groundwater extraction	Sensitivity	Directly Proportional ↑
26	Domestic Demand	Sensitivity	Directly Proportional ↑
27	Cropping Intensity	Adaptive Capacity	Inversely proportional ↓
28	Population density	Sensitivity	Directly Proportional ↑
29	Number of households	Sensitivity	Directly Proportional ↑
30	Female Ratio	Sensitivity	Directly Proportional ↑
31	Tap water connection	Adaptive Capacity	Inversely proportional ↓

4.6.1 Climate Hazard of Mayiladuthurai

Climate hazards refer to environmental events or trends that pose significant risks to human health, livelihoods, property, infrastructure, and natural resources. Critical indicators of climate hazards include drought, flood, Rx5 day (maximum 5-day precipitation), and sea level rise (area inundation). These indicators are directly linked to the overall climate risk; higher values signify greater hazard levels. This study's climate hazard index ranges from 0.411 to 0.962 (Figure 48).

Among the five blocks assessed, Sembanarkoil registers the highest climate hazard. The flood and drought hazard index are the most significant factors contributing to this high hazard level. Notably, 24 Gram Panchayats (GPs) in Sembanarkoil show a very high climate hazard, highlighting their vulnerability to climate-related risks, particularly flooding and drought conditions.

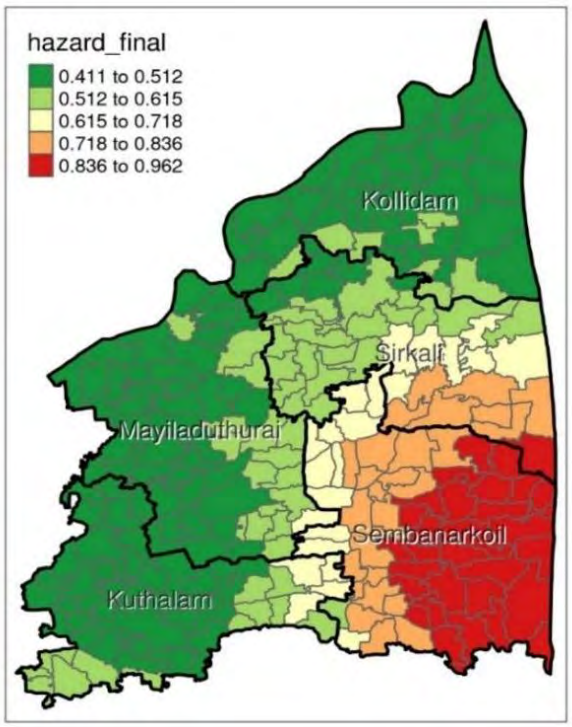


Figure 48 Gram Panchayat Level - Climate Hazard of Mayiladuthurai

4.6.2 Biophysical Index

Biophysical factors refer to the characteristics of the natural environment and their interaction with human activities. These factors are categorized into Sensitivity, Exposure, and Adaptive Capacity. Indicators used to assess biophysical vulnerability include Kuruvai flow gap, Samba flow gap, distance to river, water yield, the proportion of cultivable area for Kuruvai, Samba, black gram, green gram, and cotton, Soil Fertility Index (which measures soil nutrient levels), the proportion of cultivable wasteland, percentage of tree cover, the proportion of horticulture cultivable area, coastal salinity, coastal erosion, and the number of thermal discomfort days.

Biophysical vulnerability in the study area ranges from 0.266 to 0.632 (Figure 49). The analysis shows that 47 Gram Panchayats have very high vulnerability, 97 GP exhibit high vulnerability, 73 GP are categorized as moderate, 22 GP as low, and seven GP show very low vulnerability. Key factors influencing biophysical vulnerability include tree cover, horticulture cultivable area, distance to the river, water yield, and soil fertility. These factors play a crucial role in determining the biophysical resilience or vulnerability of the region.

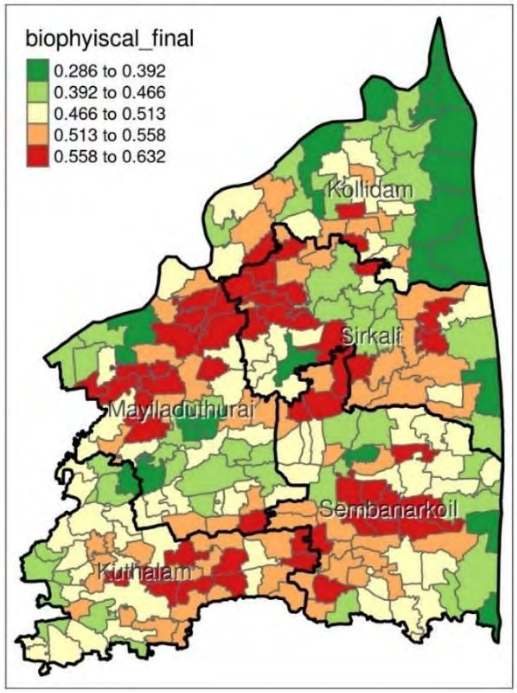


Figure 49 Gram Panchayat Level - Biophysical vulnerability of Mayiladuthurai

4.6.3 Infrastructure & Institutional Index

These factors represent the built environment and institutional support systems, all inversely proportional to risk, meaning they enhance the region's adaptive capacity. Indicators such as the number of wells, number of farm ponds, MGNREGA job cards, and number of pump sets were used to assess this capacity. The Infrastructure and Institutional Index ranges from 0.030 to 0.647 (Figure 50), with MGNREGA job cards being a key factor influencing the index.

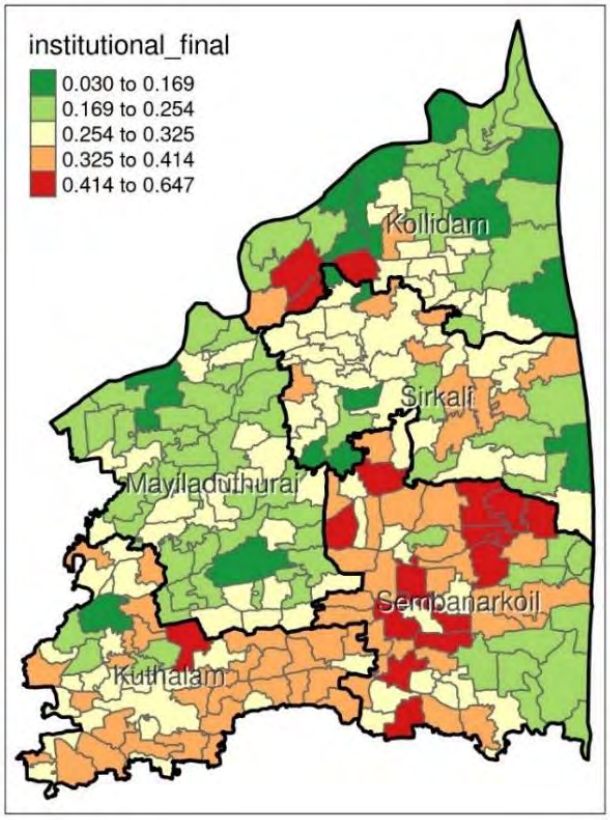


Figure 50 Grama Panchayat level Infrastructure & Institutional vulnerability of Mayiladuthurai

4.6.4 Socio-economic Indicators

These indicators provide a comprehensive overview of the social and economic conditions of the population, which directly impact both their vulnerability to challenges and their ability to adapt to them. Key socioeconomic factors considered include the proportion of small and marginal farmers, the number of agricultural laborers, livestock population per thousand people, the extent of groundwater extraction, and domestic water demand. Additional indicators include cropping intensity, population density, the number of households, the female-to-male ratio, and the availability of tap water connections.

Each of these variables contributes to understanding the region's overall socioeconomic structure. For instance, a higher proportion of small and marginal farmers may indicate a greater dependency on agriculture, while extensive groundwater extraction could signal increased pressure on natural resources. Similarly, high population density and limited access to tap water connections could highlight infrastructural challenges. These socioeconomic indicators, when combined, produce an index ranging from 0.12 to 0.45, representing varying levels of social and economic resilience or vulnerability across different areas, as depicted in Figure 51.

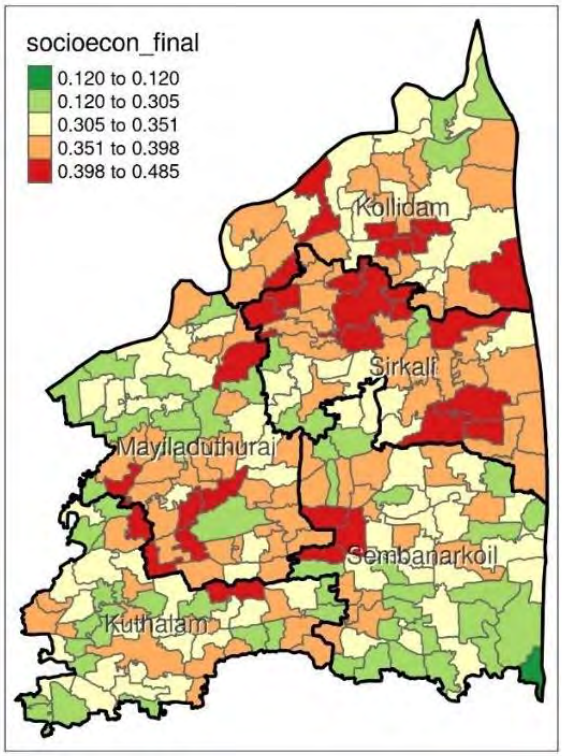


Figure 51 Socio-economic vulnerability of Mayiladuthurai

4.6.5 Comprehensive Risk of Mayiladuthurai

Sembanarkoil block is identified as the most vulnerable region, likely due to its proximity to the coast (exposure to climate hazards like sea-level rise and coastal erosion), significant water flow gaps during crucial crop seasons, high population density, and weaker infrastructure support. The composite climate risk of Mayiladuthurai is given in Figure 52. Twenty-four GPs of Sembanarkoil show a very high risk. Sembanarkoil (Akkur, Killiyur, Mukkarumbur, Thiruvilaiyattam, Thirukadaiyur, Gudaloore, Thalaiyudaiyavarkoilpathu, Mamakudi, Thiruchampalli, Kalahasthinathapuram, Memathur, Mathur, T Manalmedu, Narasinganatham, Semangalam, Melaperumpallam, Keelaperumpallam, Arupathy, Kanjanagaram, Kidangal, Madapuram, Echangudi, Elaiyalur, Neduvasal), Sirkali (Nangoore, Radhanallur, Keelasattanathapuram and Mangaimadam), Kollidam (Keelamathur). Seventy-eight GP. Indicated as high risk due to climate change. One hundred and eleven GPs are at A moderate risk of climate change. Twenty-three and two GP of Mayiladuthurai are indicated as having very low climate risk. This comprehensive risk assessment can guide targeted interventions. Sembanarkoil may

need more investment in coastal protection, water management infrastructure, and climate-resilient agricultural practices, while Kollidam and Kuthalam can continue to build on their adaptive capacity.

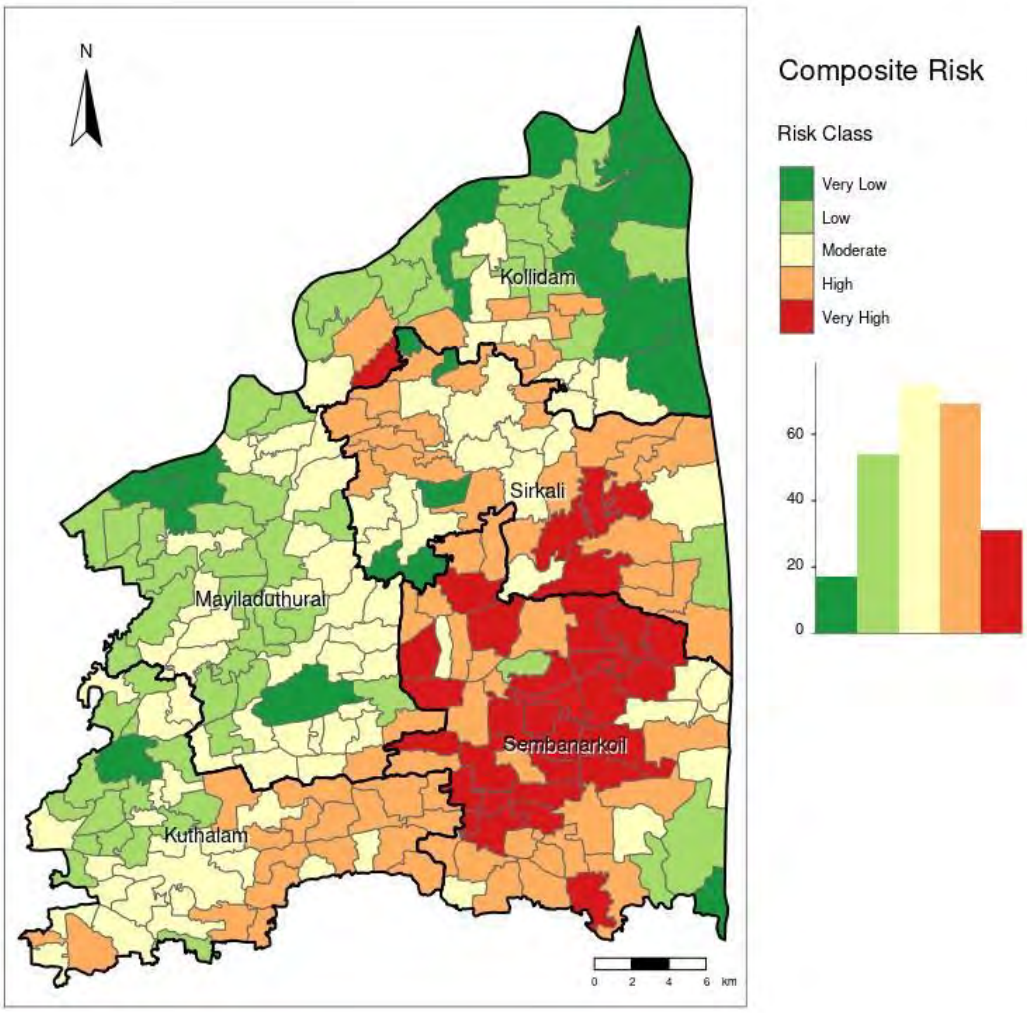


Figure 52 Composite risk assessment of Mayiladuthurai

The primary factors driving climate risk in Mayiladuthurai include a range of environmental, agricultural, and social elements. Among the most influential drivers are soil fertility, the area under horticulture cultivation, percentage of tree cover, the number of job cards issued under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), and proximity to rivers. Each of these factors affects over 200 Gram Panchayats (GPs), as shown in Figure 53, highlighting their widespread relevance across the district. These indicators suggest that soil health, agricultural diversification, employment opportunities, and access to water bodies are critical to understanding climate vulnerability in this region. Other important factors, such as the gap in Samba (a major rice-growing season) water flow, water yield, the drought hazard index, and the area under Samba rice cultivation, are linked to 150-200 GPs. These variables reflect the importance of water resources and agricultural productivity in influencing climate risk, as they directly impact both

irrigation availability and the district's ability to withstand drought conditions. In contrast, factors like the cultivable area of black gram, the number of pump sets, population density, the cultivable area of groundnut, access to tap water connections, and the risk of sea-level rise are relevant to fewer GPs, indicating that these concerns are more localized. While they are still important, their influence is limited to certain parts of the district. Lastly, factors such as the area under cotton cultivation, sea-level rise, soil salinity, and the number of farm ponds are associated with only a small number of GPs, suggesting that these issues are significant but confined to particular areas. These drivers likely represent unique vulnerabilities for coastal or saline-prone regions within the district. Overall, the varied distribution of these factors across different GPs reflects the complex and diverse nature of climate risks in Mayiladuthurai.

5. ASSESSMENT OF SECTORAL POLICIES - CLIMATE PERSPECTIVES

This chapter evaluates the impacts of various national and state-level policies/programs in five significant sectors assessed through the Climate Studio project (energy, water, agriculture, forest and biodiversity, coastal area, and sustainable urban habitat) that have been implemented in Mayiladuthurai from the perspective of climate change adaptation and mitigation. A total policy has been evaluated for the six sectors.

5.1 Power and energy sector:

The emission calculation methodology described here represents a comprehensive approach to evaluating the climate impact of policies and programs. Derived from authoritative sources such as the 2006 IPCC Guidelines, peer-reviewed literature, and the GHG Platform India's Phase III Methodology Note, this framework aims to quantify the greenhouse gas emissions added or avoided by specific interventions. The process involved consulting sectoral experts to make relevant methodological assumptions, ensuring the calculations were grounded in practical expertise. The evaluation focused on five distinct policies or programs, employing tailored equations or methods (detailed in the referenced Table 20) to calculate CO2 emission reductions for each scheme. This systematic approach likely incorporates establishing baselines, collecting activity data, applying appropriate emission factors, and modelling policy impacts. While the specific details of the policies and calculations are not provided, this methodology appears designed to offer a robust, scientifically grounded assessment of climate policy effectiveness, potentially considering factors like uncertainty, time frames, and both direct and indirect effects of policy implementation.

Table 21 Analysis of implementing policies related to power and energy sectors in Mayiladuthurai district

S.No.	Scheme/Policy	Description	Status in Tamil Nadu	Status in Mayiladuthurai District	CO_2 Emission Reduction Metric Tonnes of CO_2 avoided per year by the implementation of the scheme/policy
1.	PM Ujjwala Scheme	Provides LPG connections to women in Below Poverty Line (BPL) households to reduce dependence on traditional cooking methods.	Tamil Nadu has seen substantial distribution of LPG connections under this scheme.	65499 Total connections released under PMUY	20,423 metric tons of CO_2 per year
2.	Unnat Jyoti by Affordable LEDs for All (UJALA)	Aims to promote energy-efficient lighting through the distribution of affordable LED bulbs.	Tamil Nadu has implemented UJALA successfully, with widespread distribution of LEDs.	1,01,952 (including Nagapattinam)	7,433 metric tons of CO_2 per year.
3.	Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (KUSUM)	Encourages the installation of solar pumps and grid-connected solar power plants to increase farmer income and energy security.	Implementation is ongoing, with several solar pumps installed.	28 (16 nos. Of 7.5 HP and 12 nos. Of 5 HP pumps)	106.1 metric tons CO_2/year

4.	Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	Aims to strengthen rural electrification, focusing on feeder separation and strengthening sub-transmission and distribution infrastructure.	Tamil Nadu has made considerable progress in rural electrification and infrastructure strengthening.	1100 BPL households	95 metric tons/year
5.	PM Surya Ghar Muft Bijli Yojana	Aims to provide free solar power to households, particularly in rural and underdeveloped areas, to reduce electricity bills and promote green energy.	The status of implementation in Tamil Nadu is not widely reported.	100	369 metric tons of CO_2/year.

5.2 Water Resources

Four significant policies and schemes have been evaluated for the water resources sector. The appropriateness of the policies in addressing adaptation to climate change is addressed. The following sections include the schemes/policy description and its implementation status in the district of Mayiladuthurai.

5.2.1 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)

The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) provides 100 days of guaranteed wage employment to rural households in India, aiming to enhance livelihood security and alleviate rural poverty. It focuses on creating valuable rural infrastructure like roads, water conservation projects, and irrigation systems, while also empowering women, Scheduled Castes, and Scheduled Tribes. In Tamil Nadu, MGNREGS is crucial in reducing rural unemployment, especially in drought-prone regions, by promoting water conservation projects and strengthening rural infrastructure (Figure. 54). It has been instrumental in preventing outmigration and improving

livelihoods, making it highly relevant for sustainable rural development in the state. The MGNREGS works in Mayiladuthurai District across three fiscal years: 2021-2022, 2022-2023, and 2023-2024, with expenditures categorized into six types of works. These categories include drought proofing, flood control, land development, micro irrigation, renovation of traditional water bodies, and water conservation/harvesting.

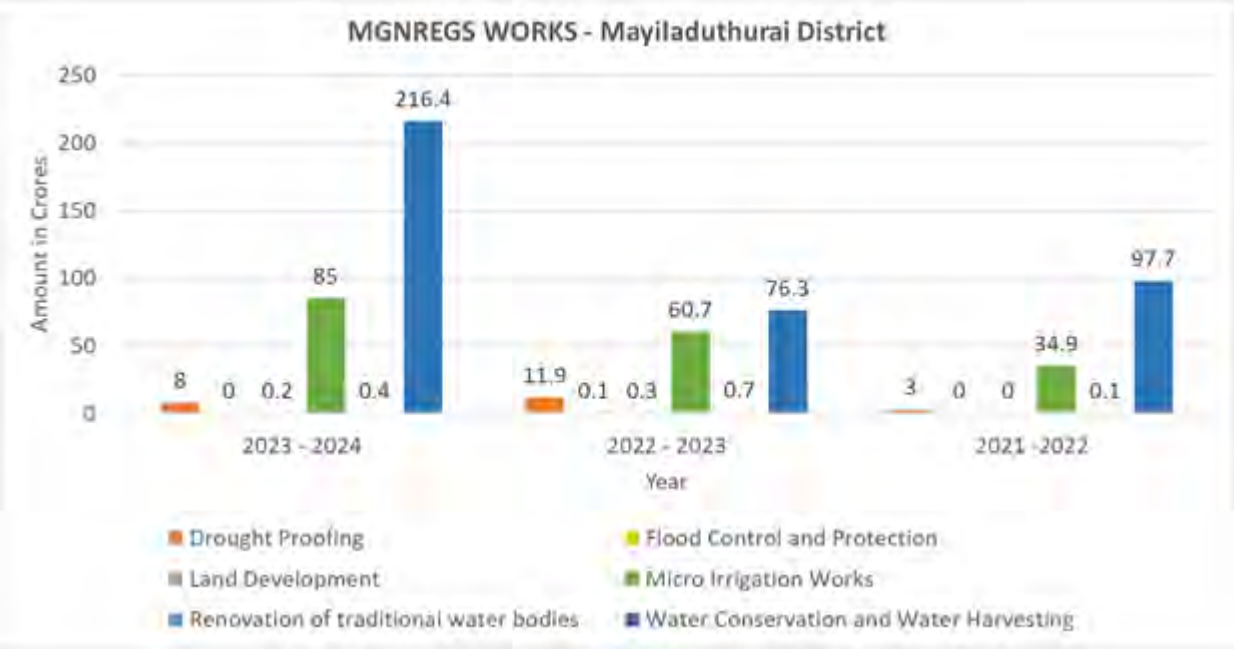


Figure 54 MGNRES Works of Mayiladuthurai for 2021- 22 to 2023-24

It is observed from the above figure 54 on the assessment of budgetary allocation under this scheme for various activities that Water Conservation and harvesting works consistently received the highest funding across the three years, with a peak of ₹216.4 crores in 2023-2024 indicating a strong focus on improving water infrastructure, which directly improves the adaptive capacity of the district in managing water scarcity and flood mitigation (Figure.55). Subsequently, there is the impetus to the micro-irrigation activities observed by the significant investment, peaking at ₹85 crores in 2023-2024. This initiative is particularly an effective adaptation effort to enhance agricultural productivity and rural livelihoods that are affected by climate vagaries of flood and drought.

The data suggests a strategic prioritization of water-related projects, particularly water body renovation and conservation, in Mayiladuthurai, reflecting the district's vulnerability to water scarcity and floods. Increased investments in land development and water management indicate efforts to improve agricultural productivity and rural livelihoods, which are crucial for long-term sustainability and climate resilience in the region.

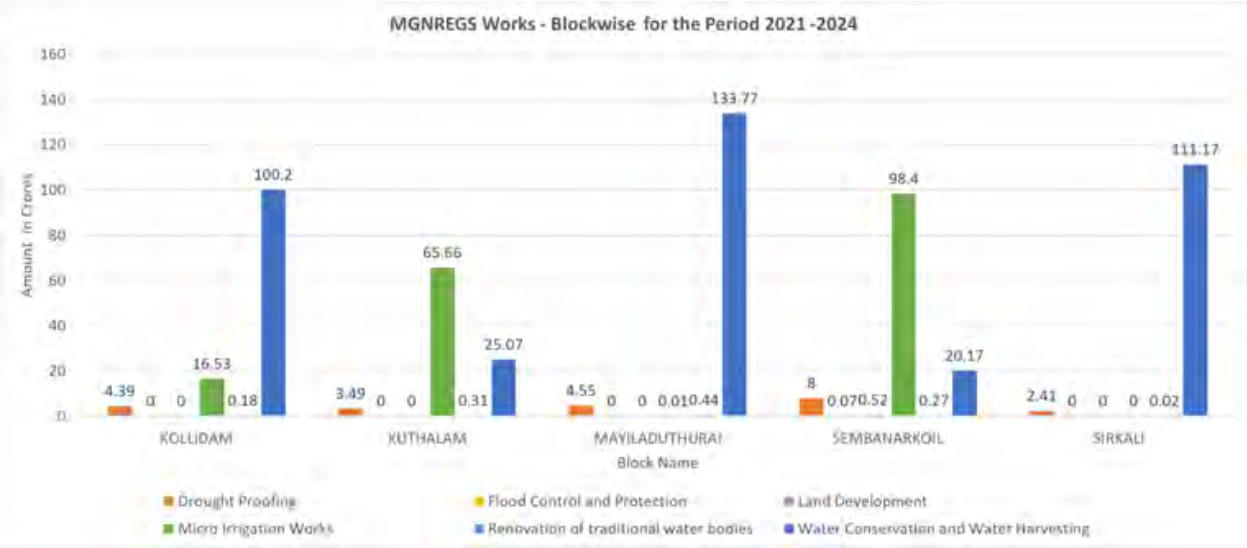


Figure 55 Block-level MGNREGS works for the period 2021-2024

From the block-level distribution of funds (figure 56) from the MGNREGS scheme it is observed that the Renovation of Traditional Water Bodies dominates the expenditure across most blocks, with Sirkali (₹111.17 crores) and Mayiladuthurai (₹133.77 crores) receiving the highest investments. Water Conservation and Harvesting also seek significant funding, especially in Kollidam (₹100.2 crores), emphasizing the importance of sustainable water management in this block. Land Development is the top priority in Sembanarkoil (₹98.4 crores) and Kuthalam (₹65.66 crores), reflecting efforts to improve agricultural land and promote rural livelihoods in these areas. Relatively, drought-proofing and micro-irrigation works received minimal funding across all blocks, suggesting less focus on climate-mediated problems during this period compared to water infrastructure and land development. The block-level data indicates a strong prioritization of water-related infrastructure, especially in renovating traditional water bodies and water conservation, which is crucial for drought resilience and flood mitigation in Mayiladuthurai District. Sirkali and Mayiladuthurai blocks invest heavily in water infrastructure, while Sembanarkoil and Kuthalam focus more on improving land productivity, reflecting regional variations in development priorities.

5.2.2 ICONIC Project (ERM) Works - WRD, Tamil Nadu (funded by NABARD Infrastructure Development Assistance (NIDA)

The ICONIC Project - Emergency Restoration Measures (ERM) Works by the Water Resources Department (WRD) in Tamil Nadu is a significant infrastructure initiative funded through the NABARD Infrastructure Development Assistance (NIDA) scheme. This project focuses on ERM to improve water management, flood control, and infrastructure resilience in vulnerable areas. It involves renovating and modernizing existing water structures, strengthening flood protection measures, and ensuring the long-term sustainability of irrigation systems. Figure 56 shows the scheme's block-level and year-wise budgetary distribution.

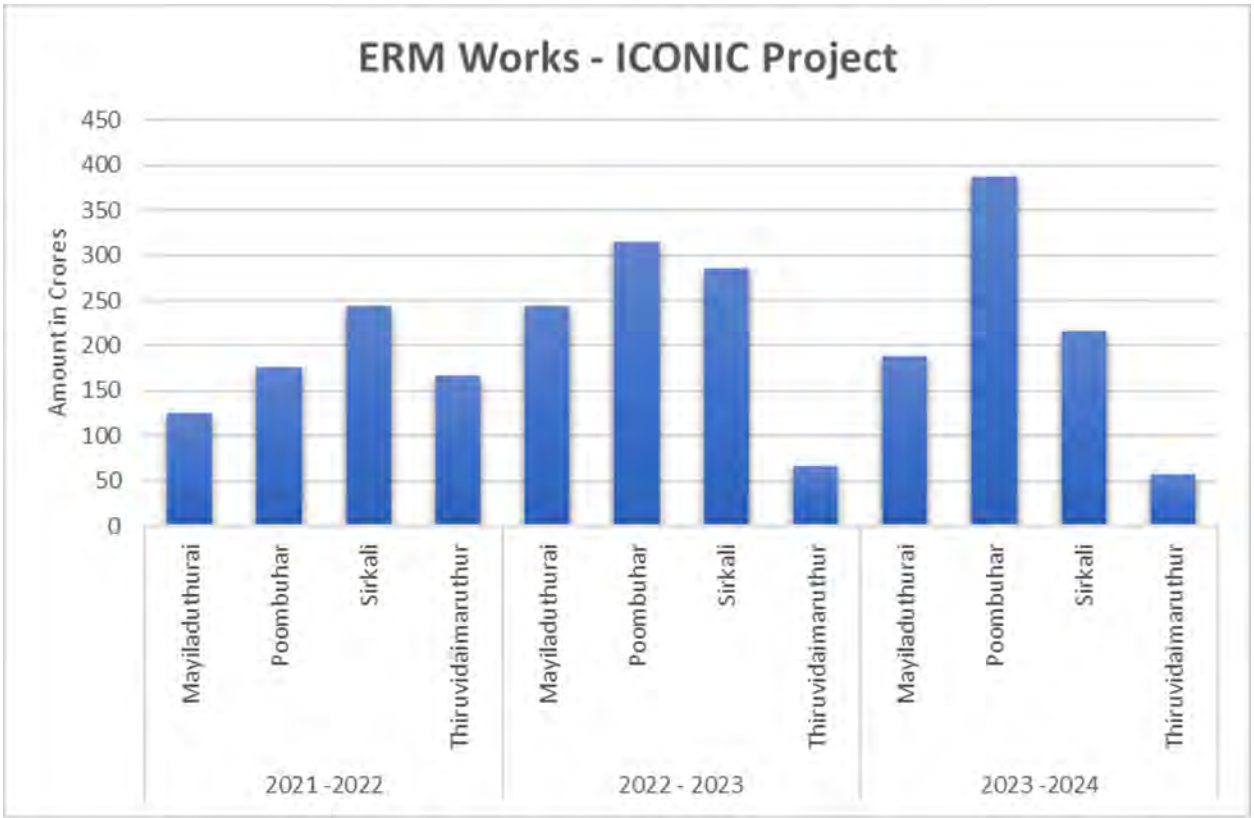


Figure 56 ERM works - ICONIC project of Mayiladuthurai

5.2.3 Jal Shakti Abhiyan: Catch the Rain Scheme

Jal Shakti Abhiyan: Catch the Rain is a nationwide campaign launched by the Ministry of Jal Shakti in 2021 to promote water conservation and rainwater harvesting across India. The campaign's motto is "Catch the rain, where it falls, when it falls," focusing on improving water availability through localized, community-driven

water conservation methods. It is particularly relevant in states like Tamil Nadu, which face water scarcity and irregular rainfall patterns.

In Tamil Nadu, the scheme emphasizes rejuvenating traditional water bodies, constructing rainwater harvesting structures, and promoting water-efficient agricultural practices. Local authorities, communities, and NGOs are involved in rooftop rainwater harvesting, watershed development, and enhancing the storage capacity of ponds, lakes, and tanks. The status of fund allocation in the Mayiladuthurai district is depicted in Figure 57.

Figure 57 Jal Shakthi Abhiyan fund allocation details of Mayiladuthurai

It is observed that the Water Conservation and Rainwater harvesting activities have gained impetus during the current fiscal year. The activities wise categorisation under the scheme is depicted in figure 58.

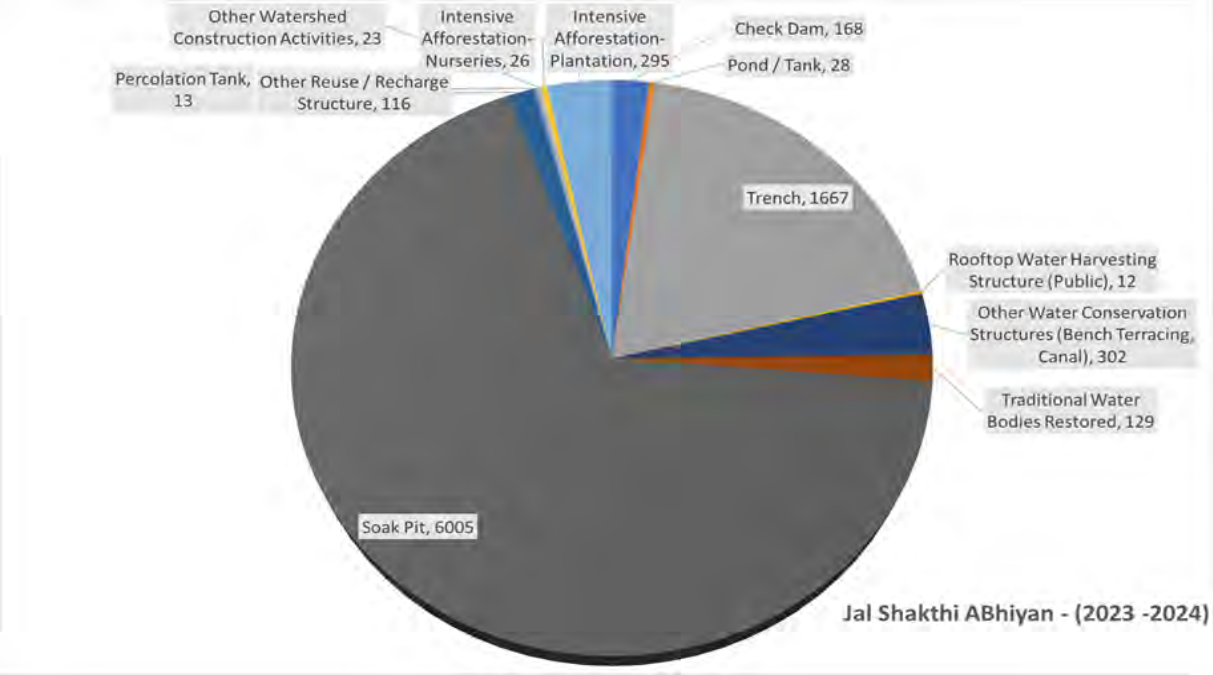


Figure 58 Jal Shakthi Abhiyan activities (2023-24)

Among the rainwater conservation activities, soak pits have been the most popular during 2023-2024. This scheme has further scope to address climate change adaptation beyond the improvisation of infrastructure such as soak pits.

5.3 Sustainable Agriculture

5.3.1 Kalaingarin All Village Integrated Agriculture Development Programme (KAVIADP):

The KAVIADP is a flagship initiative by the Government of Tamil Nadu to promote sustainable agricultural practices and improve rural livelihoods. Launched with the vision of making Tamil Nadu a leader in agriculture, KAVIADP focuses on a village-based integrated development approach, ensuring that each village maximizes its agricultural potential through modern techniques, resource optimization, and climate resilience.

Under this program, key activities include promoting rainwater harvesting, improving irrigation systems, encouraging crop diversification, and enhancing access to agricultural inputs like seeds and fertilizers. The program also supports animal husbandry, horticulture, and fishery development to boost the rural economy. By integrating these elements, KAVIADP aims to not only increase agricultural productivity but also create sustainable income opportunities for farmers and rural communities. In addition to addressing water resource

management and climate resilience, the program focuses on promoting organic farming and reducing chemical input to ensure long-term soil health and environmental sustainability.

5.3.2. The National Agricultural Development Programme

This scheme includes various other sub-components such as Distribution of Paddy MN Mixture @5kg per acre (subsidy rate @ Rs.27/Kg) or 50% whichever is less (ceiling - 2 ha/ Farmer); Distribution of Newly Released Varieties (Less than 10 year varieties) @ 50% of the cost or Rs.20/-per Kg; Production Incentive for & lt; 10 Years Variety Certified Seed (For all Fine Varieties)- Rs. 8/Kg; Seed Distribution - Less than 10-year-old varieties @Rs.20/- per Kg (or) 50% of the cost whichever is less and Distribution of Micronutrient Mixture for Paddy. This scheme has been implemented in 17 villages across Mayiladuthurai. Some of the climate benefits due to the scheme include:

- Increased resilience to extreme weather events like droughts and floods ensures better crop survival and stable yields, mitigating the risk of food insecurity and economic losses.
- lower nitrous oxide emissions (a potent greenhouse gas) are associated with overuse of nitrogen-based fertilizers.
- efficient nutrient uptake promoting healthier, more productive crops and improved soil health that helps in carbon sequestration
- Improved Yield and Food Security in Climate-Stressed Regions

Other Initiatives by the Government of Tamil Nadu that are relevant from a climate perspective are as follows:

- The establishment of a new Soil Testing Laboratory at Mayiladuthurai, to aid in continuous monitoring of soil quality.
- The Government of Tamil Nadu has facilitated the release of Rs.34.30 crore to 19,282 farmers of Mayiladuthurai district for Samba Paddy under Failed Sowing Category during 2022-23. This scheme will be continued during this year.
- Tamil Nadu Irrigated Agriculture Modernization Project (TNIAMP): Under Phase-IV, 873 Farm Ponds have been programmed to be constructed in 11 sub basins of 14 districts including Mayiladuthurai. Figure 59 showed a 2020-21 to 2022-23 registered under national programme on organic production (NPOP)

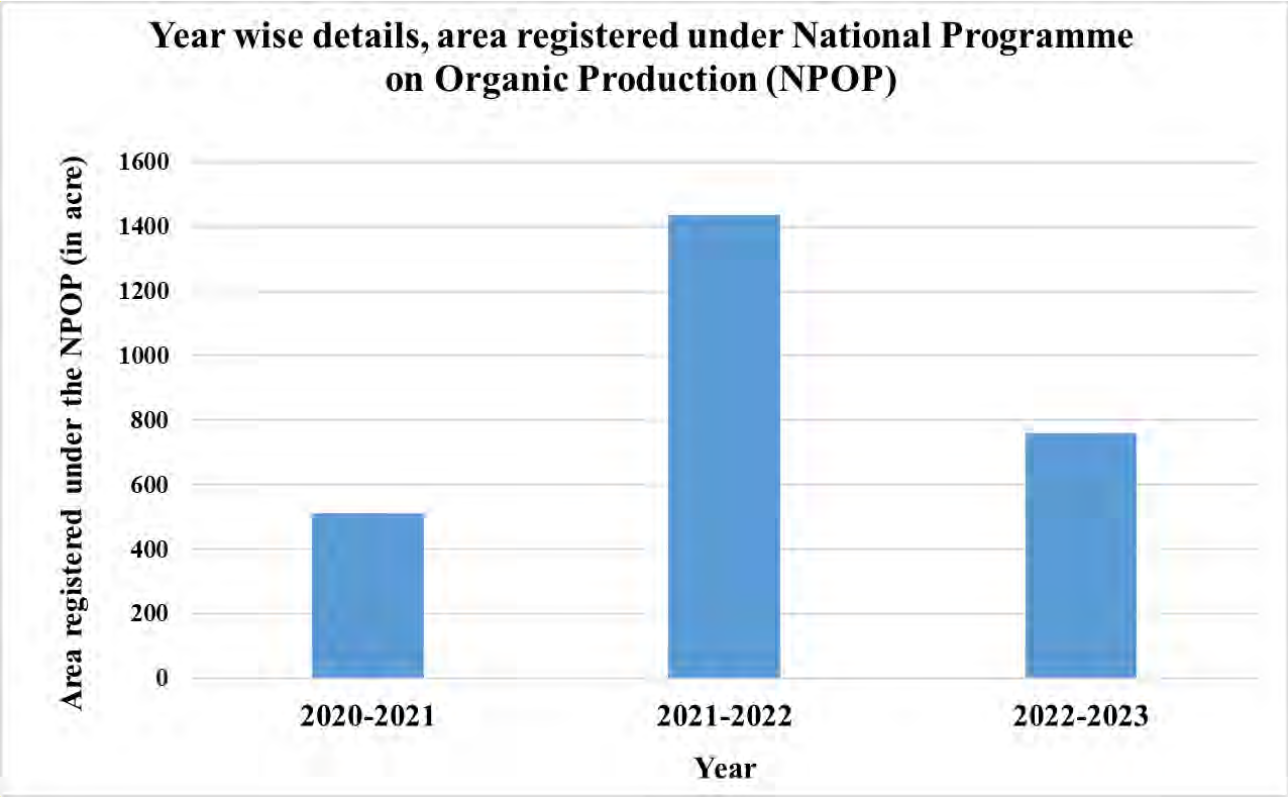


Figure 59 Year wise Details, area Registered under National Programme on Organic Production (NPOP)

6. Mayiladuthurai Climate Actions - Sector wise

6.1 Water Resources

A framework for a climate action plan in water resources centers around three core components: Surface Water Management, Groundwater Resilience, and Water Resource Augmentation as shown in Figure 60. Surface Water Management focuses on implementing efficient water use, reducing wastage, and optimizing water distribution for both domestic and irrigation needs. Groundwater Resilience involves protecting and restoring natural recharge capacity, reducing over-extraction, and maintaining water table to ensure long-term resource sustainability. Water Resource Augmentation encompasses methods to enhance water availability through techniques like rainwater harvesting, groundwater recharge, and improving storage capacities from excess runoff during the extremes like flood.

The framework for water resources directly addresses multiple Sustainable Development Goals (SDGs). Specifically, it contributes to

- SDG 1: No Poverty by ensuring access to reliable water sources, which supports livelihoods and economic growth
- SDG 2: Zero Hunger by improving crop yields and food security through efficient water management in agriculture
- SDG 3: Good Health and Well-being by reducing water-related diseases through safe irrigation practices and minimizing the contamination of water resources
- SDG 6: Clean Water and Sanitation by promoting sustainable use of water in irrigation, preventing over-extraction, and improving water-use efficiency
- SDG 11: Sustainable Cities and Communities by enhancing water resilience and infrastructure in urban and rural areas
- SDG 13: Climate Action by building resilience to climate impacts such as droughts and floods
- SDG 15: Life on Land through the protection of soil and biodiversity by preventing land degradation and promoting environmentally sound irrigation practices that conserve natural habitats

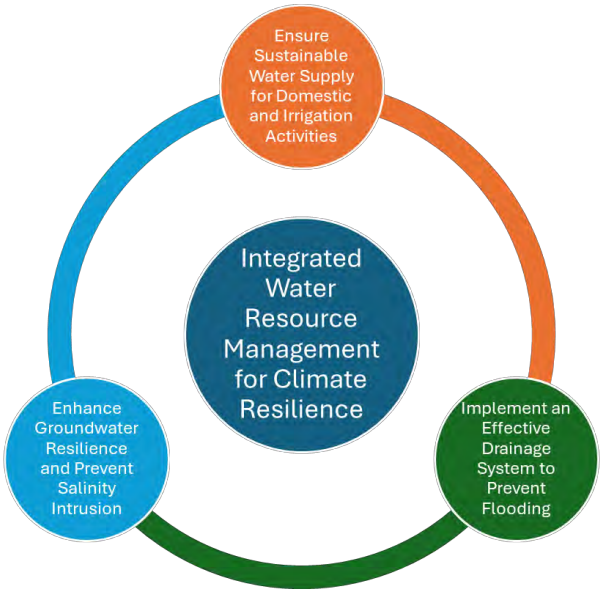


Figure 60 Climate Resilient Water Resources Action Framework

Table 22 shows the target and actions of water resources which are Ensuring a Sustainable Water supply for Domestic and Irrigation Use, Enhance Groundwater Resilience and Prevent Salinity Intrusion, implementing an Effective Drainage System to Prevent Flooding, and restorative Buckingham Canal.

Table 22 Recommendation of Targets and Actions for Water Resources

Target	Actions
Target 1: Ensure the Sustainable Water supply for Domestic and Irrigation Use	• Provide functional household tap connections (FHTC) to all villages, ensuring the prescribed domestic water supply of 55 liters per capita per day (lpcd) • Restore and cascade the ponds (RD ponds) and ensure connectivity of field (C & D) channels to improve water flow and storage efficiency
Target 2: Enhance Groundwater Resilience and Prevent Salinity Intrusion	• Construct artificial recharge structures at the farm level to promote sustainable groundwater replenishment • Formalize systems to monitor groundwater withdrawal, ensuring regulated and sustainable usage • Develop tail-end regulators to prevent saline water intrusion in agricultural lands, especially during dry seasons
Target 3: Implement an Effective Drainage System to Prevent Flooding	• Conduct regular maintenance of rivers, channels, and ponds to prevent blockages and enhance water flow • Implement measures to prevent encroachment into water bodies, ensuring they function effectively as natural drainage systems

6.1.1. Target 1: Ensure the Sustainable Water supply for Domestic and Irrigation Use

This objective aims to secure a sustainable water supply for the district's domestic needs and agricultural irrigation. A series of actions and sub-actions have been identified to address these needs, outlined below. By 2050, Mayiladuthurai district is projected to face a significant supply-demand gap, with only 3 villages expected to maintain a water surplus. The district-wide gap is predicted to increase by 31.2%, reaching 48.7 MLD, driven by an 8% decadal population growth (Population Research Centre, 2018). Mayiladuthurai block is expected to reach a gap of 11.9 MLD, with other blocks showing increases between 8.6 and 10.8 MLD. Coastal villages are expected to experience the highest supply-demand gaps, as shown in the village-level spatial variation in the future scenario map (Figure 61 & Table 23).

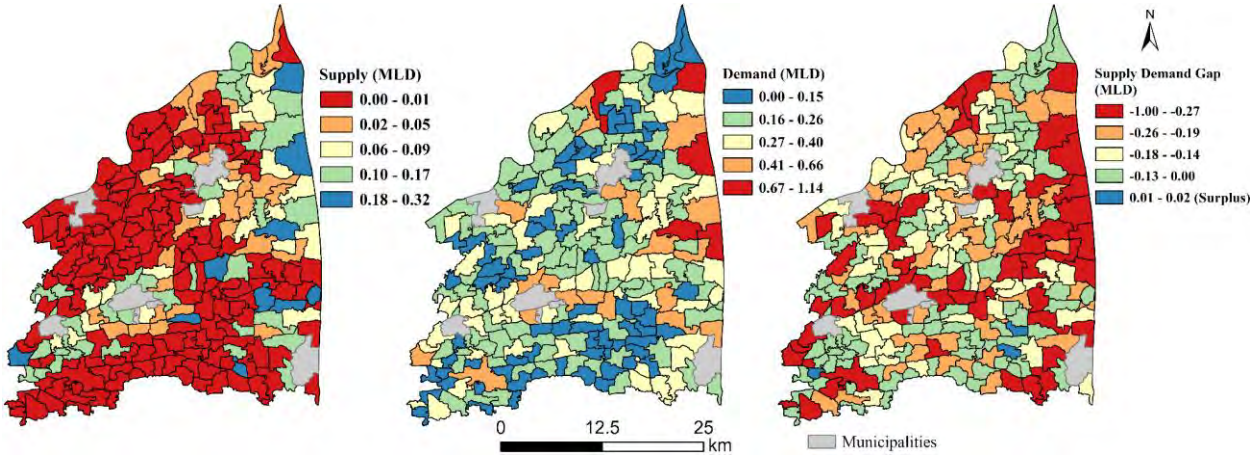


Figure 61 Domestic Supply, Demand and Deficit of Mayiladuthurai District - Projected scenario of 2050

Table 23 Comparison between present and project scenarios of Block-level Domestic Supply-Demand Gap

Block	Supply- Demand Gap (2023) (MLD)	Supply- Demand Gap (2050) (MLD)
Kolidam	6.5	8.6
Kuthalam	6.6	8.8
Mayiladuthurai	9.2	11.9
Sembanarkovil	8.2	10.8
Sirkali	6.4	8.6

To address these challenges, key recommendations include:

1. Implementing Functional Household Tap Connections (FHTC) for all villages to ensure the prescribed domestic water supply of 55 liters per capita per day (lpcd).
2. Laying out pipe water connections for all habitations in the short term.
3. Increasing the designed water supply quantity to meet future domestic demand.

These measures are crucial for improving water access and management across the district. However, given the severity of the projected deficits, additional strategies may be necessary. These could include water conservation measures, rainwater harvesting, and exploring alternative water sources to ensure long-term water security in the face of climate change and population growth. The action to address this issue was;

Action 1: Provide functional household tap connections (FHTC) to all villages, ensuring the prescribed domestic water supply of 55 liters per capita per day (lpcd)

Mayiladuthurai district is high deficit in irrigation canal supply for rice cultivation especially in Samba season. In order to overcome the issues, the scenario assessments were performed to explore ways to meet irrigation demand. These scenarios considered the integration of existing water harvesting structures, particularly farm ponds, in three aspects: 1 in 4 ponds, 1 in 2 ponds, and all ponds in each village, as potential solutions for improving water management efficiency (Table 24). A comparative analysis of irrigation deficit across villages of Mayiladuthurai district under both conventional and SRI (System of Rice Intensification) methods was carried out for the current and projected scenarios. Given the comparative analysis between conventional and SRI methods in Mayiladuthurai district, the supply-demand gap likely infers the following:

1. Current Scenario:
    - Conventional Method: A significant number of villages are in the Deficit and Highly Deficit categories, indicating a substantial irrigation deficit.
    - SRI System: The number of villages in the Deficit and Highly Deficit categories is lower compared to the conventional method, suggesting a potential improvement in irrigation efficiency.

2. Scenario Analysis:
    - Scenario-1: Both methods show a slight decrease in the number of villages in the Deficit and Highly Deficit categories, indicating a possible improvement in irrigation practices.
    - Scenario-2: The reduction in deficit is more pronounced in this scenario, especially for the SRI System.
    - Scenario-3: The SRI System shows further improvement, with a significant reduction in deficit and an increase in the number of villages with Surplus (Table 25 & 26).

Table 24 Water Use Irrigation Efficiency (IE) of Mayiladuthurai District

Blocks	Conventional (%)		SRI (%)	
	Kuruvai IE	Samba IE	Kuruvai IE	Samba IE
Kollidam	13	10	18	12
Sirkali	15	12	18	13
Sembanarkoil	15	11	22	13
Mayiladuthurai	20	16	26	20
Kuthalam	25	20	38	26

Table 25 Village level irrigation surplus and Deficit assessment for Kuruvai season

Irrigation Deficit Classification (M.Cu.ft)	Conventional Method (No. of Villages)				SRI System (No. of Villages)			
	Current	Scenario - 1	Scenario - 2	Scenario - 3	Current	Scenario - 1	Scenario - 2	Scenario - 3
Highly Deficit (< -100)	50	48	47	44	29	26	23	21
		4%	6%	12%		10%	21%	28%
Deficit (< -30)	155	149	149	145	169	165	161	154
		4%	4%	6%		2%	5%	9%
Normal (=0)	14	22	23	28	19	26	33	42
		57%	64%	100%		37%	74%	121%
Surplus (> 10)	28	28	28	30	30	30	30	30
		0	0	7%		0	0	0

Table 26 Village level irrigation surplus and Deficit assessment for Samba season

Irrigation Deficit Classification (M.Cu.ft)	Conventional Method (No. of Villages)				SRI System (No. of Villages)			
	Current	Scenario - 1	Scenario - 2	Scenario - 3	Current	Scenario - 1	Scenario - 2	Scenario - 3
Highly Deficit (< -100)	140	130	126	121	29	26	23	21
		7%	10%	14%		10%	21%	28%
Deficit (< -30)	78	81	82	87	169	165	161	154
		4%	5%	12%		2%	5%	9%
Normal (=0)	7	9	12	12	19	26	33	42
		28%	71%	71%		37%	74%	121%
Surplus (> 10)	22	27	27	27	30	30	30	30
		23%	23%	23%		0	0	0

Based on the supply-demand gap analysis, the supply pattern. indicates that the supply is sufficient only at the head release (> 500 M.Cu.ft) and leads to total scarce at the tail end (< 10 M.Cu.ft), whereas 75% of demand has been decreased (< 100 M.Cu.ft) in both Conventional and SRI methods. Therefore, the SRI System appears to be more effective in reducing irrigation deficit than the conventional irrigation canal supply method. The data suggests that implementing the SRI System in the Mayiladuthurai district could improve water management, reduce water wastage, and increase agricultural productivity.

Recommendations:

- Invest in Infrastructure:

  i) A total of 1,078 ponds have been geotagged and utilized for scenario assessment. However, the district contains approximately 2,000 ponds in total. To fully meet irrigation demand, the remaining ponds must be desilted and brought into use.

ii) The irrigation canal supply in Mayiladuthurai district is distributed through four head release regulators, with the Cauvery head regulator serving the majority of about 110 villages. To reduce irrigation demand and mitigate groundwater extraction, the Kuruvai release (2,290 M.Cu.ft) and Samba release (3,730 M.Cu.ft) should be increased by at least one-fourth of their current volumes. This adjustment would help alleviate pressure on groundwater resources.

- Promote SRI Adoption:

iii) The System of Rice Intensification (SRI) improves water efficiency by reducing the need for continuous flooding in rice paddies. It promotes alternate wetting and drying, cutting water usage by 25-50% compared to conventional methods. SRI's improved root growth and soil aeration also enhanced water absorption and reduced waterlogging. Additionally, SRI decreases reliance on groundwater extraction for irrigation.

iv) Government agencies and agricultural organizations should actively promote SRI among farmers. Training programs and technical assistance should be offered to ensure its proper implementation, leading to more efficient water use and reduced irrigation deficit.

Therefore, these recommendations as actions to address the irrigation deficiency as.

Action 2: Restore and cascade irrigation tanks (RD Tanks) and ensure connectivity of field (C & D) channels to improve water flow and storage efficiency

6.1.2 Target 2: Enhance Groundwater Resilience and Prevent Salinity Intrusion

Considering the district's reliance on groundwater, this objective is critical for safeguarding its long-term availability. Actions focus on strengthening groundwater recharge infrastructure, monitoring groundwater withdrawal, and preventing salinity intrusion, particularly in coastal areas.

The irrigation draft for Mayiladuthurai, shown in Figure 62, reveals that groundwater extraction exceeded 60% of the annual replenishment in 2020, a significant increase compared to 2011. Thillayadi and Thiruvengadu, identified as saline firkas, have had irrigation extraction restrictions in place for the past decade (2011-2020). Among the 15 firkas,

only Manalmedu shows a slight decrease in groundwater extraction over this period. Notably, Manalmedu remains the only safe firka in the district, serving as a model for effective groundwater management.

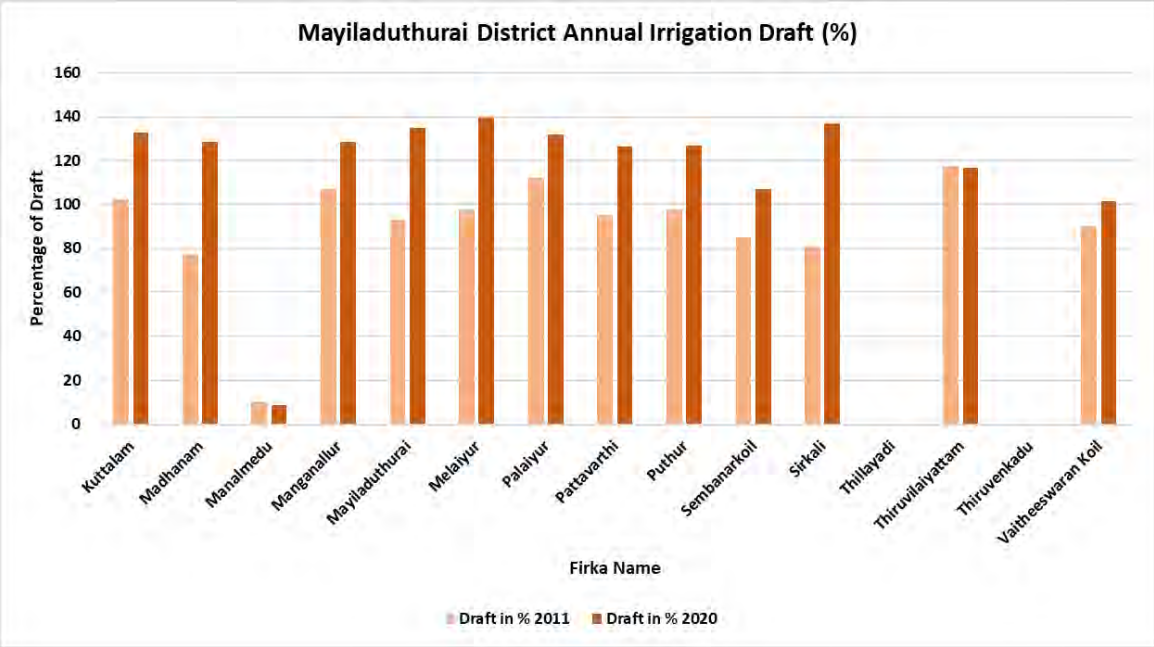


Figure 62 Percentage of Annual Groundwater Irrigation Draft for Mayiladuthurai District (2011 vs 2020)

The surface water replenishment from water harvesting structures will subsequently reduces the groundwater usage for irrigation as inferred in Target 1. Even though, the over-extraction of groundwater can be minimized by increasing the recharge structures as an action below.

Action 1: Construct artificial recharge structures at the farm level to promote sustainable groundwater replenishment

Between 2011 and 2020, groundwater extraction increased the most in Pattavarthi by 60%, while Manalmedu saw the highest decrease, with a reduction of 50%. Other firkas showing notable increases include Sembanarkoil (25%) and Sirkali (22.2%). Given the steep rise in extraction, Pattavarthi should be the primary focus for groundwater management to ensure sustainability, while Manalmedu can serve as a model for effective water conservation practices. Figure 63 shows a significant increase in groundwater extraction across most firkas in Mayiladuthurai district between 2011 and 2020.

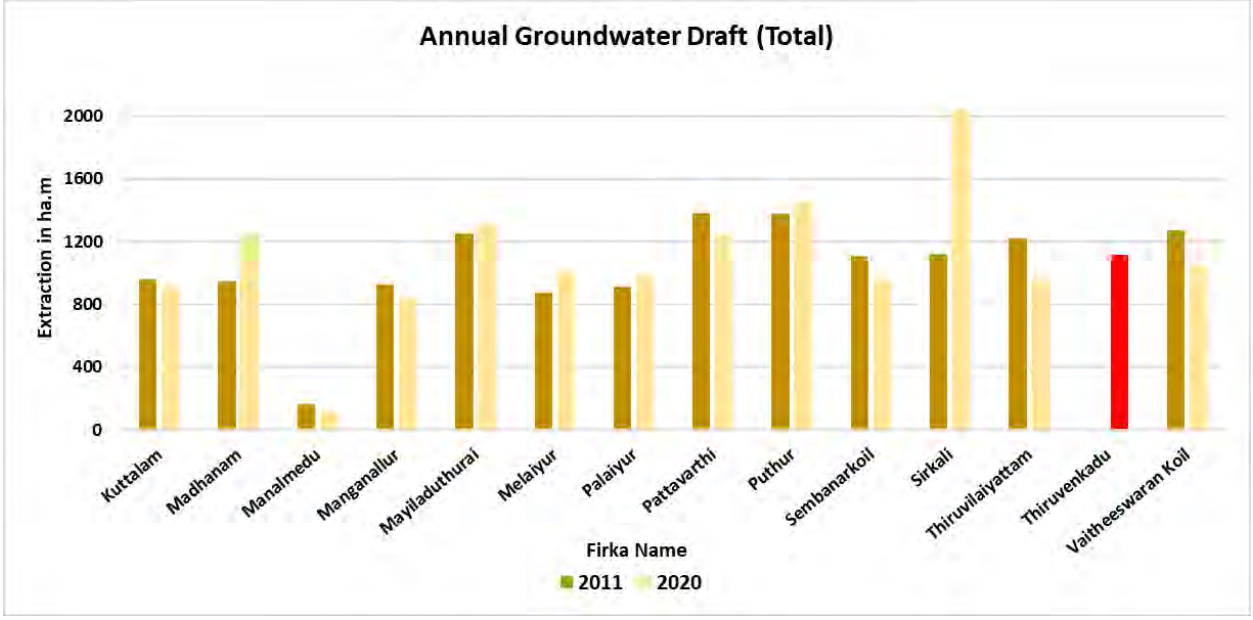


Figure 63 Total Annual Groundwater Draft for Mayiladuthurai District (2011 vs 2020)

The usage of groundwater in all aspects infers that groundwater extraction is beyond the limit all around the district due to insufficient surface water supply which has to be managed as an action below.

Action 2: Formalize systems to monitor groundwater withdrawal, ensuring regulated and sustainable usage

Figure 64 shows increased groundwater development across most firkas in Mayiladuthurai district between 2011 and 2020, with Mayiladuthurai, Mangainallur, Melaiyur, and Pattavarthi exceeding 120% development, indicating overexploitation of groundwater. Manalmedu stands out with a significant reduction in groundwater use, keeping development below 50%, making it an example of sustainable management. Other firkas, such as Puthur and Sembanarkoil, also show high development and need attention. Manalmedu has the best groundwater management, while overexploited firkas require urgent intervention.

Groundwater replenishment has improved in the firkas of Sembanarkoil (11%), Sirkali (22%), and Melaiyur (18%) due to the construction of five tail-end regulators, which have effectively prevented seawater intrusion and enhanced water storage for groundwater percolation. Additionally, one regulator is under construction, and six more are proposed, which will further improve both groundwater quality and quantity (Figure 65). This will ensure sustainable water availability for

coastal agricultural villages, where deep aquifer bore wells are currently used for irrigation. These measures aim to reduce reliance on deep wells and promote long-term water security for the region.

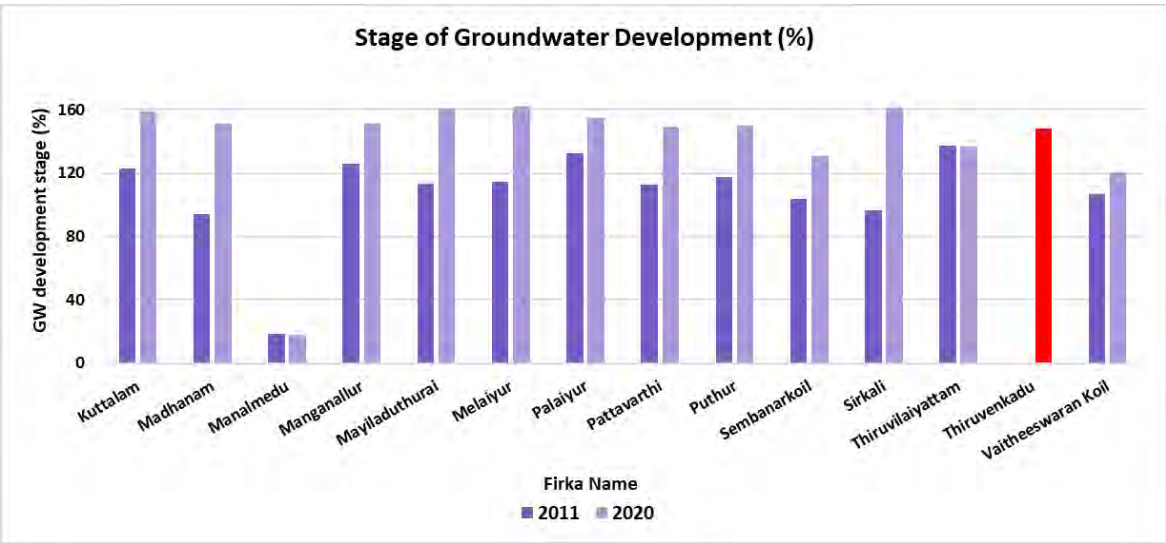


Figure 64 Groundwater Development Stage for Mayiladuthurai District (2011 vs 2020)

Figure 65 Tail End Regulators of Mayiladuthurai District

Tail-end regulators are vital in preserving the quality and quantity of groundwater while protecting agricultural lands from salinization, thereby ensuring long-term water security in coastal areas. Therefore, the action to be priortized as;

Action 3: Develop tail-end regulators to prevent saline water intrusion in agricultural lands, especially during dry seasons

6.1.3 Target 3: Implement an Effective Drainage System to Prevent Flooding

This objective focuses on protecting Mayiladuthurai district from flood risks while improving the management of existing water resources. A combination of engineering solutions and spatial planning initiatives is proposed to restore natural drainage systems and water bodies. Advanced GIS-based mapping of water bodies will also be used to prevent encroachment and ensure proper drainage.

Approximately 47% of villages, particularly in coastal areas, experience extreme flooding, while 76% of inland villages are moderately affected by drought, including specific coastal blocks like Sembanarkoil. To address both flood and drought issues in Mayiladuthurai district's coastal zones, the Buckingham Canal is identified as a solution for harvesting excess runoff from 9 major rivers. A preliminary WRD study highlights that the canal runs from Pazhaiyar village (Kollidam River) to Mahimalaiyar (Tharangambadi taluk), covering a 40 km stretch. Due to non-maintenance, much of the canal had been abandoned, but its uniform width (12 m) and depth (5 m) remain visible. If maintained throughout, the canal can store 84.76 million cubic feet of water. The abandoned stretches were identified using satellite imagery and DEM and are proposed for rectification and renovation, as shown in figure 66.

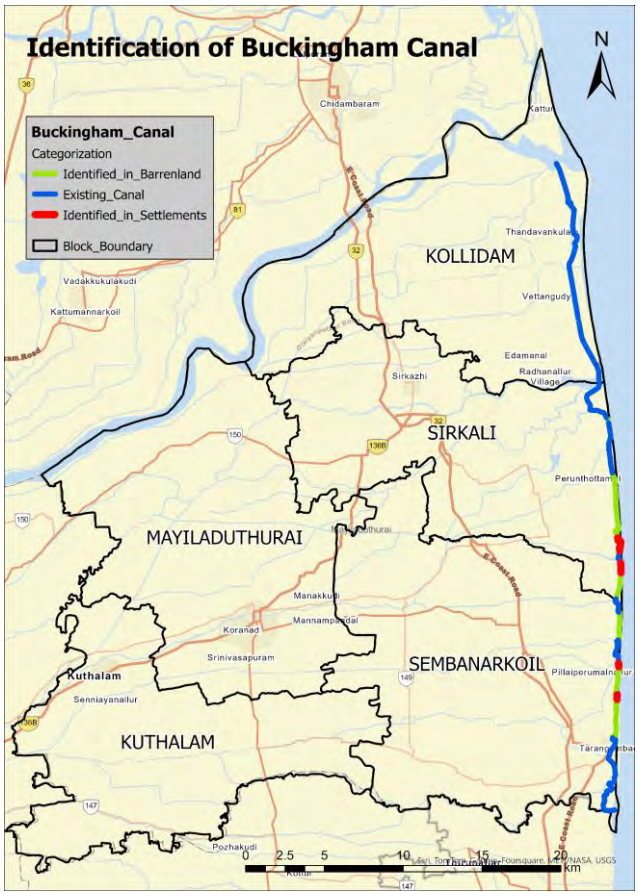


Figure 66 Identified Buckingham Canal in Mayiladuthurai District

Buckingham canal is the most important flood water carried in Mayiladuthurai district that has to be rehabilitated by the action as given below;

Action 1: Implement measures to prevent encroachment into water bodies, ensuring they function effectively as natural drainage systems

In Mayiladuthurai district, there are 365 major canals and 1,116 minor canals across 13 rivers, along with numerous unaccounted field channels (Table 27). Geotagging these canals provides more precise data to determine the annual desiltation required to prevent overflow or flooding during the northeast monsoon. Currently, desiltation works done once every three years, but annual desilting could significantly increase canal capacity. Additionally, geotagging interconnected water harvesting structures is essential to monitor and enhance water storage for future irrigation use, ensuring better flood management and water availability.

Table 27 Rivers and its A&B canals of Mayiladuthurai District

S. No	Name of the rivers	Main (A) Canal (nos)	Minor (B) Canal (nos)	Water Harvesting Structures (nos)
1	Cauvery	55	264	21
2	Veeracholanar	61	234	21
3	Manjalar	30	97	14
4	Mahimalayar	49	91	14
5	Vikramanar	22	37	5
6	Ayyavaiyanar	9	31	4
7	Manniar	-	-	6
8	Palavar	-	-	-
9	Odaiyar	7	28	3
10	Pudumanniyar	69	132	9
11	Nandalar	-	-	-
12	K.K.Manniar	9	32	1
13	South Rajan	54	170	9

Desilting rivers, canals, and ponds is crucial in delta regions, as it improves the clearance of drainage pathways and increases water holding capacity. This enhancement is essential for ensuring sustainable water use in the long term, necessitating the formulation of a comprehensive action plan.

6.2 Sustainable Agriculture

A framework for a climate action plan in agriculture centers around three core components: Good Agricultural Practices (GAP), Soil Conservation, and Water Augmentation. GAP focus on implementing sustainable and resource-efficient farming methods to optimize crop yields while minimizing environmental

impacts. Soil Conservation involves strategies to preserve soil health, reduce erosion, and maintain soil fertility, essential for long-term agricultural productivity. Water Augmentation encompasses methods to enhance water availability and efficiency, ensuring adequate water supply for agriculture, especially in water-scarce regions.

The framework directly addresses multiple SDGs. Specifically, it contributes to SDG 1: No Poverty through increased agricultural productivity and resilience; SDG 2: Zero Hunger by improving food security and sustainable agriculture; SDG 3: Good Health and Well-being by promoting farming practices that reduce environmental health risks, SDG 6: Clean Water and Sanitation, through sustainable water use in agriculture, SDG 12: Responsible Consumption and Production, by fostering efficient resource use, SDG 13: Climate Action, by mitigating and adapting to climate change impacts in agriculture, SDG 15: Life on Land, through the preservation of soil health and biodiversity (Figure 67).

This framework underscores the interconnectedness of agricultural practices, water management, and soil conservation, demonstrating that integrated strategies can address both climate resilience and the achievement of critical SDGs (Table 28). It promotes a holistic approach to sustainable agriculture, aligning with global efforts to adapt to climate change and improve food security.

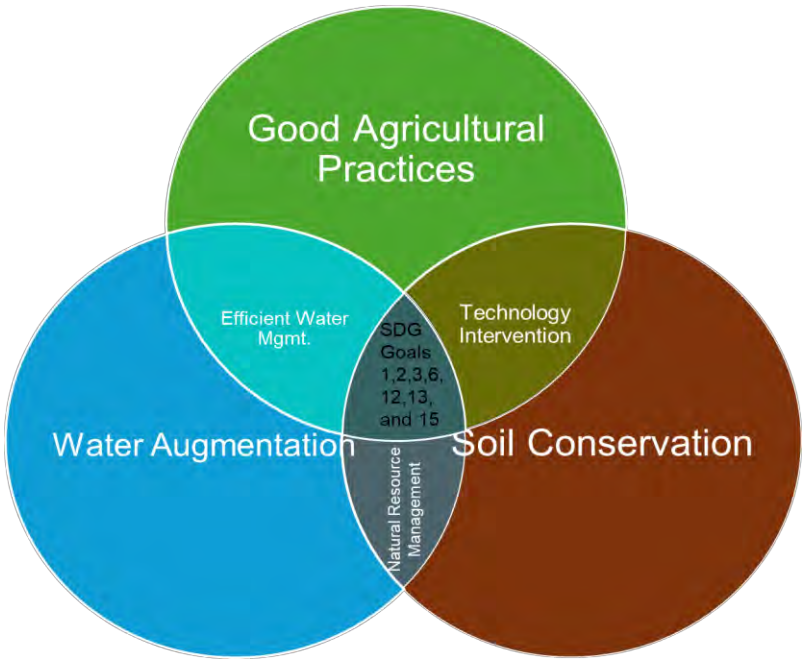


Figure 67 Agriculture Action Framework

Table 28 Target and Actions of Agriculture

Target	Actions
DEVELOP CLIMATE-SMART GOOD AGRICULTURE PRACTICES	4. Promote climate-adaptive crop varieties 5. Promote the farm-level practice of horticulture and agroforestry
PROMOTE SUSTAINABLE WATER MANAGEMENT PRACTICES	• Enhance irrigation efficiency • Integrated Water Management Strategies
IMPROVE SOIL HEALTH AND ENHANCE SOIL CONSERVATION TECHNIQUES	(b) Regularize the soil testing and control application of fertilizer (c) Implement soil conservation techniques – Cultivation of green and green leaf manure (Glyricidia), Farmyard manure

6.2.1. TARGET 1: DEVELOP CLIMATE-SMART GOOD AGRICULTURE PRACTICES

Action 1: Promote climate-resilient crop varieties

The yield performance of various rice varieties in the Mayiladuthurai shows a decline compared to baseline values. The variety CR1009 Sub1 has the slightest reduction in yield, experiencing a decrease of 4.315%. BPT5294 follows with a decline of 7.71%, while Swarna Sub-1 shows a more significant drop of 9.51%. ADT54 exhibits an even more considerable reduction at 11.99%. These variations highlight the differing resilience of these rice varieties under current cultivation conditions, with some showing more adaptability than others.

- Prioritize the cultivation of CR1009 Sub1 and BPT5204, especially in vulnerable coastal areas where climate impacts are more severe.

- Consider Swarna Sub-1 as a moderately resilient alternative, particularly in inland areas where its performance may be more stable
- Develop targeted support and adaptation strategies for farmers relying on more vulnerable varieties like ADT54 potentially introducing more resilient options or enhancing farming practices for these crops.

Action 2: Promote the farm-level practice of horticulture and agroforestry

The area under horticulture in the region is notably smaller compared to field crops, highlighting a potential gap in crop diversification. For instance, the Kollidam block stands out with the largest cultivable area for horticulture, covering 1613 hectares, whereas the Sirkali block has a much smaller area, only 367 hectares. Despite its potential economic benefits, this significant disparity suggests that horticulture has not been widely adopted across the district, particularly in some areas (Figure 68).

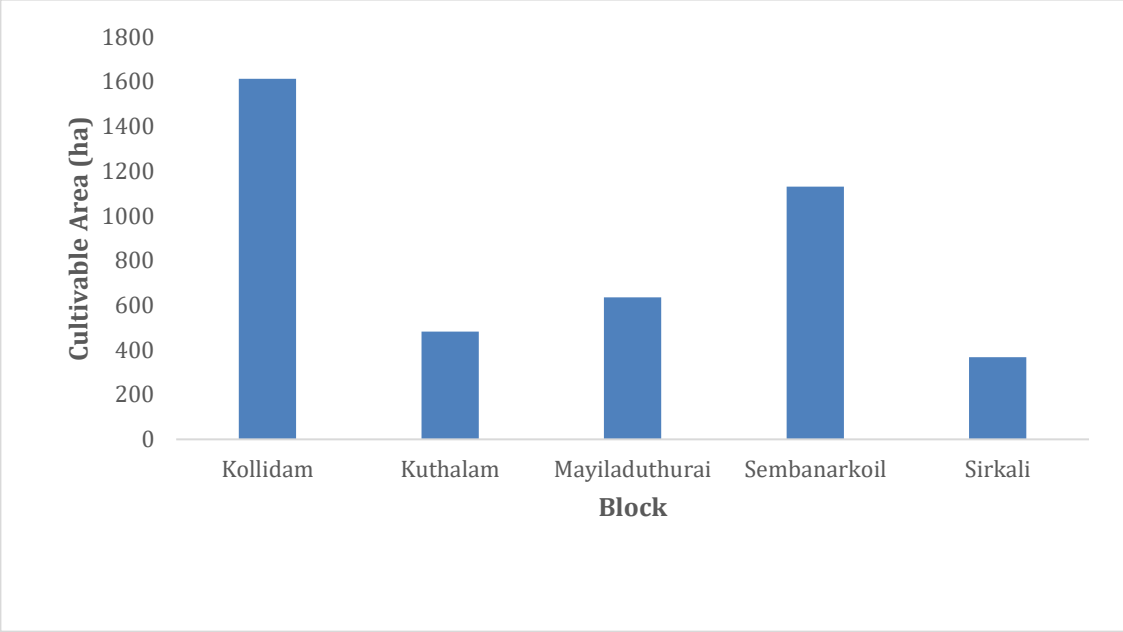


Figure 68 Block wise Horticulture Cultivable Area

6.2.2. Target:2 Promote Sustainable Water Management Practices

Action 1: Enhance irrigation efficiency

In Mayiladuthurai, three rice cultivation practices Conventional, SRI and Direct Sowing are followed. Farmers in Kuthalam and Mayiladuthurai blocks adopt SRI, which is known for its water saving potential and higher yields. However, they still rely on traditional flood irrigation, depleting groundwater through bore wells, thus not fully realizing the water conservation benefits of SRI. In contrast, coastal blocks (Kollidam, Sirkali, Sembanarkoil) continue conventional methods, leading to higher water usage and lower productivity (Figure 69).

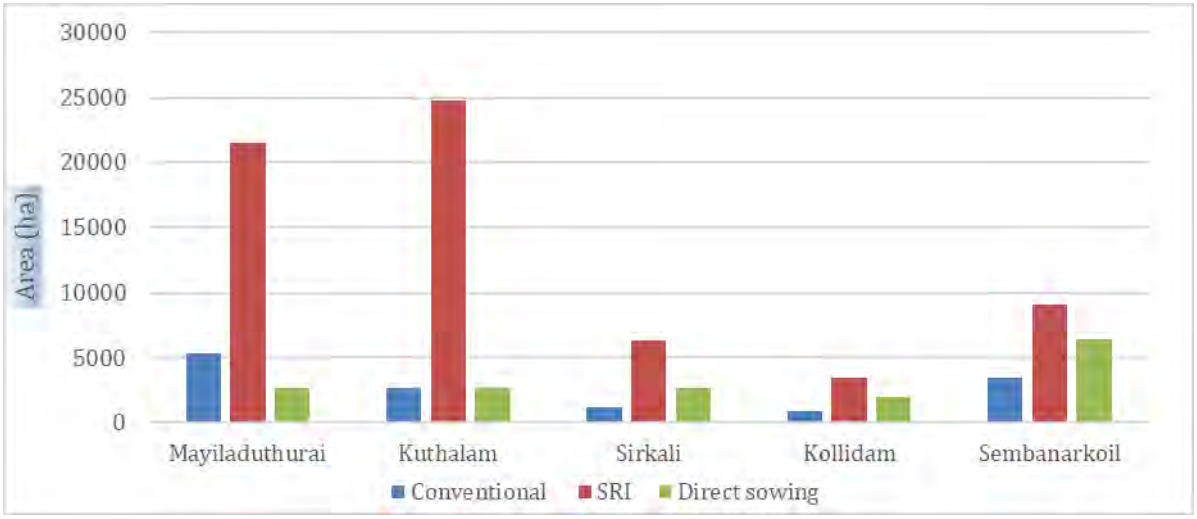


Figure 69 Block level paddy cultivation practices

Promoting Alternate Wetting and Drying (AWD) in SRI fields is essential to optimize water use, as it reduces water consumption while maintaining yields. Training in proper SRI water management practices, emphasizing minimizing flood irrigation, is crucial for farmers in these areas. For AWD and water saving technologies, financial incentives or subsidies should be provided to enhance irrigation efficiency and sustainability. Kuthalam, Mayiladuthurai, and parts of Sirkali, Kollidam, and Sembanarkoil block have a clay content in this region the farmer followed the alternate wetting and drying (Figure 70). This enhances the irrigation efficiency in rice cultivation.

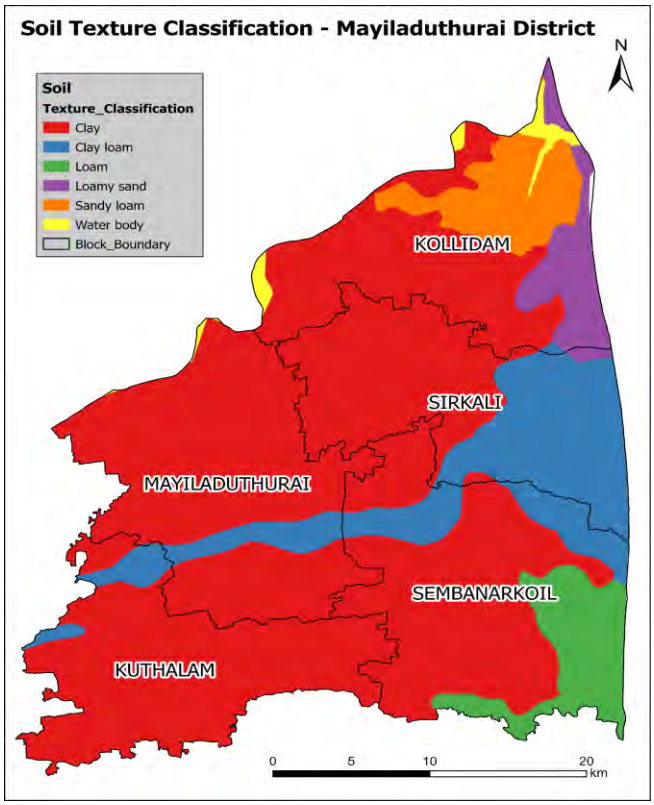


Figure 70 Soil texture of Mayiladuthurai

Action 2 Integrated Water Management Strategies

Implement a district-wide approach that combines surface water management (farm ponds) with groundwater management (sustainable borewell usage, recharge practices). Develop strategies to enhance resilience against climate variability, considering coastal and inland blocks' different water source dependencies. Kollidam has a small number of farm ponds followed by Mayiladuthurai and Sirkali block (Figure.71).

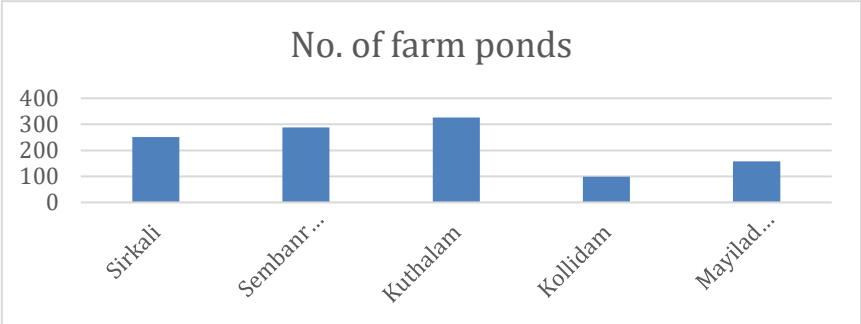


Figure 71 Block level Farm Ponds availability

Kollidam block of Mayiladuthurai is the tail end of Cauvery, farmers in this region are less the kuruvai rice due to the dependence on Cauvery, and this region has fewer farm ponds. To increase the farm ponds based on land holdings.

To construct a total of 7,081 new farm ponds across five different areas within the district. The distribution of these ponds is as follows: 1,245 in Kolidam, 1,363 in Kuthalam, 1,452 in Mayiladuthurai, 1,913 in Sembanarkovil, and 1,106 in Sirkali. The primary objective of this large-scale project is to enhance the district's water harvesting capacity. Once completed, these farm ponds are expected to collectively harvest an impressive 6.25 Million Cubic Meters (MCM) of rainwater. This initiative represents a substantial investment in local water management infrastructure, likely aimed at addressing water scarcity issues, supporting agricultural activities, and improving overall water security in the region. By capturing and storing rainwater, these ponds could play a crucial role in mitigating the impacts of irregular rainfall patterns, potentially reducing dependence on other water sources, and contributing to sustainable water use practices in Mayiladuthurai District.

Action:3 Install regulator (sensor) systems for irrigation through the bore well

6.2.3. Target 3: Implement soil conservation techniques

The Soil Health Index (SHI) being very low (less than 0.5) in 96 villages across various blocks in the Mayiladuthurai district is a significant concern. The low organic matter content and a potential decline in soil productivity. The GP-level soil nutrients are mapped (Figure 72). The organic carbon content varied between 0.22 to 0.49 %, Nitrogen 58.25 to 75.71 kg/ac, phosphorus ranged from 2.82 to 7.33 kg/ac, and Potassium varied from 67.44 to 136.20 kg/ac. 22 villages of Kollidam, 23 villages of Kuthalam, 25 villages of Mayiladuthurai block, 33 villages of Sembanarkoil Block, and 16 villages of Sirkali Block have less soil fertility.

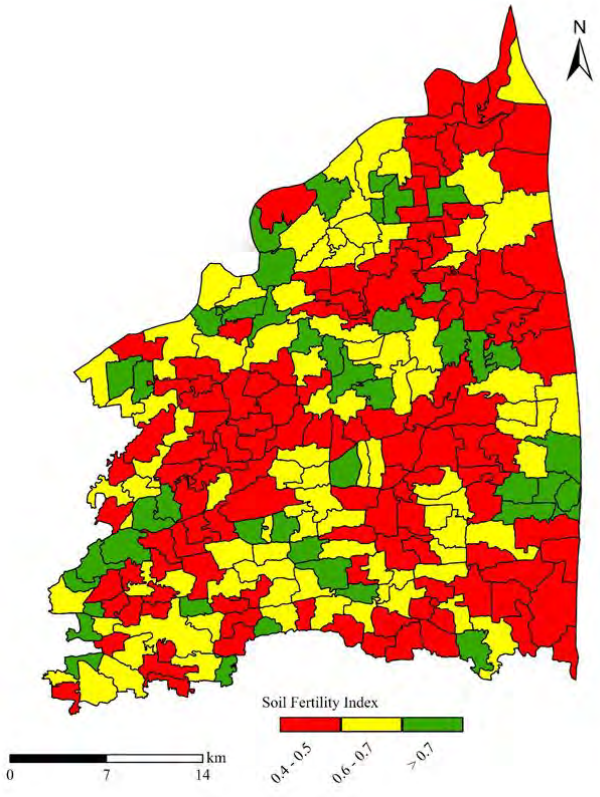


Figure 72 Soil fertility Index of Mayiladuthurai

Action:1 Cultivation of green and green leaf manure and application of Farmyard manure.

Sunhemp (*Crotalaria juncea*) and Daincha (*Sesbania bispinosa*) are green manure cultivated yearly to enhance the soil fertility of the Mayiladuthurai. It will help improve the soil's nutrients. The farmers in the mayiladuthurai are already following the rice fallow pulses (black gram and green gram). The root nodules have soil-fixing bacteria that enhance the nutrients in the soil.

Action 2: Regularize the soil testing and control application of fertilizer

This action aims to enhance sustainable farming practices through regular soil testing and the controlled application of fertilizers, ensuring optimal nutrient management, maintaining soil health, and minimizing environmental degradation. Every year farmer to be test the soil nutrient level, based on the nutrient deficient or efficient level to apply the fertilizer. The Phosphorus content in Mayiladuthurai soil is high, application of bio fertilizer Vesicular-Arbuscular Mycorrhiza (VAM) it enhances to a symbiotic relationship with plant roots.

To achieve this, a real-time soil nutrient alert portal should be developed. This portal will provide farmers with updated soil nutrient information every 10 days and after extreme weather events, such as heavy rain, cyclones, and floods, which can significantly impact soil fertility and nutrient availability. These alerts will enable farmers to quickly adjust their fertilizer application to compensate for any nutrient losses caused by such events, helping to maintain soil productivity.

Periodic soil testing campaigns should be organized at the block and village levels, supported by mobile soil testing labs that can reach even remote areas. Farmers will be encouraged to conduct soil tests before each crop cycle, and results will be communicated through the real-time portal, ensuring timely decision-making on fertilizer use.

The Soil Health Card (SHC) system should be strengthened to provide personalized recommendations on fertilizer applications based on soil test results, crop type, and local climate conditions. In addition, farmers should be encouraged to adopt organic and bio-fertilizers as part of an integrated nutrient management system (INM), minimizing the reliance on chemical fertilizers while enhancing soil health.

Strict regulations on fertilizer sales and usage should be enforced, with digital tools monitoring fertilizer applications on individual farms. This will prevent excessive or imbalanced fertilizer use, which can harm the environment and degrade the soil. Penalties should be imposed for non-compliance to ensure adherence to sustainable practices.

6.2.4 FARMER PERCEPTION-BASED ADAPTATION ACTION

A questionnaire-based perception survey on local climate change impacts was conducted across five strategic locations in the Mayiladuthurai district of Tamil Nadu, engaging 105 farmers to understand their observations and experiences regarding changing climate patterns and their effects on agriculture and water resources. The survey aimed to capture farmers' first-hand knowledge and perceptions of climate variability, adaptation strategies, and agricultural challenges. The study covered diverse geographical locations including Kalangudi, Perunthottam, Thiruvilaiyaadam, Thiruvelvikudi, and Erukkur, representing different agricultural ecosystems within the district.The questionnaire survey focused on documenting farmers' observations of local climate changes, their impacts on farming practices, and their

adaptive responses to these changes. This grassroots-level assessment provides valuable insights into how farming communities perceive and respond to climate variations in their local context.

Changing Agricultural Patterns and Challenges

In recent years, farmers in Mayiladuthurai district have undergone significant shifts in their agricultural practices in response to climate change and market demands. Over the past 2-3 years, there has been a notable transition toward short-duration, high-yielding crop varieties. This shift is primarily driven by increasing consumer preference for fine varieties and the need to adapt to changing climatic conditions. The agricultural landscape has also witnessed a dramatic decline in sugarcane cultivation, despite its historical significance as a climate-resilient and profitable crop with a 12-13-month growing period. This decline is primarily attributed to marketing challenges and the closure of local sugar mills, forcing farmers to abandon sugarcane cultivation entirely.

Agricultural Practices and Sustainability Concerns

Current agricultural practices in the district raise several sustainability concerns. Farmers' tendency to overuse fertilizers without proper soil fertility testing has become a significant issue. The gradual disappearance of traditional pest control measures has further complicated sustainable agriculture efforts. These challenges necessitate the implementation of regular soil testing programs, promoting organic and green manures, and reintegrating traditional pest management techniques alongside modern integrated pest management (IPM) approaches. To address these challenges, comprehensive farmer education and training programs on sustainable agricultural practices are essential.

Water Resource Management Issues

Water management presents a critical challenge across different blocks of the district. Farmers in the Kollidam and Sirkali blocks heavily depend on Cauvery water for Kuruvai cultivation, making them particularly vulnerable during water shortages due to limited alternative irrigation sources. The situation is equally concerning in Mayiladuthurai and Kuthalam blocks, where farmers operate bore wells for 18-20 hours daily. This intensive groundwater extraction leads to severe aquifer depletion and increases the risk of saltwater intrusion.

The absence of efficient water management strategies further exacerbates these issues, highlighting the urgent need for sustainable water resource management practices.

Agricultural adaptation techniques for climate change

The analysis of climate change adaptation methods reveals a diverse range of strategies adopted by farmers, with risk management emerging as the top priority through crop insurance (83%). Technological adaptation follows closely, with farmers embracing change through modified crop varieties (64.9%) and digital solutions like weather forecasting apps (52.1%). Sustainable agricultural practices show moderate adoption rates, including green manure application and direct seeded rice (both at 36.5%), along with strategic timing adjustments through modified sowing dates (35.1%). However, some traditional and water conservation methods show lower adoption rates - crop rotation (18.9%), flood-resistant varieties (15%), farm pond construction (13.5%), and drought-resistant varieties (12%). The data suggests a gradual transition towards modern agricultural practices, with agroforestry (10.8%), integrated nutrient and pest management (8.6%), and drip irrigation (6.8%) showing potential for increased adoption. Notably, traditional varieties have the lowest adoption rate at 2%, indicating a clear shift towards contemporary agricultural solutions (Figure.73). This pattern demonstrates that farmers are primarily focused on immediate risk mitigation and technological solutions while showing relatively less inclination towards long-term sustainable practices and traditional methods.

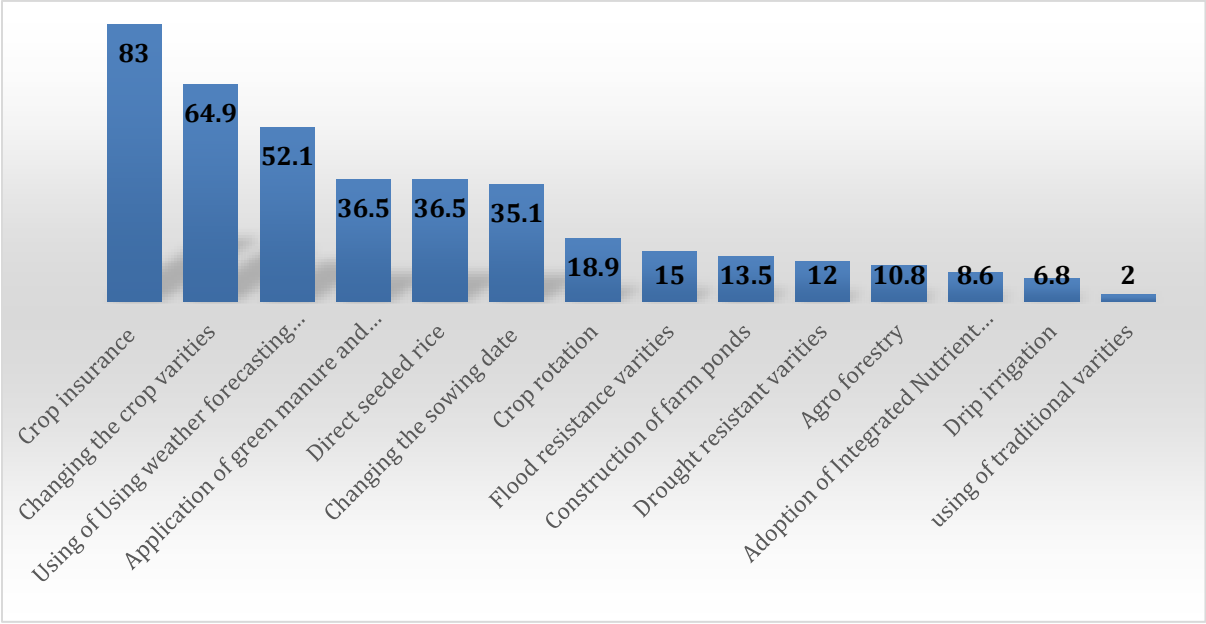


Figure.73 Farmer perception-based agriculture adaptation action

The analysis of water conservation adaptation strategies reveals that rainwater harvesting structures lead with the highest adoption rate at 65%, demonstrating its widespread acceptance as a primary water conservation method (Figure 74). This is followed closely by river/canal rehabilitation at 55% and water storage structures (including farm ponds and reservoirs) at 50%, indicating a strong preference for infrastructure-based solutions. Community water harvesting tanks and early warning systems (including radar systems and hydrological/meteorological observatories) show moderate adoption rates at 35% and 32% respectively. Lower adoption rates are seen in groundwater management strategies, with raising groundwater levels at 15%, saltwater intrusion mitigation at 14%, and general groundwater level management through wells and infiltration ponds at 12%. The least adopted strategies are irrigation activities (sprinkler, drip, surface irrigation) at 8% and watershed management/catchment conservation at 7%, suggesting that despite their potential benefits, these more complex and resource-intensive approaches face significant implementation challenges. This pattern indicates that farmers and communities tend to favor immediate, visible solutions over long-term, systemic approaches to water conservation.

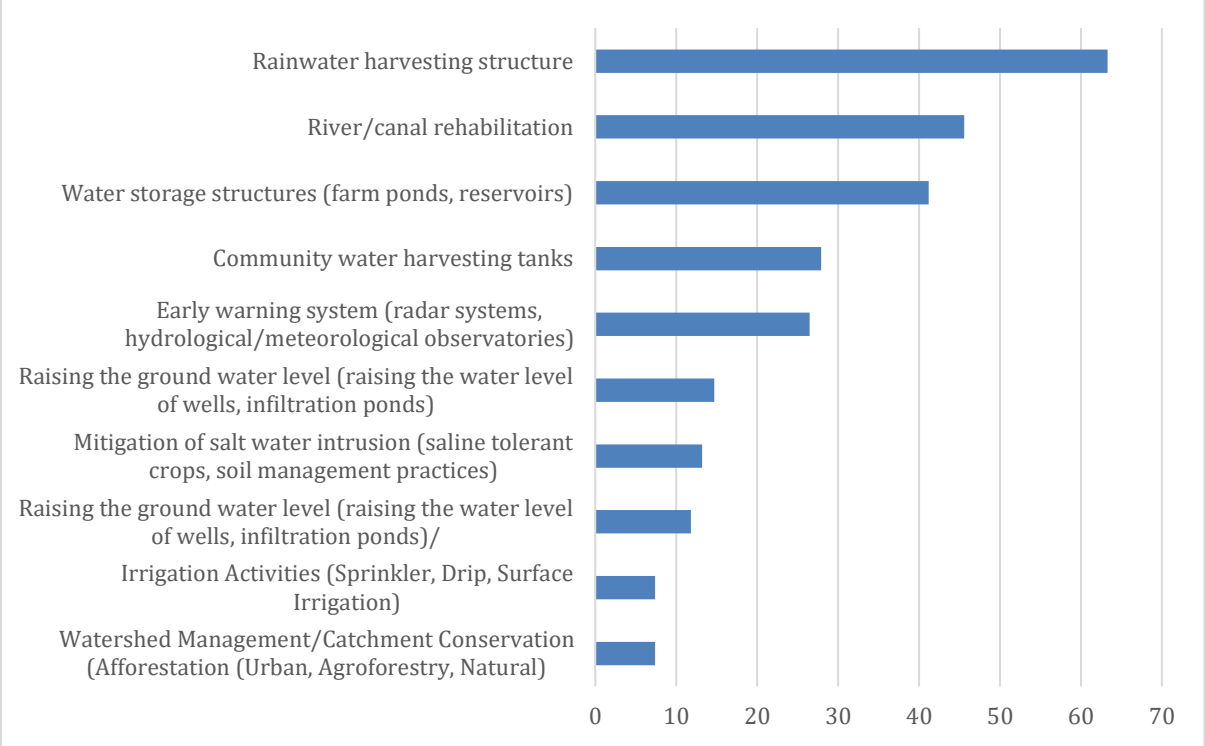


Figure 74 Farmer perception-based water resources adaptation action

6.3 Forest Ecosystem

The framework for enhancing tree cover and carbon stock in Mayiladuthurai district focuses on three key components: Green Cover Expansion, Estuarine Forest Restoration, and Educational Initiatives for Sustainability. It is designed to align with the district's climate change mitigation goals and sustainable development efforts, particularly aiming to increase tree cover from the current 3.63% (4,255 ha).

- Green Cover Expansion emphasizes promoting agroforestry, farm forestry, and tree planting along canal systems to boost carbon sequestration and rehabilitate degraded lands. This initiative supports sustainable land management practices, benefiting both agricultural productivity and ecosystem health.
- Estuarine Forest Restoration aims to expand coastal and estuarine forests, including mangrove restoration and the establishment of coastal shelter belts. These efforts are vital for protecting marine and coastal ecosystems, enhancing their resilience to climate change, and preserving biodiversity.
- Educational Initiatives for Sustainability involve setting up Blue Green Centres in schools and colleges, integrating environmental education into curricula. These centers encourage active student participation in climate action, nurturing future climate-conscious citizens (Table 29)

Table 29 Recommendation of Targets and Actions for Forest Ecosystem

Target	Actions
Enhancement of Tree Cover and Carbon Stock in Mayiladuthurai District	• Increase green cover by promoting canals, agroforestry, and farm Forestry • Increase the estuarine forest, including mangroves and coastal shelter belt plantations • Establish Blue Green Centres in Schools and Colleges

This comprehensive framework aligns with several Sustainable Development Goals (SDGs), specifically contributing to:

- SDG 4: Quality Education by integrating environmental education into school curricula.
- SDG 13: Climate Action by enhancing carbon sequestration, restoring ecosystems, and encouraging student participation in climate action.
- SDG 14: Life Below Water by protecting marine and coastal ecosystems.
- SDG 15: Life on Land by combating land degradation, restoring degraded ecosystems, and promoting sustainable land use practices.

These objectives and their associated actions constitute the core of the climate action plan for Mayiladuthurai district. By enhancing green cover and increasing CO_2 sequestration potential, the plan aims to bolster the district's resilience to climate change impacts and foster sustainable development for future generations.

Action:1 Increase green cover by promoting canals, agroforestry, and farm Forestry

The Mayiladuthurai district holds significant potential for increasing green cover by strategically using fallow lands across its five blocks: Kollidam, Kuthalam, Mayiladuthurai, Sirkali, and Semmanarkoil. The district's tree cover totals 4,255 hectares, with Kollidam accounting for the highest area of 1,891 hectares, while Kuthalam, Sembanarkoil, and Sirkali have relatively lower tree cover (Figure 75). However, the district has a vast expanse of fallow land over 12,851 hectares, or 11% of the total available land that can be leveraged to increase tree cover, sequester carbon, and enhance the region's ecosystem services.

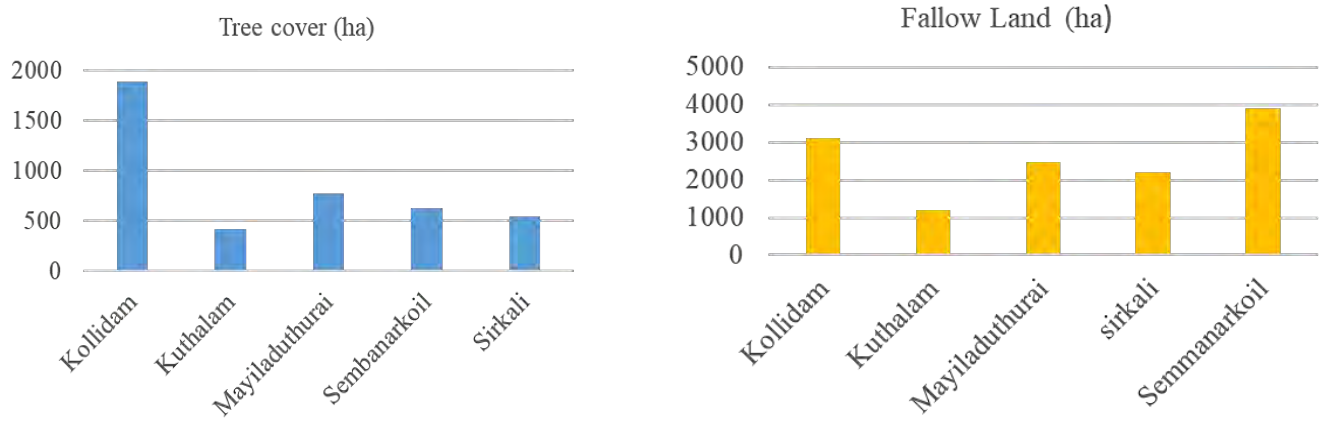


Figure 75 Block level tree cover and fallow land (ha) in Mayiladuthurai

a. Develop incentive programs to encourage farmers and households to plant and maintain trees

To encourage farmers and households to plant trees on fallow lands, incentive programs will be developed, including financial subsidies, grants, and tax incentives. These programs aim to reduce the economic burden of planting and maintaining trees, making agroforestry and farm forestry more accessible. Kollidam (with 3,107 hectares of fallow land) and Sembanarkoil (3,890 hectares) will receive special attention, given their large fallow areas, which have immense potential for green cover enhancement.

b. Provide seedlings and necessary materials to farmers and households for tree planting

The successful implementation of agroforestry depends on providing the necessary resources to farmers. This includes seedlings of native tree species suited to the local environment, as well as fertilizers, tools, and technical guidance for planting. Farmers in blocks with significant fallow land like Semmanarkoil and Mayiladuthurai (with 2,463 hectares of fallow land) will be prioritized to increase tree cover in these regions.

c. Organize awareness campaigns highlighting the benefits of agroforestry and farm forestry

Awareness campaigns will be organized to educate farmers and communities about the long-term benefits of agroforestry and farm forestry, not just for environmental conservation but also for enhancing agricultural productivity. Emphasis will be placed on the role of tree planting in reducing soil erosion, improving water retention, and increasing biodiversity. This is particularly important for blocks with low current tree cover, such as Sirkali (542 hectares) and Kuthalam (422 hectares), where community engagement can significantly improve.

d. Monitor and support the growth and maintenance of trees planted in non-forest areas

Ongoing monitoring and technical support will be provided to ensure the growth and survival of planted trees. Farmers and landowners in Kollidam and Semmanarkoil, which have the most extensive fallow lands, will receive regular assessments and assistance to maintain tree health and maximize survival rates. This process will involve community-based monitoring systems and government-supported forestry experts to guide reforestation efforts.

Action 2: Increase the Estuarine Forest, Including Mangroves and Coastal Shelter Belt Plantations

To enhance tree cover and carbon sequestration along the coastal regions of the Mayiladuthurai district, expanding estuarine forests, particularly mangroves and coastal shelter belt plantations, plays a critical role. This initiative strengthens ecological resilience and protects against coastal hazards like erosion, storm surges, and sea-level rise (Figure 76).

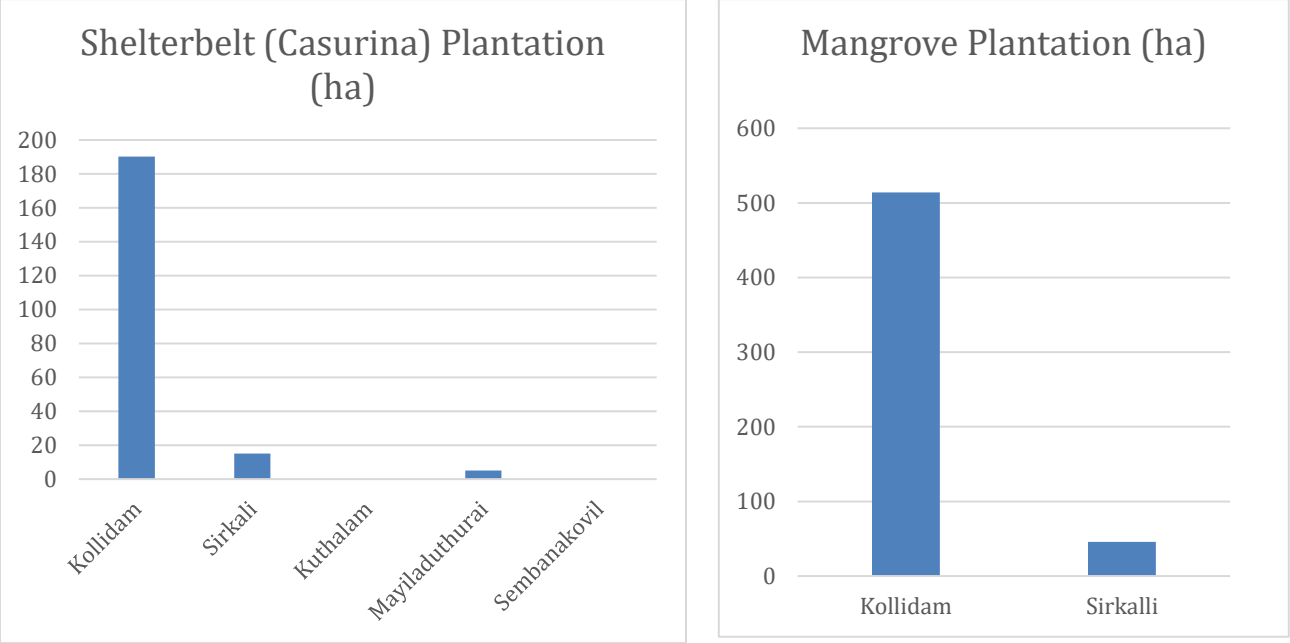


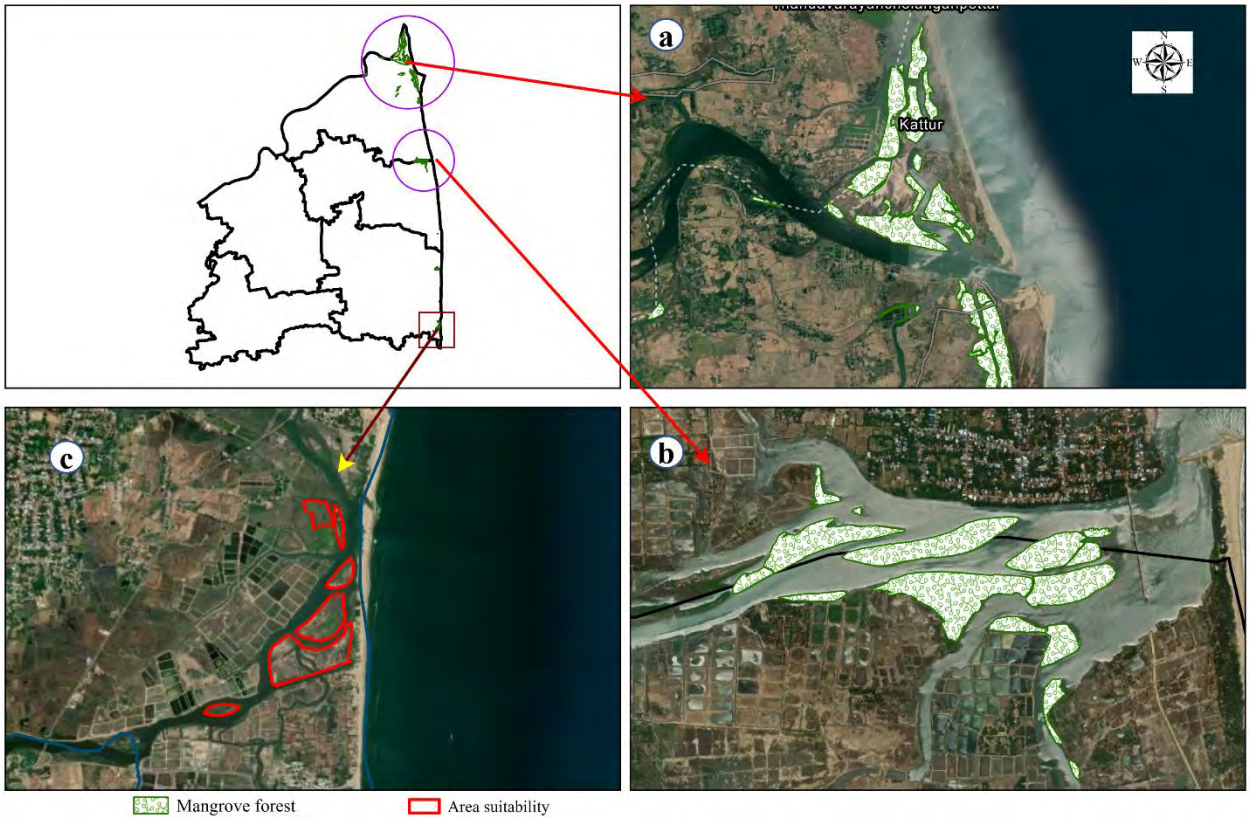
Figure 76 Block level coastal shelterbelt and Mangrove plantation

(Source: Department of Forest, Mayiladuthurai District)

a. Site Identification and Mapping

Identifying and mapping suitable sites for mangrove and coastal shelter belt plantations is the first critical step. In Kollidam, 190 hectares are available for coastal shelter belt plantations, while Sirkali has 15 hectares. Small areas in Mayiladuthurai (5 hectares) can also contribute to coastal defense. These plantations provide crucial wind and erosion protection for coastal communities (Figure 77).

Kollidam block offers the most significant potential for mangroves, with 514 hectares already designated for mangrove forests, followed by 46 hectares in Sirkali. The Sembanarkoil block presents a unique opportunity for a small-scale mangrove expansion of about 46 hectares (0.04%) at the river-sea confluence, ideally suited for mangrove growth. This expansion will be crucial for enhancing biodiversity and coastal ecosystem stability.



a&b- Mangrove Forest c – Suitability Area of Mangrove plantation

Figure 77 Current and Suitability Area of Mangrove Plantation in Mayiladuthurai District

Monitoring and Maintenance

After establishing mangrove and coastal shelter belt plantations, consistent monitoring and active maintenance are vital to ensure long-term success. This involves regular health assessments of planted trees, ensuring necessary irrigation, and protecting the newly established green cover from external threats, such as salinity changes, storms, or human interference. The active involvement of local communities in maintaining these plantations will foster stewardship and provide long-term benefits, including climate resilience and carbon sequestration.

Action 3: Establish Blue Green Centres in Schools and Colleges

In the Mayiladuthurai district, educational institutions offer promising opportunities to increase tree cover and contribute to carbon sequestration. Establishing Blue Green Centres in schools and colleges will be central to this effort, focusing on environmental education and active tree-planting initiatives. With an estimated 319 hectares of available land in schools, colleges, and government buildings, there is significant potential to enhance green cover by approximately 0.3% (Figure 78).

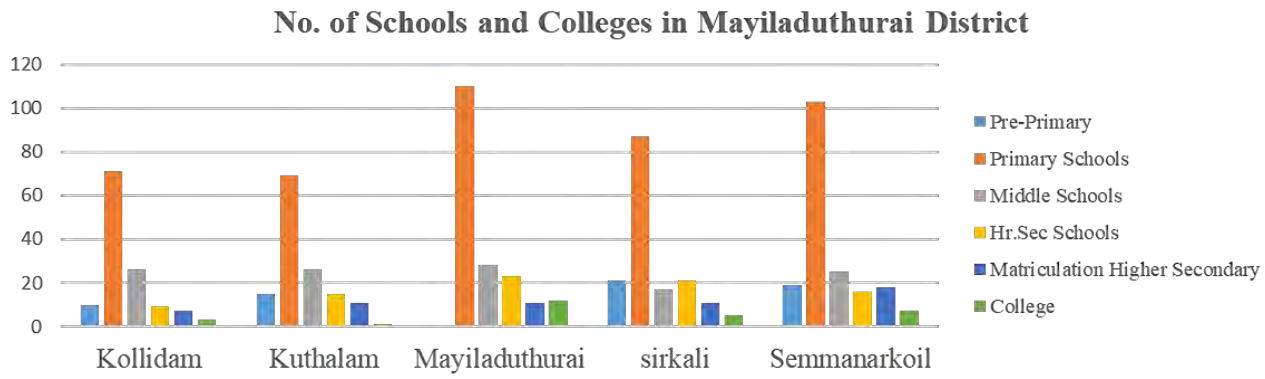


Figure 78 Block-level Schools and Colleges in Mayiladuthurai District

Source: Statistical handbook, 2022-23

a. Partner with Educational Institutions to Set Up Blue Green Centres

The initiative will collaborate with pre-primary, primary, middle, and higher secondary schools and colleges across all blocks: Kollidam, Kuthalam, Mayiladuthurai, Sirkali, and Semmanarkoil. This partnership will establish Blue Green Centres in over 950 institutions, providing platforms to foster environmental stewardship through practical learning experiences. These centers will act as hubs for tree planting and sustainability education, engaging students and staff in efforts to improve the local green cover.

b. Develop Curriculum and Extracurricular Activities on Tree Planting and Environmental Conservation

A comprehensive curriculum tailored to local ecological needs will be developed, covering topics like native tree species, biodiversity, and sustainable land use. Schools will integrate tree planting and environmental conservation into their academic and extracurricular activities, encouraging students to actively maintain the green spaces around them. This will ensure that environmental education is holistic and practical, nurturing a sense of responsibility in young minds toward sustaining tree cover.

c. Organize Tree Planting Drives and Involve Students in Nurturing Saplings

In collaboration with the Blue Green Centres, schools and colleges will host tree planting drives to increase green cover within their premises. Students will be directly involved in planting native species on available lands in their institutions and nearby government buildings. Each block will contribute to this effort, with targeted planting in blocks like Kollidam (71 primary schools and 26 middle schools)

and Mayiladuthurai (110 primary and 28 middle schools), ensuring broad community participation. The involvement of students in nurturing these saplings will guarantee long-term growth and success, ensuring the trees contribute to both local ecosystems and carbon sequestration over time.

Table 30 Climate adaptaiton action for Water Resources

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Sustainable Water supply for Domestic Demand	Functional household tap connections (FHTC) to all villages, ensuring the prescribed domestic water supply of 55 liters per capita per day (lpcd)	• At present 93.2% of households have Tap Connections. Additionally, 13161 Households need to have tap connections • Increasing the designed water supply quantity to meet future water demand (118MLD) during the year 2056	Department of Rural Development and Panchayat Raj Tamil Nadu Water Supply and Drainage Board (TWAD)	Municipal Administration and Water Supply Department	SDG 6: Clean Water & Sanitation SDG 13: Climate Action; Jal Jeevan Mission	Reduced Water Scarcity: Ensuring a sustainable water supply helps mitigate water scarcity's effects, especially during dry periods. Improved Public Health: Access to a reliable and clean water supply reduces the risk of waterborne diseases and improves overall community health. Support for Women and Children: Reducing the time spent on water collection allows women and children to focus on education and other productive activities. Enhanced Quality of Life: Consistent access to water for domestic use enhances daily living standards, reducing the time and effort spent on water collection.	2027

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Sustainable Water supply for Irrigation Demand	• Geotag, Restore, and Cascade the rural village ponds • Connectivity of field (C & D) channels to improve water flow and storage	• Geotagging of Non-system tanks (2000 nos) followed by repair and renovation • All non-system tanks have to be cascaded by delineating their drainage network • Geotagging and desilting of C and D field channels Cascading	Department of Rural Development Agency (DRDA) Department of Rural Development and Panchayat Raj Agriculture Engineering Department (AED)	National Bank for Agriculture and Rural Development (NABARD) Tamil Nadu Irrigated Agriculture Modernisation Project (TNIAMP) Tamil Nadu Watershed Development Agency (TAWDEVA)	SDG 6: Clean Water and Sanitation. SDG 2: Zero Hunger. SDG13:, Climate Action. SDG 15: Life on Land. JalShakti Abhiyan, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) Mahatma Gandhi, National Rural Employment, Guarantee Act (MGNREGA)	Data-Driven Water Management: Geotagging allows for the collection of precise data on tank and channel locations, improving planning, management, and decision-making for water resource allocation Improved Water Storage: Interlinking C and D channels to local storage ponds enhances water retention, allowing for better management of water resources during dry periods Efficient Water Distribution: Cascading RD tanks and connecting them to C and D channels ensure efficient water distribution across farmlands, optimizing irrigation	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Enhancement of Groundwater Resilience	Construct artificial recharge structures at the farm level, formalize systems to monitor groundwater withdrawal	• Irrigation draft can be minimized by establishing farm ponds in varied sizes for storage, supply, and deep percolation • Installation of recharge shafts in farm fields will allow surface water to replenish groundwater directly into the aquifers • Existing 31 observation well points have to be upgraded with an automatic water level recorder • Due to the overdraft of groundwater, there is a necessity of more than one observation well point at each firkas.	Tamil Nadu Water Supply and Drainage Board (TWAD) Central Groundwater Board (CGWB) Department of Rural Development Agency (DRDA)	Ministry of Jal Shakti Water Resources Department	SDG 2: Zero Hunger, SDG 6: Clean Water & Sanitation; SDG 13: Climate Action, SDG 15: Life on Land	Reduction of Overexploitation: Recharge structures reduce the excessive use of groundwater by naturally replenishing aquifers, ensuring long-term water availability, Water Quality Improvement: Recharged groundwater is often filtered through soil layers, which can improve its quality by reducing pollutants and salinity Improved Irrigation Planning: Regulated water usage allows farmers to better plan irrigation schedules, optimizing water use and improving crop yields Groundwater Sustainability: Proper monitoring promotes sustainable use, preventing the depletion of aquifers and maintaining the natural water cycle	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Prevention of Salinity Intrusion in groundwater	Develop tail-end regulators to prevent saline water intrusion in agricultural lands, especially during dry seasons,	Proposed (5) tail-end regulators has to be implemented to ensure the groundwater recharge and prevention of salinity intrusion for the entire coastal stretch Existing tail-end regulators (7 nos) has to be maintained for deep percolation of groundwater recharge, Sub-surface dykes are recommended along with tail-end regulators for long-term prevention of salinity intrusion	Water Resources Department (WRD)	National Bank for Agriculture and Rural Development (NABARD) Water Resources Department (WRD)	SDG 2: Zero Hunger, SDG 6: Clean Water & Sanitation; SDG 13: Climate Action, SDG 15: Life on Land	Sustainable Water Use: Tail-end regulators enable more efficient water management, ensuring that freshwater is conserved and allocated effectively for irrigation without the risk of contamination by saline water Groundwater Protection: Preventing saline water from entering freshwater sources helps maintain the quality of groundwater, ensuring its suitability for agricultural and domestic use Ecosystem Preservation: Salinity control protects nearby ecosystems, such as rivers, ponds, and wetlands, from becoming saline, supporting biodiversity and preserving natural habitats	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Effective drainage system,	Conduct regular maintenance of canals and channels to prevent blockages and enhance water flow	• Existing canals (1481 nos) and channels have to be desilted in annual terms, especially before the monsoon • Unlined canal widening by strengthening bunds and riverside plantations will be efficient against overflow	Water Resources Department (WRD) Department of Rural Development Agency (DRDA)	National Bank for Agriculture and Rural Development (NABARD) Water Resources Department,	SDG 6: Clean Water & Sanitation SDG 11: Sustainable Cities and Communities, SDG 13: Climate Action SDG 15: Life on Land	Flood Control: Clearing blockages reduces the risk of localized flooding by ensuring smooth water flow during heavy rainfall, protecting both farmland and nearby communities, Improved Irrigation Efficiency: Regular maintenance ensures unobstructed water flow, delivering a consistent water supply to agricultural fields and promoting better irrigation efficiency Prevention of Waterlogging: Clearing blockages helps prevent water stagnation and waterlogging in fields, reducing the risk of crop damage and soil degradation Reduced Maintenance Costs: Proactive, regular upkeep reduces the need for costly emergency repairs and large-scale dredging projects, saving money in the long term	2027

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Prevention of flood through flood carrying canal	Restoration of Buckingham Canal	• Identification of canals in addition to existing stretches as encroachments in settlements and abandoned in barren land due to non-maintenance • Uniform width and depth throughout the canal length can divert the flood from the nine drains that serve as floodwater carriers • The flat slope, lower elevation, and downward flow of the canal enable effective diversion of water from the right bank to nearby storage structures, such as farm ponds in coastal villages, helping sustain them during drought conditions • The canal not only	Water Resources Department (WRD),	World Bank Assistance	SDG 6: Clean Water & Sanitation SDG 11: Sustainable Cities and Communities, SDG 13: Climate Action SDG 15: Life on Land	Flood Risk Mitigation: By maintaining the natural drainage function of canals like Buckingham Canal, the risk of flooding in nearby communities is reduced, protecting homes, infrastructure, and farmland Natural Drainage Preservation: Encroachment-free water bodies act as effective natural drainage systems, reducing the risk of floods and ensuring the natural flow of rivers and canals during heavy rainfall Sustained Water Supply for Farming: Encroachment can restrict water flow or reduce storage capacity. By preventing it, farmers have a reliable water source during both wet and dry seasons Increased Community Resilience: By preserving natural drainage systems, communities become more resilient to climate change impacts like unpredictable rainfall patterns, droughts, and flooding events	2035

Table 31 Climate adaptation action for sustainable Agriculture

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Develop the Climate-Smart Good Agriculture Practices	Promote, climate-adaptive crop varieties	i. Prioritization of rice varieties CR-1009 Sub1 and BPT5204 for coastal block, Swarna Sub-1 (moderately resilient variety) for inland areas ii. Develop the high yield drought resistant and low shuttering during harvest and ultra short duration and low lodging variety Iii. Develop the fine submergence-tolerant rice variety in the coastal belt of Mayiladuthurai. Submergence gene to be introduced in existing popular varities like ADT 54, BPT 5204, CO-55	Department of Agriculture, Tamil Nadu Agricultural University	Department of Agriculture, National Adaptation, Fund for Climate, Change (NAFCC) National Innovations in Climate, Resilient Agriculture (NICRA) TamilNadu Irrigated Agriculture Modernisation Project (TNIAMP)	SDG 1 No, Poverty SDG-2 End, Hunger SDG-3 Health and Good well being, SDG-12, Sustainable Consumption and, Production, SDG- 13-, Climate Action	Increased Crop Yield Stability Help stabilize crop yields under unpredictable weather patterns such as droughts, floods, and intense rainfall	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Develop the Climate-Smart Good Agriculture Practices	Improve the Agriculture Market Infrastructure	Enhance the market availability for long duration variety (CR-1009 Sub1) which is a climate resilient, Increase the post-harvesting infrastructures such as (storage godowns, drying yard)	Department of Agriculture, Department of Agriculture Marketing	TNIAMP, Tamil Nadu Small Farmers Agri–Business Consortium (TNSFAC) Pradhan Mantri Kisan Sampada Yojana (PMKSY) Seed Village Scheme	SDG-2 End, Hunger, SDG-13, Climate Action	Enhances food security and farmer incomes. It reduces post-harvest losses, improves resilience to climate change, and promotes sustainable resource management. These initiatives empower farmers, stimulate local economies, foster innovation, and support overall rural development and community engagement	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Develop the Climate-Smart Good Agriculture Practices	Promote the horticulture crop cultivation (Vegetables and Fruits)	i. Increase the horticulture crop awareness among the farmers in Sembanarkovil and Mayiladuthurai Block (8% of total cultivable area)	Department of Agriculture, , , Department of Horticulture	Department of Agriculture, Government of Tamil Nadu, National, Horticulture Mission, (NHM) – Tamil Nadu Horticulture, Development Agency, (TANHODA), Tamil Nadu Forest, Department, Tamil Nadu Watershed, Development Agency, (TAWDEVA)	SDG 2-Zero Hunger, SDG13- Climate Action, , SDG 15-Life on Land	Improves food security, enhances climate resilience, and boosts agricultural productivity. These practices ensure sustainable water use and increase farmers' awareness through education. By diversifying crops and adopting sustainable methods, farmers become more resilient and productive, contributing to long-term agricultural and environmental sustainability	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Sustainable water management practices	Integrated water management strategies	• Construct the 7081 new farm ponds in Mayiladuthurai District (Kolidam - 1245, Kuthalam – 1363, Mayiladuthurai – 1452, Sembanarkovil - 1913, Sirkali – 1106) which can harvest 6.25MCM of rain water. • Regular maintenance of farm pond and monitor the groundwater level before and after monsoon	Department of Rural Development Agency (DRDA)	National Agriculture Development Programme (NADP) Kalaignarin All Village Integrated Agriculture Development Programme (KAVIADP)	SDG 2: Zero Hunger SDG6: Clean Water and Sanitation SDG13: Climate Action SDG 15: Life on Land	Enhanced Water Availability: Farm ponds collect and store rainwater, providing a reliable water source for irrigation during dry spells. In areas like Mayiladuthurai, where access to canal water is limited, especially in the tail-end regions, farm ponds can significantly improve water availability for crops	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Sustainable water management practices	Enhance Water User Efficiency through Cultivation and Irrigation Practice	• Promoting the SRI method of rice cultivation, especially in coastal blocks such as Kolidam, sirkali, and Sembanarkovil. The percentage of SRI cultivation in the blocks such as (Kollidam 55%, Sirkali 62%, and Sembanarkoil 47%) is less.	Department of Agriculture	National Bank for Agriculture and Rural Development (NABARD) Pradhan Mantri Krishi Sinchai Yojana (PMKSY) Tamil Nadu Irrigated Agriculture Modernisation Project National Food Security Mission Sub Mission on Agricultural Mechanization	SDG 2: Zero Hunger SDG6: Clean Water and Sanitation SDG13: Climate Action SDG 15: Life on Land	Prevention of Waterlogging and Salinization: Excessive irrigation can lead to waterlogged fields and increased soil salinity. Efficient irrigation methods prevent these issues, preserving soil structure and fertility.	2030

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Soil health and enhance soil conservation	•Encourage the Use of Green Manures and Biofertilizers • Regularize the soil testing	•The Soil Health Index (SHI) being very low (less than 0.5) in 96 villages (Kollidam 22, Kuthalam 22, Mayiladuthurai 25, Sembanarkoil 33 and Sirkali 16) in the Mayiladuthurai district. Increase the organic amendments (like compost or green manure) alongside synthetic fertilizers to balance nutrient supply in these villages •Set up systematic soil testing at farm levels and testing should be done at yearly manner to monitor the fertilizer application	Department of Agriculture	National Mission for Sustainable Agriculture (NMSA) – Soil Health Management (SHM) National Bank for Agriculture and Rural Development (NABARD) – Rashtriya Krishi Vikas Yojana (RKVY)	SDG Goal 2: Zero Hunger SDG 6: Clean Water and Sanitation SDG 12: Responsible Consumption and Production SDG 13: Climate Action SDG Goal 15: Life on Land	Increased Water Retention: Soil with good organic matter and structure can more effectively retain water, reducing the need for frequent irrigation and helping crops withstand drought conditions. Enhanced Nutrient Cycling: Healthy soil systems support the activity of beneficial microbes, earthworms, and other organisms that play a crucial role in decomposing organic matter.	2030

Table 32 Climate adaptation action for Sustainable Habitat

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Improve Public Health Resilience	Strengthen health infrastructure and services to address climate-related diseases	•Create a comprehensive database on climate-sensitive diseases •Research the climate association of climate-sensitive diseases at the district level. •Conduct regular training on climate-related health risks integrating stakeholders from the health department, health professionals, and researchers •Promote public awareness of heat-related illnesses •Ensure that hospital infrastructure is resilient to withstand natural calamities to provide continuous care during disasters •Ensure all Health facilities have converted to energy-efficient power systems including lighting (Eg. Switching over from Incandescent/CFL bulbs to LED bulbs, AC fans to BLDC fans, etc.)	District Health Department Department of Revenue Administration Department of Disaster Management Tamil Nadu Electricity Board	National Health Mission (NHM) State Disaster Response Fund (SDRF) Corporate Social Responsibility (CSR)	SDG 3, 13 National Health Policy 2017 NAPCC: Health Mission	Reduced morbidity and mortality from climate-sensitive diseases (e.g., heatstroke, vector-borne diseases like dengue and malaria) Improved capacity to manage and respond to health risks due to climate change Increased public awareness about climate-related health risks and prevention measures Strengthened collaboration between public health officials, medical professionals, and researchers Enhanced health monitoring and early warning systems for extreme weather conditions in Mayiladuthurai	2035

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Reduce the impact of Thermal discomfort in southern interior parts of the district	Develop climate-responsive urban planning strategies to reduce heat stress	• Increase green cover in urban areas • Promote reflective and cool roofing materials • Set up cooling centers in high-density areas	Municipal Administration	Atal Mission for Rejuvenation and Urban Transformation (AMRUT) State Urban Development Authority (SUDA) Green India Mission (for increasing urban green cover)	SDG -11,SDG-13 NMSH Green Indian Mission	Reduced urban heat island (UHI) effect and thermal discomfort, especially in high-density areas Enhanced livability and environmental quality for residents Increased public awareness of heat mitigation strategies (cool roofing, green spaces, etc.) Cooling centers will provide immediate relief during extreme heat events, improving public health and safety Long-term reductions in energy consumption from cooling systems due to improved building designs Creation of green jobs through afforestation and urban cooling projects	2035

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Develop Climate-Resilient Tourism	Enhance tourism infrastructure to support climate resilience and eco-tourism	•Promote eco-tourism initiatives focusing on local culture, coastal resources, specifically in areas where fishing activities have reduced and mangrove ecosystems •Upgrade tourist facilities to be climate-resilient (e.g., heat-resistant shelters, access to safe water) •Create awareness among tourists about responsible behavior and environmental conservation •Seek central government funding initiatives through Heritage City Development and Augmentation Yojana •Promote Green Temple initiatives	•Tamil Nadu Tourism Department, District Tourism Promotion Council (DTPC) •Department of Environment and Climate Change •Hindu Religious and Charitable Endowments Department	Heritage City Development and Augmentation Yojana (HRIDAY) Swadesh Darshan Scheme	SDG- 8, SDG -11, SDG -13 Tamil Nadu Tourism Policy NMSH	Increased tourism revenue through eco-tourism and cultural heritage preservation in Mayiladuthurai Preservation and sustainable use of coastal resources and mangrove ecosystems, contributing to biodiversity conservation Creation of climate-resilient tourist facilities, ensuring safe and comfortable experiences for visitors even during extreme weather conditions Empowerment of local communities through eco-tourism and responsible tourism jobs Enhanced awareness of tourists and locals on the importance of environmental conservation and climate resilience Promotion of “Green Temple” initiatives, blending cultural heritage with ecological sustainability	2035

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Sustainable Solid Waste and Waste Water Management	Sustainable Solid Waste Management Enhance wastewater management systems to prevent contamination and pollution	•Operationalization of decentralized composting and recycling facilities •Encourage community-based waste segregation •Enhance awareness to avoid single usage plastic (Meendum Manjapai) •Installation of decentralized wastewater treatment plants and online effluent continuous monitoring system (OECMS) of STPs •Regular monitoring of wastewater discharge	•Urban and Rural Localbodies •Tamil Nadu Pollution Control Board (TNPCB)	Swachh Bharat Mission (Urban and Rural) Mahatma Gnadhi National Rural Employment Guarantee Scheme (MGNREGA) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) State Innovation Fund (SIF)	SDG-6,SDG-11,SDG-12	Reduction of landfill waste through decentralized composting and recycling facilities, promoting sustainability. Improved public health and sanitation through effective solid waste segregation and reduced single-use plastics. Reduced environmental pollution and contamination of water bodies through enhanced wastewater treatment systems. Empowerment of local communities to participate in waste segregation and recycling activities, fostering ownership of environmental initiatives. Long-term reduction in waterborne diseases due to better wastewater management and monitoring systems. Protection of ecosystems and biodiversity through reduced plastic waste and cleaner water sources.	2035

Table 33 Climate adaptation action for Coastal Ecosystem

Target	Actions	Activities	Responsible Agency	Potential Source of Funding	Alignment with SDGs/ Mission	Benefits	Timeline
Enhance Climate Resilience of Coastal Ecosystem	Reduce Impact of Sea Level Rise and Shoreline Change	•Increase Mangrove plantation to reduce shoreline change and enhance carbon stock •Plantation of Casuarina to stabilize shorelines •Beach nourishment •Enhancing climate-resilient fisheries Promote collaborative research on impact of climate change (Sea level rise and Shoreline change)	•Department of Forest •Department of Fisheries	Forest Department Tamil Nadu State Coastal Zone Management Authority (TNSCZMA) Tamil Nadu Fisheries Development Corporation (TNFDC) Green Climate Fund (GCF)	SDG : 11,12,13,14,15 Tamil Nadu Climate Change Mission Tamil Nadu Coastal Restoration Mission	Mangroves provide coastal protection, improve biodiversity, and sequester carbon, contributing to climate resilience Casuarina trees help in stabilizing sand dunes, protecting coastal communities, and enhancing soil quality Beach nourishment enhances habitat for marine life, supports tourism, and protects coastal infrastructure Climate-resilient fisheries ensure food security, support livelihoods, and maintain ecosystem balance	2030

Table 34 Mitigation Action by 2030 - Energy

Target	Actions	Responsible Agency	Potential Scheme for Funding	Alignment with SDGs/ Mission	Timeline
Reduction of 50% of emissions by 2030	Install 5 KW solar-powered pumps for 24,000 farmers ON-GRID to support sustainable irrigation practices	Agriculture Engineering Department	Chief Minister's Scheme of Solar-Powered Pumpsets PM-KUSUM Scheme (Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan)	SDG. 7, SDG 12: SDG 13:	2030
	Install 3 KW solar rooftop systems for 90,000 households (ONGRID Mode)	Tamil Nadu generation and distribution corporation ltd.	PM Surya GharMuft Bijili Yojana	SDG. 7, SDG -12, SDG-13	2030
	Install solar panels with a total capacity of 32 MW for electricity generation (ONGRID Mode)	Tamil Nadu generation and distribution corporation ltd. (TEDA), GoTN	TN Solar Power Policy, 2021		2030

Target	Actions	Responsible Agency	Potential Scheme for Funding	Alignment with SDGs/ Mission	Timeline
Reduction of 50% of emissions by 2030	Promote Electric Vehicles (EVs) through subsidies and new registration vehicles has to be 40% Two Wheeler(2W) as electric 30% Three Wheeler (3W) as electric 30% Four Wheeler (4W) as electric 30% School/College Bus as electric To achieve EVs, the following initiatives to be taken: Setting up of Electric Vehicles charging stations in the Government offices, parking lots, public places and Highways with 25 km intervals. Lowering the cost of owning electric vehicles instead of No Tax Scheme for EVs Enhancement of EVs with the potential to get charged with less time period	Commissionerate of Transport And Road Safety	Electric Mobility Promotion Scheme 2024 Tamil Nadu Electric Vehicle Policy 2019 & 2023 Electric Mobility Promotion Scheme 2024 Tamil Nadu Electric Vehicle Policy 2019 & 2023	SDG. 7, SDG -12, SDG-13	2030

Table 35 Mitigation actions towards net Zero by 2070

Target	Actions	Responsible Agency	Potential Scheme for funding	Alignment with SDGs/Mission	Timeline
To Achieve NET ZERO by 2070	Efficient management of municipal solid waste resources by prioritizing waste reduction, recycling, and responsible disposal practices •Enhance Solid waste collection •Increase Composting Centres in blocks •Increase the bailing centres •Bio-mining of Waste to increase the soil health of the fallow lands	Municipal Administration and DRDA	SATAT Scheme	SDG. 7, SDG -12, SDG-13	2070

Table 36 Climate Mitigation action for Forest Ecosystem

Target	Actions	Responsible Agency	Potential Scheme for funding	Alignment with SDGs/Mission	Timeline
To Achieve NET ZERO by 2070	Mitigating methane through plant setup using the best technologies to reduce GHGs while converting waste to power	Municipal Administration and DRDA	Waste to Energy Policy (2016)	SDG. 7, SDG -12, SDG-13	2070
	Setting up of Solar Powered Street lights	Tamil Nadu generation and distribution corporation ltd.	Unnat Jyoti by Affordable LEDs for All (UJALA)		2070
	Mitigating GHGs by ensuring LPG connections	Tamil Nadu Civil Supplies and Consumer Protection	Pradhan Mantri Ujjwala Yojana (PMUY)		2070
	Solar-powered EV charging stations can set up solar charging stations. Such initiatives need to be identified by the government and incentivized through benefits to attract increased investments in renewable energy-powered EV charging stations	Commissionerate of Transport And Road Safety	Green and Clean Charging Infrastructure for Evs		2070

7.0 CLIMATE ACTION - THE WAY FORWARD

State-level climate leadership and locally led climate actions are essential to meet climate-compatible growth targets. With climate change posing alarming threats to communities across India, losses and damages will continue to increase and disproportionately affect the most vulnerable population, if rapid, deep, and sustained mitigation and accelerated adaptation actions are not taken. Tamil Nadu is spearheading key initiatives to elevate India's climate ambitions, acting as front runners for climate action by setting up the Tamil Nadu Climate Change Mission (TNCCM), Green Tamil Nadu Mission (GTNM), and Tamil Nadu Wetlands Mission (TNWM) with substantial allocation of budget to implement these three missions. The actions are being coordinated under the Tamil Nadu Green Climate Company (TNGCC). Tamil Nadu Sustainably Harnessing Ocean Resources and Blue Economy (TNSHORE) project with World Bank support to focus on sustainable coastal protection and restoration actions has also been initiated recently.

The Mayiladuthurai District Climate Action Plan presented in this Report is a comprehensive assessment of climate change drivers of the district in terms of greenhouse gas (GHG) emission inventory and climate risks to key sectors along with the recommendation of various local actions for mitigation and adaptation in line with the National and State policies and programs. It has captured the current profile and priorities of actions for various relevant sectors as well as the key departments responsible for leading the actions. The mitigation options suggested have synergies with other aspects of sustainable development and are in line with activities already being implemented by different departments under different schemes. Acceleration of these actions with a focus on low carbon-intensive development and avoidance of maladaptation practices are critical to gain multiple co-benefits. For example, biological methods for carbon dioxide removal like reforestation, improved forest management, soil carbon sequestration, and coastal blue carbon management can enhance biodiversity and ecosystem functions, employment, and local livelihoods. Adaptation benefits will include improving agricultural productivity, innovation, health and well-being, food security, livelihood, and biodiversity conservation.

The Action Plan requires further development of detailed project reports and implementation plans through the identified departments, utilizing the available avenues for financing and taping the potential sources of funding under different climate change missions summarised in Section 5.0 of the Report and convergence of actions under sustainable development programs of different Ministries/Departments. The Action Plan requires regular updating to strengthen the actions as per the changing requirements and evolving canvas of climate risks and climate finance. Setting up a District Climate Information Centre at the district level under the District Climate Change Mission is strongly recommended to disseminate and update the climate action plan.

7.1 Community Participation

Systemic transformation is critical to achieving rapid and deep emissions reductions and adaptation to climate change in unprecedented scale and speed. Behavior and lifestyle changes supported by policies, infrastructure, and technology are required for a shift to low-emissions-intensive consumption. Alongside the implementation of hard-core interventions, the development of soft skills and capacity building and mainstreaming climate action at every level are important to reduce vulnerability and strengthen resilience capabilities. It is also important to promote sustainable use of resources and develop long-term strategies to conserve them through an ecosystem-based approach. Active participation of local communities in project activities is the key to the sustenance of the initiatives. Climate literacy enhancement through schools, and higher education institutions involving NGOs and self-help groups shall be a continuous activity in line with the National Mission LiFE and Swatch Bharath Mission. Training and capacitating the officials who could enable beneficiaries to adopt such sustainable interventions is vital. Though it is difficult to mobilize communities for a new way of working, increased engagement is expected as the actions take momentum. A shift from the currently followed top-down approach to a bottom-up approach is essential to widen the reach and fast-track the implementation process. By enhancing climate literacy, leveraging the strengths of local communities, and aligning with national initiatives like the LiFE Mission, the district can empower individuals and institutions to contribute to meaningful climate actions to reduce greenhouse gas emissions, build resilience among vulnerable populations, and ensure inclusive and sustainable development.

Integrating local knowledge with climate data, devolving decision-making to the lowest appropriate level, and investing in local capabilities are recommended for locally led climate actions. Interventions in this regard could include the following

- Impose stricter regulations on activities that generate excessive greenhouse gases, such as burning crop residue and improper waste disposal.
- Incentivize low-carbon alternatives, such as transitioning from traditional fuelwood stoves to clean cooking technologies.
- Empower women as climate champions by integrating them into planning and decision-making processes.
- Utilize SHGs and *Mahalir Thittam* to disseminate information and implement grassroots-level climate initiatives.
- Establish a robust monitoring and evaluation framework to track the progress of climate interventions and ensure their effectiveness.
- Encourage participatory evaluation with inputs from stakeholders, including community members and local organizations.

7.2 Resource Mobilisation

Improved availability of and access to finance is critical to enable accelerated climate action. Resource mobilization for climate action involves securing new resources, making better use of existing resources, and maximizing resources originating from various sources like public funds and private investments. Global climate finance flows have not yet kept pace with the resource requirements. Several instruments are already in existence at the global and regional/domestic levels, operating through the widely recognized concepts of concessional and blended financing. Grants are generally mobilized through established funds or bilateral or multilateral agreements and do not place any financial burden on the recipients. Green bonds are financial instruments that fund projects aligned with environmental and climate objectives while providing investors with regular or fixed-income payments. Asian Infrastructure Investment Bank (AIIB) has established a private equity

fund called the SUSI Asia Energy Transition Fund (SAETF) to engage institutional investors in funding projects related to the energy transition in developing Asia and fund projects related to energy storage, renewable energy, microgrid projects, and energy efficiency. The mechanisms for mobilizing timely and adequate climate finance need further analysis at the detailed project report stage. The following options are suggested for consideration to have sustainable revenue streams to support climate action.

- Green Bonds and Climate Funds
  - Issue district-level green bonds to raise funds for climate-resilient infrastructure projects such as flood control systems, renewable energy installations, and afforestation programs.
  - Leverage national and international climate funds such as the Green Climate Fund (GCF), National Adaptation Fund for Climate Change (NAFCC), or private sector CSR initiatives.
- Public-Private Partnerships (PPP)
  - Foster partnerships with private entities to co-finance sustainable projects like solar energy parks, rainwater harvesting systems, and eco-tourism ventures.
  - Incentivize private companies to invest in green projects through tax rebates and subsidies.
- Community-Based Contributions
  - Introduce voluntary community climate funds where citizens contribute small amounts towards local climate action projects.
  - Implement participatory budgeting to involve community stakeholders in prioritizing climate initiatives.
- Carbon Credits and Offsets
  - Develop a district-level carbon credit mechanism where industries and organizations offset their emissions by investing in local green projects.
  - Promote Mayiladuthurai as a carbon offset hub through afforestation and renewable energy projects.
- Climate Resilience Trust Fund
  - Create a dedicated district-level trust fund for climate resilience, managed by a committee of stakeholders from government, private sector, and civil society.

- Tax Increment Financing (TIF)
    - Capture the increased property tax revenue from areas benefiting from climate-resilient infrastructure to reinvest in similar projects.
    - Introduce a nominal "Green Development Fee" on property taxes or utility bills to fund local climate initiatives.
    - Levy a small fee on businesses generating higher GHG emissions to promote low-carbon practices.
- User Fees
    - Charge user fees for community resources like rainwater harvesting systems, eco-tourism sites, or renewable energy facilities.
    - Introducing a parking fee in urban areas to discourage vehicle emissions and promote public transportation.
    - Impose a plastic usage fee or penalty on excessive waste generation, with the revenue used for waste recycling and management projects.
    - Collect eco-charges from tourists visiting ecologically sensitive areas to fund conservation projects.
    - Add a surcharge on non-renewable energy usage to incentivize the transition to renewable sources.

An effective mode of interdepartmental coordination could resolve the challenge of convergence of various government schemes. Subsistent efforts are to be made to pave the way in creating different financial models including private and public funding channels and gradually tapping into the consumer's share with the intent of enhancing the sense of ownership amongst beneficiaries. Successful examples in mobilizing government and CSR funds towards ecological and environmental sustainability from various sources viz., Special Central Assistance to Aspirational Districts, funds issued by the Ministry of New and Renewable Energy, and Renewable Energy Development Agency are to be considered.

7.3 Best Practices

The Compendium of Best Practices on Climate Action from Indian States (2022) under 2° Secretariat Climate group, India States Climate Leadership project has reported that since 2017, the Mangrove Foundation has been implementing a Government of Maharashtra scheme titled Mangrove Conservation and Livelihood Generation in the coastal districts of the state. Under this scheme, local communities have been supported with sustainable livelihood activities (mainly mangrove and estuarine conservation-related aquaculture activities such as mud crab and oyster farming, fish cage culture, ornamental fish culture, and ecotourism initiatives). The scheme being implemented in about 120 coastal villages, with women being key drivers of these programmes has been successful in garnering the support of the local coastal communities for mangrove and marine conservation issues, and since 2019 a revenue of more than INR 9.1 million has been generated by local communities through the livelihood activities. Other best practices reported include

- Assam promoting participatory eco-learning through Nature Conservation Clubs
- Bihar strengthening its climate resilience using Systematic Catchment Area Treatment
- Climate change adaptation for natural resource-dependent communities in Kachchh, Gujarat
- Ecological and Sustainable Energy Transformation (RESET) project in Jharkhand
- Carbon Neutral Meenangadi in Kerala: A bottom-up model for integrating climate action into development planning
- Restoration of traditional water supply sources in Indore
- Conservation of mangroves and marine biodiversity, in Maharashtra
- Cross-sectoral analysis to formulate a climate budget by Odisha

Mission Green Ramnad and GIZ supported the WASCA (Water Security and Climate Adaptation) initiative in Tiruvannamalai are two best practices within Tamil Nadu fit for emulation and scaleup.

a) Mission Green Ramnad

Mission Green Ramnad is a transformative initiative to combat aridity and minimal forest cover in Ramanathapuram. Spearheaded by the District Administration, this project focuses on enhancing green cover through large-scale tree plantations, Miyawaki mini forests, and seed ball dispersal, supported by MGNREGS workers. A notable achievement includes creating 1,000 mini forests and employing innovative methods like surface mulching for water conservation. The project has revitalized unused land, contributing significantly to environmental sustainability and improving the district's ecosystem.

Glimpses of Mission Green Ramnad

Key Objectives

- Adoption of the Miyawaki Method for rapid forest growth with a survival rate of over 99%.
    - Creation of 1,000 mini forests, each with 500 saplings over 500 sq. meters.
    - Inclusion of 14 native tree species to ensure biodiversity.
- Implementation of water conservation techniques using surface mulching with coir pith and leaf waste.
- Development of 300 community wells exclusively for the upkeep of mini forests.
- Community involvement for maintenance and protection through the MGNREGA program.

Impact and Achievements

- Transformation of unused lands into productive green spaces.
- Plantation of 5,41,050 saplings, each producing approximately 118 kg of oxygen annually.
- Significant enhancement of the district's green cover, mitigating aridity and contributing to ecological balance.

This project demonstrates a scalable model for greening arid regions by leveraging innovative plantation techniques, local resources, and community participation.

Source: http://www.tnwasca-mgnrega.org/sites/default/files/Ramnad%20Case%20 study.pdf

b) GIZ supported WASCA Scheme

The WASCA (Water Security and Climate Adaptation) initiative in Tiruvannamalai and Ramanathapuram districts of Tamil Nadu, implemented with the support of the GIZ team, integrates community-driven, nature-based solutions with technological and participatory planning. The project highlights best practices in water conservation to adapt to climate challenges while promoting sustainable livelihoods.

Ramanathapuram District

1. Forest Restoration and Community Engagement:
    - Seed Ball Initiative: School children and SHG (Self-Help Group) women created seed balls for forest plantation, promoting traditional biodiversity.
    - Mini and Mega Forests: MGNERGA workers transformed wastelands into green spaces with native plant varieties.
2. Sustainable Livelihood and Agriculture:
    - Cattle, goat, and country chicken rearing, alongside Azolla and mushroom production, were initiated by MGNERGA women, integrating income generation with nature-based solutions.
    - Nutritional Gardens: Fruits and vegetables grown by MGNERGA women supported maternal health and supplied schools to improve child nutrition.
3. Rainwater Harvesting and Groundwater Recharge:
    - Community TANKAS Model: Rainwater storage tanks were established in salinity-affected villages to secure potable water.
    - Farm Ponds: Designed for agriculture and livestock, enhancing groundwater recharge.
4. Tree Plantations and Nursery Development:
    - Avenue plantations distributed saplings to schools and village volunteers, encouraging community participation.
    - Roadside Plantations: MGNERGA women planted flowering species to enhance aesthetics and green cover.
5. Catch the Rain Campaign:
    - Promoted rainwater harvesting for agriculture, livestock, and human use, improving water security in drought-prone areas.

Tiruvannamalai District

1. Capacity Building and GIS Integration:
    - A GIS mapping center, established by DRDA, facilitated participatory planning and coordination for integrated water resource management.

- Composite Water Resource Management (CWRM): GIS-based frameworks-built capacities among officials, Panchayat institutions, and the public for natural and non-natural resource management.

2. Climate-Adaptive Rural Infrastructure:
    - Check dams, gully checks, contour trenches, and water body renovations were piloted as innovative solutions for water conservation.
    - Silvopasture Models: Combined farm ponds and silvopasture systems for multipurpose use.
3. Afforestation and Soil Erosion Prevention:
    - Greening of hill rocks using contour plantations and staggered trenches to prevent soil erosion and recharge groundwater.
    - Nurseries focused on healthy and medicinal saplings for afforestation efforts.
4. Livelihood Development on Wasteland:
    - Wastelands were converted into fodder crop cultivation, supporting cattle feeding and livelihood resilience.
5. Model Village Selection:
    - Villages demonstrated integrated practices like farm ponds, drainage line treatments, afforestation, and micro-irrigation systems to inspire scalability.

Key Outcomes

- Community-Led Conservation: MGNERGA and SHG women were central to activities, fostering inclusivity.
- Increased Green Cover: Massive afforestation initiatives enhanced ecosystem services.
- Improved Water Security: Farm ponds, rainwater harvesting, and TANKAS reduced water stress in drought-prone regions.
- Sustainable Livelihoods: Integration of agriculture, livestock rearing, and plantations bolstered rural incomes.
- Capacity Building: GIS-enabled planning empowered stakeholders for effective resource management.

Source: http://tnwasca-mgnrega.org/node/48126; http://tnwasca-mgnrega.org/

ANNEXURE-I

Glimpses of block level Farmer Survey in Mayiladuthurai

ANNEXURE-II

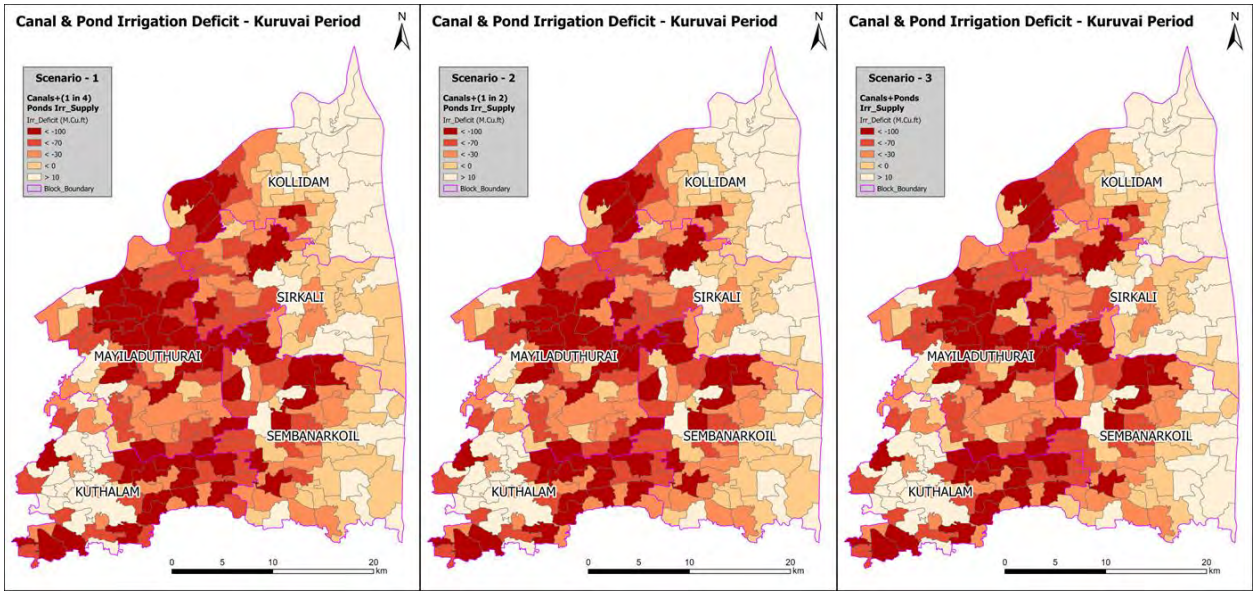


Figure A1. Projected Scenarios of Canal and Pond Irrigation Supply for Deficit during Kuruvai Cropping in Mayiladuthurai District (Conventional Method)

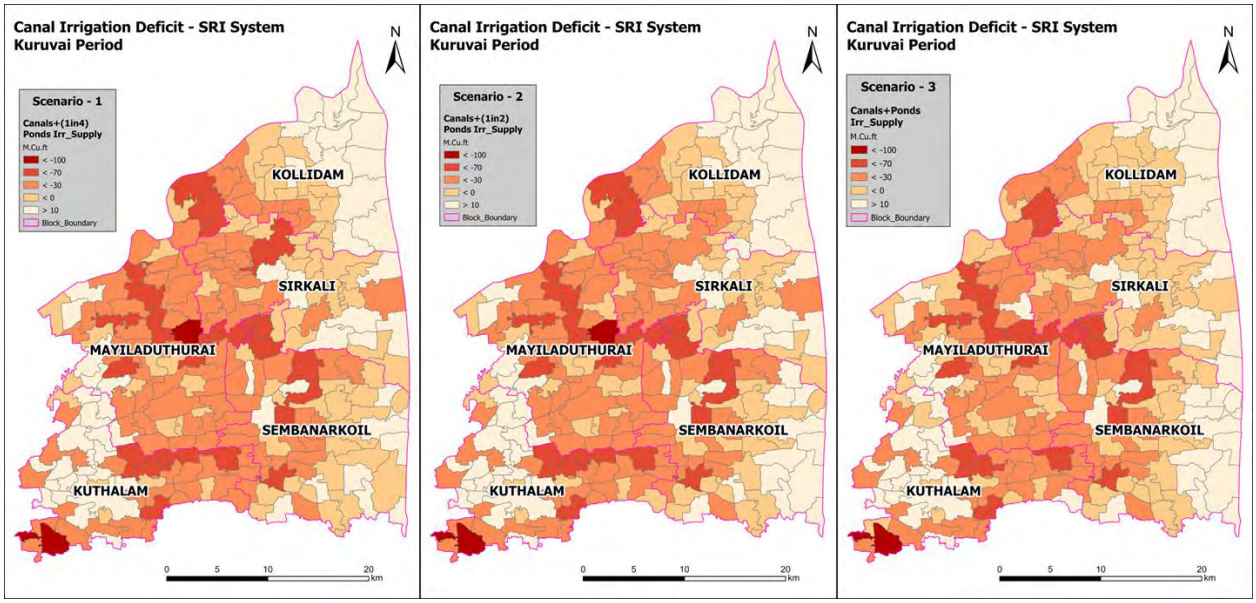


Figure A2 Projected Scenarios of Canal and Pond Irrigation Supply for Deficit during Kuruvai Cropping in Mayiladuthurai District (SRI System)

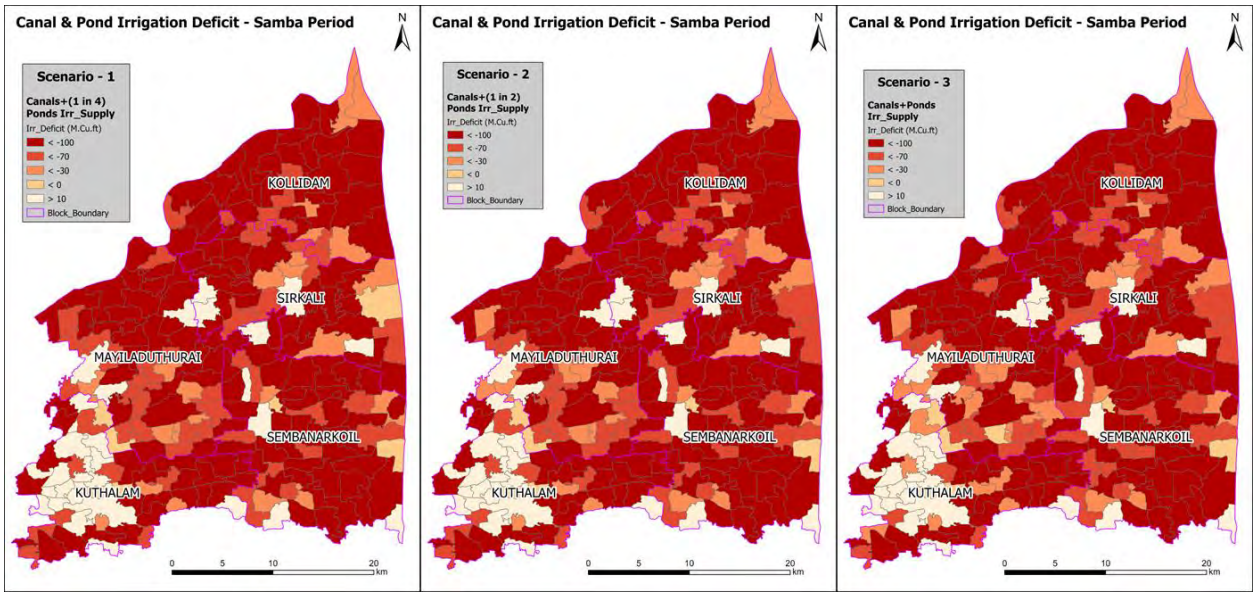


Figure A3 Projected Scenarios of Canal and Pond Irrigation Supply for Deficit during Samba Cropping in Mayiladuthurai District (Conventional Method)

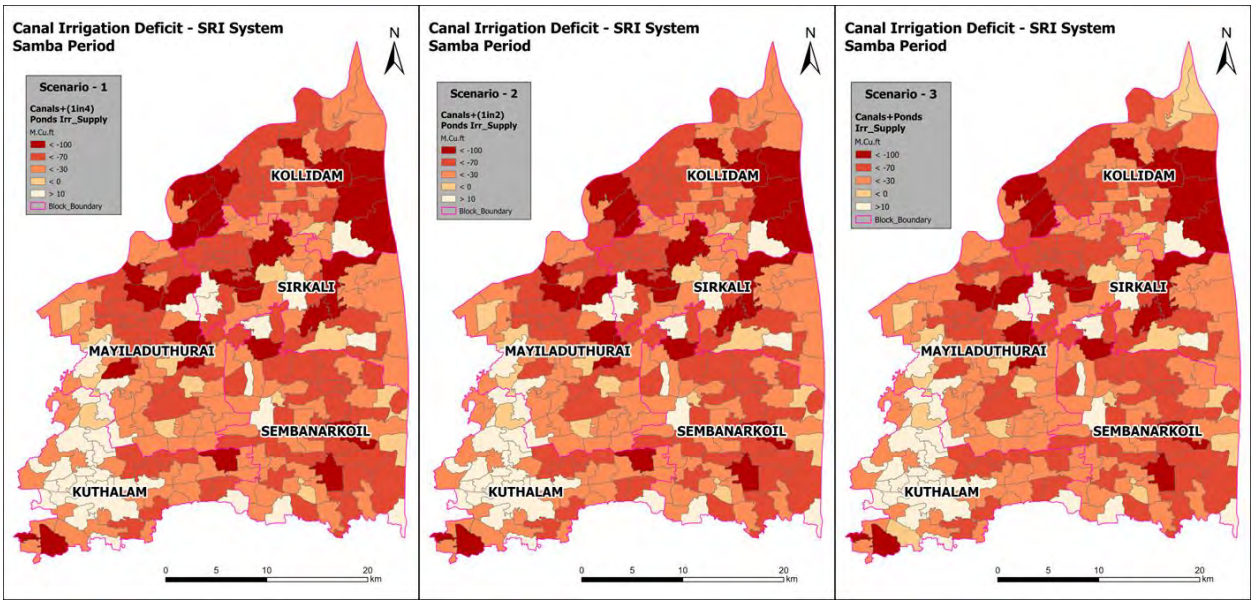
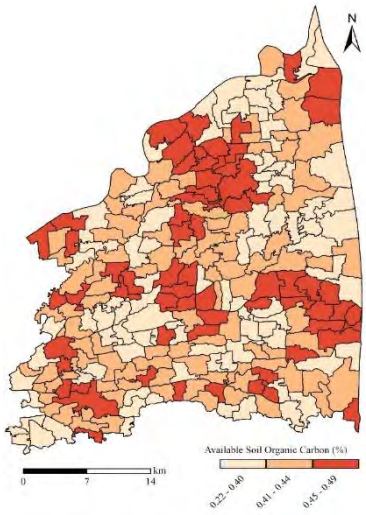
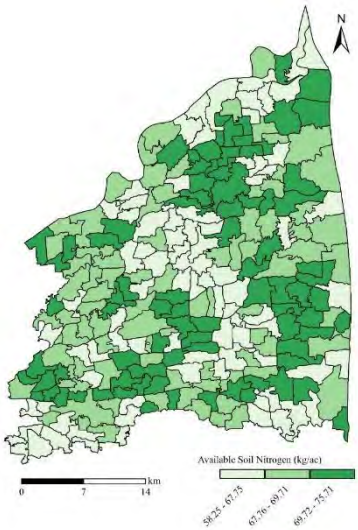


Figure A4 Projected Scenarios of Canal and Pond Irrigation Supply for Deficit during Samba Cropping in Mayiladuthurai District (SRI System)

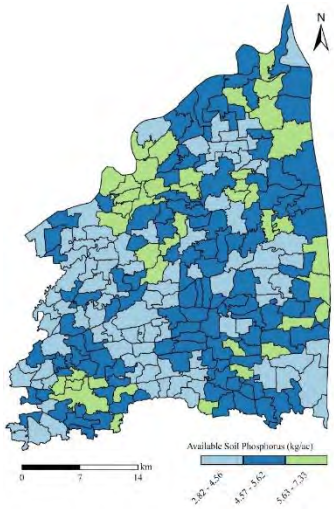
Organic Carbon (%)



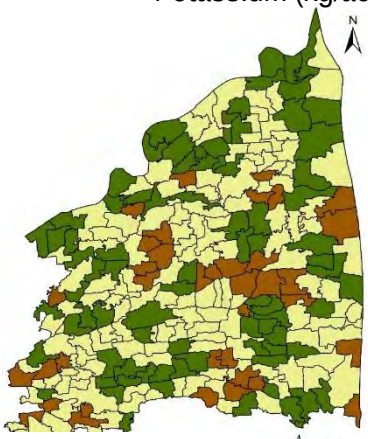
Nitrogen (kg/ac)

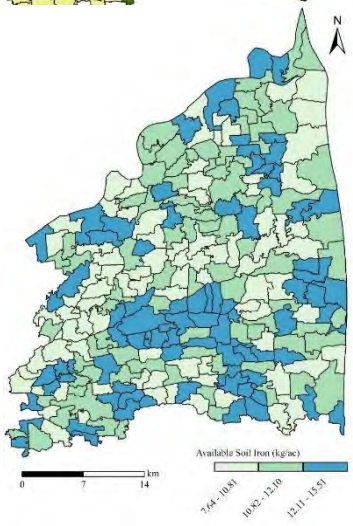


Phosphorous (kg/ac)

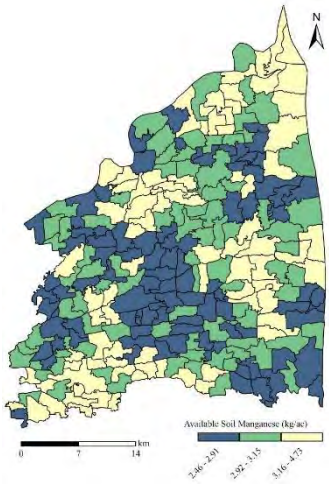


Potassium (kg/ac)

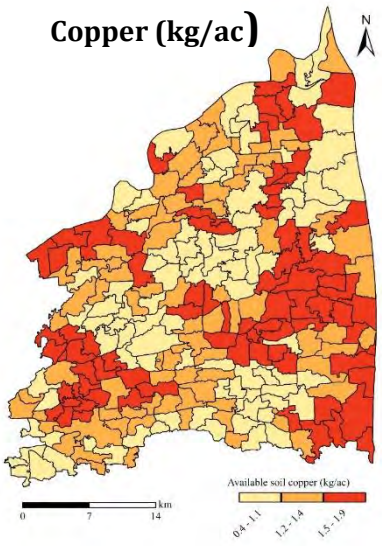




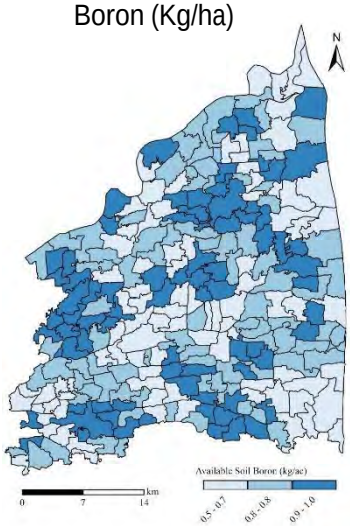
Zinc (Kg/ha)



Copper (kg/ac)



Boron (Kg/ha)



ANNEXURE-III

TableA1 Block level ADT43 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	5472.71	5017.15	-8.32
Kollidam	5464.60	4938.52	-9.63
Mayiladuthurai	5474.71	5023.65	-8.24
Sembanarkoil	5452.94	4934.17	-9.51
Sirkali	5461.66	4945.32	-9.45

TableA2 Block level CO-51 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	6355.20	5842.16	-8.07
Kollidam	6195.41	5613.42	-9.39
Mayiladuthurai	6364.76	5887.53	-7.50
Sembanarkoil	6222.49	5664.80	-8.96
Sirkali	6228.57	5674.12	-8.90

TableA3 Block level ADT54 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	6092.50	5450.76	-10.53
Kollidam	5899.07	5167.01	-12.41
Mayiladuthurai	6185.05	5504.79	-11.00
Sembanarkoil	6005.63	5275.64	-12.16
Sirkali	6001.13	5270.71	-12.17

TableA4 Block level CR1009 Sub1 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	6603.303	6327.475	-4.18
Kollidam	6459.898	6190.699	-4.17
Mayiladuthurai	6628.538	6317.031	-4.70
Sembanarkoil	6466.556	6197.063	-4.17
Sirkali	6484.429	6208.667	-4.25

TableA5 Block level BPT 5204 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	6150.44	5702.82	-7.28
	6158.02	5659.96	-8.09
Kollidam	6178.69	5722.48	-7.38
Mayiladuthurai	6125.88	5654.79	-7.69
Sembanarkoil	6145.68	5663.58	-7.84
Sirkali	6150.44	5702.82	-7.28

TableA6 Block level Swarna Sub-1 yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	5547.817	5112.217	-7.85
	5542.678	4955.613	-10.59
Kollidam	5567.511	5186.597	-6.84
Mayiladuthurai	5530.53	4965.439	-10.22
Sembanarkoil	5541.969	4992.901	-9.91
Sirkali	5547.817	5112.217	-7.85

TableA8 Block level Blackgram yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	839.04	919.58	9.60
	852.24	931.31	9.28
Kollidam	860.97	946.09	9.89
Mayiladuthurai	838.19	906.13	8.10
Sembanarkoil	851.09	924.94	8.68
Sirkali	839.04	919.58	9.60

TableA9 Block level Greengram yield change of Mayiladuthurai

Block	Baseline Yield (kg/ha)	Future Yield (kg/ha)	Yield change (%)
Kuthalam	944.69	1032.71	9.32
	977.53	1049.94	7.41
Kollidam	968.65	1061.88	9.63
Mayiladuthurai	940.97	1014.29	7.79
Sembanarkoil	964.06	1039.86	7.86

Table A10 Composite Risk Index

RISK_INDEX	No of Villages Blockwise					
Vulnerability Category	Kollidam	Kuthalam	Mayiladuthurai	Sembanarkoil	Sirkali	Total GP
Very High	1	0	0	24	4	29
High	12	15	3	24	24	78
Moderate	20	32	45	8	9	114
Low	7	5	6	2	3	23
Very Low	0	0	1	0	1	2

Centre for Climate Change and Disaster Management

Department of Civil Engineering, Anna University, Chennai - 600 025

VISION

The CCCDM to be the Centre for Excellence to address challenges of Climate Change and Disaster Management

MISSION

CCCDM shall contribute to the sustainable development by

- Disseminating Knowledge of regional climate risks and cadastral level climate resilient actions to cope up with changing climate
- Promoting climate science and disaster risk reduction research
- Strengthening the capacity for climate change adaptation, mitigation and disaster risk reduction

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