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COMPENDIUM OF ACTIVITIES WASCA TAMIL NADU

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COMPENDIUM OF ACTIVITIES WASCA TAMIL NADU

MESSAGE

Hans Raj Verma, IAS
Additional Chief Secretary
Government of Tamil Nadu

The Indo-German project on Water Security and Climate Adaptation in Rural India (WASCA) is being implemented in partnership with the Ministry of Rural Development and the Ministry of Jal Shakti by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ India) from 2019-2022 to improve Climate-Resilient Management of Rural Water Resources. WASCA is operational at the national level and in five states namely, Tamil Nadu, Rajasthan, Madhya Pradesh, Uttar Pradesh and Karnataka.

In Tamil Nadu, the project is being implemented in two districts: Ramanathapuram and Tiruvannamalai. These are the most vulnerable districts in terms of very high exposure to climate extremities from 1951-2015, high agricultural as well as socio-economic vulnerability, and a wide gap between supply and demand of availability of water resources for productive and domestic use.

With its motto of "Climate Resilience for Future Livelihoods", WASCA Tamil Nadu has already conducted a scoping study which carefully scrutinized the state's rural water security through a systematic analysis via availability, accessibility of water and its governance through the climate lens using 18 different biophysical and socio economic indicators under 4 dimensions via climate (5 indicators), Water (5 Indicators) agriculture (4 Indicators) and socio economic (4 indicators) which have been composed and categorized into adaptive capacity, sensitivity and exposure indicators for the analysis.

The project is localised through the Composite Water Resources Management (CWRM) planning framework, using which 1289 Gram Panchayat-based plans have been developed and are designed to be further integrated and consolidated at block and district levels. Using CWRM planning to conserve and recharge water effectively under MGNREGS for WASCA, a total of 12,02,243 number of works have been identified with three major Water Actions:

Rajeev Ahal
Director, Natural Resource
Management and Agroecology
GIZ India

1. Development of Public & Common Lands
2. Development of Agricultural and Allied Sector development (Productivity Enhancement)
3. Development of Rural Infrastructure

Further, the Steering Mechanism of the State is a major strength for the implementation of WASCA in Tamil Nadu. The State has taken total ownership for this project; both District Collectors and Project Directors have extended their full support throughout the project period.

WASCA's interventions in Tamil Nadu will also help achieve five Sustainable Development Goals (SDGs) - SDG 1 (no poverty), SDG 2 (no hunger), SDG 6 (clean water & sanitation), SDG 13 (climate action) & SDG 15 (Land on land); and 2 of India's NDC Mitigation & Adaptation targets (Target 5 - enhancing carbon sinks and Target 6- adaptation, respectively).

Community participation is assured under WASCA through dialogues, discussions with various village level institutions, GP officer bearers, farmers, and resource user groups. Translating plans into action, every block in the two districts model GP are created for ensuring community ownership, leadership in WASCA implementation.

We hope that the WASCA interventions in Tamil Nadu as documented in this compendium will serve as a useful knowledge input for improving the scope and implementation of various rural development programmes such as Mahatma Gandhi NREGA, Catch The Rain Campaign, Jal Jeevan Mission, State-Specific Action Plans for water, State Action Plans for Climate Change among others.

We look forward to sharing the results and evidence from the piloting process in the WASCA project locations and supporting our partners in further upscaling and mainstreaming these practices and learnings nationwide.

Rajeev Ahal
Director, Natural Resource Management and Agroecology
GIZ India

> **In Tamil Nadu, the project is being implemented in two districts: Ramanathapuram and Tiruvannamalai. These are the most vulnerable districts in terms of very high exposure to climate extremities from 1951-2015**

Hans Raj Verma, IAS
Additional Chief Secretary
Government of Tamil Nadu

MESSAGE

Dr K.S Palanisamy, IAS
Commissioner, Rural Development and Panchayat Raj,
Government of Tamil Nadu

Bilateral project between GIZ and Rural Development & Panchayat Raj department on WASCA in Tamil Nadu launched with a state level workshop during November 2019. Scientific data collection, use of GIS and training of GP and Block level officers in drawing actual ground situation with statistics on water budget assessments, demand and supply gaps of water requirement in rural areas, land use, rain water run-off management are key in WASCA. This was enabled by training all officers at project districts of Ramanathapuram and Tiruvannamalai by GIZ and their technical partner, M.S.Swaminathan Research Foundation. The project completed 1289 GP level Composite Water Resources Management Plans. Every GP plan has assessed 135 data sets related to non-spatial and spatial data. Based on the data, at every GP works from 262 permissible list are identified, converted into shape file (KML) as per GIS planning guidelines of MoRD. All the 1289 GP level plans will be transferred into NREGA soft in current financial year under GIS planning sub section (D-29). This will enable sustained implementation of works in saturation mode in the next three years.

The Compendium provides all the steps, actions taken by Rural Development & Panchayat Raj department in the last one year. The various chapters in the book helps planners, decision makers in explaining to community and GP office bearers the need for working in convergence with line departments and area-based watershed approach for augmenting water resources. The book will also be very useful to other districts in Tamil Nadu to learn the process and results under WASCA for adoption in their respective areas. I take this opportunity to thank all the district officers who worked dedicatedly and collectively despite of covid-19 pandemic for this excellent model. GIZ and its technical partners provided the guidance, framework for the officers in the project area in planning and implementing WASCA.

> **The book will also be very useful to other districts in Tamil Nadu to learn the process and results under WASCA for adoption in their respective areas.**

Dr K.S Palanisamy, IAS
Commissioner, Rural Development and Panchayat Raj,
Government of Tamil Nadu

MESSAGE

Tmt G Muthu Meenal
Additional Director (MGNREGS), RD&PR,
Government of Tamil Nadu

Water Security and Climate Adaptation (WASCA) is unique project taken up in Ramanathapuram and Tiruvannamalai districts of Tamil Nadu in collaboration with GIZ. It focus on holistic development of rural areas with scientific planning, convergence and actions to match changing climate. The Composite Water Resource Management (CWRM) approach approved by MoRD and MoJS was adopted and customised to suit to the needs of the project district and state. The Executive Engineers, AEE's, AE's have worked as a team with GIZ in developing unique model with Four vulnerable areas (Social, Climate, Water and Agriculture), 18 Indicators as base for building plans and implementing mechanisms. The complex problem of Water and Natural Resources Management was simplified by analysis both non-spatial data and use of Bhuvan NRSC GIS thematic maps. The guidance provided by MoRD and GIZ on GIS based planning helped in planning and implementation. Joint Field visits by State Nodal Officers of WASCA, District Nodal Officers, GIZ, Technical Agencies of WASCA – MSSRF, CCCDM, Anna University, SDMRI and Prime Meridian helped in identifying works of local importance and need. District level reviews through Steering Committees by Collectors of both the districts brought all line departments to work together under WASCA.

The works related to Cascade Tank Development, salinity reduction in coastal areas, watershed works for treating drainage lines, improving dry lands with farm trench cum bund, farm ponds, fallow land development, roof rain water harvesting, pasture development, block plantation with soil conservation works identified under CWRM will give good results. During implementation of the 1289 GP plans under WASCA, convergence, demonstration of model GPs will help for scale up. I wish all the stakeholders, teams involved in preparing CWRM and Compendium for generating a good learning for sharing with other districts and states as models in Mahatma Gandhi NREGS.

> **The complex problem of Water and Natural Resources Management was simplified by analysis both non-spatial data and use of Bhuvan NRSC GIS thematic maps**

Tmt G Muthu Meenal
Additional Director (MGNREGS), RD&PR,
Government of Tamil Nadu

MESSAGE

Dinesh Ponraj Oliver, IAS
District Collector,
Ramanathapuram

The WASCA project is launched in Ramanathapuram district during January 2020 with an objective of preparing the district to ensure water security in the context of increasing climate risks. The project introduced Composite Water Resources Management (CWRM) planning framework to estimate the GP based water budget by assessing the available water supply and assessing the demand. The district officials with the technical support of WASCA Resource centre in the district has completed the CWRM plans for all the 429 GPs.

The plans are comprehensive from the village development perspective covering proposed works in both natural resources management(NRM) and non NRM adopting saturation approach. The plans are verified at the ground level with the participation of village panchayat officials for preparing works and labour budget for this year. Besides, the district has started piloting innovative models on Climate Resilient Measures in creating sustainable solutions for accessing drinking water, development of public and common lands, afforestation (mini-forests) and nurseries.

I am confident that this CWRM plan is a practical tool for scientific planning in strengthening the water resources of the district and ensure access to water to all sectors in the district in the coming years.

> **I am confident that this CWRM plan is a practical tool for scientific planning in strengthening the water resources of the district**

Best wishes,

Dinesh Ponraj Oliver, IAS
District Collector,
Ramanathapuram

MESSAGE

Sandeep Nanduri, IAS
District Collector,
Tiruvannamalai

The WASCA project has started In Tiruvannamalai district on January 2020 with a district level inception meeting. It supported in building the capacity of the AE's and AEEs in GIS based planning adopting Composite Water Resources Management (CWRM) planning framework. Based on this the team has developed village based CWRM plans for 860 GPs. The CWRM plans assessed both the supply and demand for water using data pertaining to land resources, climate parameters, catchment areas, soil, surface runoff, agriculture and prepared a water budget. Besides, it has identified a set of key water actions for the development of public and common land, agriculture and allied activities and rural infrastructure.

The whole planning process followed a bottom-up approach in identifying appropriate actions based on scientific analysis using social, hydrological and bio-physical parameters. The plans are verified at the ground level by the block and GP officials and based on that list of works and labour budget are finalized. Further, the GP based plans are consolidated at block and district levels for prioritizing the actions and planning.

I consider such decentralized level of planning is necessary in ensuring water security in the context of increasing climate change impacts.

> **I consider such decentralized level of planning is necessary in ensuring water security in the context of increasing climate change impacts**

Best wishes,

Sandeep Nanduri, IAS
District Collector,
Tiruvannamalai

ACKNOWLEDGEMENT

According to India's Composite Water Management Index (2018) developed by NITI Aayog, 600 million people in the country are suffering from an acute shortage of water. A shrinking and sometimes contaminated water supply, heavy reliance on rainfall and lack of efficient irrigation systems are major problems in rural areas, where almost 70 percent of the Indian population live. India is one of the most affected countries by climate change and occupies sixth place in the Global Climate Risk Index 2018. In this changing climate scenario, water security is therefore a prime concern.

The **Ministry of Rural Development (MoRD)** is the principal partner in development and social programmes in rural India. **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)** making a substantial contribution to rural infrastructure development and rural livelihoods. The 65 percent of the Mahatma Gandhi NREGA expenditure goes towards sustainable Natural Resource Management. Also, MGNREGA including land and soil development, water harvesting and conservation. Further, Mahatma Gandhi NREGA works address the climate change vulnerability and protect the farmers from such risks and conserve natural resources.

The **Ministry of Jal Shakti (MoJS)**, newly formed in May 2019, is the nodal ministry for water in India, and now brings all the national agencies working on water including the National Water Mission, Central Water Commission, Central Ground Water Board, River Boards, Department of Drinking Water and Sanitation, etc. under one umbrella. On 1 July 2019, MoJS launched the Jal Shakti Abhiyan (Waterpower Campaign) in convergence with MoRD, Ministry of Environment, Forest and Climate Change (MoEFCC) and other ministries.

The National Water Mission (NWM) is one of the 8 missions under India's National Action Plan on Climate Change (NAPCC). It was launched in 2014 with the main objective of "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". NWM and Mahatma Gandhi NREGA provides guidance on long term strategy to address the water issues at National and State levels respectively.

The Indo-German project on Water Security and Climate Adaptation in Rural India (WASCA) is a partnership project with the Ministry of Rural Development and Ministry of Jal Shakti and is being implemented in five states namely, Tamil Nadu, Rajasthan, Madhya Pradesh, Uttar Pradesh and Karnataka. In Tamil Nadu, the project is implemented in two Districts; Ramanathapuram and Tiruvannamalai. The duration of the project is for three years (2019-2022). The core objective of the initiative is to accelerate the climate-resilient water resource management practices in the district adopting bottom-up approach in planning with a base at Gram Panchayat scale.

The Government of Tamil Nadu is committed to adopt the Composite Water Resource Management (CWRM) Plan to address the water related issues in WASCA. The state strongly believes that there is a need to protect our natural system and strengthen water security and spur economic growth through continued efforts and sustained actions.

Besides, the State Government is taking affirmative actions at grass-root level especially Gram Panchayat level aimed at encouraging innovative technologies in water sector. This will help to achieve water security in the state. In addition, it will make the state economy vibrant in the times to come and to lead the state on "Climate Resilience for Future Livelihoods" growth trajectory.

In line with its long-term goals, the state has developed its WASCA Compendium, which would help policy makers planners, officials, scientists and stakeholders to better understand the complexity of climate-imposed water issues and inter-linkages among environmental and economic issues. Such inter-sectoral understanding enables them to work in a manner that fosters sustainable development of water security in the State. It is important to highlight that numerous stakeholders at an individual or institutional capacity have been associated in finalizing the Tamil Nadu WASCA compendium document which needs a mention and deserves recognition for their contribution and acknowledgement.

Department of Rural Development and Panchayat Raj (RD&PR), Govt. of Tamil Nadu acknowledges the efforts of District Rural Development Authority (DRDA) of Ramanathapuram & Tiruvannamalai. The hard work and cooperation of the officials of the WASCA Districts - Ramanathapuram and Tiruvannamalai, members of line departments, experts and professionals – both external and from the state govt. departments, organizations and all those associated in finalizing this document are recognized gratefully.

RD&PR further acknowledges the various technical partners of this WASCA project namely State Ground and Surface Water Resources Data Centre, Tharamani, Chennai, Tamil Nadu, M.S. Swaminathan Research Foundation, Chennai, Centre for Climate Change and Disaster Management, Anna University, Sugandhi Devadasan Marine Research Institute, Thoothukudi, Prime Merdian, Chennai.

RD&PR gratefully recognizes and sincerely thank the technical support received from Natural Resource Management and Agro Ecology Centre, GIZ (Deutsche Gesellschaft fur Internationale Zusammenarbeit) under the Indo-German technical cooperation in facilitating the WASCA Project.

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ABBREVIATIONS AND ACRONYMS

A - C

ADRD
Additional Director for Rural Development

AER
Agro-Ecological Region

BDO
Block Development Officer

BCM
Billion Cubic Metre

BMZ
German Federal Ministry for Economic Cooperation and Development

CCCDM
Centre for Climate Change and Disaster Management

CDD
Community Driven Development

CWC
Central Water Commission

CE
Chief Engineer

CGARD
Centre for Geoinformatics Application in Rural development

C - E

CII
Confederation of Indian Industry

CORDEX
Coordinated Regional Downscaling Experiment

CSR
Corporate Social Responsibility

CVI
Cumulative Vulnerability Index

CWRM
Composite Water Resources Management

CWRMP
Composite Water Resources Management Plan

DLSC
District Level Steering Committee

DPR
Detailed Project report

DRDA
District Rural Development Agency

EBA
Eco System Based Approach

ET
Evapo transpiration

F - I

GCF
Green Climate Fund

GP
Gram Panchayat

GIS
Geographical Information System

GIZ
Deutsche Gesellschaft für Internationale Zusammenarbeit

GW
Ground Water

HaM
Hectare Metre

ICAR
Indian Council of Agricultural Research

IDNDR
International Decade for Natural Disaster Reduction

IEC
Information, Education and Communication

IWRM
Integrated Water Resources Management

J - N

MCM
Million Cubic Metre

MGNREGA
Mahatma Gandhi Rural Employment Guarantee Act

MGNREGS
Mahatma Gandhi Rural Employment Guarantee Scheme

MoEFCC
Ministry of Environment, Forest and Climate Change

MoJS
Ministry of Jal Shakti

MoRD
Ministry of Rural Development

MSSRF
M.S. Swaminathan Research Foundation

NABARD
National Bank for Agriculture and Rural Development

NAFCC
National Adaptation Fund on Climate Change

NDC
Nationally Determined Contributions

NCIWRD
National Commission on Integrated Water Resources Development

NE
North East Monsson

NGO
Non-Governmental Organization

N - R

NHM
National Horticulture Mission

NIRD & PR
National Institute of Rural Development & Panchayati Raj

NMSA
National Mission for Sustainable Agriculture

NRLM
National Rural Livelihood Mission

NRSC
National Remote Sensing Centre

NWC
National Water Commission

PDMC
Per Drop More Crop

PIP
Participatory Identification of Poor

PKSKY
Pradhan Mantri Krishi Sinchayee Yojana

PPP
Public Private Partnership

PRI
Panchayati Raj Institutions

RDPR
Rural Development & Panchayati Raj

RKVY
Rashtriya Krishi Vikas Yojana

RWHS
Rain Water Harvesting Structures

S - Z

SAPCC
State Action on Climate Change

SDG
Sustainable Development Goal

SDMRI
G Suganthi Devadasan Marine Resources Institute

SE
Superintendent Engineer

SMAF
Sub Mission on Agro-Forestry

SoP
Standard Operating Procedure

SLSC
State Level Steering Committee

SWM
South West Monsson

TMC
Thousand Million Cubic feet

TNSLRM
Tamil Nadu State Rural Livelihoods Mission

TN SAPCC
Tamil Nadu State Action Plan for Climate Change

TWAD
Tamil Nadu Water Supply and Drainage Board

WASCA
Water Security and Climate Adaptation in Rural Areas

EXECUTIVE SUMMARY

The compendium presents the consolidated work carried out in Water Security and Climate Adaptation in Rural India (WASCA), Tamil Nadu from November 2019 to March 2021. The project is jointly implemented by the Department of Rural Development & Panchayat Raj, Government of Tamil Nadu, Chennai and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Delhi.

The main purpose of the compendium is to share the framework and processes adopted and the key learnings of WASCA to policy makers and technical officials of other line departments, staff within various ministries (Water Resources, Rural Development, Agriculture etc) and researchers.

The compendium is structured into five chapters:

Chapter 1: Explains the objectives and approaches of WASCA in Tamil Nadu, the steering mechanism of the project at the national, state and district levels. It documents various processes followed in identifying the pilot study districts and provide the details of the technical partners associated with the project. The key learning is that well- structured steering mechanism helped in guiding the implementation of WASCA, even during the Covid-19 pandemic situation.

Chapter 2: Presents the three action research studies undertaken to implement the WASCA objectives in the pilot districts. The Scoping study helped to identify the vulnerable districts in the state for the WASCA project. The second study focused on ground water status in both the districts. While the third study was conducted to understand the sea water intrusion and its impact on salinity in Ramanathapuram district. These studies inputs were useful in strengthening the framework of CWRM planning linking with climate change study outcomes and designing the site specific problem based interventions in both the districts. The synopsis or extended abstract of the studies were given in three sub sections.

Chapter 3: This chapter elaborates the framework, approach and analysis of CWRM planning undertaken in 1289 GPs of Tiruvannamalai and Ramanathapuram districts. The chapter also delves into details of various activities to be undertaken under WASCA in different subsections:

- The first subsection provides the key elements and steps in planning, categorization of the GP boundaries with revenue village boundaries and climate indicators used in the study under three different categories of the work: development of public and common land, development of agriculture and allied sector and development of rural infrastructure.
- The second subsection details the capacity building programmes organized at different levels to operationalize the CWRM planning at the GP level.
- The third subsection presents the district wise analysis of the key water challenges. The issues are categorized in socio-economic, bio-physical and hydrological dimensions.
- Following this, the fourth sub section delves into the district-wise key water actions namely public and common land, agriculture and allied sectors and rural infrastructures.

- The fifth subsection provides two case studies: one GP from each of the districts to illustrate how CWRM planning processes unfolds into analysis, results and impacts.
- The sixth subsection shows the ranking of block based on the degree of vulnerabilities in four dimensions viz., socio-economic, climate, water and agriculture and allied activities.
- The seventh subsection describes the approach adopted in the Climate Resilient Measures (CRM) and the details of the CRMs identified for demonstration in both the districts based on the site-specific vulnerabilities.
- The eighth subsection narrates how the CWRM-TN framework is aligned with state plan, national goals and global policies in climate change and water sectors. The analysis covered Intended nationally determined contribution goals of Government of India, United Nations Sustainable Development Goals and the Tamil Nadu State Action Plan for Climate Change.
- The final subsection consolidates the expected impacts of the district wise key water actions in to three categories.

Chapter 4: The chapter delves on financing and partnerships. It describes how the CWRM plan outputs can be translated into actions by harnessing the opportunities through available schemes and projects under convergence, exploring public private partnerships and accessing existing climate finance mechanisms.

Chapter 5: The chapter narrates the capacity development and cooperation strategy to upscale the learning by partnering with multi-stakeholders at the state level.

CHAPTER 1
WASCA PROJECT OVERVIEW

1.1 WASCA APPROACH AND STEERING MECHANISM

1.1.1 OBJECTIVES OF WASCA

The Indo-German Project Water Security and Climate Adaptation in Rural India (WASCA), is a bi-lateral project commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) in partnership with the Ministry of Rural Development (MoRD) and Ministry of Jal Shakti (MoJS) is implemented by GIZ (Represented by Government of Germany). The Project WASCA seeks to address planning, financing and implementation mechanisms developed in the field of rural water resource management and climate change adaptation. It aims for the following three output areas (Fig 1.1).

The project aims to improve water resource management through an integrated approach, Composite Water Resource Management (CWRM) Planning through Mahatma Gandhi NREGA and convergence at national, state and local levels (Gram Panchayat, Block & District) with respect to water security and climate adaptation (Fig 1.2).

1. Improving existing planning and financing mechanisms
2. Developing Climate - Resilient Water Management Measures
3. Strengthening Cooperation with private sector

Fig 1.1: Key output areas of WASCA

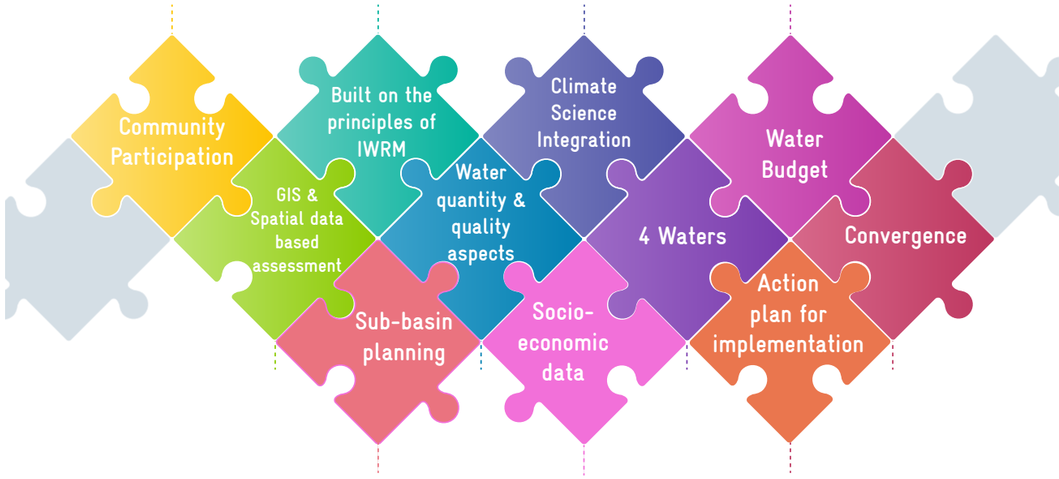


Fig. 1.2: Components of Integrated Water Resources Management (IWRM) approach

1.1.2) PROJECT STATES & DISTRICTS

The project is operational in five States – Tamil Nadu, Madhya Pradesh, Rajasthan, Uttar Pradesh and Karnataka in about 13,000 villages in 10 districts (Fig 1.3 & 1.4). The project period is three years from April 2019 to March 2022. The project includes land and soil resources development, water harvesting and conservation, and measures for protection against extreme weather events, such as drought and flooding, thus creating significant climate adaptation and mitigation co-benefits.

Fig 1.3: WASCA project in India

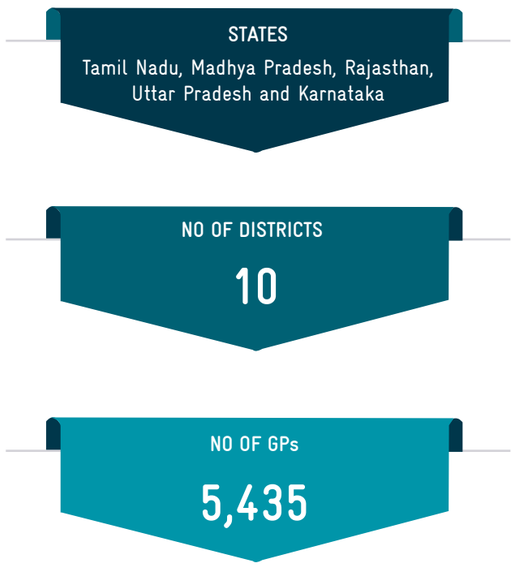


Fig 1.4: Operational states of WASCA and number of districts and GPs covered

The Ministry of Rural Development, through Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) provides the key platform for WASCA implementation. At the State Level, the Directorate of Rural Development and Panchayat Raj and at the District Level, the District Rural Development Agency (DRDA), play a key role in the implementation of WASCA Project. Convergence, Ridge to Valley approach, Four Waters and use of technology, GIS are key tools involved in the implementation of WASCA.

The Department of Rural Development and Panchayat Raj (RD&PR), Government of Tamil Nadu is the nodal implementing agency for WASCA.Department of RD&PR, Govt of TN has included WASCA project in its planning document for budget 2020-21 and also in the draft Tamil Nadu State Action Plan on Climate Change (TN-SAPCC).

The Ministry of Jal Shakti, the nodal ministry for water in India, brings together National agencies working on water including National Water Mission, Central Water Commission, Central Ground Water Board, River Boards, Department of Drinking Water and Sanitation, Atal Bhujal Yojana for ground water management and Jal Jeevan Mission to enhance the scope for WASCA interventions in rural India.

State Ground Water and Surface Water Resource Centre, Department of Public Works (Water Resources Department) is the State Nodal Agency for National Water Mission. The Chief Engineer of the centre and State Nodal Officers of State National Water Mission are providing the data, sub-basin information and assessment support to WASCA Tamil Nadu.

Fig 1.5: WASCA - Implementation Partnership

1.1.3) WASCA RESOURCE CENTRES

To facilitate participatory planning, implementation and coordination, GIZ in collaboration with Commissioner, Rural Development & Panchayat Raj (RD&PR), Additional Collector / Project Director, District Rural Development Agency (DRDA) have established WASCA District Resource centre's. The District Level WASCA Resource Centre's provide the required knowledge and tools for CWRM and Climate Adaptation planning and financing for the project will be majorly contributed by Mahatma Gandhi NREGS. The WASCA resource centres works under the supervision, guidance of District Collector and concerned Project Director of DRDA, to implement WASCA utilizing all the existing guidelines / schemes of state and central governments.

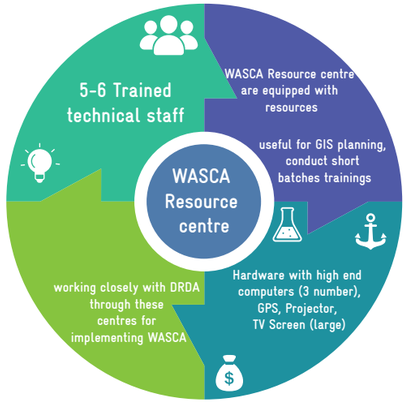


Fig 1.6: WASCA Resource Centre

M.S. Swaminathan Research Foundation, the lead technical agency for GIZ under WASCA provides the necessary trained human resources for the WASCA Resource Centre's.

The resource centres provide the following support to DRDA for implementation of WASCA objectives:

TABLE 1.1: SUPPORT OF WASCA RESOURCE CENTRE TO DRDA

a) Establishment of GIS lab	• Computers • Trained human resources • Technical agency supporting GIS based planning • Scanner, printers, GPS	• Material useful for GIS planning • Connect each resource centre with Technical Agency and CSR for sustained inputs
b) Modules Development	• Planning module for water and climate for GP to district / sub-basin level using GIS tools • CWRM Framework for the river sub-basin and district	• Module on Climate Resilience measure • Handbook on Potential Financing water security and Climate Adaptation: Projects, Programmes and schemes
c) Assessments and studies	• Training Needs Assessment • Capacity building needs assessment • Potential for Artificial recharge to rejuvenate river basin	• Climate Adaptation strategies and innovations
d) Trainings and Workshops	• Conduct trainings on understanding water sector useful for the district • Conduct Training for the officers concerned (RD&PR, Mahatma Gandhi NREGS and other line departments) on GIS based tools for effective participatory planning	• Conduct Workshop and Trainings on Water Security, Ground Water Recharge, Pollution Control, Climate Change etc. • Organize workshops for increasing technical capacities of staff under RD&PR and other line departments
e) Generating IEC material for the project	• Facilitate in preparation of DPR at GP and district for River Sub-basin • Any other inputs as per suggestion by RD&PR will be included in the resource centre	

1.2 STEERING STRUCTURE FOR IMPLEMENTATION OF WASCA TAMIL NADU AND OUTCOMES

The Department of RD&PR, Govt of Tamil Nadu is the implementation agency in the state. At the state level Directorate of Rural Development and Panchayat Raj is coordinating and implemented by DRDA at the district level. The activities of the project is closely guided by a group of multi-disciplinary experts both at the state and district level as State Level Steering Committee (SLSC) and District Level Steering Committee (DLSC) respectively. The following is the broader framework of the project guidance and monitoring structure (Fig 1.7).

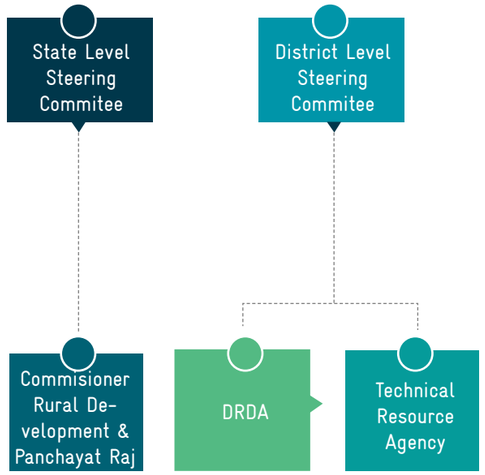


Fig 1.7: Project guidance and monitoring structure

1.2.1 STATE LEVEL STEERING COMMITTEE

The core objective of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is to provide 100 days of wage employment and create durable assets. In the year 2016, Mahatma Gandhi NREGS taken up national wide to address the water scarcity, implement Mission Water Conservation (MWC) across the country. Mission Water Conservation is a convergence framework for scientific planning and execution of water management works with the use of latest technology. This has been mandated in consultation with an agreement of the Ministry of Water Resources (now Jal Shakthi) and the Ministry of Agriculture and Farmers' Welfare. Out of 262 permissible works / activities under Mahatma Gandhi NREGA 182 works are related to Natural Resource Management.

Mission Water Conservation, a convergence framework emphasized that the works taken up in Mahatma Gandhi NREGS should change from taking up individual, standalone works in a typical 'relief works mode' to an Integrated Natural Resource Management (INRM) perspective. Also, it was reiterated that planning and systematic development of land and harnessing of rainwater following watershed principles should become the central focus to sustainably enhance farm productivity and income of poor people.

The provision in Sub Para (2) of Para 4 of Schedule 1 Mahatma Gandhi NREGA, lays down that, "Provided that the District Programme Coordinator shall ensure that at least 60% of the works to be taken up in a district in terms of cost shall be for creation of productive assets directly linked to agriculture and allied activities through development of land, water and trees". With the thrust on development of livelihoods, works prioritised in the convergent planning process for individual beneficiaries will be given priority. The master circular 2020-21 section 6.3 elaborated on need for Focus on Climate Change infrastructure built under Mahatma Gandhi NREGS leading to increased water availability for irrigation, ground water recharge, increased agricultural production, and carbon sequestration.

In order to oversee and smooth implementation of WASCA in state of Tamil Nadu through Mahatma Gandhi NREGS and Convergence, it is decided to constitute a State Level Steering Commitee (SLSC) the chairpersonship of Additional Chief Secretary to Government, Government of Tamilnadu, RD&PR, Commissioner, Rural Development & Panchayat Raj (RD&PR) as Member Secretary. The SLSC meet once in every quarter and review the progress, approve action plans, provide guidance and direction on reaching the objectives set for WASCA. For the formation of SLSC, the Government of Tamil Nadu has issued a GO (Ms.) No. 170 dated 25.11.2019 given in Annexure 1. The members of SLSC are Heads of Line Departments: Public Works Department (PWD), Tamil Nadu Water Supply and Drainage Board (TWAD Board), Department of Agriculture, Horticulture, Fisheries Department, Animal Husbandry, Forest Department, NA-

BARD, M.S. Swaminathan Research Foundation, Madras School of Economics, Confederation of Indian Industry, Research institutes and academia represented by Centre for Climate Change and Disaster Management (CCCDM) and, Department of Water Resources from Anna University, Tamil Nadu Agricultural University, ICAR- Indian Institute of Soil and Water Conservation etc.

MONITORING SYSTEMS AT DIFFERENT LEVELS

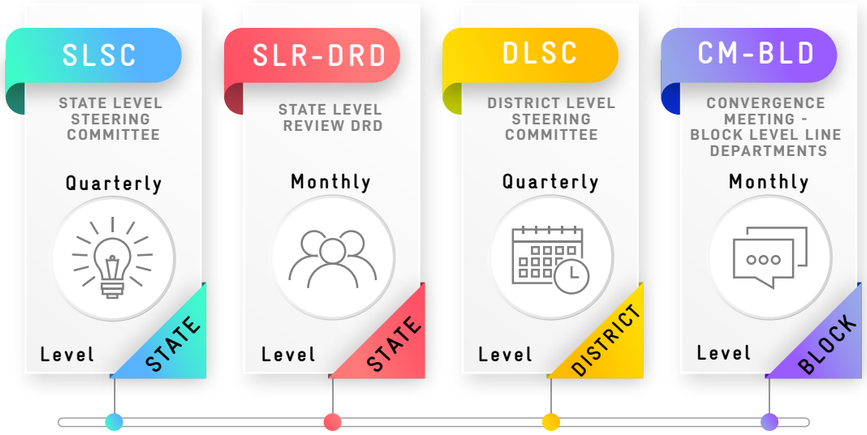


Fig 1.8: Monitoring Systems of WASCA Project

Till to date, four SLSC meetings were organized and the details of the meeting are furnished below. The SLSC was constituted in November 2019 and formally announced in the state level launch workshop held in 29 & 30th November 2019.

PROGRESS OF WASCA – TN - STATE LEVEL STEERING COMMITTEE & RESOLUTIONS

STATE LEVEL MEETING FOR CONSTITUTION OF SLSC:

29 Nov 2019

Chennai

- A State Level Steering committee with Additional Chief Secretary as Chairperson, and Director, RD&PR as Convenor was constituted with members from line departments, experts from research institutions and GIZ for overall management of the WASCA
- Director RD&PR is the state project implementing officer for WASCA implementation
- Additional Director (Mahatma Gandhi NREGS) and Superintending Engineer (Mahatma Gandhi NREGS)are the state nodal officers for WASCA project

- The State Level Resource Centre (SLRC) and District Level Resource Centre (DLRC) were set up in January 2020
- State level WASCA Launch Workshop was held on 29 & 30th November 2019.
- GIZ to organize the workshop in close co-ordination with DRD and state nodal officer

FIRST SLSC MEETING

29 Nov 2019

Chennai

- Finalized WASCA implementation districts namely Ramanathapuram & Tiruvannamalai
- Conduct launch workshop and trainings at WASCA districts
- Organize District Level Steering Committee Meeting
- Schemes and Programmes related to Water Conservation is explained by all heads of departments
- All line departments agreed to shared their departmental schemes details for convergence

SECOND SLSC MEETING

27 May 2020

Chennai

- Works identified for implementation in current season
- GPs CWRM plan Approval
- CWRM plans to be done at GP level, but the analysis and assessment of data can be done at revenue village.
- Focus on water conservation works, traditional water bodies restoration and supply channels, natural drainage lines to be brought under soil and water conservation works
- Necessary support from revenue department through District Collector orders for removal of encroachment of water body courses
- All line departments share their plan of action and area of intervention so that convergence will be done
- Ramanathapuram district to focus on series of water storage structures as per contour, watershed and construct new water storage structures at saturation mode
- District Collector to facilitate convergence meetings
- Plantations to be given high priority. All water conservation and soil conservation work invariably to have vegetative measures and plantations with livelihood and employment generation
- Identification of private sector partnership with CII
- Monthly reviews of progress of WASCA to be conducted and reports to be submitted by 24th of every month to the Directorate
- Monthly State Level Review with GIZ and Chairperson shall be taken up on 25th of every month

THIRD SLSC MEETING:

9 Oct 2020

Chennai

- The Additional Chief Secretary, Govt of Tamil Nadu suggested to tie up with NABARAD Consultancy Services, a subsidiary of NABARD for financing to strengthen the Realtime water management systems (soil moisture, ground water table and surface water bodies)
- WASCA needs to integrate advanced technologies (Artificial Intelligence & Machine Learning) to monitor the prime indicators of water and climate factors on regular and Realtime basis
- Inclusions of Experts on wetlands and Afforestation

FOURTH SLSC MEETING:

29 Feb 2021

Chennai

- Requested to chronicle the whole process of CWRM planning and publish as a process document to share the experiences as a compendium of actions.
- The identified number of works, estimated budget and person days are presented by District Collectors are approved for both the districts
- The perspective plan for three years and for Annual Action Plan are approved
- Requested to fine-tune the climate resilient models in both the districts
- Focus on outputs, implementation of CWRM plans from 22 February 2021
- The district level consolidation reports were released and approved
- Merging and integrating CWRM plans into NGREGS Soft in phased manner (GIS Planning Portal)

SOUTHERN REGION WATER SUMMIT

23 Oct 2019

Chennai

- The CII - Regional Summit on water resource management towards a water secure South India was jointly organized on 23 October 2019 with CII in Chennai.
- The discussion focused on four themes:
  - Water security and climate change
  - Industrial use
  - Urban water management in building resilient cities
  - Evolve a policy framework to address the gaps in execution

DISTRICT LAUNCH WORKSHOP

13 Jan 2020

Ramanathapuram

- GIZ to share tool related to planning of Water Resource Management to EEs, AEEs and AEs
- Undertaking trainings to capacitate GP, Block, District officers on GIS, Key water challenges and Water actions
- Line departments ready to share their respective departmental schemes details for convergence

DISTRICT LAUNCH WORKSHOP

29 Jan 2020

Tiruvannamalai

- Sharing the Composite Water Resource Management plan format to EEs, AEEs and AEs district immediately
- Build the capacity of the district officials on appropriate and necessary training should be given to all officers regarding CWRMP
- Preparing Line departments ready to share their respective departmental schemes details for convergence

WASCA- TN REVIEW

9 Jul 2020

Chennai

Commissioner, RD&PR and SE (Mahatma Gandhi NREGS), Additional Collector, Ramanathapuram, Project Director, DRDA, Tiruvannamalai, Executive Engineers of both the district, GIZ, and Technical Partnering agencies under WASCA

- For Preparation of CWRM plans necessary training, technical training must be organized by GIZ and MSSRF complete the planning, works selection process by end of August 2020 in phased manner for all GPs in both the districts
- The Additional Collector, Project Directors, Executive Engineers need to ensure timely identification of works, approval of CWRM plans under WASCA
- MSSRF may discuss with SE (Mahatma Gandhi NREGS) & the state nodal officer of specific support from districts
- Based on the key water challenges, appropriate works to be identified with the support of the technical agencies of WASCA, to be verified at the ground level before finalizing the office
- Districts shall submit detailed report of list of GPs, list of works and estimated costs by end of July 2020 to the office

- The works identified to be local specific estimates be realistic and practical with quantifiable outcomes, indicating the exact labour material and convergence finance requirements
  - Coastal watershed formation of Committee and Nodal Officer at Ramanathapuram
  - Three Pilot sites identification in Coastal Watershed

NATIONAL MEETING ON PRIVATE SECTOR PARTICIPATION

3 Sep 2020

Virtual

- The National Consultation Workshop on 'Enhancing Private Sector Cooperation under WASCA' was organized on 3 September 2020
- The overall concept of WASCA and its implementation process was shared with the participants. About 35 representatives from diverse industries have joined the discussion
- They were also sharing their in the environment and social sector and their polices under Corporate Social Responsibility programme
- The workshop supported the programme to reach out to the private partners and enabled to work together in water sector in states where WASCA programmes are under implementation

WASCA- TN REVIEW

6 Nov 2020 &
5 Dec 2020

Chennai

- WASCA CWRM plan and actions in poor performing blocks are identified in both the districts and instructions provided to completed it
- 30 November 2020 set as target to complete all GP level plans for Ramanathapuram district and 5 December 2020 for Tiruvannamalai district
- One AE per block as in charge to complete the planning for both the district
- In the Climate Resilient actions - following specific works are to be taken on priority basis:
  1. Nursery establishment
  2. Community Block Plantation and Avenue plantation
  3. Cascade of Tanks
     a) Promoting Agro-forestry and horticultural plantation
     b) Coastal Micro-watershed pilot

1.2.3 DISTRICT LEVEL STEERING COMMITTEE

At the District, District Level Steering Committee (DLSC) is headed by District Collector as Chairperson and Project Director, DRDA as Convener, line departments, research institutions, local NGOs and representatives of private sectors as members. The important line departments namely Dept of Agriculture, Dept of Horticulture, Dept of Forest, Dept of Agricultural Engineering, Dept. of Fisheries, Dept. of Animal Husbandry, TWAD Board, WRO, CGWB and NABARD.

DETAILS OF DLSC MEETINGS, RAMANATHAPURAM DISTRICT

FIRST DLSC MEETING

13 Jan 2020

Ramanathapuram

- Build awareness on the concept of WASCA based planning at block and district level officials
- Extend on-line hands-on training for the GIS based planning and execution
- Requested to use the WASCA resource centres services and resources

SECOND DLSC MEETING

22 May 2020

Ramanathapuram

- Presentation of model GP Plan (GIS Plan) and Progress of Work
- Categorization of GPs and complexities
- Data collection from line departments (Primary Data)
- Sea Water Intrusion – Need for a focused study
- Climate Resilience pilot works identification
- Nursery raising, Mini Forests, Mangroves, Sand dune stabilization

THIRD DLSC MEETING

24 Aug 2020

Ramanathapuram

- The departments DRDA, Agriculture, Agriculture Engineering, Horticulture, TWAD, PWD, Fisheries, Animal husbandry and Forest formed into teams. These teams are given task to visit one coastal GP and one inland GP, study the CWRM plan developed and derive comprehensive development approach for convergence
- Ten model GPs with convergence action plans (3 Coastal and 7 Non-Coastal)
- All the Head of the Department and concerned responsible GP officials will visit the 10 GPs and collect available schemes, prepare activity plan with budget and evolve a plan to implement in convergence mode on or before 15th September 2020
- 10 GPs to initiate horticulture parks (3 GPs from coastal areas)
- Coastal Watershed GPs Pilot 1 verification of plans by line department teams
- Conduct the baseline and impact study of WASCA
- Plan will be two types in 10 GPs – Short term/tangible plan and long- term plan and accordingly activities are to be identified:

TANGIBLE PLAN/SHORT TERM PLAN:

- Farm ponds
- Agriculture land expansion like Horticulture park and change cropping systems with diversification and intensification
- Renovation of Water Bodies
- Afforestation- Mini forest and
- Quality Water supply for drinking

LONG TERM PLAN:

- Ground water Recharge
- Livelihood Activities

FOURTH DLSC MEETING

08 Feb 2021

Ramanathapuram

- The CWRM plans including spatial, non-spatial and KML was completed for all 429 Gram Panchayats and approved. In phase wise these plans will be merged through NREGA Soft
- Using CWRM planning to conserve and recharge water effectively under Mahatma Gandhi NREGS for WASCA totally **6,54,296** number of works has been identified
- All the above works identified in a scientific manner will be added in to shelf of projects (SOP) in every GP. The SOP will be available for GP to implement the works as per the priority and following the guidelines of Mahatma Gandhi NREGA as perspective plan
- Administrative Sanction can be provided to these works following the guidelines of Mahatma Gandhi NREGA for the works for the financial year 2021-22 for implementation
- To implement WASCA plans, the cooperation and convergence of all line departments is important. Hence, all the line departments are requested to provide necessary support at the block level to implement the works using WASCA plans as a base to come together in the areas of sharing the available schemes and technical capacities

- To enhance the Climate Resilient measures following works are discussed and agreed. For technical support GIZ is committed to provide support through technical partners and subject matter experts
- The facility created at WASCA Resource Centre and the outputs can be utilized by all district officials at the block as well as other line departments
- The detailed district report (draft) was submitted by GIZ is accepted
- The GP wise and block wise, works and person days will be communicated by the Additional Collector, Ramanathapuram for necessary approvals and implementations to BDOs and Asst. Engineers atthe block level

DETAILS OF DLSC MEETINGS, TIRUVANNAMALAI DISTRICT

FIRST DLSC MEETING

29 Jan 2020

Tiruvannamalai

- Review the water bank work done by the district at GP and block levels
- Build awareness on the concept of WASCA based planning at block and district level officials
- Extend on-line hands-on training for the GIS based planning and execution
- Requested to use the WASCA resource centres services and resources

SECOND DLSC MEETING

22 May 2020

Tiruvannamalai

- Categorization of GPs from type 1 to 5 and its complexities was discussed
- Presentation of model GP Plan (GIS Plan) and Progress of Work
- Climate resilient measures were identified in consultation with local community and GP officials
- Discussion along with district officials were held to implement the CWRM plan

THIRD DLSC MEETING

28 Aug 2020

Tiruvannamalai

Suggested to focus on:

- Building awareness of farmers – water literacy
- Change in the cropping systems to one crop in a season with low water requiring crops to improve the soil quality and reduce the water demand
- Promote adoption of water saving irrigation technologies
- Encourage the cultivation in the field without leaving as fallow
- Need to identify the government land and plantation work
- The employment and livelihood opportunities have to be raised for labour less people.
- Under Public Private sector partnership, need to prepare a framework on why they should invest in Tiruvannamalai
- Requested the team to start the 4 GPs work – based on the CWRM plan by adopting convergence mode.

FOURTH DLSC MEETING

16 Feb 2021

Tiruvannamalai

- The CWRM plans including spatial, non-spatial and Keyhole Markup Language (KML) was completed for all 860 Gram Panchayats and approved
- Using CWRM planning to conserve and recharge water effectively under Mahatma Gandhi NREGS for WASCA totally **5,47,947** number of works has been identified
- All the above works identified in a scientific manner will be added in to shelf of projects (SOP) in every GP. The SOP will be available for GP to implement the works as per the priority and following the guidelines of Mahatma Gandhi NREGA
- Administrative Sanction can be provided to these works following the guidelines of Mahatma Gandhi NREGA
- The meeting approved the activities proposed for the year 2021-22. A total of 5.3 CR persons days are proposed which is duly approved. This covers 1.47 Lakhs works
- To implement WASCA plans, the cooperation and convergence of all line departments is important. Thus all the line dept are requested to provide necessary support at the block level to implement the works using WASCA plans as a base to come together in the areas of sharing the available schemes and technical capacities
- To enhance the Climate Resilient measures following works are discussed and agreed. For technical support GIZ is committed to provide support through MSSRF, Prime Meridian, Tamil Nadu Agricultural University
- The facility created at WASCA Resource Centre and the outputs can be utilized by all district officials at the block as well as other line departments
- The detailed district report (draft) was submitted by GIZ is accepted
- The GP wise and block wise, works and person days will be communicated by the Project Director (PD) DRDA, Tiruvannamalai for necessary approvals and implementations to BDOs and Assistant Engineers at the block level

1.2.4 CONVERGENCE AND JOINT FIELD ASSESSMENTS

To facilitate the joint planning and implementation, convergence among line departments has been promoted at the block and GP levels. The Block Development Office is the coordinating point, under the guidance of Additional Collector / Project Director, all concerned departments jointly discuss and visit the fields based on the inputs from the CWRM plan. To support the discussion, the integration of GP based CWRM plans at block level is initiated, in addition following joint field visits are undertaken

JOINT FIELD VISIT NO 1

19-21 May 2020

Tiruvannamalai

- 860 CWRM GP plan should be completed 30th August 2020
- The CWRM Plans developed under each GP will then be consolidated at block, watershed, catchment (sub-basin) and district levels
- The consolidation process will start from July and complete all the process by mid-October
- During this consolidation process, the financing for the water security from various existing schemes, opportunities for private sector will be identified and action plans derived with active participation of line departments and private sector (facilitated by CII at National and Regional Level)
- Some of the hotspot areas (Greening of hillocks, river rejuvenation, Aquifer and ground water restoration & water use efficiency) were identified for Climate resilient (CR) measures

JOINT FIELD VISIT NO 2

21-23 May 2020

Ramanathapuram

- 429 CWRM GP plan should be completed 30th August 2020
- The CWRM Plans developed under each GP will then be consolidated at block, watershed, catchment (sub-basin) and district levels
- The consolidation process will start from July and complete all the process by mid-October
- During this consolidation process, the financing for the water security from various existing schemes, opportunities for private sector will be identified and action plans derived with active participation of line departments and private sector (facilitated by CII at National and Regional Level)
- Some of the hotspot areas (Afforestation, river rejuvenation, aquifer and ground water restoration & water use efficiency) were identified for climate resilient measures

JOINT FIELD VISIT NO 3

22-23 Oct 2020

Ramanathapuram

- Block level convergence framework was organised with all associated line departments
- Discussion was held and a format was developed
- GP based water works action plan was also shared with them
- All the line departments officials at the block level joined and visited the field to verify the actions and work under convergence with available schemes

JOINT FIELD VISIT NO 4

12-13 Jan 2021

Ramanathapuram

- Field visit with the soil and water conservation expert has been undertaken to identify the appropriate activities under coastal watershed and other dry region of the district
- Interacted with Panchayat officials on the specific water actions necessary keeping the context of climate change
- Visited the fields and assessed the key water challenges and proposed relevant key water actions under each of the three categories - public land, agriculture land and rural infrastructures

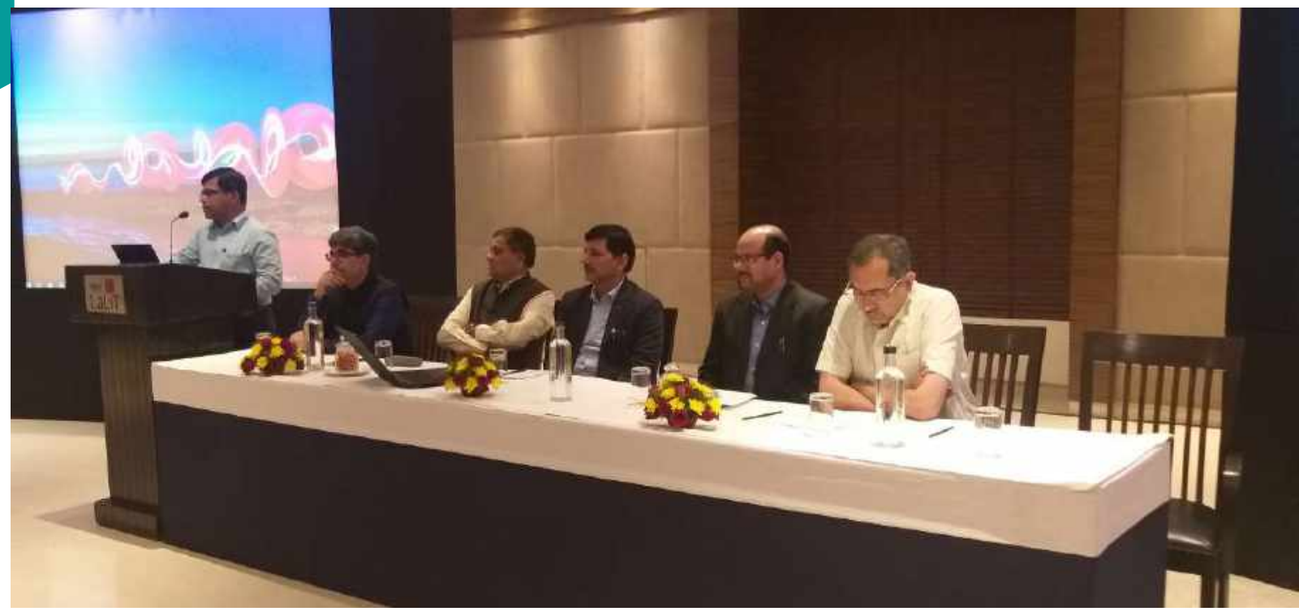
JOINT FIELD VISIT NO 5

16-17 Feb 2021

Tiruvannamalai

- Field visit was carried out to the Greening of Hillocks climate resilient measures and interacted with the officials on the performance of the action
- Visited the few of the soil and water conservation sites - check dams, gabions and percolation tanks
- Field tested the CWRM plan of the Kilpakkam GP in Vandavasi block and interacted with local community as part of verification proces
- Interacted with the village representatives and district officials on the river rejuvenation sites
- Interacted with officials of Department of Agriculture for the Integrated Farming system under convergence mode especially on knowledge side

1.2.5 NATIONAL LEVEL STEERING COMMITTEE



The 1st National Steering Committee (NSC) Meeting for the project 'Water Security and Climate Adaptation in Rural India' (WASCA) was held under the chairpersonship of Joint Secretary (Mahatma Gandhi NREGA) on 23rd July 2020, 4:00 PM through video conferencing. The Mahatma Gandhi NREGA Division, Ministry of Rural Development (MoRD) along with National Water Mission (NWM), Ministry of Jal Shakti (MoJS) and GIZ appraised project partners on the project and its progress. The aim was to seek valuable suggestions and inputs from the stakeholder states and to jointly decide on the future direction of the project. Officers from MoRD, NWM (MoJS), Rural Development Departments in Rajasthan, Uttar Pradesh, Madhya Pradesh, Tamil Nadu and GIZ participated in the meeting.

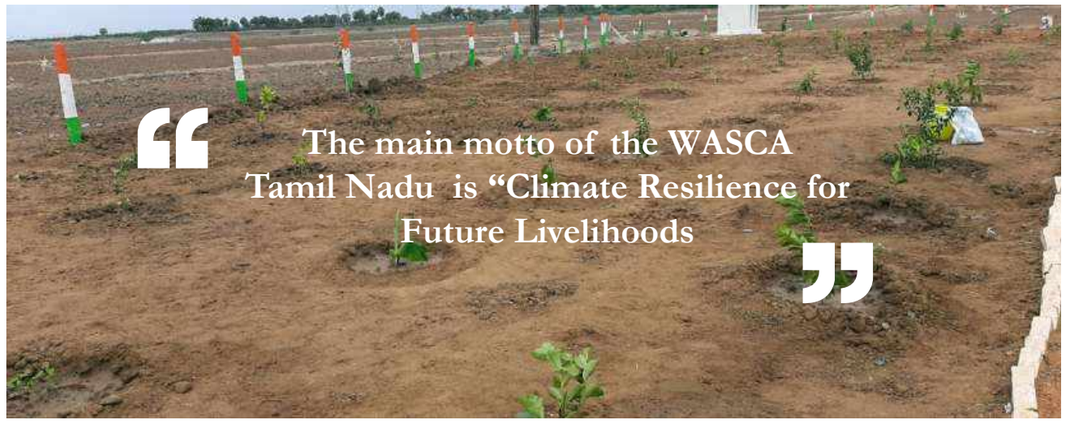
From Tamil Nadu the Additional Chief Secretary, Special secretary, Commissioner RD&PR, District Collectors and State Nodal & District Nodal Officers were participated.

Major Action Points

1. Judicious use of water is as important as water conservation. To take this agenda forward, agriculture and horticulture ministries at national level and the respective departments at state level, may be requested to be associated with the project activities
2. It was noted that participation of the community and the Gram Panchayats needs to be ensured in the CWRM planning processes in states. While there are some challenges due to Covid 19 situation, the states to ensure that CWRM will be taken up for discussion in the upcoming Gram Sabas
3. It was recommended that the baseline data needs to be collected before start of work implementation under CWRM in States. This will help in effectively monitoring the impact of CWRM planning and WASCA on the interventions
4. A provision for monitoring of WASCA progress in the NREGA soft Management Information Systems (MIS) was requested by few states. MoRD confirmed that this is already under discussion and the designing of MIS reports will be done shortly
5. The vertical and horizontal filter for wastewater management in Tamil Nadu was noted as a learning for implementation in Uttar Pradesh
6. Quarterly meetings for regular sharing of project activities and promote learning among the four states will be undertaken by MoRD with support from GIZ

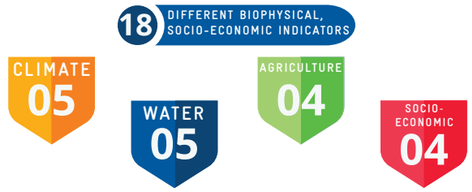
Fig 1.9: Major Action Points of WASCA

1.3 WASCA PROJECT FOCUS IN TAMIL NADU



1.3.1 WASCA-TN- IDENTIFICATION OF PILOT DISTRICTS BASED ON SCOPING STUDY

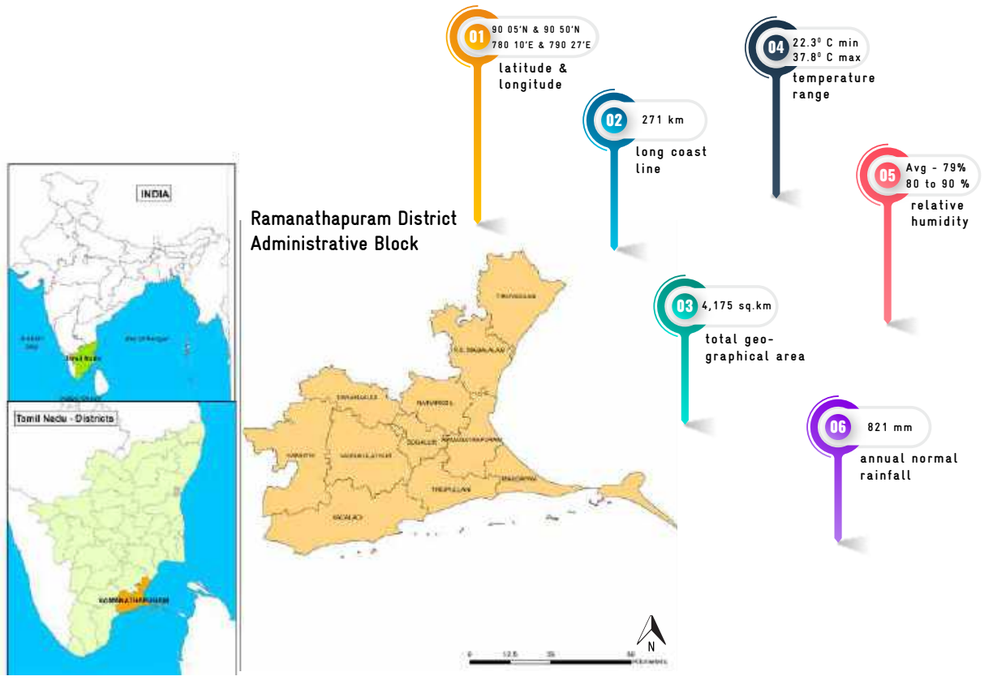
The GIZ conducted a scoping study in Tamil Nadu during July-October 2019, with the technical support of Centre for Climate Change and Disaster Management (CCCDM), Anna University, which studied the State's rural water security through a systematic analysis via availability, accessibility of water and its governance through climate lens at the district scale. At present, the State is one of the water deprived states in India, which is clearly evident from the fast decline in the per capita availability of water in Tamil Nadu and the current per capita water availability is well below the National average of 1,544 cubic meters.



The scoping study used 18 different biophysical, socio-economic indicators under 4 dimensions via climate (5), water (5), agriculture (4) and socio-economic (4) have been composed and categorised into adaptive capacity, sensitivity and exposure indicators for the analysis. Based on the analysis Ramanathapuram and Tiruvannamalai districts were selected for implementing the WASCA. The details are given in Chapter 2 under studies CCCDM, Anna University.

1.3.2 RAMANATHAPURAM DISTRICT

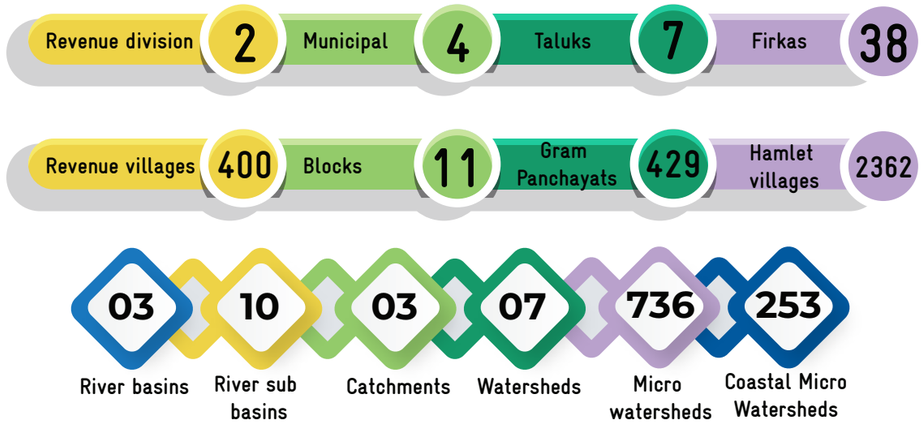
Ramanathapuram is one of the coastal districts in Tamil Nadu where one can find the predominant nature of agriculture in sea-belt. It is located between the latitude of 9^0 05'N and 9^0 50'N and longitude of 78^0 10'E and 79^0 27'E (Map 1.1). It has a long coast line measuring about 271 km, which is one fourth of the coastal length of Tamil Nadu state. The coastline is almost a sandy tract with minimal vegetation.



Map 1.1: Location and block map of Ramanathapuram

The total geographical area of the district is 4,175 sq.km. The district has a hot tropical climate, temperature ranging from 22.30°C as a minimum to 37.80°C as a maximum. The relative humidity is as high as 79% on an average, it ranges between 80 to 90 % in the coastal areas. The annual normal rainfall is 821 mm, in which 60% of rainfall is received during North East Monsoon (October – December) season.

ADMINISTRATIVE UNITS AND WATER RESOURCES IN THE DISTRICT



Sources: District Human Development report 2017; official web site of Ramanathapuram Dist. 2018; District Agricultural Plan Ramanathapuram, 2008, and Census of India 2011.

Fig 1.10 & 1.11: Administrative Units and Water Resources in Ramanathapuram District

The Ramanathapuram district is the most vulnerable district in terms of,

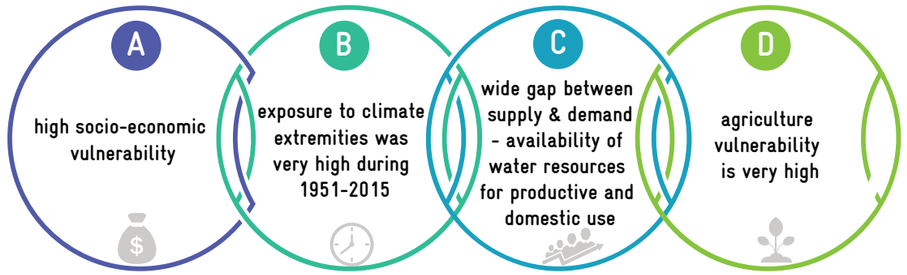


Fig 1.12: Vulnerable Dimensions of Ramanathapuram District

SOCIO-ECONOMIC STATUS: Demographic features of the Ramanathapuram district, as per 2011 census is with the population of 1,353,445 with a sex-ratio of 983 females for every 1,000 males. The district has of 69.60% of the rural population with population density of 331 inhabitants which is lower than the State population density (555) in 2011 census. Scheduled Castes population in the district constitutes 18.4% of its total population. The district has the literacy rate of 80.7%.

CLIMATE: The vulnerability will be further exacerbated under the changing climate scenarios in both mid (2050) and end century (2080). It is projected that there will be an increase in annual rainfall by 2050s and in 2080s it will be +1.0% with respect to baseline (1970-2000) of 821 mm along with sharp increase in both minimum and maximum temperatures.

WATER RESOURCES: According to the CGWB study, 2018-19, on the ground water status, out of 11 blocks one block is under saline category and rest under safe category. The Table 1.2 shows the definition for the different ground water development status in the district.

AGRICULTURE: The net sown area of the district is 1,72,646 Ha (as per 2016-17 G-return) with an average cropping intensity of 100.2%. Of the total cultivated area, 33% is irrigated and remaining 67% is under rain-fed cultivation.

The total operational land holders in the district is 3,93,888, and 82% of them are marginal holders having less than one Ha of agricultural land. Paddy, chillies, millets, cotton and pulses are the predominant crops cultivated in the district.

TABLE 1.2: STATUS OF GROUND WATER DEVELOPMENT ACROSS DIFFERENT BLOCKS IN THE DISTRICT

Sl. No	GW Development Category	Number of blocks	Level of Ground Water Development	Explanation
(1)	(2)	(3)	(4)	(5)
1	Safe	10	0-70%	Areas which have ground water potential for development
2	Semi critical	-	70-90%	Areas where cautious ground water development is recommended
3	Critical	-	90-100%	Areas which need intensive monitoring and evaluation for ground water development
4	Over exploited	-	>100%	Areas where future ground water development is linked with water conservation measures
5	Saline	1	-	Areas where ground water development is recommended for augmenting freshwater table

SAFE	‹ 70%
SEMI CRITICAL	› 70% BUT ‹ 90%
CRITICAL	› 90% BUT ‹ 100%
OVER EXPLOITED	100 & › 100%
SALINE	› 100%

The district has considerable number of water bodies managed by the panchayat as well as the state government (Table 1.3).

TABLE 1.3: AYACUT AREA UNDER DIFFERENT IRRIGATION SOURCE IN THE DISTRICT (HA)

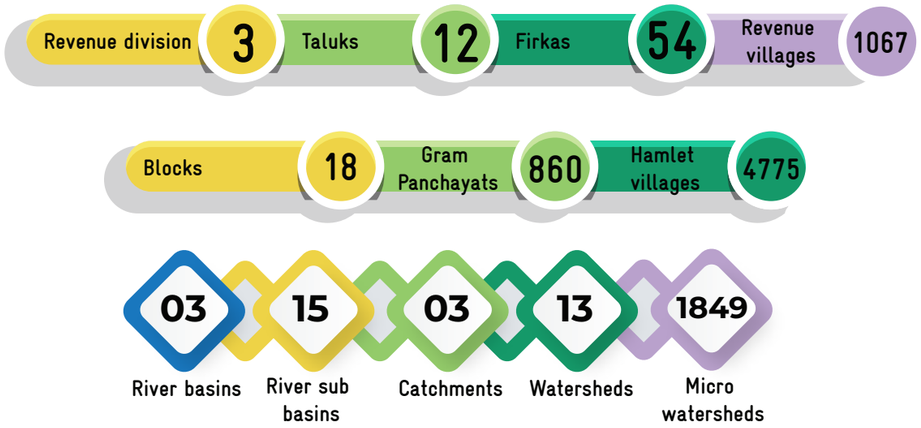
Sl. No.	Block	PWD Tanks	Panchayat Union Tanks	Ex zamin Tanks	Total
(1)	(2)	(3)	(4)	(5)	(6)
1	Ramanathapuram	5180.8	660	102.4	5943.2
2	Thiruppullani	2478.4	784.8	64.8	3328
3	Mandapam	38	–	–	38
4	Paramakudi	5819.6	276.4	1312.8	7408.8
5	Bogalur	3000.4	66.8	632	3699.2
6	Nainarkoil	4198	133.6	914.4	5246
7	Thiruvadanai	5114.8	2049.2	968.8	8132.8
8	R.S. Mangalam	10060	1944	1065.2	13069
9	Kamuthi	3676.4	2454.4	468.8	6599.6
10	Mudukulathur	3740.4	1773.2	53240	6046
11	Kadaladi	7025.6	2352	235.6	9613.2
	Total	**50332**	**12494**	**6297**	**69124**

- Besides, as Ramanathapuram is a coastal district, seawater intrusion is one of the major issues affecting the ground water quality. The ground water in the district is present in both the porous and fissured formations. The aquifer system consists of unconsolidated & semi-consolidated formations and of weathered and fractured crystalline rocks. The ground water levels in the district range from 6 meter to 777 meters below ground level depending upon the type of the formation. The quality of ground water in general is colourless, odourless and slightly alkaline, and total hardness exceeds the permissible limits. So proper water management strategies are to be adopted before using the ground water for drinking, domestic, irrigation and industrial purposes.

1.3.3 TIRUVANNAMALAI DISTRICT

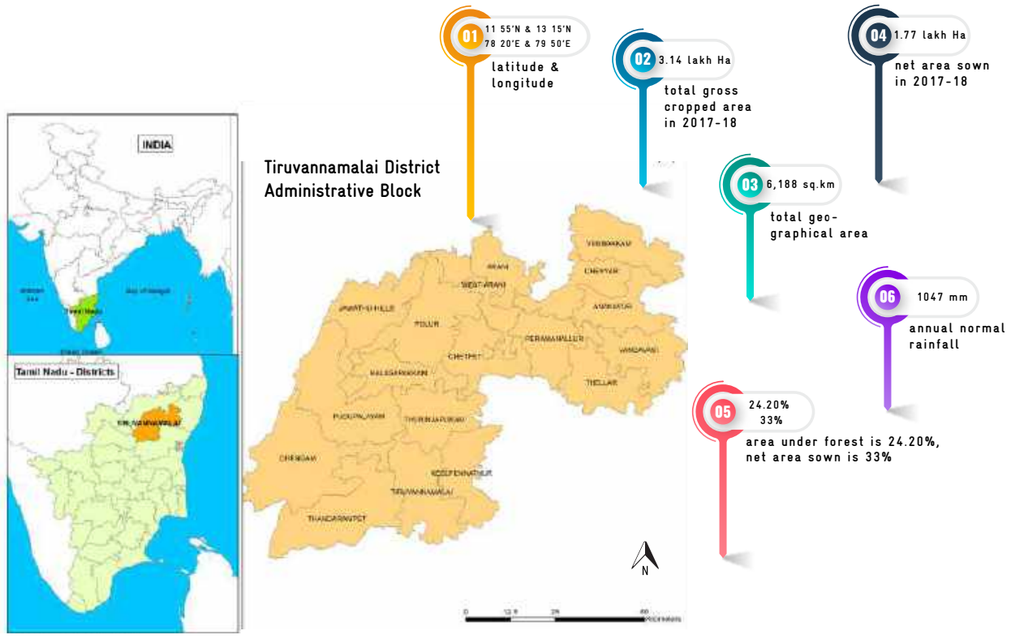
The Tiruvannamalai District geographically lies between 11^0 55' and 13^0 15' North latitude and 78^0 20' to 79^0 50' East longitude. The total geographical area of the district is 6188 sq km (Map 1.2). The total geographical area of the district is 6.31 lakh Ha. The total gross cropped area of the district was 3.14 lakh Ha and net area sown was 1.77 lakh Ha in 2017-18. The area under forest is 24.20% and the net area sown is 33% of the total geographical area. The district has 2,14,243 wells and 1,966 tanks based on the G returns of 2018-19. So far, to improve the sustainability of drinking water resources, 546 check dams, 39 percolation tanks, 9 ooranies, 24 defunct borewell recharge and 30 roof top rainwater harvesting structures were in place in the district . The dominant soil type is red loam followed by black loam in river bed regions of the district. The annual rainfall is 1047 mm and distributed fairly both in SW and NE monsoon season.

ADMINISTRATIVE UNITS AND WATER RESOURCES IN THE DISTRICT



Sources: District Human Development report 2017; official web site of Tiruvannamalai Dist 2018; District Agricultural Plan Tiruvannamalai district, 2008 and Census of India 2011.

Fig 1.13 & 1.14: Administrative Units and Water Resources in Tiruvannamalai District



Map1.2: Location and block map of Tiruvannamalai District

Tiruvannamalai is also the most vulnerable district in terms of,

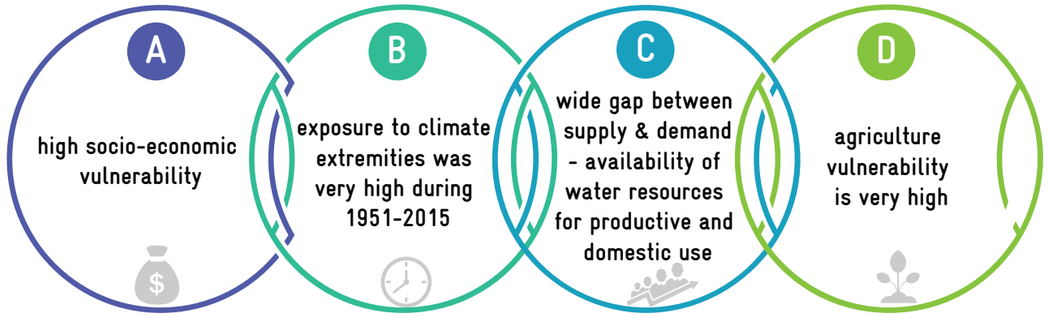


Fig 1.15: Vulnerable Dimensions of Tiruvannamalai District

SOCIO-ECONOMIC STATUS: The total population of the district is 24.64 lakhs (12.35 lakhs male and 12.28 lakhs female), of the total population, 79.9% of its population living in rural and 20.08% in urban region. The average population density is 399 per sq.km. The overall literacy rate of the district is 74.21%, of which 83.11% for male and 65.32% female.

CLIMATE: The vulnerability will be further exacerbated in the changing climate scenarios in both mid (2050) and end century (2080). It is projected that there will be an increase in annual rainfall by 2050s and 2080s it will be +1.0% with respect to baseline (1970-2000) of 821 mm along with sharp increase in both minimum and maximum temperatures.

WATER RESOURCES: According to the CGWB study, 2018-19, on the ground water status, out of 18 blocks, five are semi critical, two are critical, nine are over exploited and remaining two blocks are under safe category. The Table 1.4 shows the definition for the different ground water development status in the district.

AGRICULTURE: The area sown more than once has increased from 0.4 lakh Ha in 2016-17 to 1.06 Ha in 2017-18. Paddy and sugarcane, the high-water requiring crops are the primary crops followed by groundnut, vegetables and flowers. The area under irrigated agriculture is 69% while remaining 31% of the total cultivated area is under rainfed agriculture. The gross area under cultivation is 1,66,289 Ha. and the cropping intensity is 136%.

https://cdn.s3waas.gov.in/s318997733ec258a9fcaf239cc55d53363/uploads/2019/10/2019101872.pdf)
https://www.twadboard.tn.gov.in/content/tiruvannamalai

The area under irrigation supported by

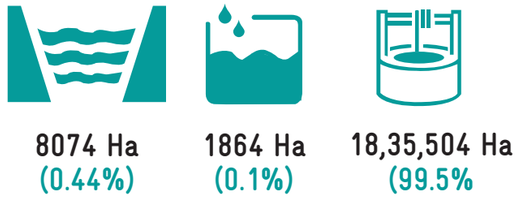


Fig 1.16: Irrigation Facilities in Tiruvannamalai District

The area irrigated more than once is 59,45,580.5 Ha. Due to the large-scale extraction of ground water though wells and Tube wells, the ground water availability is depleting at a faster rate. Majority of the irrigation tanks, which were intensively used for irrigation has now degraded, reduced their storage capacity, water is not used for irrigation fully and require urgent repairs and renovation.

TABLE 1.4: STATUS OF GROUND WATER DEVELOPMENT CATEGORY

Sl.No.	GW Development Category	No of blocks	Level of Ground Water Development	Explanation
(1)	(2)	(3)	(4)	(5)
1	Safe	Thellar and Pernamallur	0-70%	Areas which have ground water potential for development
2	Semi critical	Anakavur, Arni, Chetpet, Cheyyar and Vembakkam	70-90%	Areas where cautious ground water development is recommended
3	Critical	West Arni and Jawadhu hills	90-100%	Areas which need intensive monitoring and evaluation for ground water development
4	Over exploited	Chengam, Kalasapakkam, Kilpenathur, Polur, Pudupalayam, Thandarampattu, Thiruvannamalai, Thurinjipuram, Vandavasi	>100%	Areas where future ground water development is linked with water conservation measures

Source: CGWB Survey, (2017).

SAFE	‹ 70%
SEMI CRITICAL	› 70% BUT ‹ 90%
CRITICAL	› 90% BUT ‹ 100%
OVER EXPLOITED	100 & › 100%
SALINE	› 100%

1.4 APPROACH WASCA – TN

The implementation of WASCA in Tamil Nadu is planned to strengthen its water resources and build context specific climate resilient models to build better resilience under this bilateral support. Effective water management strategies are to be adopted to augment surface and ground water resources in meeting the demands for drinking, domestic uses, irrigation and rural industrial needs. To understand the current status of surface and ground water resources, soil moisture, Evapo-transmission and land management action based studies on the potential for augmentation, conserving soil moisture and Evapo-transpiration for the entire districts are also undertaking alongside with GP level scientific planning using GIS tools.

WASCA TN adopts the following approaches, strategies in planning, facilitating and piloting the interventions:

A) **Scientific Planning**
   (a) Evidence Based Planning: GIS, Hydrology, Statistical data analysis along with socio-economic parameters of the village/ block
   (b) Adopts Ecosystem Based Approach (EBA) for Natural Resources Management and Sustainable Livelihoods: The data analysis as well as planning follows EBA to reduce the vulnerability by building appropriate risk reduction measures, enhance the systems productivity by conserving all forms of natural resources and achieve sustainable livelihoods
   (c) Capacity building of the planners: Building the capacity of the government officials who work at GP level in water budget estimation, use scientific evidence-based inputs for planning water conservation initiatives. The Capacity building focus on:
      a. Treat all four waters with local specific works
      b. Contextualize upon socio-economic needs
      c. Works suitability depending on types of land and soil
      d. Approaches matching to agro-climatic and ecological zones

B) **Nature Based Solutions are considered in identification of works**
   (a) **Blue:** Conservation and enhancement of Four Waters (Rain, Surface, Ground and Soil Moisture)
   (b) **Green:** Nature Based Solutions and vegetative Improvement (on farm, off farm and public and private lands)
   (c) **Grey:** Civil Structures (Earthen and CC) for water storage, re-charge, recycling and conservation

C) **Saturation and Area Based Project Approach for enhancing results, provisions under Mahatma Gandhi NREGA**

- The provision under sub Para (2) of Para 4 of Schedule 1, Mahatma Gandhi NREGA, lays down that, "at least 60% of the works to be taken up in a district in terms of cost shall be for creation of productive assets directly linked to agriculture and allied activities through development of land, water and trees". With the thrust on development of livelihoods, works prioritised in the convergent planning process for individual beneficiaries will be given priority

  In pursuance of Schedule-I of Mahatma Gandhi NREGA, 262 kinds of works/ activities have been identified as permissible works, of which 182 kinds of works relate to NRM alone and out of the 182 NRM works, 85 are water related. 164 of the total works are related to Agri and Agri-Allied works
- The works taken up in Mahatma Gandhi NREGS should change from taking up individual, standalone works in a typical 'relief works mode' to an INRM perspective. Planned and systematic development of land and harnessing of rainwater following watershed principles should become the central focus of Mahatma Gandhi NREGS work across the country to sustainably enhance farm productivity and income of poor people. Even the works on private lands should be taken up following the principles of watershed management in an integrated manner

D) **Community Participation:** Through Gram Sabha organised by Department of Rural Development with the support of government officials at the district and block levels

E) **Convergence:** Convergence at the block and district levels for the Mahatma Gandhi NREGA work implementation along with other line department schemes including Department of Agriculture, Horticulture, Animal Husbandry, Agricultural Engineering, Adi Dravidar and Tribal Welfare etc. Given below the convergence guidelines as mentioned in the Annual Master Circular of Mahatma Gandhi NREGA 2020-21 adopted to bring synergy in technical, financial and other resources

F) **Implementation level:**
   - Integrating water conservation works across various schemes
   - through multi-dimensional measures for packaging works
   - execution and ensuring the stakeholders participation

Box 1: Mahatma Gandhi NREGA Convergence guidelines salient points from Mahatma Gandhi NREGA annual master circular 2020-21

- "Convergence both at State and District level with departments / schemes like agriculture, forest, horticulture, fisheries, sericulture, animal husbandry, FFC / SFC grants to Panchayat, irrigation, minerals, National Rural Livelihoods Mission (NRLM), Pradhan Mantri Awas Yojana (PMAY), Members of Parliament Local Area Development Scheme (MPLADS), Railways, Drinking Water and Sanitation, School education etc.
- There can be two kinds of convergences

  (1) Where the converging department provides its technical know-how to Mahatma Gandhi NREGS

  (2) Where the converging department also provides funds for convergence with Mahatma Gandhi NREGS e.g. AWC buildings
- Even in this case, there are two ways of converging funds. In one method, the converging department can deposit its funds with State Employee Guarantee Fund and complete the works using both the funds. In the second method, the converging department and Mahatma Gandhi NREGS clearly identify the items to be completed by their own funds respectively such that the work can be completed.
- Works identified under convergence plan shall be approved by the competent Panchayat i.e. the Gram Panchayat / Intermediate Panchayat / District Panchayat level, before being included in the Shelf of Projects.
- If the work identified for convergence is to be taken up after the appropriate Panchayat has approved the Annual Action Plan, then such works can be placed before the competent Panchayats for their approval. After such approval, the works will become part of the Annual Action Plan.

G) **Information Education and Communication (IEC)**: At the district level, to promote the common awareness, working in technical cooperation as a team on WASCA project framework, series of virtual and face - face training workshops were organised from January 2020 - December 2021 for facilitating GP level planning, execution of works as per guidance of SLSC and DLSC. Simultaneously to convey the key messages of the project through a communication plan which is jointly evolved by stakeholders of WASCA-TN in line with the key objectives and outputs of WASCA. The communication materials are shared using social media and online platforms to ensure:

- Strengthened knowledge and capacity of public and private institutions, as well as stakeholders at different levels, to plan and implement integrated water resources management
- Collaboration between various government departments and other stakeholders promoted to improve financing of climate adapted water security
- Holistic pilot measures at district/ sub-catchment level in selected districts for successful approaches to be scaled-up at the state and national levels

Fig 1.17: E-Posters- Strategy to build awareness among stakeholders

1.5 TECHNICAL PARTNERS OF WASCA -TN

1.5.1 CENTRE FOR CLIMATE CHANGE & DISASTER MANAGEMENT, ANNA UNIVERSITY

Centre for Climate Change and Disaster Management Anna University, Chennai

The Centre for Climate Change and Disaster Management (CCCDM) was started in 2008 in Anna University marking the occasion of International Decade for Natural Disaster Reduction (IDNDR). The mandate of the Centre for Climate Change and Disaster Management is to bring together all the scientific community, government agencies, National research institutes and other universities with an integrated research programme addressing the national issues on climate change aspects, from its causes to its impacts on community, ecosystems, public health, the built environment and the economy. It evolved as a focal point for a diverse national network of researchers from other universities and major governmental groups. Unlike other disciplines CCCDM promoted multidisciplinary approach integrating various field such as Atmosphere, Water management, Agriculture, Forestry and Biodiversity, Oceanography and Coastal Studies, Geology and Soil Science, Remote Sensing and GIS, Energy, Economics and Social studies.

www.annauniv.edu/cccdm/index.html

1.5.2 M S SWAMINATHAN RESEARCH FOUNDATION

MSSRF
Science for Sustainable Development

The M.S. Swaminathan Research Foundation (MSSRF) was established in 1988 as a non-profit & non-political Trust committed to a mission of harnessing science and technology for environmentally sustainable and socially equitable development. The mission of MSSRF is to link the science with society for sustainable rural development. Since its inception, the Foundation focuses on harnessing science and technology options for rural development through pro-poor, pro-women and pro-nature approach to address the practical problems faced by rural men and women in agriculture, food and nutrition and in technology development and dissemination. While it aims to accelerate the use of modern science, it adopts participatory and anticipatory research for sustainable development to improve lives and livelihoods of tribal and rural communities. These efforts have been undertaken in a participatory manner and in partnership with local communities and other knowledge-based institutions, public and private sector organizations by adopting inter-disciplinary approaches.

The core thematic areas of focus are; Coastal Systems, Biotechnology, Biodiversity, Ecotechnology, Food Security and Information, Education and Communication. Gender, Climate Change and Rural Institutions are the three crosscutting themes across the thematic programme areas. Department of Scientific and Industrial Research (DSIR) of Government of India (GoI) have recognized MSSRF as a scientific institution. It closely works with Depart-

ment of Biotechnology, Ministry of Rural Development and Indian Council of Agricultural Research, Ministry of Agriculture. It has played a major role in developing policies for sustainable development with GOI. At the global level it works with United Nations Development Programme, Food and Agricultural Organization, United Nations Environment Programme, World Food Programme, DFID, World Bank and IFAD are some of the international organizations, which are closely working with MSSRF. MSSRF is also associated with Consultative Group for International Agricultural Research (CGIAR) in evolving policies on sustainable Agriculture and development. More than 20 fulltime research scholars with different discipline backgrounds are pursuing their doctoral research in the institution. MSSRF has been collaborating with research organizations and universities for organizing studies, workshops and seminars for mutual sharing of experiences.

www.mssrf.org/

1.5.3 SUGANTHI DEVADASON MARINE RESEARCH INSTITUTE (SDMRI)

Suganthi Devadason Marine Research Institute (SDMRI) is a Non-Governmental Marine Research and Higher Education organization established in 1998 at Tuticorin, Tamil Nadu, India. The institute was recognized in 2000 by the Manonmaniam Sundaranar University of Government of Tamil Nadu as Research Centre for Marine Science leading to Ph.D. programme in Marine Science. Later in 2002, the University Grants Commission of Government of India accorded recognition to the institute. Recently in 2019, the Department of Scientific and Industrial Research of Ministry of Science and Technology, Government of India, recognized SDMRI as Scientific and Industrial Research Organization. SDMRI is one of the five research institutions identified by the Government of India for environmental monitoring of the Sethusamuthiram Ship Canal Project in 2005. SDMRI is an institution identified by the Tamil Nadu State Coastal Zone Management Authority for Coastal Baseline Studies and Monitoring including Marine Water and Sediment Quality; Heavy Metals in Organisms; Fish Catch; Underwater Survey and Monitoring of Corals, Seagrass Beds and associated Fauna, Flora and Fish Population.

SDMRI's research works are multidisciplinary in nature with the primary focus on the following. Conservation and management of coastal and marine ecosystems (Survey, assessment, baseline data collection and creating spatial database using GIS); Survey and monitoring of endangered / threatened species (Coral reefs (shallow and deep water), reef associated fishes, dugong, sea turtles, sea horses, and mollusks); Coastal ecosystem rehabilitation (Coral rehabilitation, Deployment of Artificial reefs, Seagrass rehabilitation); Coastal ecosystem monitoring (Coral reef and seagrass ecosystems – Distribution, diversity, threats, status and health; reef resilience; Assessment and monitoring of coral disease prevalence; Coral reproduction and larval recruitment; and reef fish spawning aggregations – species, season and habitats); Changes in island morphology through surveying and mapping, protection of island through artificial reefs and coastal habitat rehabilitation; Pollution Monitoring (Heavy metals, pesticides, microbial and marine debris including macro-, meso- and microplastics); Assessment of seawater intrusion in the freshwater resources through vulnerability mapping and assessment; Climate change impacts on coastal habitats, associated biodiversity and adaptation measures; and imparting Awareness and Capacity Building to the stakeholders.

www.sdmri.in/

1.5.4 PRIME MERIDIAN

The Prime Meridian (PM) has good reputation in India of being economically priced, punctual in completing tasks and work of high quality in all survey and mapping work allotted to us with a qualified team of work force. The Agency is in this field of survey such as carrying out Topographic survey using UAV, DGPS, Total Station, Digital level, preparation of Land Plan Schedule, Geo technical Investigation, Ground and Surface Water Analysis and GIS Mapping for the past 26 years. Agency has a good strength of personnel to cater the needs of survey and consulting services across the country. PM has developed procedures and techniques to incorporate the latest technologies and best available information into the surveying and process of mapping utilities. It uses the most modern technology to offer a highly professional range of services. It provides the answer to your search for a total mapping package. The PM Agency has completed survey & mapping for more than 8.00 lakh hectares, 60,000 kms and these surveys include cadastral, land, engineering, route and other surveys for state, central govt, PSUs, ADB, MNCs etc.

1.5.5 ADVISORS

The WASCA programme is supported by a cadre of Key experts who has been pioneer in subject knowledge and contributed to the relevant national and international policies. They have been guiding the field team in conceptualising the context based resilient measures based on the key climate risks and vulnerabilities. Also, in the process of implementation, they interact with the team by regularly observing the progress and extending need based inputs for its continuous improvement. The profile of such advisors representing different disciplines will be collected and organised in to database for further support to the district team.

TABLE 1.5: NAME OF THE EXPERTS SUPPORTING WASCA -CRM INITIATIVES

No	Name	Expertise
1	Dr K Palanisamy	Cascade Tank & Water Management, Climate Adaptation & Finance
2	Mr B Lakshmikantham IFS (Rtd)	Forestry & Nursery Raising
3	Dr A Balasubramanian	Agro Forestry
4	Dr Shanmugasundaram	Horticulture
5	Dr Panneerselvam	Water Management
6	Dr Vinod	Sand Dune Management
7	Dr S Ramasubramanian	Coastal Resources
8	Dr S Manivannan	Soil and Water Conservation

1.5.6 CONFEDERATION OF INDIAN INDUSTRY

As promoting partnership with private sectors is one of the key objectives of the WASCA programme, strategies and actions are identified to establish under Corporate Social Responsibility.

WASCA has established an MoU with CII, an industry-led organisation, playing a proactive role in enhancing the industrial participation in sustainable development processes as well as improving policy advocacy for private sector participation at national and international platforms. WASCA collaborates with CII for improving their access and liasoning with key water sector industries in the project location, and additionally to do joint research, knowledge creation and policy advocacy for strengthening public-private partnerships for water security. WASCA and CII organised an online national consultation workshop with the Government and private stakeholders on 03 September 2020, to provide an overview of the project objectives and activities to discuss with the stakeholders about potential way forward. WASCA along with CII will working together in establishing public-private partnership models in the project states for convergent implementation of CWRM activities and other activities related to improving water security and climate adaptation.

CHAPTER 2

ACTION RESEARCH STUDIES ON WATER AND CLIMATE

To implement the WASCA objectives in the Tamil Nadu, district specific studies were undertaken to help designing of interventions, strengthening the framework for CWRM planning, inclusion of assessments ground water parameters, providing technical data on four waters. These studies are identified during the interaction's with key stakeholders, Department of Rural Development & National Water Mission and recommendations of SLSC meetings. The studies are all aligned to WASCA parameters laid down and approved by SLSC and the principles of IWRM.

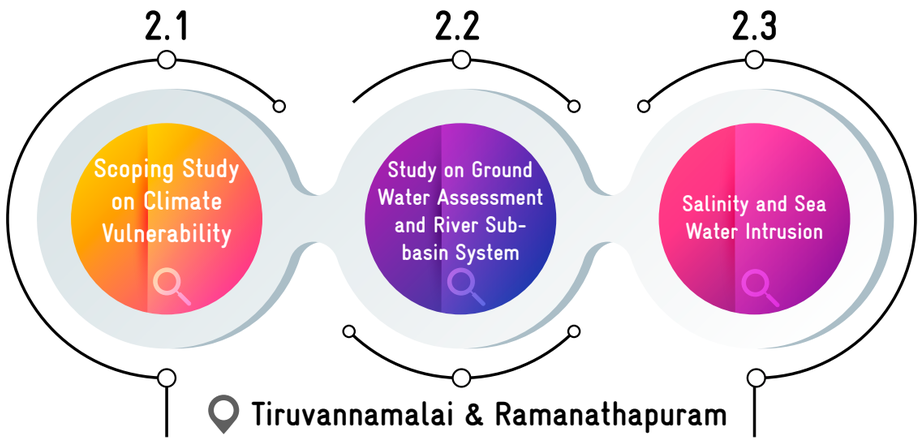


Fig 2.1: Details of Action Research Studies on Climate and Water

2.1 SCOPING STUDY FOR WATER SECURITY AND CLIMATE ADAPTATION

2.1.1.STUDY BACKGROUND

It is an undeniable fact that the world's climate is changing. The fluctuating rainfall patterns, extreme rainfall and temperatures are creating shorter rainy seasons and longer dry seasons. These shifts have severe impact on natural resources such as water resources, agriculture, coastal, forest, biodiversity, livelihoods of rural poor.

The availability of water is an essential component for ecosystems and affects many of mankind's social and economic actions. Hence, water security is one of the major challenges that the society faces today at both global and local level. Water security and climate change are cross-cutting issues of recent global agreements, such as the Sustainable Development Goals and the Paris Agreement on Climate Change. **The UN Water** (United Nation's inter-agency coordination mechanism for all water-related issues) defined **water security** as **"the capacity of a population to safeguard sustainable access to adequate quantities of andacceptable quality water for sustaining livelihoods, human well-being, and socio-economic development for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability".**

The availability and access to water are the pre-eminent issues affecting global economic development, in particular, livelihoods of the poor as they often suffer the most when resources are scarce. **India is not isolated from these drivers, with water security emerging as an issue of extreme urgency for the country.**

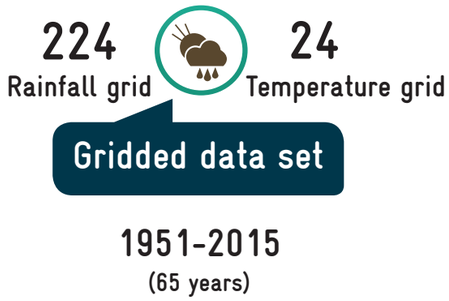
2.1.2. STUDY METHODOLOGY & CLIMATE INDICATORS FOR WASCA - TN

The assessment used in the scoping study started with an analysis of basin-wise surface and ground water resources:basin-wise (Except Cauvery Basin) water availability, analysis of basin and its potential, ground water extraction, changes in land use, irrigation and cropping patterns, land holdings and sectoral demand and gap. The current and future climate change scenarios were assessed using high resolution Indian Meteorological Department (IMD) gridded data and Coordinated Regional Climate Downscaling Experiment (CORDEX) Asia's global climate model data. The significant increase in maximum and minimum temperature hadbeen observed in the past during 1951- 2015 and under future climate change scenarios till 2100. Later, the district-wise cumulative vulnerability index was derived using IPCC protocol in order to identify the vulnerable districts in terms of water security enabling possible interventions.

2.1.3 CLIMATE PROJECTIONS OF STATE AND DISTRICT

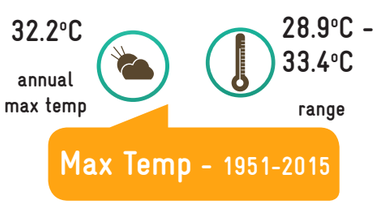
Observed ClimateVariability

The high resolution gridded temperature (1°× 1°) and rainfall data (0.25°× 0.25°) were used to calculate the observed climate change over the period 1951- 2015



(65 years) (Rajeevan et al., 2006). In total, 224 rainfall and 24 temperature grids covering entire state were extracted from IMD gridded data set and analysed. District wise annual rainfall and temperature mean values were calculated for the period 1951-2015 and its trends were also projected.

Mean Maximum temperature and its changes during 1951-2015



The annual maximum temperature for Tamil Nadu was 32.2°C with a range varying from 28.9°C to 33.4°C. Among the districts, the highest value of annual maximum temperature (33.3°C) were observed in Chennai and Kancheepuram districts followed by Thiruvallur (33.2°C) and Villupuram, Trichirappalli, Cuddalore, Perambalur, Nagapattinam, Pudukottai, Thiruvarur, Ariyalur districts (32.1°C). While the lowest value (29.8°C) were observed in The Nilgiris and the average maximum temperature in Coimbatore district is 29.7°C. Increasing trend of maximum temperature has also been observed in all districts. Even though the maximum temperature in north-east coastal districts is high, change in temperature is more in the middle and southern coastal districts such as Thiruvarur, Thanjavur, Nagapattinam, Ramanathapuram, Pudukkottai, Thirunelveli, Thoothukkudi, Sivagangai, Virudhunagar, Kanyakumari and Madurai (Figure 2.2).

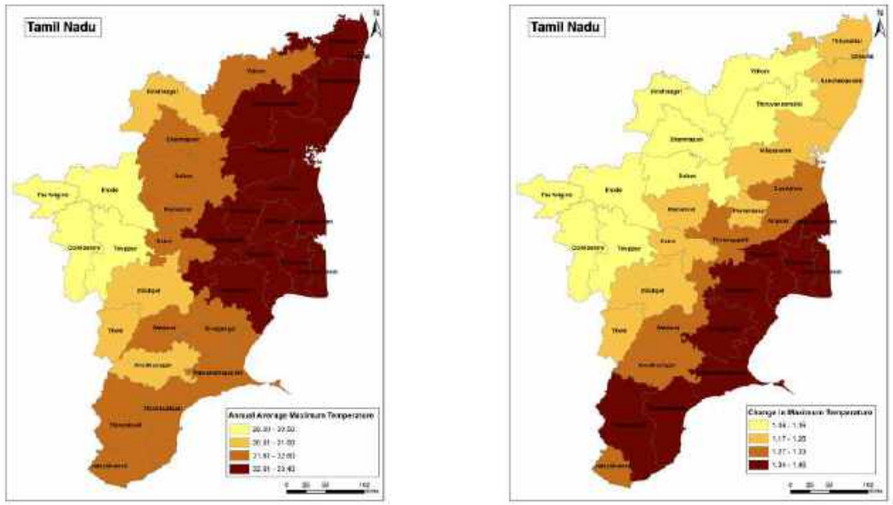
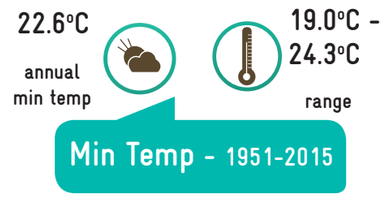


Fig 2.2: District wise a) Annual mean maximum temperature and b) Changes in maximum temperature during 1951-2015

The average annual minimum temperature for Tamil Nadu was 22.6°C with a range varying from 19.0°C to 24.3°C (Figure 2.3 a). The night time temperature was highest in Thiruvarur (24.3°C) district, followed by Nagapattinam, Cuddalore (24.1°C), Thanjavur (24°C) districts, while the lowest values were observed in the



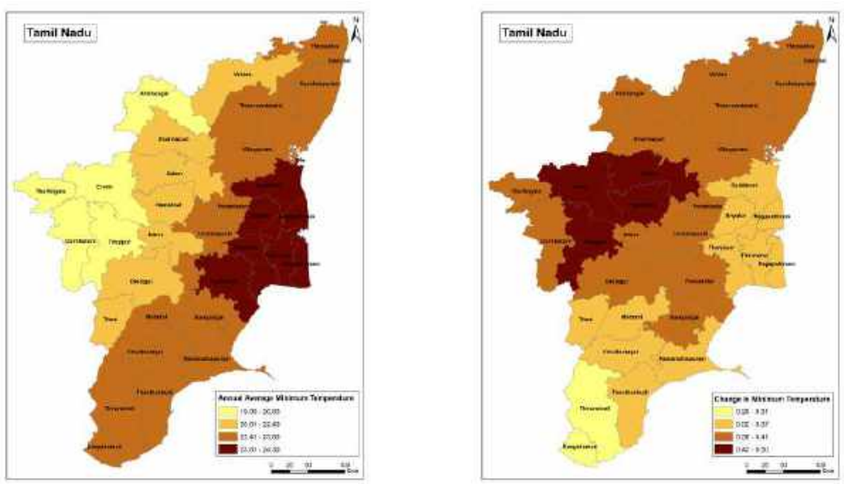
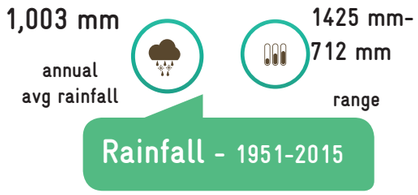


Fig 2.3: District wise a) Annual mean minimum temperature and b) Changes in minimum temperature during 1951-2015

Nilgiris district. Ariyalur, Pudukkottai, Kanyakumari, Chennai, Thoothukkudi, Kancheepuram, Ramanathapuram, Sivagangai, Vilupuram, Trichirappalli, Perambalur, Thirunelveli, Thiruvallur, Tiruvannamalai, Virudhunagar, Madurai, Karur, Vellore and Namakkal were in the range of 23.9°C to 22.1°C. The moderate temperature ranges (21°C to 22°C) were observed at Theni, Dindigul, Salem, Namakkal and Dharmapuri districts. Krishnagiri, Tiruppur, Coimbatore and Erode districts showed the lowest range from 20.6°C to 19.8°C. The Nilgiris district had an average night temperature of 19°C. Though interior districts average night time temperature was lower as compared to other districts, the change in minimum temperature was high in central-west districts such as Erode, Namakkal, Tiruppur, Salem, Dindigul, Tiruvannamalai and Krishnagiri (Figure 2.3 b).

Annual Average rainfall during 1951-2015

The average annual rainfall in Tamil Nadu during the period 1951-2015 was 1,003 mm that ranged between 1425mm to 712 mm (Figure 2.4 a). The Nilgiris, Nagapattinam, Chennai, Thiruvarur, Cuddalore, Kancheepuram, Thiruvallur, Coimbatore, Thanjavur Kanyakumari districts received an average of above 1,000 mm rainfall during the past 65 years. Perambalur, Vellore, Pudukkottai, Theni, Salem and Dharmapuri districts received rainfall between 900 to 1000 mm.



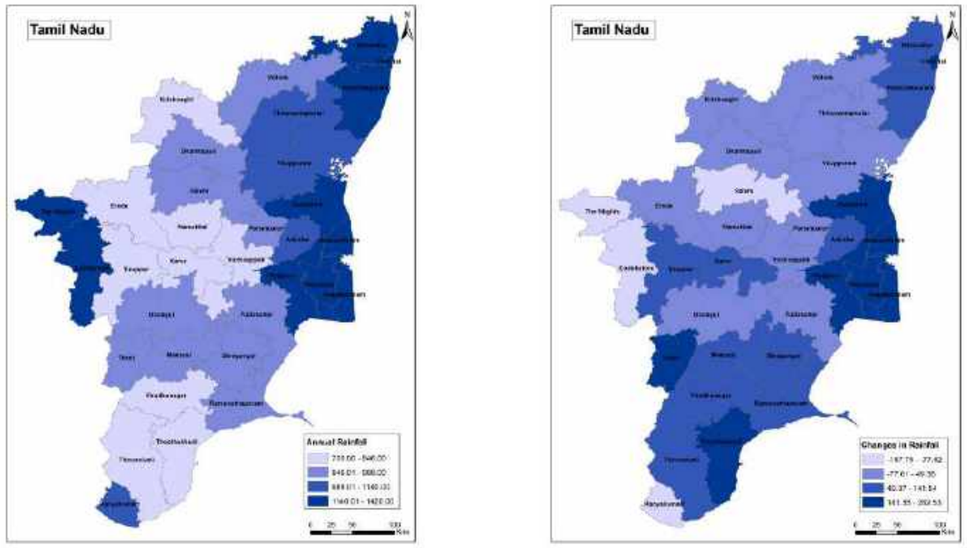


Fig 2.4: District wise a) Annual average rainfall b) Rainfall changes during 1951-2015

Madurai, Sivagangai, Trichirappalli, Dindigul, Ramanathapuram, Krishnagiri, Thirunelveli, Virudhunagar, Erode, Namakkal, and Tiruppur districts received 800-900 mm rainfall. Karur and Thoothukkudi districts received rainfall below 800mm. Rainfall in Vilupuram, Trichirappalli, Dharmapuri, Namakkal, Salem, Kanyakumari, The Nilgiris and Coimbatore districts were on a decreasing trend (-4 to -185mm). Increased rainfall wasobserved in Nagapattinam, Thanjavur, Chennai, Thiruvarur, Cuddalore, Thoothukkudi and Theni Districts, in the range of 150-260mm (Figure 2.4 b).

District-wise future climate change scenario data were downloaded from GIZ's climate vulnerability portal 'http://climatevulnerability.in/'. 10 GCMs from CORDEX domain under RCP 4.5 (moderate emission scenario) and 8.5 (high emission scenario) scenario for mid-century (MC) (2040-70) and end century periods (EC) (2070-2100) were considered. The mutli model ensemble mean for 10 GCMs were used in future climate projection for the state of Tamil Nadu. The downloaded data were analysed and spatially mapped using Arc GIS.

Temperature projections

Ensemble mean of the CORDEX South Asia climate data for IPCC AR5 RCP 4.5 and RCP 8.5 scenarios for districts of Tamil Nadu area were analysed to understand the changes in the annual maximum and minimum temperature. The average annual maximum temperature for IPCC AR5 RCP 4.5 scenario was projected to increase by about 0.9°C towards mid-century and by 1.3°C towards end-century (EC). While for IPCC AR5 RCP 8.5 scenario, it was projected to increase by about 1.4°C towards mid-century (MC) and 3.4°C towards EC for Tamil Nadu. The projected temperature increase is higher in end- century than mid-century. Figure 2.5 shows change in annual maximum temperature towards mid-century (MC) and end-century (EC) with respect to baseline (BL) under IPCC AR5 RCP 4.5 scenarios.

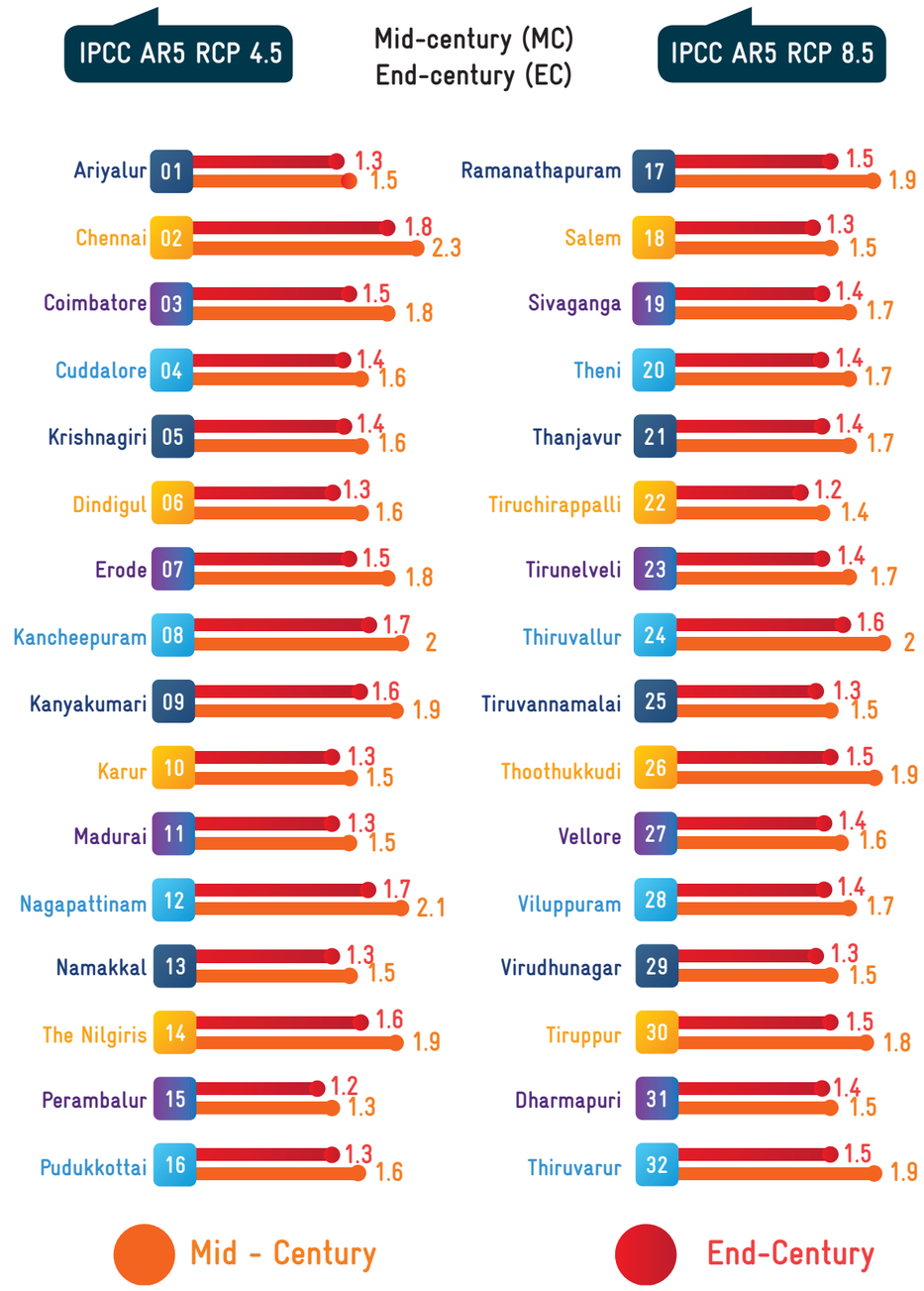


Fig 2.5: Projected changes in Maximum Temperature for MC and EC periods from BL under IPCC AR5 RCP 4.5scenario

The projected increase in maximum temperature towards MC varies from 1°C to 1.6°C and 1.2°C to 1.8°C for EC period under IPCC AR5 RCP 4.5 scenario. The projected increase in maximum temperature varies from 1.3°C to 2.3°C for MC period while the same varies from 3.0°C to 4.6°C towards EC period for IPCC AR5 RCP 8.5. For both IPCC AR5 RCP 4.5 and RCP 8.5 scenarios, increase in annual maximum temperature is projected for Tamil Nadu and its districts towards MC and EC. However, IPCC AR5 RCP 8.5 scenario shows higher increase than that of IPCC AR5 RCP 4.5 scenario.

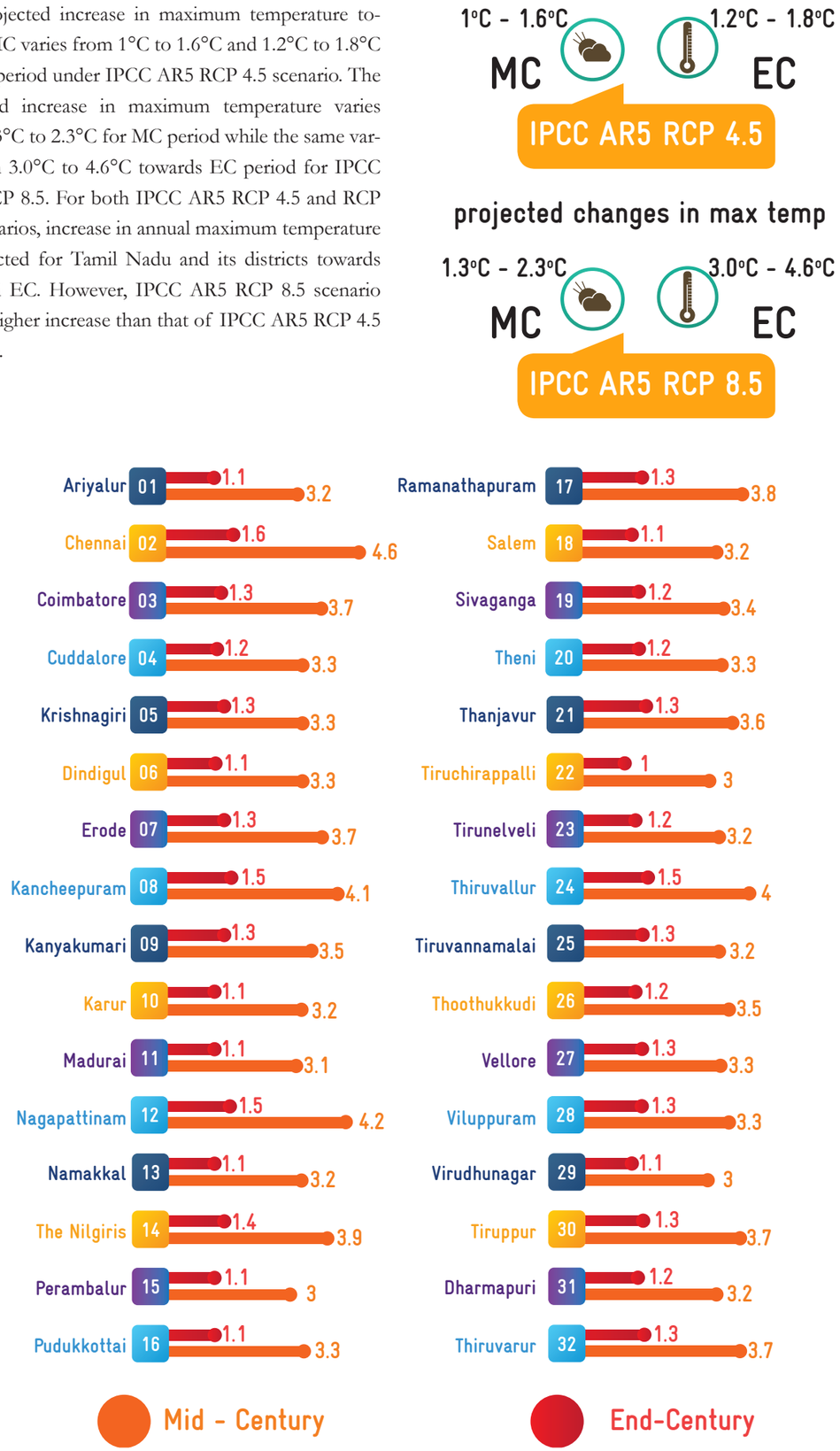


Fig 2.6: Projected changes in maximum temperature for MC and EC period from BL under IPCC AR5 RCP 8.5 scenario

The average annual minimum temperature for IPCC AR5 RCP 4.5 scenario was projected to increase by about 1.2°C towards mid-century and 2.8°C towards end- century. While for IPCC AR5 RCP 8.5 scenario, it was projected to increase by about 1.2°C towards mid-century and 3.4°C towards EC for Tamil Nadu. The projected temperature increase is higher in end-century than mid-century. Figure 2.7 shows change in annual minimum temperature towards MC and EC with respect to BL under IPCC AR5 RCP 4.5 scenarios. The projected increase in maximum temperature towards MC varies from 1°C to 1.4°C and 1.8°C to 2.5°C for EC period under IPCC AR5 RCP 4.5 scenario.

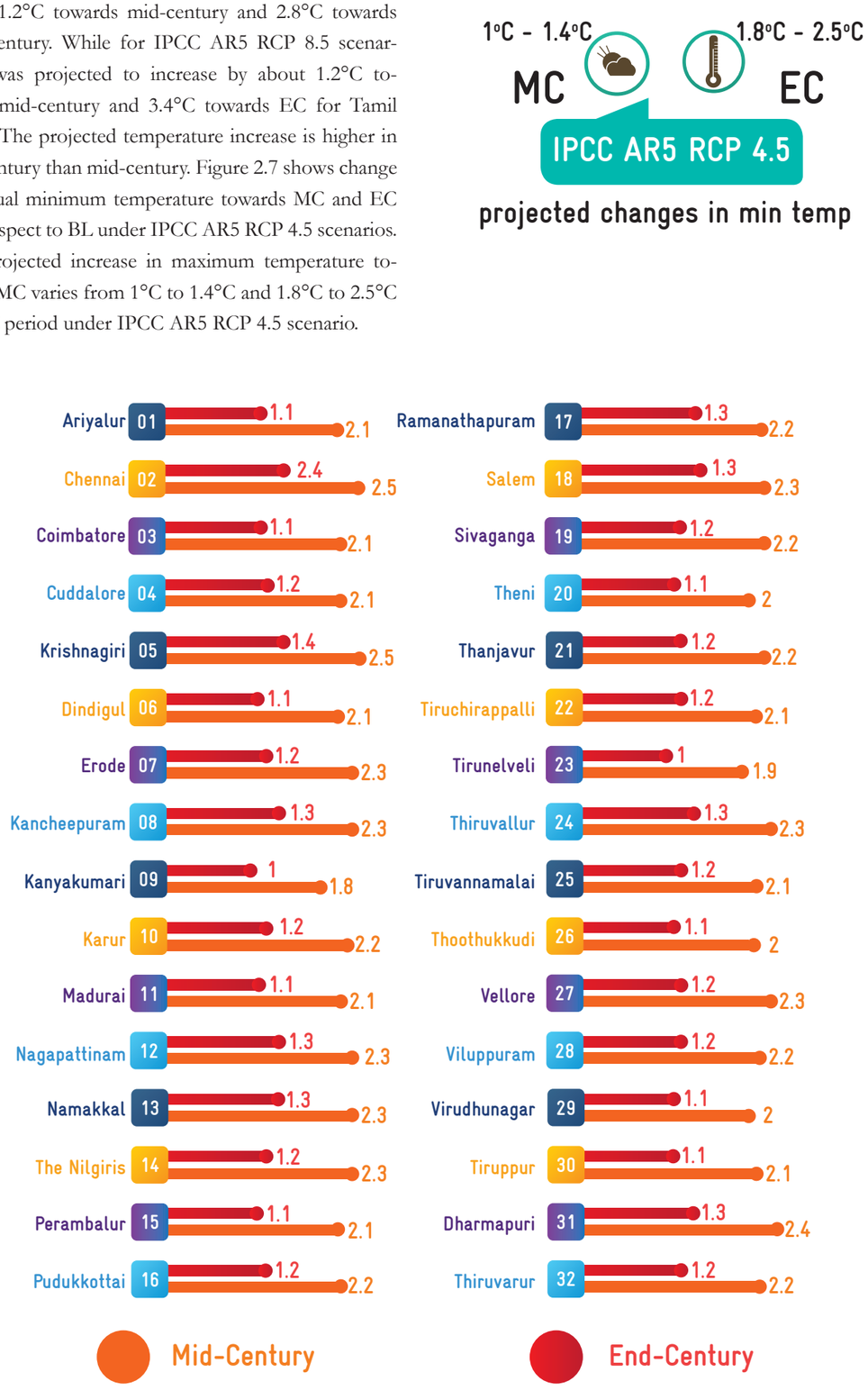
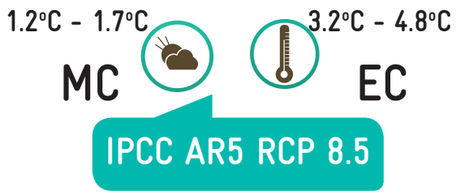


Fig 2.7: Projected changes in minimum temperature for MC and EC periods from BL under IPCC AR5 RCP4.5 scenario

The projected increase in minimum temperature varies from 1.2°C to 1.7°C for MC period while the same varies from 3.2°C to 4.8°C towards EC period for IPCC AR5 RCP 8.5. For both IPCC AR5 RCP 4.5 and RCP 8.5 scenarios, increase in annual maximum temperature is projected for Tamil Nadu and its districts towards MC and EC. However, IPCC AR5 RCP8.5 scenario shows higher increase than that of IPCC AR5 RCP 4.5 scenario. The Chennai, Krishnagiri and Dharmapuri districts show high increase in minimum temperature. Figure 2.9 represents spatial representation of changes in maximum, minimum temperature and rainfall for MC period under RCP 4.5 scenario.



projected changes in min temp

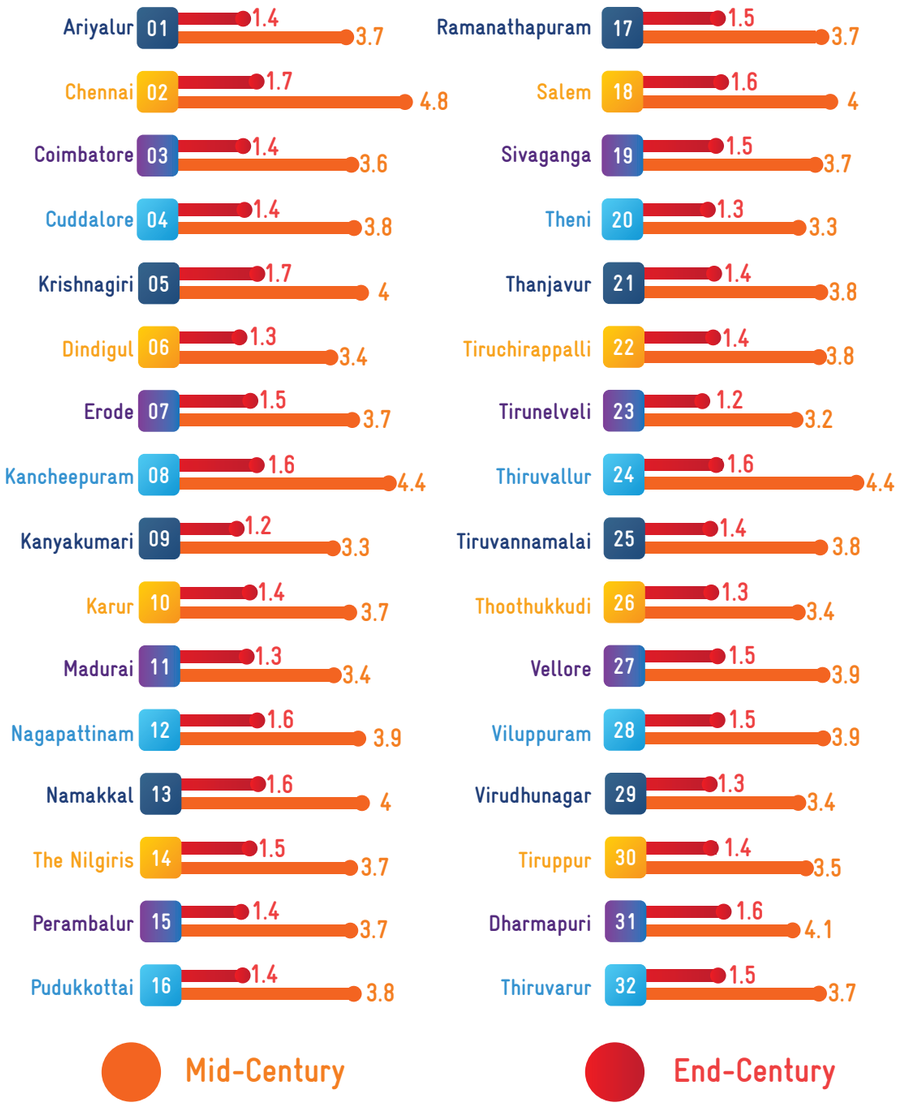
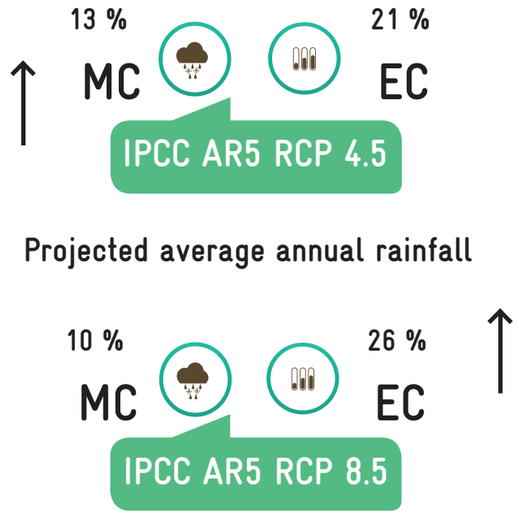
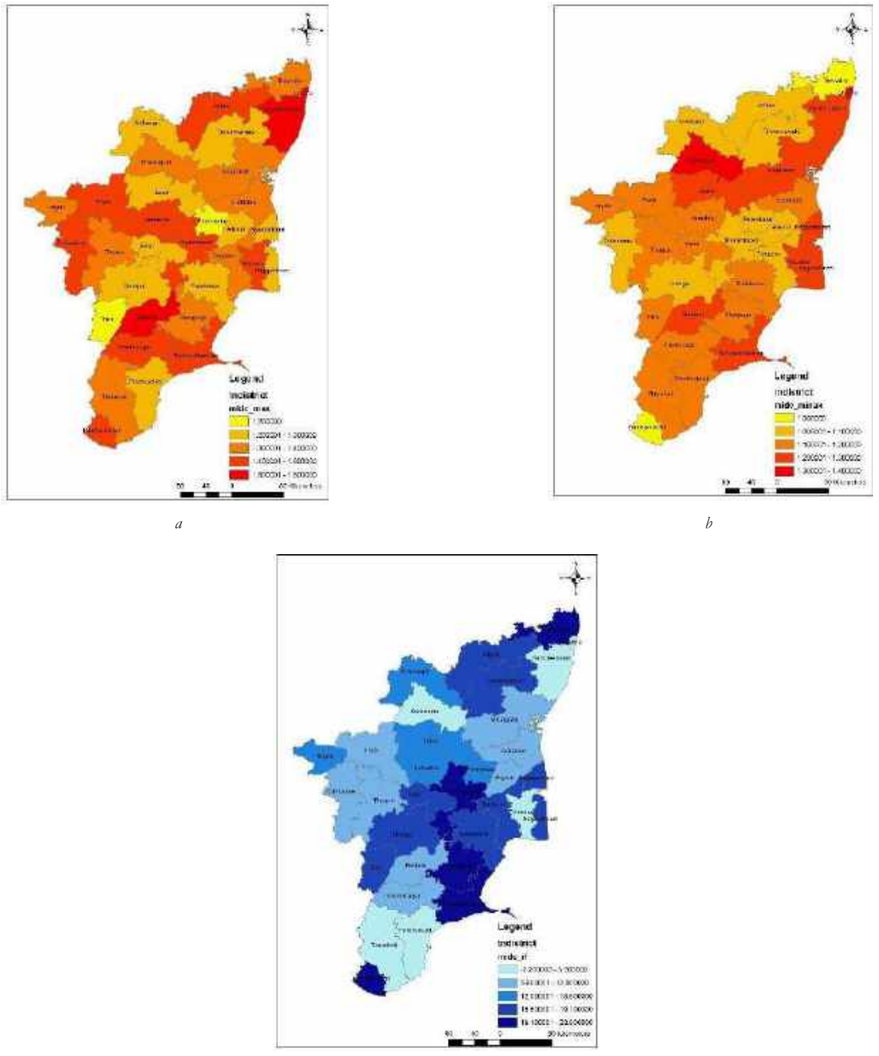


Fig 2.8: Projected changes in minimum temperature for MC and EC periods from BL under IPCC AR5 RCP 8.5 scenario

Rainfall Projections

Figure 2.10 shows projected change in annual rainfall towards MC and EC with respect to BL under IPCC AR5 RCP4.5 scenarios. Average annual rainfall for IPCC AR5 RCP4.5 scenario is projected to increase about 13 per cent towards mid-century and increase by about 21 per cent towards end-century period. While spatial variability of rainfall is observed between districts, for IPCC AR5 RCP8.5 scenario, it is projected to increase marginally by about 10 per cent towards mid-century and 26 percent towards end-century for the state. The percentage of the projected rainfall increase is high in EC and MC, and EC under both RCP climate scenarios.





a *b* *c*

Fig 2.9: Future climate projections under IPCC AR5 RCP 4.5 scenario a) Maximum temperature b) Minimum temperature c) Annual rainfall

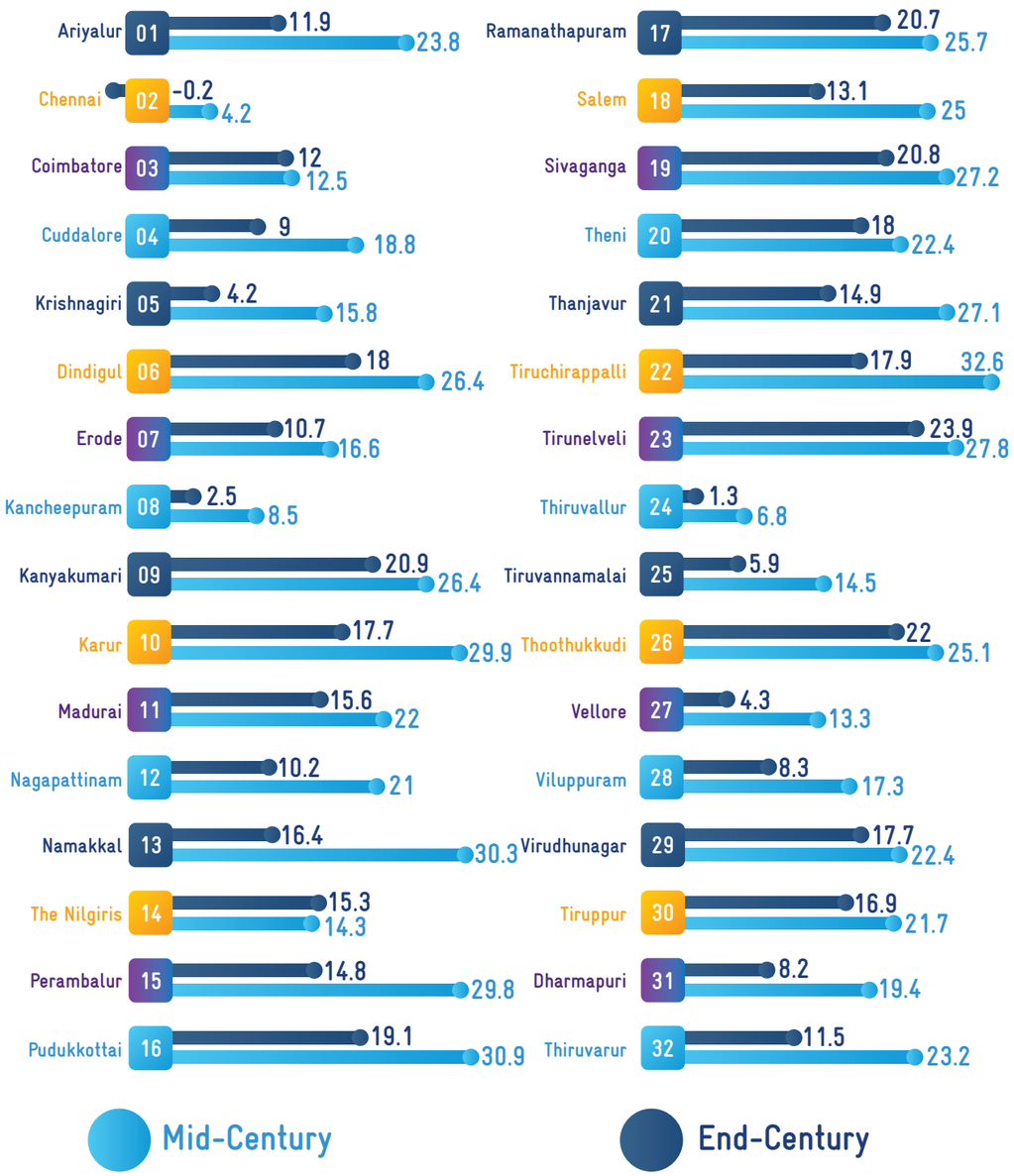


Fig 2.10: Projected changes in Rainfall for MC and EC periods from BL under IPCCAR5 RCP 4.5scenario

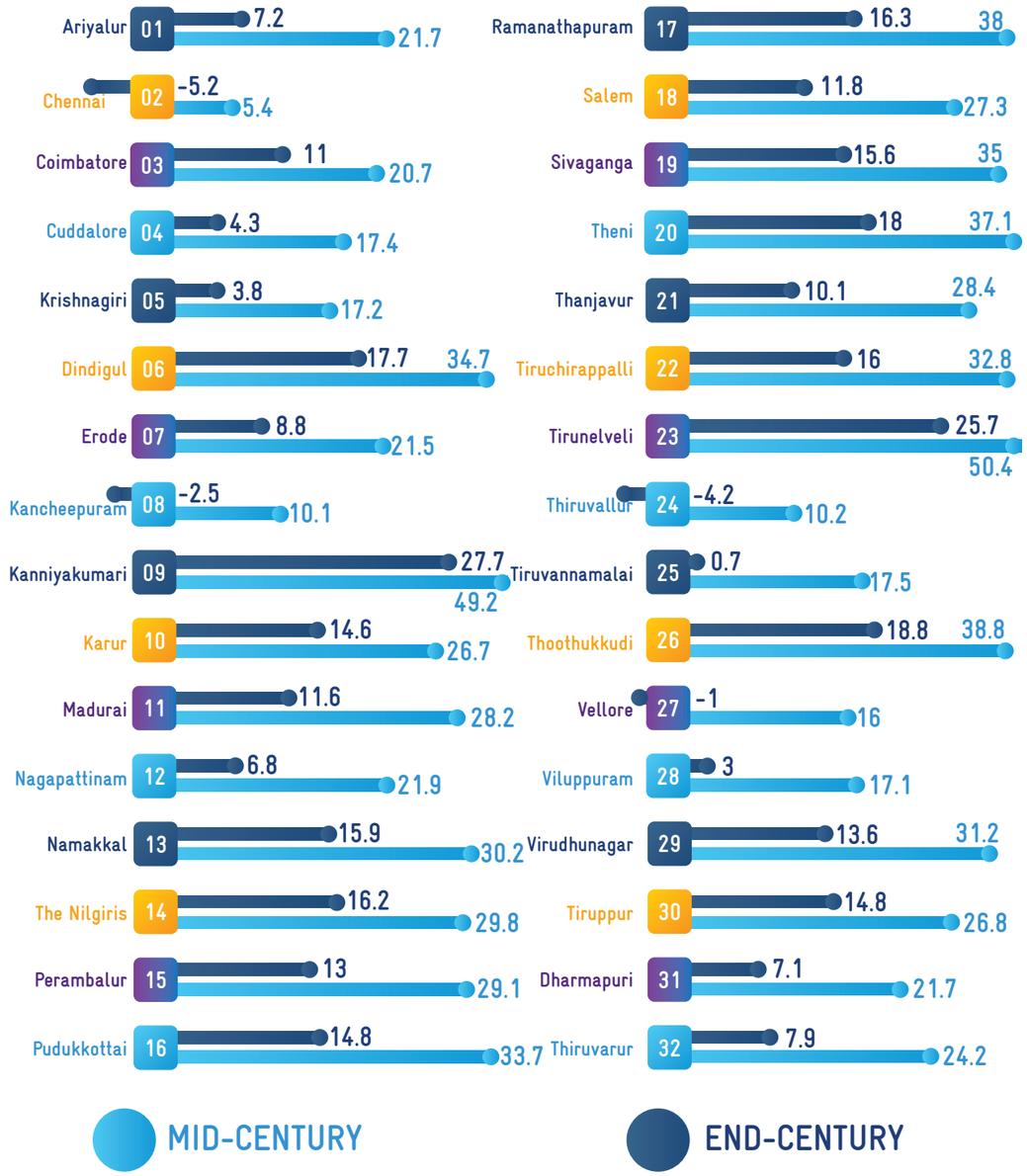


Fig 2.11: Projected changes in Rainfall for MC and EC periods from BL under IPCCAR5 RCP 8.5scenario

The districts in the central part of Tamil Nadu namely, Perambalur, Karur, Namakkal, Pudukkottai and Tiruchirappalli show highest projected increase in rainfall as compared to the other districts towards EC period with respect to BL period. Chennai district shows decrease in annual rainfall towards MC with respect to BL for IPCC AR5 RCP4.5 scenario. Chennai, Kancheepuram and Thiruvallur districts show decrease in rainfall under RCP 8.5 scenario. The observed and projected changes in climate will have serious impacts on thestate's are in the areas of:

(1) Soil moisture, (2) Evapotranspiration, (3) Riverflow, (4) Water availability and (5) Water quality.

The changes in climate and alteration in monsoon patterns as captured by the analysis will lead to threats such as increasing water demand for irrigation domestic and industrial purposes and lowering water table. The salinity would increase due to seawater intrusion. Hydro-electric power generation would also be affected, Delta Levees will be affected due to sea level rise. On the whole, climate change induced water-related issues will affect habitats and its sustainability.

Indicators used in the Assessment

The primary and secondary data collected from authorized sources are carefully analysed and overall, 18 indicators (climate, water, agriculture and socio economic) that reflect/influence state's rural water security through four interconnected areas namely, climate extremities, water resources, agriculture and socio-economic are selected to assess climate vulnerability (Table 2.1). These data are normalised, aggregated and composite vulnerability index (CVI) values are calculated using a robust statistical tool.

TABLE 2.1: LIST OF BIOPHYSICAL AND SOCIO-ECONOMIC INDICATORS USED IN VULNERABILITY ASSESSMENT - WASCA-TN

S NO	Climate Vulnerability Area for WASCA	WASCA Climate Vulnerability Indicators	Climate Vulnerability Indicator	Unit for Assessment
1	2	3	4	5
1	Climate	Changes in maxT	C1	Degree Celsius
2		Changes in minT	C2	Degree Celsius
3		Changes in RF	C3	%
4		Excess rainfall years	C4	No. of Years
5	Water Resource	Deficient rainfall years	W1	No. of Years
6		Ground water extraction	W2	%
7		Ground water recharge	W3	in cubic meter
8		Surface water availability	W4	mm
9		Water gap	W5	MCM
10		% of contamination	W6	%
11	Agriculture	Rainfed area	A1	%
12		Cropping intensity	A2	%
13		Soil moisture	A3	kg/m^2
14		Evapotranspiration	A4	$kg/m^2/s$
15	Socio-economic	Rural proportion	S1	%
16		Multidimensional poverty index	S2	Index Value
17		Source of drinking water within premises in rural	S3	%
18		Marginal farmer land holdings	S4	%

Composite Vulnerability Index: The Composite Vulnerability Index (CVI) was prepared using the above 18 indicators and ranked the different districts (Table 2.2 and Fig 2.12).

TABLE 2.2: CVI VALUES OF ALL THE DISTRICTS IN TAMIL NADU

District name	Changes in maxT	Changes in minT	Changes in RF	Excess RF years	Deficient RF years	GW extraction	GW Recharge	Surface water	Water gap	Water contamination	Rain fed area	Cropping intensity	Soil moisture	ET	Rural proportion	MPI	source drinking water	land holdings
Ariyalur	0.584	0.438	0.635	0.583	0.615	0.221	0.803	0.434	0.394	0.228	0.638	0.904	0.398	0.286	1.000	0.765	0.685	0.869
Coimbatore	0.215	0.565	0.000	0.417	0.231	0.787	0.813	0.000	0.926	0.199	0.324	0.981	0.269	0.429	0.135	0.147	0.000	0.227
Cuddalore	0.578	0.283	0.940	0.667	0.538	0.360	0.086	0.774	0.657	0.037	0.343	0.551	0.442	0.286	0.678	0.059	0.426	0.809
Dharmapuri	0.170	0.565	0.382	0.417	0.154	0.831	0.808	0.961	0.271	1.000	0.669	0.557	0.933	0.143	0.913	1.000	1.000	0.801
Dindigul	0.469	0.631	0.429	0.250	0.308	0.721	0.672	0.940	0.358	0.451	0.562	0.973	0.347	0.286	0.631	0.676	0.685	0.618
Erode	0.000	1.026	0.493	0.250	0.462	0.632	0.638	0.947	0.075	0.323	0.287	0.910	0.489	0.143	0.434	0.471	0.557	0.432
Kancheepuram	0.445	0.565	0.582	0.583	0.615	0.397	0.441	0.833	0.270	0.023	0.070	0.799	0.688	0.429	0.264	0.000	0.354	0.836
Kanyakumari	0.685	0.000	0.218	0.583	0.385	0.088	0.900	0.652	0.167	0.240	0.624	0.915	0.000	1.000	0.000	0.412	0.033	0.999
Karur	0.458	0.565	0.578	0.417	0.615	0.654	0.871	0.978	0.296	0.400	0.419	0.939	0.469	0.143	0.583	0.735	0.613	0.434
Krishnagiri	0.067	0.574	0.502	0.500	0.308	0.772	0.806	0.948	0.303	0.386	0.677	0.790	1.000	0.000	0.836	0.706	0.849	0.772
Madurai	0.625	0.467	0.568	0.333	0.538	0.419	0.658	0.996	0.000	0.422	0.377	0.892	0.406	0.429	0.302	0.265	0.692	0.878
Nagapattinam	0.837	0.399	1.000	0.917	0.769	0.662	0.962	0.220	0.306	0.201	0.168	0.265	0.269	0.286	0.838	0.147	0.489	0.754
Namakkal	0.316	0.848	0.322	0.417	0.231	0.897	0.820	0.896	0.193	0.306	0.540	0.705	0.667	0.143	0.590	0.706	0.538	0.672
The Nilgiris	0.270	0.565	0.044	0.333	0.000	0.000	1.000	0.450	0.760	0.000	1.000	0.998	0.199	0.857	0.324	0.471	0.872	0.815
Perambalur	0.469	0.545	0.445	0.750	0.385	0.787	0.914	0.875	0.125	0.176	0.749	0.865	0.567	0.286	0.914	0.794	0.725	0.807
Pudukottai	0.806	0.498	0.527	0.500	0.538	0.250	0.441	0.926	0.341	0.007	0.192	0.964	0.355	0.286	0.882	0.441	0.934	0.868
Ramanathapram	**0.817**	**0.437**	**0.731**	**0.500**	**1.000**	**0.000**	**0.687**	**0.992**	**0.379**	**0.565**	**0.656**	**1.000**	**0.808**	**0.714**	**0.730**	**0.794**	**0.980**	**0.822**
Salem	0.175	0.797	0.245	0.000	0.154	1.000	0.728	0.923	0.366	0.268	0.551	0.658	0.805	0.143	0.440	0.500	0.869	0.769
Sivagangai	0.741	0.492	0.587	0.333	0.615	0.037	0.459	0.972	0.277	0.273	0.216	0.999	0.616	0.429	0.723	0.559	0.748	0.880

Thanjavur	0.864	0.465	0.969	0.667	0.846	0.713	0.563	0.678	0.638	0.253	0.015	0.592	0.334	0.286	0.659	0.676	0.393	0.805
Theni	0.517	0.417	0.826	0.083	0.769	0.456	0.797	0.871	0.363	0.650	0.452	0.897	0.280	0.571	0.400	0.706	0.374	0.718
Thiruvallur	0.380	0.524	0.723	0.667	0.462	0.419	0.510	0.872	0.506	0.158	0.068	0.595	0.343	0.286	0.242	0.294	0.423	0.852
Thiruvarur	1.000	0.436	0.941	0.833	0.538	0.382	0.432	0.401	0.325	0.090	0.000	0.000	0.293	0.286	0.869	0.500	0.525	0.692
Thoothu-kudi	0.771	0.357	0.861	0.583	0.692	0.721	0.379	0.981	0.295	0.092	0.811	0.979	0.443	0.429	0.452	0.382	0.820	0.533
Trichirap-palli	0.583	0.553	0.383	0.417	0.538	0.551	0.888	0.884	0.213	0.087	0.518	0.902	0.542	0.286	0.465	0.324	0.423	0.807
Thirunelve-li	0.771	0.198	0.707	0.667	0.462	0.794	0.773	0.863	0.671	0.024	0.274	0.839	0.212	0.429	0.462	0.294	0.541	0.812
Tiruppur	0.183	0.836	0.700	0.500	0.615	0.566	0.644	0.914	0.825	0.455	0.357	0.983	0.357	0.143	0.294	0.176	0.443	0.000
Tiruvan-namalai	**0.267**	**0.591**	**0.439**	**1.000**	**0.769**	**0.221**	**0.726**	**0.915**	**0.737**	**0.392**	**0.289**	**0.683**	**0.842**	**0.286**	**0.874**	**0.500**	**0.548**	**0.857**
Vellore	0.254	0.519	0.479	0.333	0.385	0.772	0.680	0.946	0.385	0.445	0.509	0.793	0.836	0.286	0.549	0.206	0.439	0.859
Vilupuram	0.387	0.496	0.407	0.500	0.615	0.574	0.000	0.895	1.000	0.007	0.254	0.628	0.707	0.429	0.945	0.647	0.780	0.842
Virudhun-agar	0.694	0.313	0.699	0.333	0.846	0.382	0.707	1.000	0.238	0.146	0.601	0.950	0.549	0.286	0.447	0.765	0.849	0.726

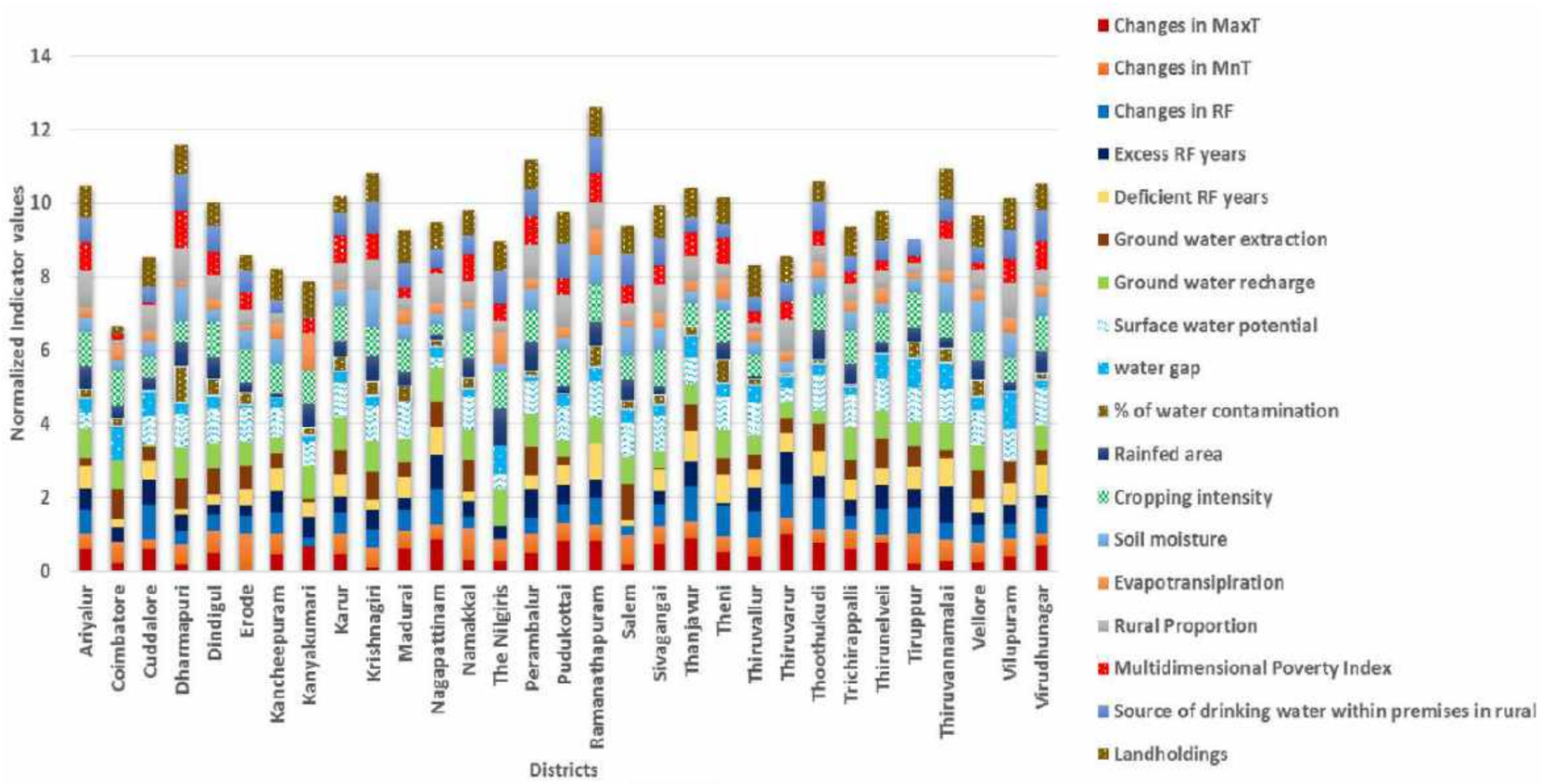


Fig 2.12: Climate Vulnerability Index Dimensions

Based on the cumulative vulnerability index score, four hot spot districts namely Ramanathapuram, Dharmapuri, Perambalur and Tiruvannamalai are prioritised for demonstrating pilot project.

CVI for Demonstration Districts for WASCA- TN

TABLE 2.3: WASCA - TN: CLIMATE VULNERABILITY INDICATOR: CWRM PLANNING TIRUVANNAMALAI AND RAMANATHAPURAM DISTRICT

Climate Vulnerability Area	Climate Vulnerability Indicator	Computed Composite Index Value		
		Functional Relationship with Climate Vulnerability	Tiruvannamalai	Ramanathapuram
1	2	3	4	5
Socio Economic Vulnerability	Rural proportion	A	0.73	0.817
	Multidimensional poverty index	A	0.794	0.437
	Source of drinking water within premises in rural	B	0.98	0.731
	Small & marginal Farmer landholdings	A	0.822	0.500
Agriculture Vulnerability	Rainfed area	A	0.656	1.000
	Cropping intensity	B	1	0
	Soil moisture	B	0.808	0.687
	Evapotranspiration	A	0.714	0.992
Water Resources Vulnerability	Ground water extraction	A	0	0.379
	Ground water Recharge	B	0.687	0.565
	Surface water availability	B	0.992	0.656
	Water gap	A	0.379	1.000
	Percentage of contamination	A	0.565	0.808
Climate Vulnerability	Changes in maxT	A	0.817	0.714
	Changes in minT	A	0.437	0.730
	Changes in RF	A	0.731	0.794
	Excess rainfall years	A	0.5	0.980
	Deficient rainfall years	A	1	0.822
WASCA - TN: Climate Vulnerability Index Range for all Districts of TN: 0-1				
A : Higher Value high vulnerability				
B : Lower Value High vulnerability				

The districts Ramanathapuram, Dharmapuri, Perambalur, and Tiruvannamalai are ranked high in cumulative vulnerability index (CVI) and the CVI values are 0.7, 0.64, 0.62 and 0.61, respectively (Table 2.4).

TABLE 2.4: RANKING OF HIGHLY VULNERABLE DISTRICTS IN THE STATES BASED ON CVI VALUES

Districts	Climate	Water Resource	Agriculture	Socio-economic
1	2	3	4	5
Ramanathapuram	4	16	1	13
Dharmapuri	28	1	9	11
Perambalur	18	12	6	7
Tiruvannamalai	6	11	17	5

Of the four highly vulnerable districts in the State, Ramanathapuram and Tiruvannamalai districts were prioritized for WASCA interventions through approval by State Level Steering Committee on WASCA, headed by Additional Chief Secretary, Department of Rural Development & Panchayat Raj and Heads of all line department. The districts of Ramanathapuram and Tiruvannamalai are the most vulnerable district in terms of

Hot Spot 1 - Ramanathapuram District

The geographical extent of Ramanathapuram District is 4,089.57 sq.km and accounts 3.14 per cent of the geographical area of the state. It is a plain coastal district located in southern agro climatatic zone. The number of village panchayats is 429 and is further bifurcated into 38 firkas. Principal crops are Cotton (9.1 per cent), Cumbu (5.1 per cent), Cholam (3.8 per cent), Groundnut (1.8 per cent), Paddy (1.4 per cent), Gingelly (1.1 per cent), to the total area sown in 2015-16. The net irrigated area is 53599 ha in 2015-2016. Source-wise, net area irrigation and open wells contribute more. There are 24,633 tanks, 28,688 open wells and 278 tube wells. Generally, the climate is hot, the mean annual maximum temperature is 32.6^{0}C and minimum temperature is 23.8^{0}C during the long-term period 1951-2015. The annual average rainfall is 847.3 mm. North-east rainfall is the major contributor and accounts nearly 61 per cent of the total annual rainfall, and south-west monsoon contributes 18 per cent of the total rainfall. Climate projection based on global climate models indicate there would be 1.1^{0}C increase in maximum temperature in mid-century period (2041-2070) and 1.9^{0}C increase in end-century period (2071-2100) from the baseline scenario under RCP 4.5 climate scenario. The minimum temperature would increase nearly 1.3^{0}C and 2.2^{0}C during MC and EC periods. The dimensions of vulnerability indicators are shown in Figure 26 and its inference are discussed below:

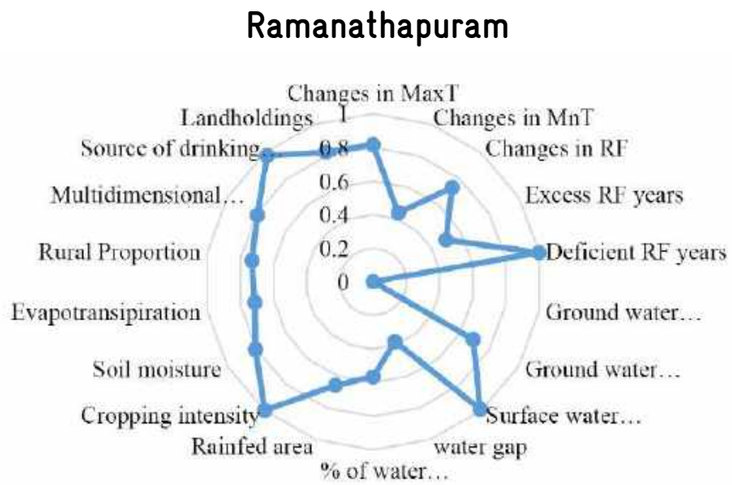


Fig 2.13: Indicators dimensions – Ramanathapuram District

Indicators interference:

Exposure in climate extremities is very high during 1951-2015

- Increase in day time temperature is very high (1.4^{0}C)
- Rainfall variability is very high
- Deficient rainfall years (below 59 per cent)are highest among all districts (18 years)

Water resource vulnerability

- Low surface water availability
- Supply and Demand gap
- Saline/poor quality of water – firkas are more

Agriculture vulnerability is very high among all districts

- Rain fed area (66.28 per cent)
- Cropping intensity is very low
- Evapotranspiration is more
- Soil moisture is very less

Socio-economic vulnerability

- Poverty index is more (0.63)
- Source of drinking water within premises in rural area is very low (5.6 per cent)
- Marginal farmers are more (93 per cent)
- High rural proportion (69.7 per cent)

Hot Spot 2 - Tiruvannamalai District

Located in north eastern agro climate zone, the geographical extent of the district is 6312.05 sq.km and accounts 4.85 per cent of the geographical area of Tamil Nadu. For administrative purpose, it has been further sub-divided into 52 forks, with 860 village panchayats. The principal crops cultivated are Groundnut (19.3 per cent), Cumby (9.4 per cent), Paddy (6.9 per cent), Sugarcane (2.4 per cent), and Raga (2.2 per cent) Gingelly (2.1 per cent), Cotton (0.2 per cent), Cholas (0.1 per cent), to the total area sown in 2015-16. Total net area irrigated area is 153,960 ha. Source wise net irrigated area are as follows: Canals (151), Tanks (22441), Open wells (128049), and Tube wells (3319). The annual maximum temperature of the district is 33^{0}C and minimum temperature is 22.8^{0}C during the long-term period 1951-2015. The annual average rainfall is 1,054.5 mm. North east rainfall accounts 45.8 per cent of the total annual rainfall and south west monsoon contribute nearly 43 per cent. Climate projection based on global climate models indicate that there would be 1oC increase in maximum temperature in mid-century period (2041-2070) and 1.5^{0}C increase in end-century period (2071-2100) from the baseline scenario under RCP 4.5 climate scenario. The minimum temperature would increase nearly 1.2^{0}C and 2.1^{0}C during MC and EC periods. The dimensions of vulnerability indicators are shown in Figure 29 and its inference are discussed below:

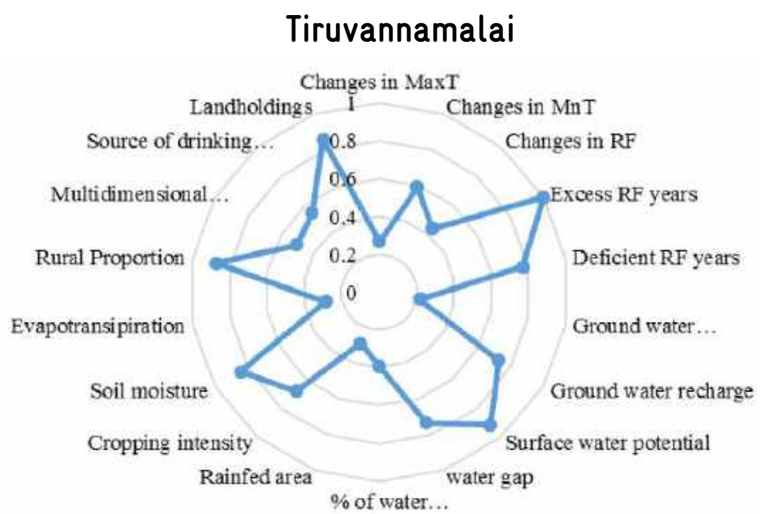


Fig 2.14: Indicators dimensions – Tiruvannamalai District

Indicators interference:

Exposure in climate extremities is very high during 1951-2015

- Increase in day time temperature is high (1.2^{0}C)
- Minimum temperature increase is high (0.5^{0}C)
- Excess rainfall are more (15 years)
- Deficient rainfall years (15)

Water resource vulnerability

- Nearly 71 per cent of the blocks are overexploited
- Out of 52 firkas, 37 are over-exploited, 7 are critical, 8 are semi-critical and there is no safe firka
- Ground water recharge is low
- Low surface water availability
- Demand supply gap is more
- Fluoride, Nitrate contamination in water

Agriculture vulnerability

- Soil moisture is low
- Evapotranspiration is high

Socio-economic vulnerability

- Poverty index is high (0.53)
- Source of drinking water within premises in rural is 18.8 per cent
- Marginal farmers are very high (94.7 per cent)
- Rural proportion is 79.9 per cent

The vulnerability will be further exacerbated under the changing climate scenarios in both mid (2050) and end century (2080) as mentioned below in the sub section 2.1.4.

In this backdrop, implementation of WASCA in Ramanathapuram and Tiruvannamalai districts are planned to strengthen its water resources and build context specific climate resilient models to create better resilience under this bilateral support. Effective water management strategies are to be adopted while using the surface water and ground water for drinking, domestic, irrigation and industrial purposes. In order to take proper management action, a detailed study was undertaken to estimate the extent of ground water availability and potential for augmentation for the entire district.

2.1.4. CLIMATE PROJECTIONS FOR THE WASCA PILOT DISTRICTS

2.1.4.1. TIRUVANNAMALAI DISTRICT

The climate projection study carried out by the CCCDM, has indicated that there has been changes in the maximum and minimum temperature as well as rainfall quantity compared the annual normal (1970-2000) of the district.

Maximum temperature: The maximum temperature, the annual normal value of the district is 33.2°C, The average maximum temperature range in the district is predicted to 2.1°C mid of the century. For End- century, this increase would be of 3.2°C.(Fig 2.15 and Table 2.5).

33.2°C Maximum Temperature

MC - 2.1°C
EC - 3.2°C

TABLE 2.5: PROJECTED FUTURE CHANGES IN ANNUAL MAXIMUM TEMPERATURE BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR MID AND END CENTURY WITH BASE LINE OF 1970-2000 FOR TIRUVANNAMALAI DISTRICT

Projection year with Respect to Base-line	Projection Period	Maximum Temperature (Projected)
2020	2010-2040	1.1°C
2050	2040-2070	2.1°C
2080	2070-2100	3.2°C

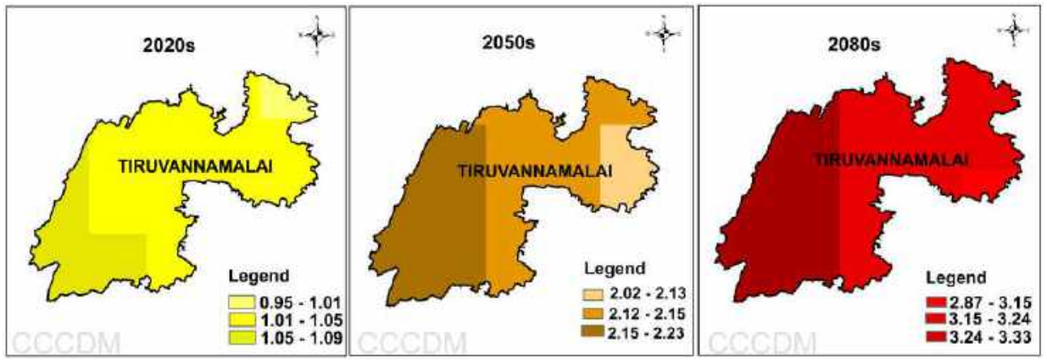


Fig 2.15: Projected Future changes in Annual Maximum Temperature by PRECIS, Reginal climate model projections for Mid and End Century with Base line of 1970-2000 for Tiruvannamalai District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

Minimum temperature: While for the minimum temperature, the annual normal value of the district is 23.5° C. The average minimum temperature in the district is predicted to 2.4° C mid of the century. For End- century, this increase would be of 3.7° C(Fig 2.16 and Table 2.6).

23.5°C Minimum Temperature

MC - 2.4°C
EC - 3.7°C

TABLE 2.6: PROJECTED FUTURE CHANGES IN ANNUAL MINIMUM TEMPERATURE BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR MID AND END CENTURY WITH BASE LINE OF 1970-2000 FOR TIRUVANNAMALAI DISTRICT

Projection with respect to baseline (Projection Period)	Minimum Temperature (Projected)
2020 (2010-2040)	1.10°C
2050 (2040-2070)	2.40°C
2080 (2070-2100)	3.70 °C

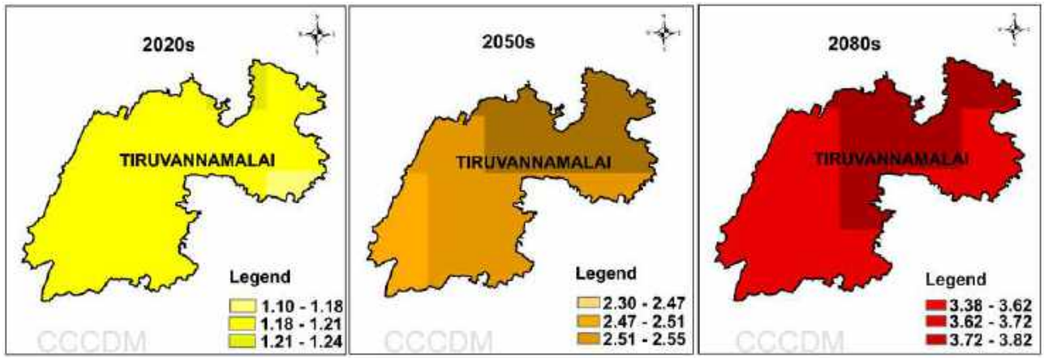


Fig 2.16: Projected Future Changes in Annual Minimum Temperature by PRECIS, Reginal climate model projections for Mid and End Century with Base line of 1970-2000 for Tiruvannamalai District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

Rainfall: The annual rainfall of the district is 1041mm, the estimated projections for the period is there will be a decrease in 5% and 4% of rainfall in both the century (Mid and End) (Fig 2.17 and Table 2.7).

1,041 mm Annual rainfall

MC - 5 %
EC - 4 %

TABLE 2.7: PROJECTED FUTURE CHANGES IN ANNUAL AVERAGE RAINFALL BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR 2020, MID AND END CENTURY WITH BASE LINE OF 1970-2000 FOR TIRUVANNAMALAI DISTRICT

Projection with respect to baseline (Projection Period)	Average Annual Rainfall (Projected)
2020 (2010-2040)	- 2.0%
2050 (2040-2070)	- 5.0%
2080 (2070-2100)	- 4.0 %

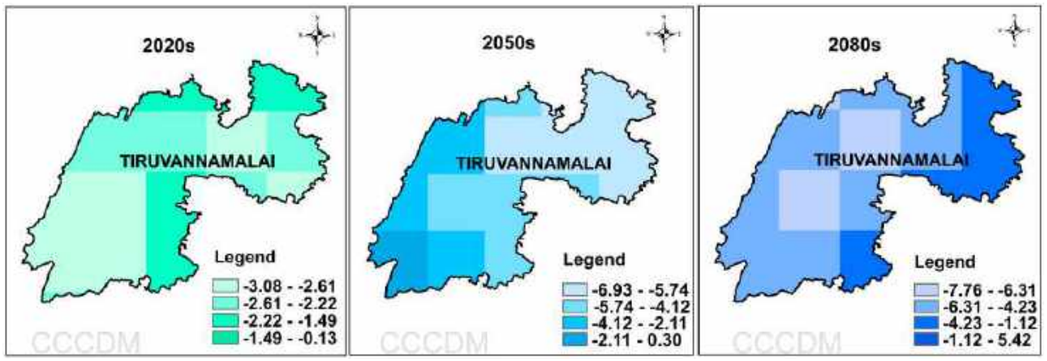


Fig 2.17: Projected Future Changes in Annual Average rainfall by PRECIS, Reginal climate model projections for 2020, Mid and End Century with Base line of 1970-2000 for Tiruvannamalai District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

2.1.4.2. RAMANATHAPURAM DISTRICT

Maximum temperature: The maximum temperature, the annual normal value of the district is 31.8°C, The average maximum temperature range in the district is predicted to 1.83° C- 2.51°C mid of the century. For End-century, this increase would be of 2.71° C-3.73 ° C (Fig 2.18 and Table 2.8).

31.8°C Maximum Temperature

MC - 1.83°C - 2.51°C
EC - 2.71°C - 3.73°C

TABLE 2.8: PROJECTED FUTURE CHANGES IN ANNUAL MAXIMUM TEMPERATURE BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR MID AND END CENTURY WITH BASE LINE OF 1970-2000 FOR RAMANATHAPURAM DISTRICT

Projection year with respect to baseline	Projection Period	Maximum Temperature (Projected)
2020	2010-2040	0.89°C -1.26°C
2050	2040-2070	1.83°C - 2.51°C
2080	2070-2100	2.71°C - 3.73°C

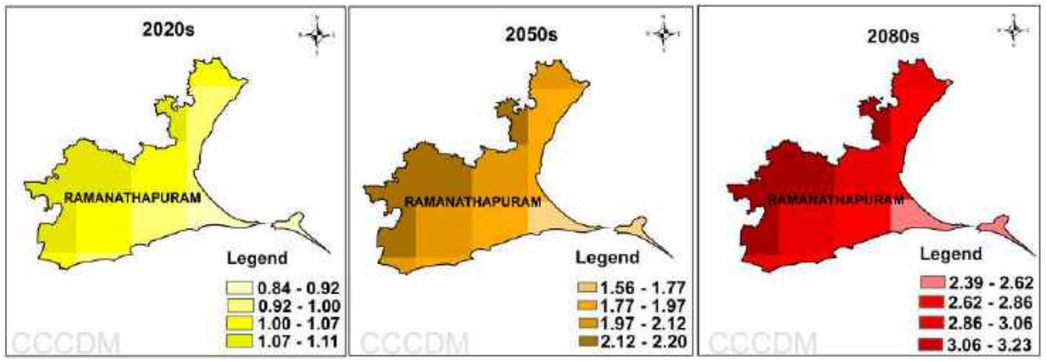


Fig 2.18: Projected Future changes in Annual Maximum Temperature by PRECIS, Reginal climate model projections for Mid and End Century with Base line of 1981-2010 for Ramanathapuram District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

Minimum temperature: While for the minimum temperature, the annual normal value of the district is 25.2° C. The average minimum temperature in the district is predicted to 1.56° C-2.20° C mid of the century. For End-century, this increase would be of 2.39 ° C-3.23° C (Fig 2.19 and Table 2.9).

25.2°C Minimum Temperature

MC - 1.56°C - 2.20°C
EC - 2.39°C - 3.23°C

TABLE 2.9: PROJECTED FUTURE CHANGES IN ANNUAL MINIMUM TEMPERATURE BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR MID AND END CENTURY WITH BASE LINE OF 1970-2000 FOR RAMANATHAPURAM DISTRICT

Projection with respect to baseline (projection Period)	Minimum Temperature (projected)
2020 (2010-2040)	0.84°C -1.11°C
2050 (2040-2070)	1.56°C -2.20°C
2080 (2070-2100)	2.39°C -3.23 °C

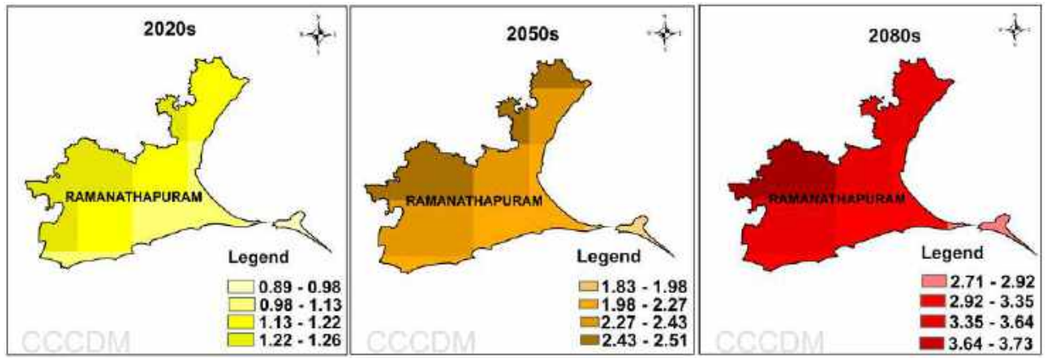


Fig 2.19: Projected Future Changes in Annual Minimum Temperature by PRECIS, Reginal climate model projections for Mid and End Century with Base line of 1970-2000 for Ramanathapuram District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

Rainfall: The annual rainfall of the district is 821mm, the estimated projections for the period is there will be an increase in 1% rainfall in both the century (Mid and End) (Fig 2.20 and Table 2.10)

821 mm Annual rainfall

MC - 1 %
EC - 1 %

TABLE 2.10: PROJECTED FUTURE CHANGES IN ANNUAL AVERAGE RAINFALL BY PRECIS, REGINAL CLIMATE MODEL PROJECTIONS FOR 2020, MID AND END CENTURY WITH BASE LINE OF 1981-2010 FOR RAMANATHAPURAM DISTRICT

Projection with respect to baseline (Projection Period)	Average Annual Rainfall (Projected)
2020 (2010-2040)	+0.1%
2050 (2040-2070)	+ 1.0%
2080 (2070-2100)	+1.0 %

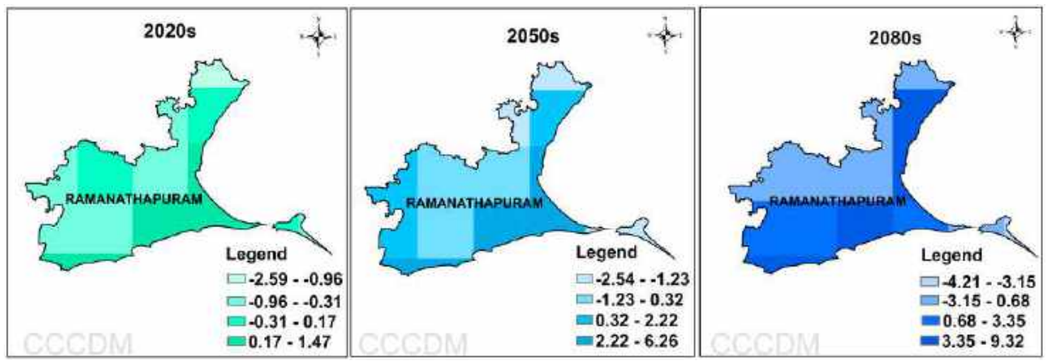


Fig 2.20: Projected Future Changes in Annual Average rainfall by PRECIS, Reginal climate model projections for 2020, Mid and End Century with Base line of 1970-2000 for Ramanathapuram District

Source: Climate Change Projection of Tamil Nadu, AR4 ,2012, CCAR, Anna University

2.2 STUDY ON GROUND WATER ASSESSMENT AND RIVER SUB-BASIN SYSTEM, TIRUVANNAMALAI AND RAMANATHAPURAM DISTRICTS

A study on ground water its dynamics with surface water for CWRM planning was carried out in both Tiruvannamalai and Ramanathapuram districts. The ground water is a renewable nature resource, its occurrence and movement is based on various hydro geological conditions which are not uniform throughout the district.

2.2.1. Common Key issues of ground water in both the district

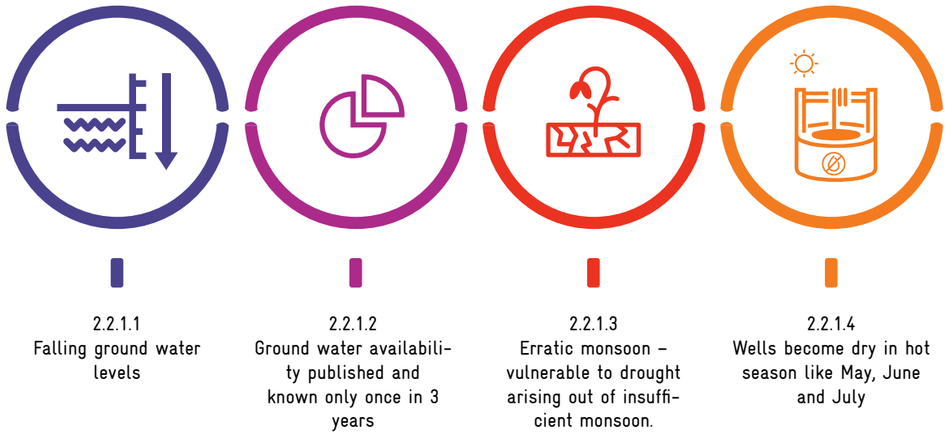


Fig 2.21: Common Key issues of ground water in both the districts

In addition to the above issues in Ramathapuram district, *in-situ* geological formation is one of the important sources for the poor water quality.

Approach and Methodology for solving the Ground Water issues:

2.2.1.1) FALLING GROUND WATER LEVELS:

To overcome the falling Ground Water Level trends and improve water quality, the lithological and geophysical parameters have been studied for the entire District. The number of wells used for identifying lithology is 151 and number of sites in which geo physical survey were conducted are 36 in Tiruvannamalai while it was 31 and 36 respectively in Ramanathapuram. Based on the detailed analysis, the following recharge proposal is recommended.

Fig 2.22: Number of Recharge Structures Proposed in Both the Districts

2.2.1.2) GROUND WATER AVAILABILITY

The real time ground water availability by which ground water availability can be assessed at any time, dedicated templates have been framed with the following concept.

A) **Sources of Ground Water Recharge:** The main sources of ground water recharge are Monsoon rainfall, return flow from irrigation, seepage from tanks and ponds and recharge from water conservation structures.

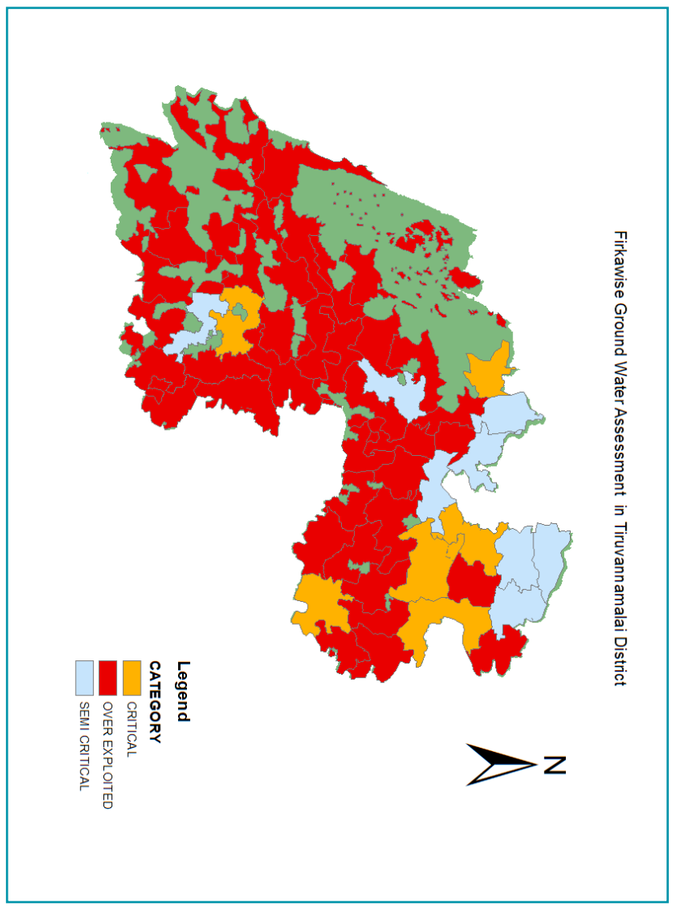
B) **Discharge components of Ground Water Recharge:** The discharge components of ground water recharge are ground water extraction for irrigation, domestic purpose and industrial purpose.

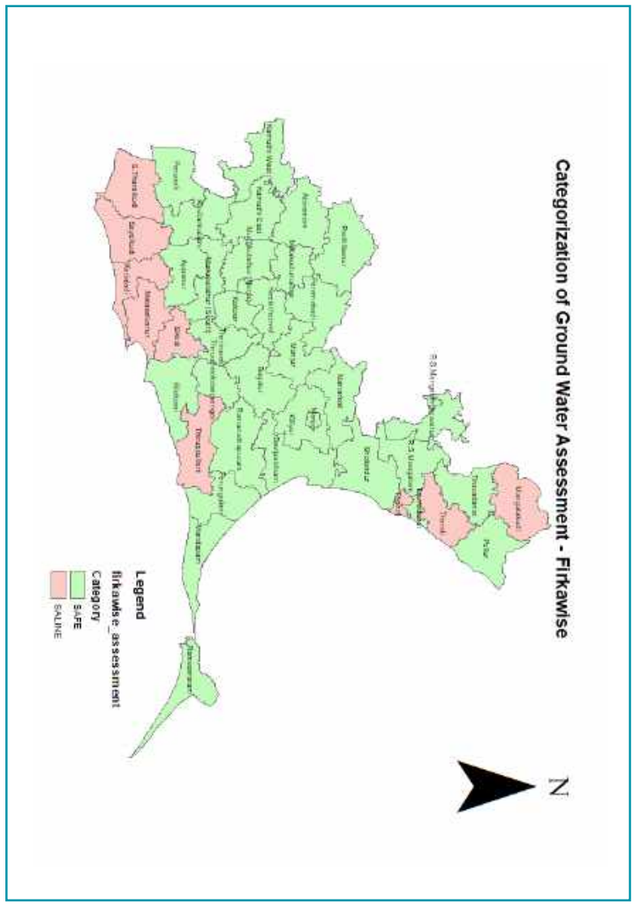
Methodology used for Ground water estimation: The methodology used for ground water estimation are estimation of ground water extraction, estimation of ground water recharge from other sources, estimation of ground water recharge from rainfall, ground water recharge during monsoon season, ground water recharge during non-monsoon season, annual replenishable ground water resource, net annual ground water availability, future utilization of ground water resource, stage of ground water development and categorization of assessment units.

Categorization of Assessment Units:

1. Estimation of Annual Replenishable Ground Water Resources
2. Net Ground Water Availability – (after deducting allocation for natural discharge)
3. Computation of Annual Ground Water Draft – Irrigation, Domestic & Industrial Uses
4. Stage of Ground Water Development = Annual GW Draft/ Net Annual GW availability *100
5. Categorization of Assessment Units – Stage of Ground water Extraction

The Ground Water Assessment for the period ending March 2020 and status of ground water has been completed and given in Table 2.11 and 2.12 and Map 2.1 and 2.2.





Map 2.1 and 2.2: Ground water category in Tiruvannamalai and Ramanathapuram District

TABLE 2.11: ASSESSMENT OF GROUND WATER IN TIRUVANNAMALAI DISTRICT (FIRKAWISE)

Sl. No	Assessment Unit Firka	Rainfall (mm)	Average Pre-monsoon Water level (mbgl)	Average Post-monsoon Water level (mbgl)	Average Fluctuation (m)	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge {(4)+ (5)+ (6)+ (7)}	Provision for Natural Discharge	Net Annual Ground Water Availability {(8)-(9)}
			1	2	3	4	5	6	7	8	9	10
1	Agrapalayam	1100.20	7.62	5.78	1.84	779.55	1432.62	114.77	72.15	2399.09	239.91	2159.18
2	Anakkavoor	1193.10	4.94	3.14	1.80	927.48	1533.37	126.29	81.33	2668.47	266.85	2401.62
3	Arni	1079.50	7.51	5.83	1.68	349.43	510.58	50.27	22.31	932.59	93.26	839.33
4	Chengam	924.78	7.55	5.55	2.01	570.98	2107.28	102.21	119.86	2900.33	290.03	2610.30
5	Chennavaram	1193.10	4.28	6.64	-2.36	644.63	751.27	58.04	29.65	1483.59	148.36	1335.23
6	Cheyyar	1108.40	4.48	3.46	1.01	505.55	906.21	66.21	57.54	1535.51	153.55	1381.96
7	Desur	1193.10	4.62	2.58	2.04	961.80	866.06	86.60	50.04	1964.51	196.45	1768.06
8	Dusi	1116.17	6.36	4.88	1.49	810.76	1165.25	109.93	128.91	2214.86	221.49	1993.37
9	Eraiyur	933.70	10.04	7.27	2.77	580.34	3035.98	103.88	139.87	3860.07	386.01	3474.06
10	Kadaladi	1135.40	8.72	5.80	2.92	408.32	1853.16	74.29	66.81	2402.59	240.26	2162.33
11	Kalasapakkam	1135.40	8.72	5.80	2.92	565.81	1540.87	102.95	136.95	2346.58	234.66	2111.92
12	Kannamangalam	1049.10	8.04	6.65	1.39	435.85	866.65	76.68	60.74	1439.93	143.99	1295.93
13	Kelur	904.93	9.68	7.15	2.52	722.34	2729.54	116.63	64.32	3632.83	363.28	3269.55
14	Kettavarampalayam	1135.40	8.88	5.88	2.99	667.33	2247.11	121.42	70.91	3106.77	310.68	2796.10
15	Kilkodungalur	1193.10	6.46	4.31	2.15	906.69	1051.25	81.64	59.73	2099.31	209.93	1889.38
16	Kilpennathur	878.70	7.09	4.10	2.98	624.58	944.97	98.53	292.06	1960.14	196.01	1764.12
17	Kolappalur	1081.70	5.37	3.92	1.45	676.39	813.68	90.51	54.41	1635.00	163.50	1471.50
18	Malaiyur	1193.10	4.56	2.68	1.89	556.31	1043.37	75.13	30.35	1705.16	170.52	1534.64
19	Mandakolathur	1049.10	7.69	4.62	3.07	496.73	2465.40	87.39	108.84	3158.36	315.84	2842.53
20	Mangalam	878.70	9.76	6.18	3.59	642.10	976.52	101.29	263.47	1983.38	198.34	1785.04
21	Melpallipattu	933.70	7.52	5.63	1.89	86.45	1117.04	870.74	132.41	2206.63	220.66	1985.97
22	Modayur	1079.50	7.67	4.62	3.05	582.04	2401.26	110.29	116.98	3210.57	321.06	2889.51

23	Mullipattu	1049.10	7.09	6.22	0.87	338.11	816.26	60.15	35.82	1250.33	125.03	1125.30
24	Nateri	1079.50	6.90	5.55	1.35	394.31	1365.48	71.72	30.87	1862.37	186.24	1676.13
25	Nayadumangalam	878.70	9.76	6.18	3.59	501.80	2147.14	79.16	91.57	2819.66	281.97	2537.69
26	Nedungunam	1193.10	5.97	3.82	2.14	608.06	1008.96	65.40	40.36	1722.77	172.28	1550.50
27	Osur	1193.10	6.63	4.49	2.14	740.38	897.47	66.66	46.62	1751.15	175.11	1576.03
28	Pachal	933.70	7.96	5.65	2.31	574.46	1378.22	102.83	115.94	2171.46	217.15	1954.31
29	Peranamallur	1081.70	6.13	3.82	2.31	734.83	768.69	98.33	62.49	1664.35	166.44	1497.92
30	Perungattur	1079.50	6.48	4.94	1.54	959.31	902.34	128.47	63.36	2053.47	205.35	1848.12
31	Polur	984.60	10.31	7.31	3.00	467.59	1959.86	75.50	42.49	2545.44	254.54	2290.89
32	Pudupalayam	933.70	9.92	7.25	2.67	700.47	3679.73	125.38	100.67	4606.26	460.63	4145.63
33	Santhavasal	796.50	10.22	7.56	2.66	646.74	1962.51	127.70	70.39	2807.34	280.73	2526.60
34	Sathyavijayanagaram	1079.50	18.92	5.87	13.05	457.27	1048.11	82.23	78.18	1665.79	166.58	1499.21
35	Somaspadi	878.70	7.09	4.10	2.98	741.88	735.24	78.02	162.31	1717.46	171.75	1545.71
36	Tiruvannamalai (North)	878.70	7.81	4.63	3.18	534.03	981.32	86.96	83.25	1685.56	168.56	1517.00
37	Tiruvannamalai (South)	878.70	7.89	4.71	3.18	420.84	1068.93	66.39	118.35	1674.50	167.45	1507.05
38	Thachambadi	1081.70	7.86	4.71	3.15	510.07	1777.35	68.25	76.82	2432.49	243.25	2189.24
39	Thandarampat	921.30	6.43	3.57	2.86	515.57	1563.80	318.56	191.70	2589.62	258.96	2330.66
40	Thanipadi	921.70	6.27	3.44	2.82	735.76	1410.49	123.36	318.34	2587.95	258.80	2329.16
41	Thatchampattu	878.70	7.57	4.48	3.09	425.93	1444.97	67.19	102.62	2040.72	204.07	1836.64
42	Thellar	1193.10	4.53	2.69	1.84	943.62	1340.57	113.97	69.69	2467.85	246.79	2221.07
43	Thethurai	1193.10	5.08	3.14	1.94	918.79	1109.25	120.30	56.09	2204.43	220.44	1983.98
44	Thurinjapuram	878.70	9.95	6.18	3.78	466.23	1329.18	73.55	130.76	1999.71	199.97	1799.74
45	Vadathandalam	1107.10	4.35	3.67	0.67	612.29	1449.25	107.02	58.28	2226.84	222.68	2004.16
46	Vakkadai	1109.70	5.16	4.20	0.96	528.84	1415.70	73.22	70.50	2088.25	208.83	1879.43
47	Vandavasi	1193.10	6.16	4.11	2.05	649.71	1028.98	66.43	74.51	1819.62	181.96	1637.66
48	Vanapuram	1026.30	6.43	3.42	3.02	753.92	2071.56	132.21	214.07	3171.75	317.18	2854.58
49	Vembakkam	1189.50	6.04	4.96	1.08	1901.13	1172.83	194.53	65.42	3333.90	333.39	3000.51
50	Veraiyur	878.70	8.04	4.66	3.38	655.76	800.69	68.96	118.38	1643.80	164.38	1479.42
51	Vettavlam	878.70	7.09	4.15	2.94	662.66	489.57	69.69	61.32	1283.23	128.32	1154.91
52	Vinnamangalam	1079.50	7.67	4.62	3.05	456.49	1001.30	82.09	59.64	1599.52	159.95	1439.57

TABLE 2.12: ASSESSMENT OF GROUND WATER IN RAMANATHAPURAM DISTRICT (FIRKA WISE)

Sl. No	Assessment Unit Firka	Rainfall (mm)	Average Pre-monsoon Water level (mbgl)	Average Post-monsoon Water level (mbgl)	Average Fluctua-tion (m)	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Wa-ter Recharge {(4)+ (5)+ (6)+ (7)}	Provision for Natu-ral Dis-charge	Net Annual Ground Water Availability {(8)-(9)}
			1	2	3	4	5	6	7	8	9	10
1	Aappanur	641.04	-0.52	0.50	-1.02	444.4481	1274.227	80.92193	225.5278	2025.125	202.5125	1822.613
2	Kadaladi	639.09	-0.52	0.50	-1.02	-	538.6904	0	99.99825	-	-	-
3	Melaselvanur	641.04	-0.52	0.50	-1.02	-	871.2354	0	277.354	-	-	-
4	S.Tharaikudi	641.04	-0.52	0.50	-1.02	-	421.4017	0	179.0713	-	-	-
5	Sayalkudi	641.04	-0.52	0.50	-1.02	-	557.0544	0	208.2173	-	-	-
6	Sikkal	641.04	-0.52	0.50	-1.02	-	973.1947	0	270.2365	-	-	-
7	Abiramam	750.31	-1.25	0.84	-2.09	531.0647	1290.456	323.5588	432.422	2577.501	257.7501	2319.751
8	Kamuthi East	750.31	0.10	1.88	-1.78	585.1693	571.9363	147.418	222.8323	1527.356	152.7356	1374.62
9	Kamuthi West	750.31	-1.25	0.84	-2.09	676.106	720.1934	170.3271	353.4888	1920.115	192.0115	1728.104
10	Kovilankulam	750.31	-1.25	0.84	-2.09	551.9653	532.9001	139.0531	245.424	1469.343	146.9343	1322.408
11	Perunaazhi	750.31	-1.25	0.84	-2.09	543.5577	263.862	136.9351	141.6625	1086.017	108.6017	977.4155
12	Mudukulathur South	712.30	-2.19	0.66	-2.85	441.6437	1162.711	96.12133	260.0283	1960.505	196.0505	1764.454
13	Kakkur	712.30	-2.36	0.68	-3.04	332.5354	876.4784	72.3745	191.054	1472.442	147.2442	1325.198
14	Keelathuval	712.30	-2.36	0.66	-3.02	490.1145	1149.259	106.6707	141.2213	1887.265	188.7265	1698.539
15	Melakodumalur	712.30	-2.19	0.66	-2.85	337.895	879.1488	73.541	202.3595	1492.944	149.2944	1343.65
16	Mudukulathur North	712.30	-2.19	0.66	-2.85	440.4419	1174.111	95.85977	218.1495	1928.563	192.8563	1735.706
17	Theriruveli	712.30	-2.36	0.66	-3.02	467.0393	1118.153	101.6485	197.6475	1884.488	188.4488	1696.04
18	Bogalur	712.30	-1.93	1.94	-3.87	618.6945	1447.432	134.6555	279.3525	2480.134	248.0134	2232.121
19	Kiliyur	994.17	-1.84	0.67	-2.51	659.9562	1203.6	130.5606	278.9123	2273.029	227.3029	2045.726

20	Nainarkoil	994.17	-1.84	0.67	-2.51	801.4053	1306.263	158.5438	296.6873	2562.899	256.2899	2306.609
21	Manjur	994.17	-2.17	0.72	-2.89	1804.26	124.5	39.01597	163.516	46.47739	4.647739	41.82965
22	Paramakudi	994.17	-2.17	0.72	-2.89	728.7057	1086.427	144.1615	372.5833	2331.877	233.1877	2098.69
23	Parthipanoor	994.17	-2.17	0.72	-2.89	957.7254	2433.728	189.4689	569.1388	4150.062	415.0062	3735.055
24	Mandapam	994.17	-0.92	0.89	-1.81	747.8274	347.1842	162.0563	331.648	1588.716	158.8716	1429.844
25	Perunkulam	994.17	-0.92	0.89	-1.81	838.2102	392.592	161.5415	511.719	1904.063	190.4063	1713.656
26	Devipattinam	994.17	-0.97	0.99	-1.96	1202.446	1465.056	231.7377	198.0393	3097.279	309.7279	2787.551
27	Aanandhur	730.10	-1.33	1.16	-2.49	550.0115	1552.816	101.1216	46.812	2250.761	225.0761	2025.685
28	T.U.Mangai	1212.35	-0.09	1.07	-1.16	732.9895	1176.534	158.8409	192.0745	2260.438	226.0438	2034.395
29	Keelakkarai	994.17	0.30	1.18	-0.88	373.377	542.8789	61.21626	291.9763	1269.448	126.9448	1142.504
30	Thirupullani	994.17	0.30	1.18	-0.88	-	674.8761	0	519.502	-	-	-
31	Rameswaram	905.70	-0.42	0.54	-0.96	580.8103	14	125.8632	104.3318	825.0053	82.50053	742.5048
32	Mangalakudi	730.10	-1.33	1.16	-2.49	-	1290.427	0	251.6183	-	-	-
33	R.S.Mangalam	829.52	-1.24	1.11	-2.35	772.376	2087.049	148.0405	137.0403	3144.506	314.4506	2830.056
34	Sholandhur	1411.72	-1.33	1.16	-2.49	700.6653	2056.177	128.8199	69.44025	2955.102	295.5102	2659.592
35	Thiruvadani	909.18	-1.33	1.16	-2.49	614.26	1414.365	112.9339	220.6335	2362.193	236.2193	2125.973
36	Thondi	730.10	-1.33	1.16	-2.49	-	1923.137	0	330.8393	-	-	-
37	Ramanathapuram	994.17	-0.97	0.99	-1.96	1031.385	743.0013	198.7706	179.518	2152.675	215.2675	1937.408
38	Pullur	730.10	-1.33	1.16	-2.49	618.2026	1704.278	113.6588	379.592	2815.732	281.5732	2534.158

2.2.1.3) ERRATIC MONSOON – VULNERABLE TO DROUGHT ARISING OUT OF INSUFFICIENT MONSOON.

The drought index tool has been used to estimate the possibility of occurrence of drought. This would enable the Rural Department Engineers to identify the occurrence of drought at the end of every month not waiting for till the end of monsoon season and to announce drought and further to take up the mitigation measures. The computation procedure of Ground Water Index (GWI) is as follows.

$$GWDI_{ij} = \frac{MDGW_i - GWD_{ij}}{GWD_{i\max}}$$

Where, GWDIij= Ground Water Drought Index for ith month and jth year.

MGWDj= Mean depth to ground water table below surface (10 yrs, m)

GWDij= Depth to ground water table in ith month and jth year (in meter).

GWDimax= Maximum depth to ground water table in ith month in available data set for n number of years (in meter). i= 1, 2, 3, 4, ..., 12. ; j = 1, 2, 3, ..., n, n = total numbers of years for which monthly groundwater records are used.

Groundwater Drought Index (GWDI)	Groundwater deficit class
> - 0.15	Normal
-0.16 to - 0.30	Mild
-0.31 to -0.45	Moderate
-0.46 to - 0.60	Severe
< - 0.60	Extreme

TABLE 2.13: GROUND WATER DROUGHT INDEX , TIRUVANNAMALAI AND RAMANATHAPURAM DISTRICTS

Sl. No.	Month/ Week	No of Wells Observed	Max. observed water level depth from ground surface for given month in m	Average water level depth from ground surface for given period (11 years Average, 2006-2016) in m	Actual observed Water level depth from ground surface in m	Difference in water level depth from average in Meters	GWDI	Ground Water Deficit Class
(1)	(2)	(3)	(4)	(5)	(6)	(7)=(5-6)	(8)= (7/5)	(9)
A)	Tiruvannamalai district							
1	May 2020	208	23.50	6.02	6.91	-0.89	-0.0379	Normal
2	June 2020	208	23.50	6.02	7.83	-1.81	-0.0770	Normal
3	July 2020	208	28.2	6.02	8.35	-2.33	-0.0826	Normal
4	August 2020	208	22.30	6.02	8.04	-2.02	-0.0906	Normal
5	September 2020	208	21.20	7.38	8.11	-0.73	-0.0344	Normal
6	October 2020	208	22	6.94	7.46	-0.52	-0.0236	Normal
7	November 2020	208	23	5.9	6.67	-0.77	-0.0335	Normal
8	December 2020	208	22.3	4.48	3.72	0.76	0.0341	Normal
B)	Ramanathapuram district							
1	May 2020	110	13.25	4.41	4.69	0.07	0.0053	Normal
2	June 2020	110	13.80	4.41	4.95	-0.54	-0.0391	Normal
3	July 2020	110	13.9	4.41	5.09	-0.68	-0.0489	Normal
4	August 2020	110	13.95	4.41	5.20	-0.79	-0.0566	Normal
5	September 2020	110	14.60	5.08	4.83	0.25	0.0171	Normal
6	October 2020	110	14.76	5.01	4.82	0.19	0.0129	Normal
7	November 2020	110	13.6	4.63	4.52	0.11	0.0081	Normal
8	December 2020	110	13.2	4.17	3.97	0.20	0.0152	Normal

Results and output from the Ground Water Study:

Ground water Study: The dedicated templates have been designed and disseminated to the rural department Engineers so that they can continue this assessment at any point of time even after the project period.
The ground water resources is decreasing due to increasing of irrigation draft, extraction of ground water for irrigation increased, extraction of ground water for the city and urban areas, extraction of ground water for industrial use, environmental degradation, deficit rainfall. the improvement of ground water resources can be done in two ways. they are reduction in irrigation draft and construction of artificial recharge structures.

2.2.2. RIVER BASIN MANAGEMENT

2.2.2.1) TIRUVANNAMALAI DISTRICT

The major rivers traversing Tiruvannamalai district are Ponnaiyar and Cheyyar. The major part of the district falls under the Palar sub catchment and extreme southern part of the district fall under Ponnaiyar sub catchment.Cheyyaru River is an important seasonal river that runs through the Tiruvannamalai District of the state of Tamil Nadu in South India. It is a tributary of Palar River, a river which originates in Jawadhu Hills and flows through Tiruvannamalai district before emptying into the Bay of Bengal. The river receives most of its water from the Northeast and Southwest monsoons and is the major source of irrigation for several villages, including the towns of Cheyyaru and Vandavasi. As a pilot basin, Naganadhi subbasin is selected.

VEGAVATHI SUB-BASIN:

Vegavathi is a minor tributary of Palar River and it originates from the surplus flow of tanks near Sankarambadi village (79° 33’ 36” E, 12° 51’ 27”N) and Kilar village (79° 34’ 23” E, 12° 52’ 03” N). It flows for a distance of 23 Km and joins Palar near Villivalam village at 79° 46’ 54” E, 12° 47’ 08” N).At 79° 22’ 38” E, 12° 52’ 44” N, near Thirumalaicheri village, Kaveripak Channel, Kambakkal Channel and surplus flow of Kannigapuram Tank (79° 23’ 04”E, 12° 53’ 48”N) joins the Palar river. The sub basin covers 411.16 Sq Km and flows over Kanchipuram and Walajapet blocks in Kanchipuram District, Vembakkam of Tiruvannamalai District and Kaveripakkam, Nemili, Thimiri, Walajah and Arcot of Vellore District.

KILIYAR SUB-BASIN:

Kiliyar is an east flowing river, The kiliyar sub basin spreads over 1322.08 Sq Km and covers Kanchipuram district (Acharapakkam, Chithamur, Kattankolathur, Lathur, Madhurantakam, Thirukkalukkunram, Uthiramerur and Walajapet blocks) and Tiruvanamalai district (Anakkavur, Pernamallur, Thellar and Vandavasi blocks). The main river course starts as Suka Nadi River, at Kilnandiyambadi village [at 79° 32’ 19” E and 12° 30’ 58” N] where the surplus of tanks from Melpadi, Thenkaral and Pudhur villages forms the Suka Nadi. After flowing for a distance of 29 km, at Kiliyanagar

CHEYYAR SUB-BASIN:

The Cheyyar River originated from Inner Jawadhi reserved Forest, at an elevation of 600 to 1000 m above msl and runs for 186 Km to join Palar River at Thirumukkudal village (79° 51’ 46” E, 12° 45’ 25”N). The sub basin spreads over 4362.69 Sq Km and covers Kanchipuram District (Kanchipuram, Walajapet and Uthiramerur Blocks), Tiruvannamalai District (Anakkavur, Arni, Chengam, Cheyyar, Chetput, Jawadhu Hills, Kalasapakam, Pernamallur, Polur, Pudupalayam, Thandrampet, Thurinjipuram, Vembakkam and West Arni blocks) and Vellore District (Alangayam, Anicut, Arcot, Kaniyambadi, Thimiri and Vellore blocks). The excess of Mattavettu Eri originates as Kallaru and joins Cheyyar at Singaravadi Village (78° 57’ 53”E, 12° 23’ 39”N) after flowing for 10 km. Two tributaries by name Vannatuar and Melattuar originates from Mulakadu Reserved Forest at an elevation of 539 m MSL and 817 m MSL respectively and mingles near Vadakatainammiyandal Village(78° 54’ 37”E 12° 29’ 08”N) and flows as Mirukanda Nadhi. These tributary confluences with Cheyyar at Elattur Village.

2.2.2.2) RAMANATHAPURAM DISTRICT

The major part of Ramanathapuram district falls in Gundar-Vaigai river basin. Vaigai and Gundar are the important rivers and in addition, Virusuli, Kottakariyar & Uppar are the other rivers draining the district. The drainage pattern, in general, is dendritic. All the rivers are seasonal and carry substantial flows during monsoon period. Vaigai., which is one of the important rivers of the district, which is flow and drain in the Paramakudi, Bogalur, Tirupullani and Mandapam blocks. The Gundar river originates in Kottamalai hills in the Saptura forest and enters the district near Anankulam and flows in a south –eastern to due south direction and enters the Bay of Bengal near Mukaiyur. The river assumes the name of “ Reghunatha Cauveri “ from Kamudhi. The Kottakarai, Virusuli and Uppar are other rivers flowing in south easterly direction and entering the Bay of Bengal. Kottakaraiar subbasin spread across the district.

KOTTAKARAIYAR SUB BASIN: Nattarkal river, Suriyankottaiyar, Nattar, Saruganiar, Kottakaraiyar and Uppar river are the main rivers of Kottakaraiyar sub basin.

NATTARKAL:

Nattarkal river originates at Kuttikadu reserve forest area at an elevation of 100 m above MSL. It passes through Nattarasankottai, Kurukkatti, Siramam, Vilangattur, Anchavayal and Kottamangalam village. Finally, Nattarkal confluences with Kottamangalam tank. The length of Nattarkal river is 16 Km and the number of tanks benefited is 11, having an ayacut of 649.18Ha.

SURIYANKOTTAIYAR:

The surplus of Kottamangalam tank passes through a system of tanks and near Suriyankottai village, it takes the name of Suriyankottaiyar. Suriyankottaiyar passes through Kalladittidal and Marudavayal villages and finally confluences with Raja Singa Mangalam (R.S. Mangalam) big tank.

NATTAR:

Nattar river is a flood carrier formed by the surplus of Alankulam, Kandani Peria Kanmoi, Kattondi Kanmoi and Velanji Kanmoi. Its origin is located near Kandani village of Sivaganga taluk. It runs for about 24 Km in easterly direction and confluences with Karaikulam Kanmoi of Ilayangudy taluk and finally finds its way to Raja Singa Mangalam big tank through Akkavayal and Viswanur tanks. There are 4 anicuts in this river and the total number of tanks benefited by this river is 17 having an ayacut area of 688.04 Ha.

SARUGANIAR:

Saruganiar originates from the surplus of Alavaikottai tank of Sivagangai taluk. Alavaikottai tank is the tail end tank of 48th sluice of 12th Branch channel of Periyar Main Canal. Saruganiar runs for a total distance of 63 Km (42 Km in Sivaganga district and 21 Km in Ramnad) before confluencing with Rajasingamangalam big tank. There are 11 anicuts feeding 126 tanks having a command area of 7810.65 hectares. From Alavaikottai, it passes through Perungudi, Nagarampatti, Paganeri, Kalattippatti, Puduvetti, Chattravayal, Sarugani, Sukkiravatti, Kadambakudi, Velarendal, Puthur and finally confluences with Raja Singa Mangalam big tank.

KOTTAKARAIYAR:

The Northern flood surplus of Raja Singa Mangalam big tank is called Kottakaraiyar. It passes through Chettikottai, Melmadai, Kilmadai, Sittanendal, Odaikkal, Pallappacheri and Puthukadu and finally it confluences with Palk Bay in between Uppurchattram and Karankadu. The length of Kottakaraiyar is about 35 km and feeding an ayacut of 686.80 ha.

UPPAR RIVER:

The southern flood surplus flow of Raja Singa Mangalam big tank is called Uppar river. Uppar river passes through Kosavanendal, Mullikkudi, Sinangudi, Pappanendal and finally confluences with Palk bay at 1 Km south of Thiruppalakkudi.

LOWER VAIGAI FEEDER CANAL:

The Raja Singa Mangalam big tank receives supply from lower Vaigai feeder canal. The lower Vaigai feeder canal originates from the Vaigai river at about 2 km east of Paramakudi town. It then passes through Kil Ayykudi, Valasai, Pithambaranendal, Arambakkottai, Ariyankottai and feeds Raja Singa Mangalam big tank.

2.2.3. SURFACE WATER STUDY:

A User defined model on SWAT has been developed for Tiruvannamalai District and has been validated. SWAT is the Acronym for Soil and Water Assessment Tool, a river basin or watershed scale model developed to predict the impact of land management practices on water sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and managements conditions over long periods of time. It is physically based model which requires specific information about weather soil properties, topography, vegetation and land management practices occurring in the watershed. The physical processes associated with water movement, sediment movement crop growth nutrient cycling etc, are directly modeled by SWAT. For modeling a watershed may be partitioned into a number of sub watersheds or sub basins which are then further subdivided into hydrologic response units (HRUs) that consist of homogeneous land use, management, and soil characteristics. The overall hydrologic balance is simulated for each HRU, including precipitation, and irrigation water between surface runoff and infiltration, redistribution of water within the soil profile, evapotranspiration, lateral subsurface flow from the soil profile, and return flow from shallow aquifers.

SWAT Model Input Data

The inputs to the SWAT model are the Digital Elevation Model (DEM), soil data, land use and climatic data for predicting stream flow and other water balance components.

Digital Elevation Model:

The Cartosat DEM with 30 m * 30 m spatial resolution, downloaded from BHUVAN was used in this study. This approach helped in watershed delineation and analysis of drainage patterns. The DEM was the source from which sub-watershed slope gradient, slope length of terrain and stream network characteristics such as channel slope, length and width were calculated.

Soil Data

The Soil map of scale 1: 50000 showing properties of the soil group, texture, bulk density, depth, saturated conductivity, soil albedo, erosion K, and organic carbon were collected from the report of the Tamil Nadu Agricultural University at Coimbatore. The soil map then converted to raster format and reclassified according to swat database.

Land Use:

For the year 2011-12 land use and land cover map at 1: 250,000 Resolution were collected from the National Remote Sensing Centre through Bhuvan portal. Land cover in the catchment was categorized into 16 classes. The above SWAT land use classes were arrived at by reclassifying the conventional land use classification provided by the National Remote Sensing Agency (NRSA).

Weather Data

Climatic inputs used in SWAT include daily precipitation, maximum and minimum temperature, solar radiation data, relative humidity, and wind speed data, which can be input from measured records and/or generated. The dataset from 2000-2019 were used for this study. The data set were sorted as per SWAT format and converted as text file by using weather generator.

Methodology:

The hydrological freely accessible model SWAT v.2012 was chosen (Arnold *et al.*, 2012) as a tool to simulate the influence of topography, the influence of soil and LULC on the water balance. Modeling with SWAT comprises the following steps: catchment model building (relief data is based on CARTODEM) including initial soil data LULC, preparation of the meteorological data, calibration of parameters, validation and then implementation. Because of gaps in the time series of climate data, the period 2000–2019 was chosen for set-up, calibration and validation of the model. This period contains years which are representative for relatively wet and dry conditions and can be used for both model calibration and validation. The catchment model was built with the ArcSWAT2012 GIS-interface.

HRU Development: The SWAT model representation of the upland watershed area is set up using HRUs. SWAT provides a built-in HRU overlay mechanism in the ArcSWAT interface. SWAT HRUs are formed from an intersection of land use, major soils and user-defined slope classes. HRU development for the both the districts was also implemented to facilitate the phosphorus loading reduction analysis phase of the project. As a result, model setup required creating HRUs specific to potential future implementation activities. The following steps describe how HRUs are developed in the ArcSWAT interface:

Import hybrid land use and soil data layers.

Specify three broad slope classes, namely, 0–5 percent, 5–10 percent and above 10 percent. Slope was calculated by the ArcSWAT interface using a 30-meter DEM of the basin. HRUs with slope greater than 5 percent could fall in the highly erodible land category.

Overlay land use, soil and slope layers: With some exceptions (described below), specify a threshold of 5 percent for land use, 10 percent for soil and 5 percent for slope while defining HRUs. Only land uses, soil types, and slope classes that exceed these percentages in a watershed were used to generate HRUs. This avoided creating an excessive number of HRUs, which would significantly increase model run time.

Defining climate database: One of the main sets of input for simulating the watershed in SWAT is climate data. Climate inputs consist of precipitation, maximum and minimum temperature, solar radiation, wind speed and relative humidity. The daily precipitation records for the period of 2000–2019 were used which were analysed to develop the climate-input files required for the model.

Model input set-up: The Write Input tables menu contains items that allow building database files containing the information needed to generate default input for SWAT. The Write commands become enabled after weather data were successfully loaded. These commands were enabled in sequence and need to be processed only once for a project. Before SWAT can be run, the initial watershed input values have been defined. These values were set automatically based on the watershed delineation and landuse/ soil/ slope characterization. There are two ways to build the initial values: activate the Write All command or the individual Write commands on the Write Input Tables menu. The first option has been selected. Finally, the other key aspects of the SWAT simulation performed for the watershed are listed below:

* Output time step: Daily
* Simulation period: : 20 years (2000–2019)
* Rainfall distribution: skewed normal
* Evapotranspiration: Pennman–Monteith approach

Model calibration: Model calibration is necessary for preliminary testing of a model and observed data can be tuned with it. Model calibration is necessary for the successful use of any hydrologic simulation. The model was first automatically calibrated for hydrology. Model calibration was conducted for 20 years from 2000 to 2019. The first five years were used for priming the model. The model needs at least five years for better estimation of results through priming (Gitau et al., 2003).

SWAT Simulation: The SWAT Simulation menu allows us to finalize the setup of input for the SWAT model and to run the SWAT model after this sensitivity analysis and auto-calibration has been carried out. From 2000 to 2004 is considered as warm up period. The output of the model are Surface runoff , Evapotranspiration, Soil water, Percolation and Ground water recharge (Table 2.14).

TABLE 2.14: WATER BALANCE COMPONENTS

A) Tiruvannamalai district					
YEAR	Evapo-transpiration mm	Soil water mm	Percolation mm	Surface runoff mm	Ground water recharge mm
2005	731.65	54.61	107.45	456.36	45.06
2006	483.521	46.80	38.06	166.39	38.18
2007	641.65	56.41	69.83	364.28	29.89
2008	635.59	55.20	86.84	405.71	46.21
2009	545.43	51.12	71.37	285.44	42.52
2010	623.19	54.34	89.88	368.72	43.67
2011	668.64	72.58	75.39	367.51	41.56
2012	622.44	47.56	42.54	270.36	28.01
2013	588.12	42.86	47.90	256.84	29.73
2014	621.66	50.711	46.78	254.50	19.25
2015	699.36	51.078	133.31	669.64	50.01
2016	469.00	60.00	90.00	135.00	99.00
2017	678.00	74.00	151.00	260.00	64.00
2018	544.00	53.00	80.00	121.00	59.00
2019	742.00	55.00	187.00	274.00	89.00

A) Ramanathapuram district					
YEAR	Evapo-transpiration mm	Soil water mm	Percolation mm	Surface run-off mm	Ground water recharge mm
2005	609.94	103.88	439.98	99.15	330.32
2006	439.68	86.45	283.97	90.00	308.26
2007	579.74	105.41	215.19	55.76	166.77
2008	640.77	100.86	503.63	205.27	435.58
2009	469.11	109.24	278.80	84.59	200.15
2010	624.49	108.06	402.01	111.70	300.34
2011	812.60	106.95	101.17	180.34	117.48
2012	766.23	103.04	68.24	117.88	66.00
2013	533.68	93.97	75.25	91.01	53.88
2014	514.94	106.57	256.46	57.20	161.77
2015	678.69	115.80	220.86	37.81	161.33
2016	821	61	181	288	80
2017	530	53	67	80	68
2018	719	67	126	224	60
2019	708	62	153	267	86

Results and output from the Surface Water Study:

Surface Water Study: The average annual water balance components were listed in the table. The evapotranspiration from 2005 to 2019 were derived from SWAT model for the Tiruvannamalai district. The ETo ranges from 483.52 mm to 742.64 mm. The ETo is high in 2005 due to good amount of rainfall and low in 2006. The soil water ranges from 42.86 mm to 74 mm. The soil water is low in 2013 and high in 2017. The percolation ranges from 38.05 to 187.00. The very high value is derived in the year 2019. Low value arrives in the year 2006. The surface runoff value ranges from 166.39 to 669.64. the value is high in 2015 and low in 2006. The ground water recharge ranges from 19.24 to 99.00. the ground water recharge value is high in 2014 and low in 2016.

To validate the model, simulated and observed Evapotranspiration at the Dushayyangulam station were compared for five years. It shows that the calculated hydrographs reasonably match the observed ETo data. The most widely used statistics reported for calibration and validation are r2. The r2 statistic can range from 0 to 1, where 0 indicates no correlation and 1 represents perfect correlation, and it provides an estimate of how well the variance of observed values are replicated by the model predictions (Krause *et al.,* 2005). Here the r2 value is 0.6611 which is moderately correlated with observed and predicted data.

ETO	483.52 mm to 742.64 mm
SOIL WATER	42.86 mm to 74 mm
PERCOLATION	38.05 to 187.00
SURFACE RUNOFF	166.39 to 669.64
GROUND WATER RECHARGE	19.24 to 99.00

2.3.4. HYDROLOGICAL PROBLEM

A) Tiruvannamalai district:

A model sub basin namely Naganadhi has been taken and the hydrological problems have been identified and solutions given thereon.

The hydrological problem is Setharampattu tank from Kamandala river silted up and tank not receiving water for 30 years. So additional supply channel is needed from previous anicut.

Hydrological problem - Vellore anicut requiring renovation

The hydrological problem is sand mining in Kamandala river- Action to be initiated for stopping of the sand mining .

Renovation works need to be taken in Kangranandal anicut

B) Ramanathapuram district

A model sub-basin namely Kottakaraiar has been taken and the hydrological problems have been identified and solutions given thereon.

Hydrological problems in Varavani Tank Weir Partially Broken: Water is not stored to its full capacity. Hence the quantity of water supplied to irrigation is getting reduced. Rectification to this work is of minor in nature and should be carried out immediately.

Hydrological problem is no defined course in weir of Varavani tank: Surplus water going through field. Action to be initiated for forming a course for the smooth and efficient flow of water to the lower tank.

Hydrological problem- Water does not enter into the tank due to silting up of inflow point through Sarukaniar anicut to Kottakarai river. Necessary landscaping and allied works should be carried out to overcome this problem so that inflow to R.S.Mangalam tank is to be realized without any obstructions.

Hydrological problemin Suriankottai river: Lot of encroachment and river flowing as two compartments. Action to be taken is to remove encroachment.

Hydrological problem in Melaselvanur pond: water loss is through evaporating, need recharge shafts.

Hydrological problem- Head Sluice for R.S. Mangalam tank in dilapidated condition and Renovation works need to be taken.

Hydrological problem- Surplus course from 560 feet weir with no culvert, starting point of Peeyar river. It has no culvert, Priority is to is to construct culvert for smooth flow of river.

Hydrological problem - Inflow point of Vaigai River water to R S Mangalam- no dependable supply as there are lot of encroachment which needs to be removed and the entire system need to be removed.

Hydrological problem- Kaikudi tank surplus with lot of vegetation obstructing the flow to Sholandur big tank and Encroachment need to be evicted.

Hydrological problem- Illegal earthern bund across Peeyar river feeding Sholandur big tank which obstructing the natural flow. Rectification measures needs to be taken.

Hydrological problem - Water scarcity villagers of Seenangudi carrying water in carts. To overcome this problem, recharge well having 2m diameter and 4m depth with two shaft having 3m depth shall be provided in tanks near the area.

Hydrological problem- Tirupalaikudi tank anicut. Villagers shutting the vents since water in the anicut is salty and if opened it will salanise the tank water.

Hydrological problem- Backwater near Tiruppalaikudi village upto 5 m and to overcome this, check dam and recharge well construction is proposed

Hydrological problem- Kottakaraiyar bridge downstream side back water and check dam and recharge well construction is proposed.

2.2.5. SUB- BASIN MANAGEMENT PLAN

2.2.5.1. TIRUVANNAMALAI

The hydro geological conditions of the district was studied in detail and proposal for recharge of ground water has been framed and shared with the Engineers of the rural department (Table 2.15 and Map 2.3)

Map 2.3: Map showing the areas of proposed ground water recharge

TABLE 2.15: COST ESTIMATE FOR CONSTRUCTION OF RECHARGE STRUCTURES, TIRUVANNAMALAI DISTRICT

COST ESTIMATE FOR CONSTRUCTION OF RECHARGE WELLS

Sl. No.	Category	Qty (Nos.)	Unit Price (in Rs.)	Amount (in Rs.)
1.	Recharge Well	54	30,00,000	**16,20,00,000**

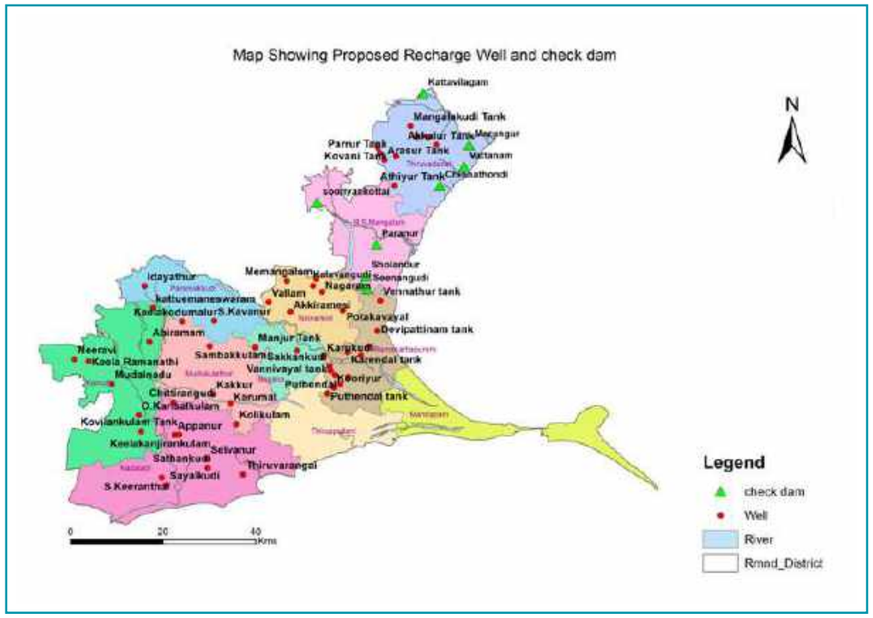
COST ESTIMATE FOR CONSTRUCTION OF CHECK DAMS

Sl. No.	Category	Length (meters)	Qty(Nos.)	Unit Price for length(in Rs.)	Amount (in Rs.)
1.	Kamandalar_Naganathi	62.17	1	8 ,00,000	4,97,36,000
2.	Pudhupalayam	20.02	1	8 ,00,000	1,60,16,000
Total					**6,57,52,000**

Total Estimate of Recharge well and Check Dam **Rs.20,97,52,000**

2.2.5.2. RAMANATHAPURAM

The hydro geological conditions of the district was studied in detail and proposal for recharge of ground water has been framed and shared with the Engineers of the rural department. Basin management is a geographically based approach of protecting and restoring water quality and quantity. Due to falling Ground water level, recharge structures and check dams are proposed (Table 2.16 and Map 2.4)



Map 2.4: Map showing the areas of proposed ground water recharge

TABLE 2.16: COST ESTIMATE FOR CONSTRUCTION OF RECHARGE STRUCTURES, RAMANATHAPURAM DISTRICT

COST ESTIMATE FOR CONSTRUCTION OF RECHARGE WELLS

Sl. No.	Category	Qty (Nos.)	Unit Price (in Rs.)	Amount (in Rs.)
1.	Recharge Well	54	30,00,000	**16,20,00,000**

COST ESTIMATE FOR CONSTRUCTION OF CHECK DAMS

Sl. No.	Category	Length in (mts)	Qty (Nos.)	Unit Price (in Rs.)	Amount (in Rs.)
1	Marungur	191.2	1	8 ,00,000	152960000
2	Vattanam	55.6	1	8 ,00,000	44480000
3	Chinnathondi	70.8	1	8 ,00,000	56640000
4	Kattavilagam	121.5	1	8 ,00,000	97200000
5	Paranur	217.2	1	8 ,00,000	173760000
6	Sooriyankottai	55.6	1	8 ,00,000	44480000
7	Kalavangudi	166.9	1	8 ,00,000	133520000
8	Sholandur	422.1	1	8 ,00,000	337680000
9	Seenangudi	58.1	1	8 ,00,000	46480000
Total					**10,87,200,000**

Total Estimate of Recharge wells and Check Dams **Rs.124,92,00,000**

2.2.6. RESOURCES FOR USE BY DISTRICT OFFICIALS

The relevant shp/kml/kmz at Village/GP level is provided for use by block and district officers to plan, implement and monitor the progress under WASCA, with in CWRM framework. The files on the following themes have been developed for integration in shape file format with CWRM Framework (Table 2.17).

TABLE 2.17: LIST OF FILES DEVELOPED FOR INTEGRATION WITH CWRM IN SHAPE FILE FORMAT IN TIRUVANNAMALAI DISTRICT

Sl. no	Shape files	Sl. no	Shape files
1	Block Map	**18**	Isohyetal Map – Below Normal Year
2	Taluk Map	**19**	Isohyetal Map – Above Normal Year
3	Village Map	**20**	Isohyetal Map – Summer Season
4	Firka Map	**21**	Isohyetal Map – Winter Season
5	Gram Panchayat Map	**22**	Isohyetal Map – South West Monsoon
6	Drainage Map	**23**	Isohyetal Map – North East Monsoon
7	Tanks	**24**	Isohyetal Map – Jan – May
8	Lithology Details	**25**	Full Climatic Stations
9	Geology Map	**26**	Thiessen polygon of Full Climatic Stations
10	Geomorphology Map	**27**	Network of Observation Wells
11	Soil Map	**28**	Ground Water level in a Normal Year – Pre Monsoon
12	Land use Map	**29**	Ground Water level in a Normal Year – Post Monsoon
13	Digital Elevation Model	**30**	Drought Year – Deepest Ground Water level
14	Network of Raingauge stations	**31**	Wet Year – Shallowest Ground Water level
15	Thiessen polygon of Raingauges	**32**	Locations of Geophysical Survey
16	Isohyetal Map –Annual Average Rainfall	**33**	Proposed Recharge Well and Check dam
17	Isohyetal Map – Normal Year	**34**	Firka and GP wise Ground water assessment

2.3 SALINITY AND SEA WATER INTRUSION

2.3.1 INTRODUCTION

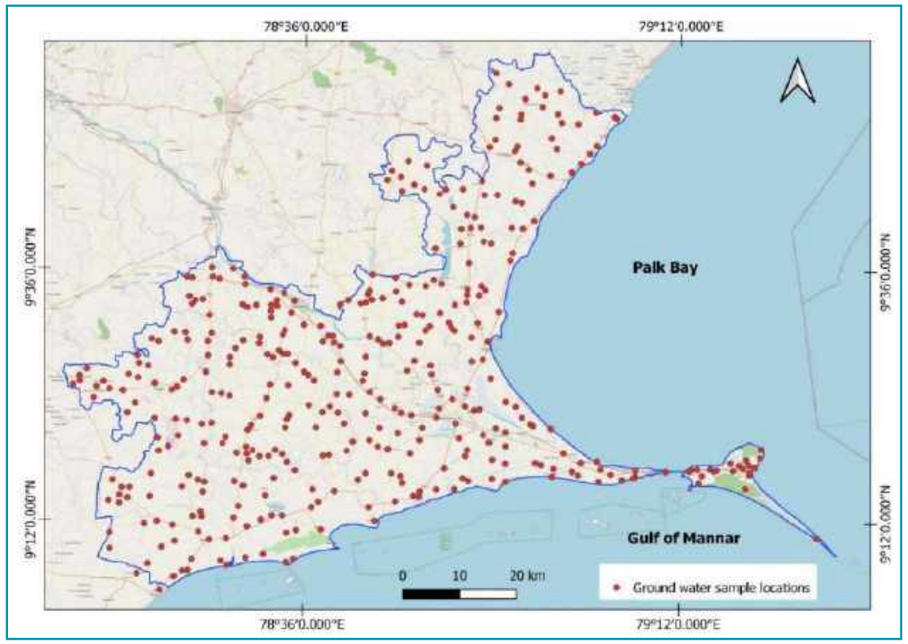
The Ramanathapuram is a coastal district, seawater intrusion is one of the major issues affecting the ground water quality. The ground water sources in Ramanathapuramare present in the porous as well as fissured formations. The aquifer system consists of unconsolidated and semi-consolidated formations and they are of weathered and fractured crystalline rocks. The ground water levels in the district range from 6 to 777 m below ground level depending upon the type of the formation. The quality of ground water in general is colorless, odourless and slightly alkaline in nature, and total hardness exceeds the permissible limits. From the irrigation point of view, the ground water has high to very high salinity hazard, and medium to high alkali hazard, due to seawater intrusion and/or rock water interaction. So proper water management strategies are to be adopted before using the ground water for drinking, domestic, irrigation and industrial purposes. For taking proper management action, it is necessary to undertake a detailed study of the extent of seawater intrusion in aquifers and of the ground water quality for the entire district. This enable easy identification of the water challenges and facilitate water budget estimation and preparation of action plan under Mahatma Gandhi NREGS activities at Gram Panchayat levels as per CWRM plan. In this backdrop, study was conducted on 'Reducing effects of seawater intrusion into freshwater resources through vulnerability mapping and assessment for Ramanathapuram District with the following objectives.

- To map vulnerability of the ground water quality in aquifers, extent of seawater intrusion in the aquifers of Ramanathapuram District
- Estimate annual rate of seawater intrusion
- Develop effective plan, suitable methodology for the sustainable management for arresting/ reducing seawater intrusion in Ramanathapuram district (with Climate Adaptation)

The results are made available in the form of shapefile/kml format and they can be utilized in preparing CWRM plan at Gram Panchayat levels for the entire district.

2.3.2 METHODOLOGY

The study was conducted with the following methodology: a) Evaluation of seawater intrusion include ground water chemistry, pattern diagrams and geographical information studies and b) GIS, RS methodologies with high resolution to understand and act at the field level.



Map 2.5: Map showing the ground water sample locations for the Ramanathapuram district

2.3.2.1. COLLECTION OF GROUND WATER SAMPLES:

The entire Ramanathapuram District was divided into 227 grids of 5 km from the coastline landwards, and samples from the grids were collected at 1x1km. Samples were collected from the available bore wells or open wells in the grid during pre-monsoon and post-monsoon. Extensive fieldwork was undertaken for the entire Ramanathapuram district from 15th to 18thJuly 2020 and 18th to 21st August 2020 to collect ground water samples for pre-monsoon season and from 5th to 12th January 2021 for post-monsoon season. Totally 378 numbers of samples were taken during each season (Fig. 2.22). Handheld Global Positioning System (GPS) was used to mark the coordinates of the bore wells and open wells.

2.3.2.2. ANALYSIS OF GROUND WATER SAMPLES

Both the physical and chemical parameters were analysed for the collected ground water samples using standard methodology (APHA 2005). Physical parameters like EC, pH and TDS were measured with handheld digital meter with an accuracy of 1 µS/cm and 1ppm. Salinity was measured with handheld refractometer. Chemical parameters such as contents of Sodium (Na) and Potassium (K) were analysed with Flame Photometer; Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using EDTA standard solution in the presence of eriochrome black T as an indicator. Alkalinity was determined by titration with H2SO4 standard solution in the presence of methyl orange as an indicator. Chloride (Cl) was estimated by titrating against AgNO3 standard solution in the presence of potassium chromate as an indicator, whereas Sulphate (SO4) and Nitrate were estimated using UV-spectrophotometer.

2.3.2.3. WATER QUALITY INDEX (WQI) AND SEAWATER MIXING INDEX (SMI)

Water Quality Index is defined as a measure of rating that provides the composite influence of individual water quality parameter on the overall quality of water (Saeedi *et al.* 2010; Wu *et al.* 2017). Similarly, Seawater Mixing Index is for the effective isolation of seawater mixing in ground water in coastal regions. For the present study both the indices were applied.

2.3.2.4. SPATIAL MAPPING USING GIS

Base map for the current study was prepared with the help of open street map and toposheet using ArcGIS software (QGIS). To this base map, the collected GPS points of the sampling sites were transferred from GPS to the GIS software. Attribute tables were created for each station and results for the collected samples were fed into the tables for the corresponding sample locations. With this spatial data, spatial variations of the results for different water quality parameters were developed using Inverse Distance Weighted (IDW) interpolation method. Similarly, thematic map for WQI and SMI were prepared (Horvat 2013). This GIS data format of kml/shapefile can be used in preparing and developing effective CWRM plan.

2.3.3.RESULTS

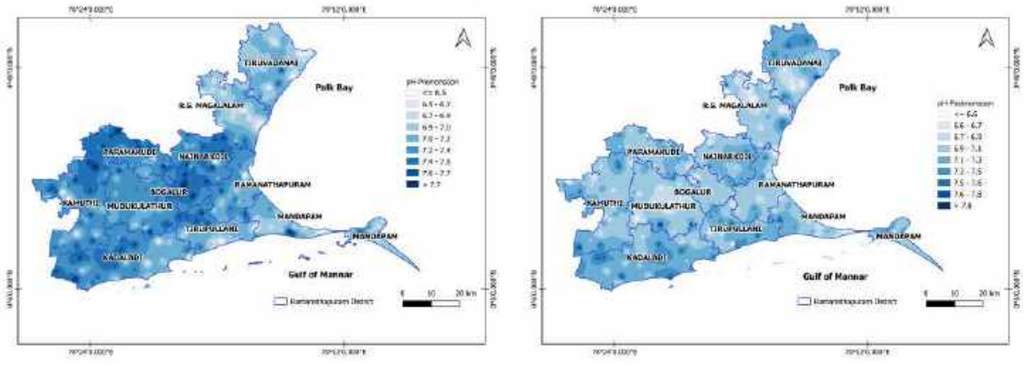
The ranges of various physico-chemical characters of pre-monsoon and post-monsoon ground water quality for the analysed samples are listed in the Table 2.18

TABLE 2.18: SHOWS THE RANGES OF VARIOUS PHYSICO-CHEMICAL CHARACTERS OF PRE- AND POST-MONSOON GROUND WATER QUALITY AGAINST WHO AND IS DRINKING WATER STANDARDS

Parameters	Pre-monsoon	Post-monsoon	WHO standard	IS standard (BIS 10500:1991)	
				Desirable	Permissible
pH	6.1 to 8.1	6.25 to 8.0	8.5	6.5 to 8.5	6.5 to 8.5
Salinity (ppt)	0 to 40	0 to 28	-	-	-
EC (µS/cm)	377 to 53,900	167 to 38,290	-	-	-
TDS (mg/l)	214 to 32,020	104 to 23,740	500	500	2000
Total Alkalinity (mg/l)	220 to 481	43 to 1297	-	200	600
Carbonate (mg/l)	34 to 152	3 to 279	-	-	-
Bicarbonate (mg/l)	121 to 363	36 to 987	200		
Total hardness(mg/l)	45 to 6,425	20 to 2,835	-	300	600
Calcium (mg/l)	21 to 2,937	10 to 1,356	75	75	200
Magnesium (mg/l)	12 to 1,645	2 to 1,461	30	-	-
Sodium (mg/l)	10 to 4,270	8 to 1,262	200	-	-
Potassium (mg/l)	1 to 97	1 to 168	100	-	-
Chloride (mg/l)	32 to 8,609	15 to 6,452	200	250	1000
Nitrate (mg/l)	1 to 140	1 to 186	45	45	100
Sulphate (mg/l)	2 to 240	2 to 268	200	200	400

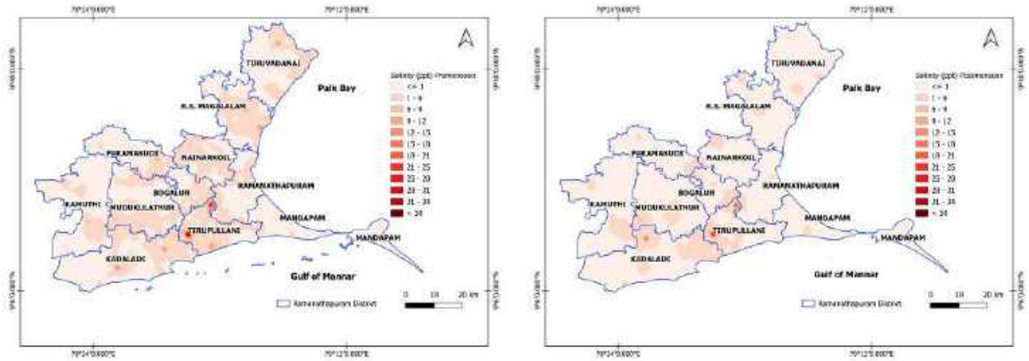
2.3.3.1. pH

The pH values of ground water samples range between 6.12 and8.13 for the pre-monsoon and between 6.25 and8.02 for the post-monsoon seasons (Table 2.18). The minimum value occurs in Raghunathapuram and the maximum in Tharakudi for pre-monsoon, while the minimum value occurs in K.Maduari and Pathanadhal, and the maximum occurs in Poongulami during post-monsoon. The spatial distribution diagram of pH indicates reduction in the value of pH in the central region and slight increase in the pH in the coastal region during post-monsoon as compared with pre-monsoon.



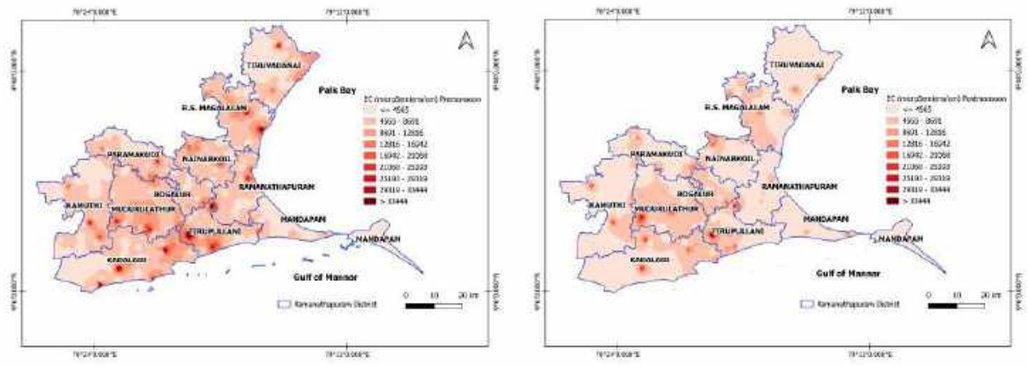
2.3.3.2. SALINITY

The salinity values of ground water samples range between 0% and 40% for the pre-monsoon and 0‰ and 28‰ for the post-monsoon season (Table 2.18). The highest value occurs at Mariyarayapuram for both the seasons. The spatial distribution diagram of salinity indicates that salinity is present in the central and some parts of the coastal regions of the district. Similarly, there is reduction in salinity during post-monsoon.



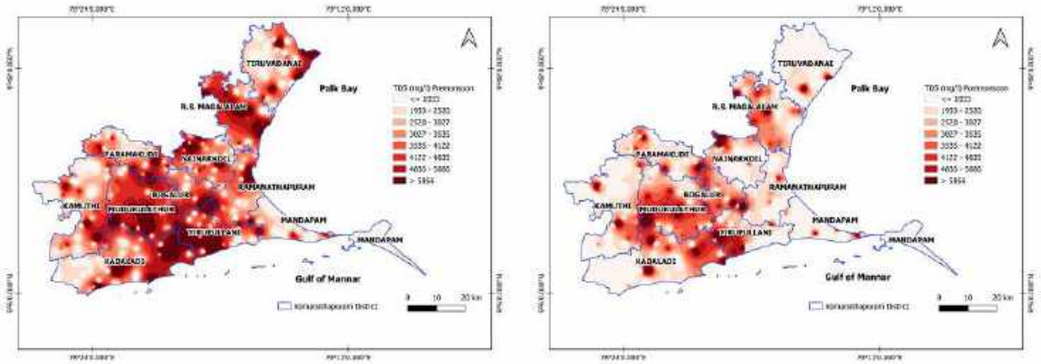
2.3.3.3. ELECTRICAL CONDUCTIVITY (EC)

The EC values of ground water samples range between 377 and 53,900 µS/cm for the pre-monsoon and 167 and 38,290 µS/cm for the post-monsoon season (Table 2.18). Higher EC value occurs at Mariyarayapuram during both the seasons. The spatial distribution diagram of EC indicates higher concentration in the south, central and northern parts of the district during pre-monsoon, which decreases considerably during post-monsoon.



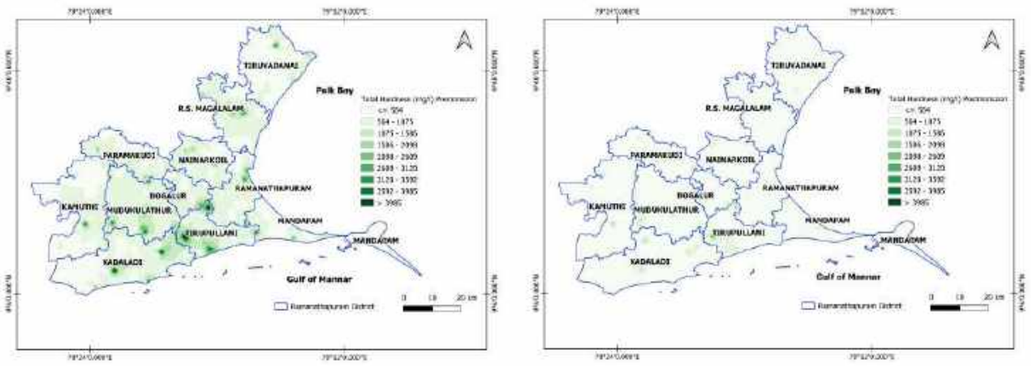
2.3.3.4. TOTAL DISSOLVED SOLIDS (TDS)

The TDS values of ground water samples range between 214 and 32,020 mg/l for the pre-monsoon. For post-monsoon, they range between 104 and 23,740 mg/l (Table 2.18). Higher TDS is observed at Mariyarayapuram during both the seasons. The spatial distribution diagram of TDS indicates higher concentration in the south, central and northern parts of the district during pre-monsoon, which is reduced considerably during post-monsoon.



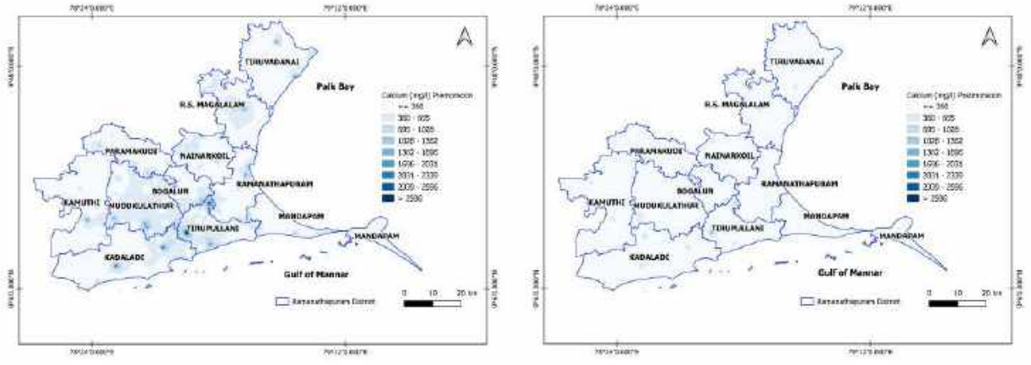
2.3.3.5. TOTAL HARDNESS (TH)

The TH values of ground water samples range between 45 and 6,425 mg/l for the pre-monsoon and between 20 and 2,835 mg/l for the post-monsoon seasons (Table 2.18). Higher TH is observed at Mariyarayapuram during both the seasons. The spatial distribution diagram of TH indicates higher concentration in the south-central and a few regions in the northern parts of the district during pre-monsoon, which decreases considerably during post-monsoon.



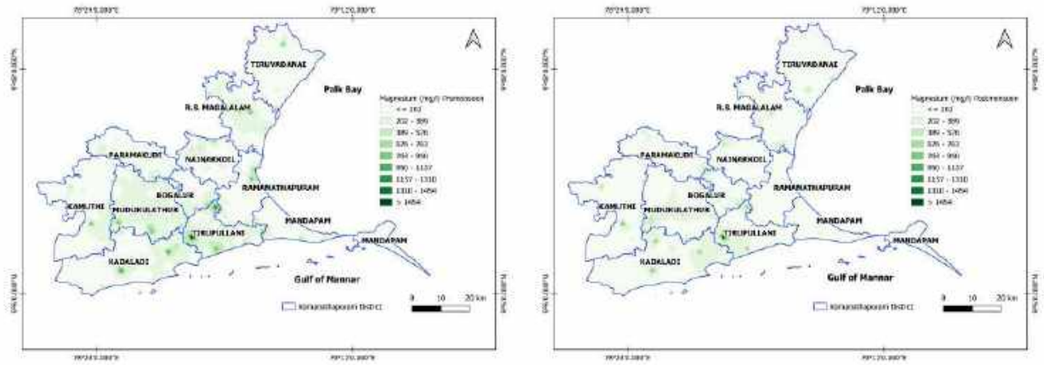
2.3.3.6. CALCIUM (CA)

The calcium values of ground water samples range between 21 and 2,937 mg/l for the pre-monsoon and between 10 and 1,356 mg/l for the post-monsoon seasons (Table 2.18). Higher Ca concentration is observed at Mariyarayapuram during both the seasons. The spatial distribution diagram of Ca indicates higher concentrationin the south and central parts of the district during pre-monsoon, which falls considerably during post-monsoon.



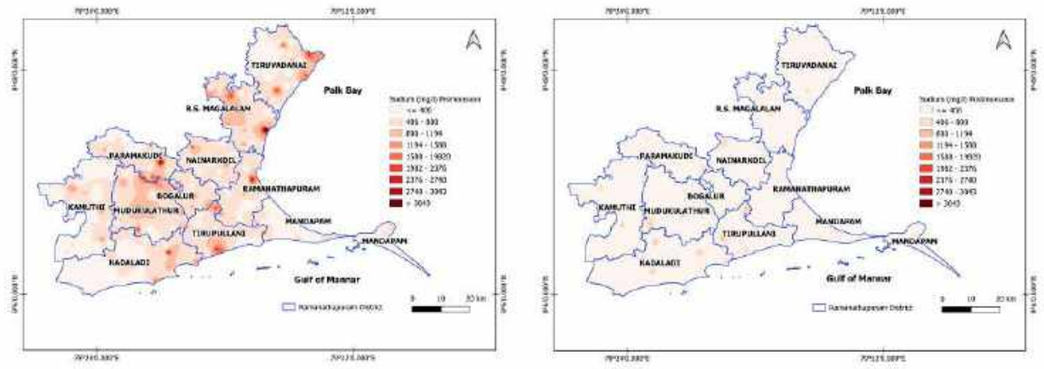
2.3.3.7. MAGNESIUM (MG)

The magnesium values of ground water samples range between 12 and 1,645 mg/l for the pre-monsoon and between 2 and 1,461 mg/l for the post-monsoon seasons (Table 2.18). Higher Mg is observed at Mariyarayapuram during both the seasons. The spatial distribution diagram of Mg indicates higher concentration in the south and central parts of the district during pre-monsoon, which drops during post-monsoon.



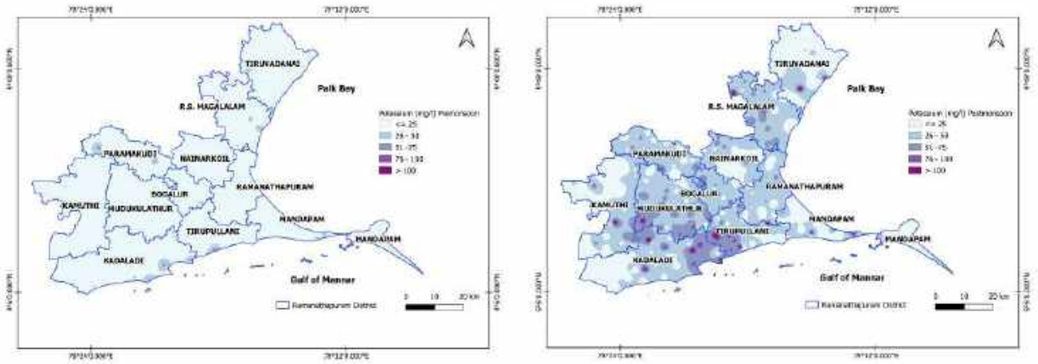
2.3.3.8. SODIUM (NA)

The sodium values of ground water samples range between 10 and 4,270mg/l for the pre-monsoon and between 8 and 1,262 mg/l for the post-monsoon seasons (Table 2.18). Higher Na values are observed at Uppur and Mariyarayapuram during pre-monsoon and post-monsoon respectively. The spatial distribution diagram of Na indicates higher concentration in the south-central and northern parts of the district during pre-monsoon, which is reduced considerably during post-monsoon



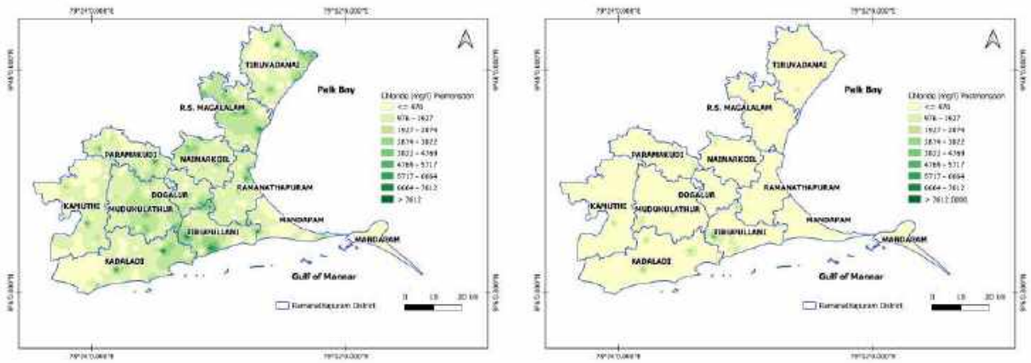
2.3.3.9. POTASSIUM (K)

The potassium values of ground water samples range between 1 and 97mg/l for the pre-monsoon and between 1 and 168 mg/l for the post-monsoon seasons (Table 2.18). Higher K values are observed at PP Yenthal and Mariyarayapuram during pre-monsoon and post-monsoon respectively. The spatial distribution diagram of K indicates that there is increase in the concentration of potassium during post-monsoon.



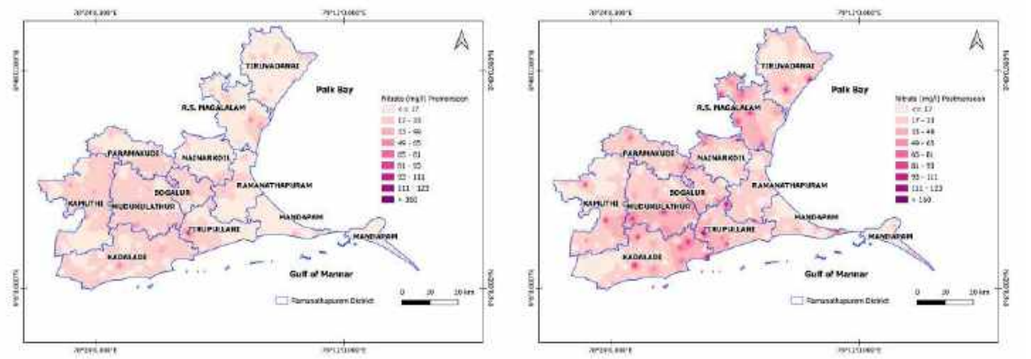
2.3.3.10. CHLORIDE (CL)

The chloride values of ground water samples range between 32 and 8,609 mg/l for the pre-monsoon and between 15 and 6,452 mg/l for the post-monsoon season (Table 2.18). Higher Cl concentrations are observed at Mariyaray-apuram during both the seasons. The spatial distribution diagram of Cl indicates higher values in the south, central, northern parts and in places along the coastal region during pre-monsoon, which decreases considerably during post-monsoon.



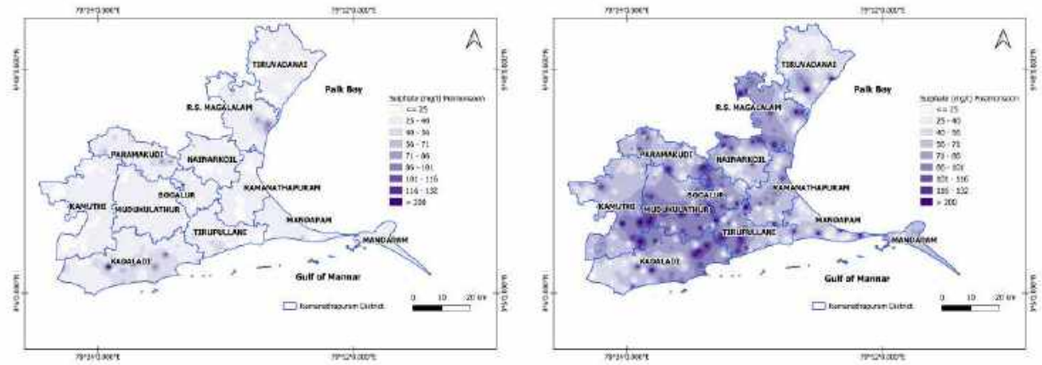
2.3.3.11. NITRATE (NO3)

The nitrate values of ground water samples range between 1 and 140 mg/l for the pre-monsoon and between 1 and 186 mg/l for the post-monsoon seasons (Table 2.18). Higher NO3 values are observed at Mariyarayapuram during both the seasons. The spatial distribution diagram of NO3 indicates that there is increase in the concentration during post-monsoon. The values are higher in south-central and some parts of northern regions.



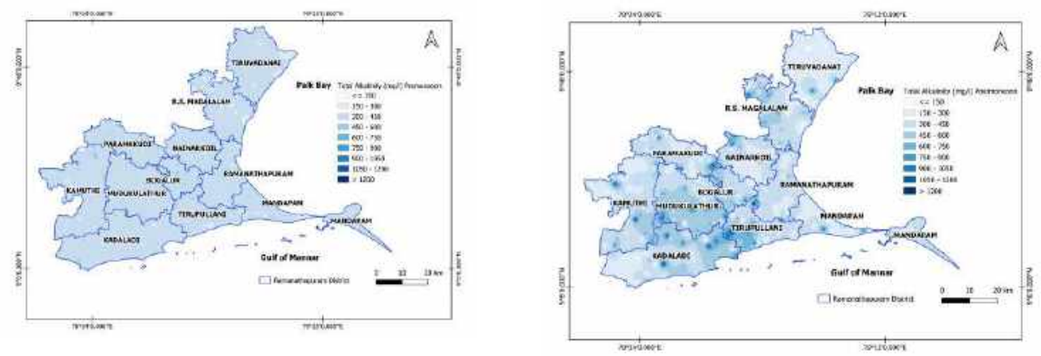
2.3.3.12 SULPHATE (So4)

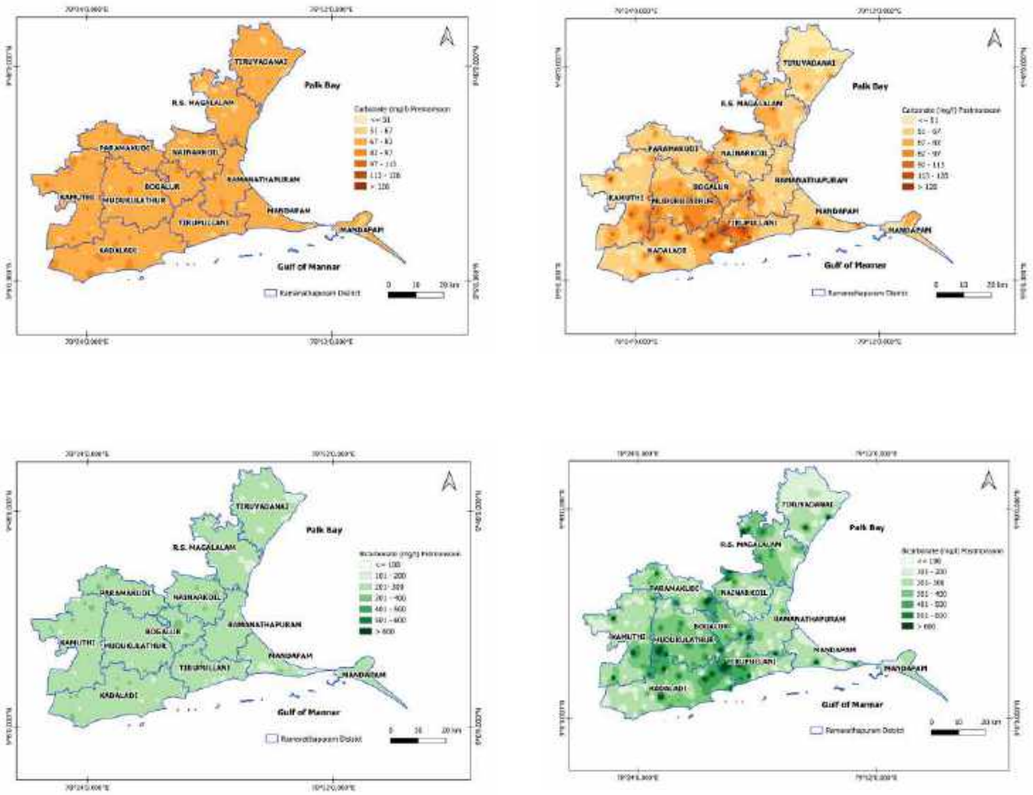
The sulphate values of ground water samples range between 2 and 240 mg/l for the pre-monsoon and between 2 and 568 mg/l for the post-monsoon seasons (Table 2.18). Higher So4 concentrations are observed at Pullandhai and Mecca Nagar during pre-monsoon and post-monsoon seasons. The spatial distribution diagram of SO4 indicates that there is increase in the concentration during post-monsoon and it is higher in south-central and some parts of north-west regions of the district.



2.3.3.13. TOTAL ALKALINITY (TA)

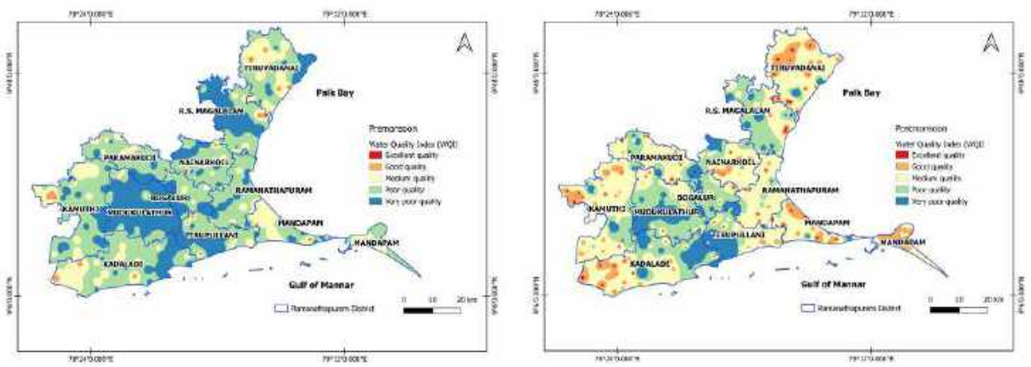
The total alkalinity values of ground water samples range between 220 and 481 mg/l for the pre-monsoon and between 43 and 1,297 mg/l for the post-monsoon seasons (Table 2.18). Carbonate ranges between 34 and 152 mg/l for pre-monsoon, whereas it ranges between 3 and 279 mg/l for post-monsoon. Similarly, bicarbonate ranges between 121 and 363 for pre-monsoon and between 36 and 987 mg/l during post-monsoon respectively. Higher TA is observed at Tharaikudi and Mecca Nagar during pre-monsoon and post-monsoon respectively. The spatial distribution diagrams of total alkalinity, carbonate and bicarbonate indicate that there is increase in concentration at south-central and north-western regions, while decrease in concentration in the rest of the region during post-mon-soon.





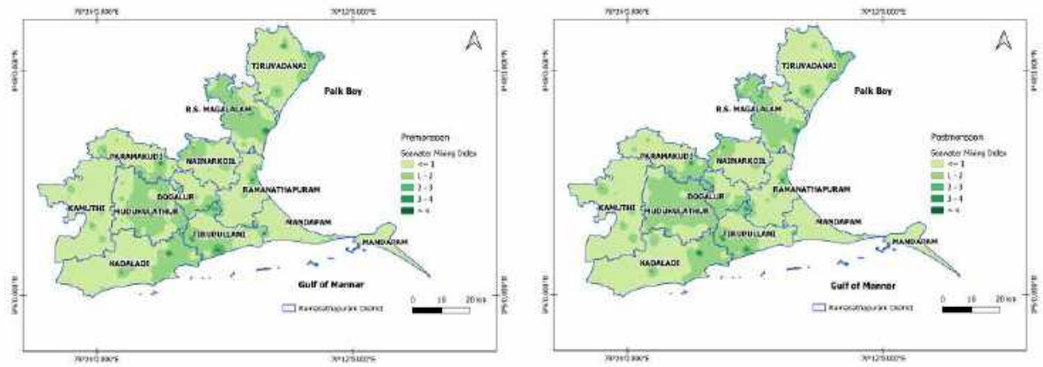
2.3.3.14. WATER QUALITY INDEX (WQI)

The spatial distribution diagram of WQI indicates increase in the quality of ground water during post-monsoon season. Nearly 50 % of the collected samples fall under excellent and good quality during post-monsoon, whereas nearly 50 % of the samples fall under poor and very poor-quality during pre-monsoon.



2.3.3.15. SEAWATER MIXING INDEX (SMI)

The spatial plot demarcates the seawater intrusion and freshwater zone, where southern, central and northern regions of the Ramanathapuram district are affected by seawater intrusion during pre-monsoon and post-monsoon. The SMI values indicate that 30% of the samples are influenced by seawater intrusion.



2.3.4. Key Findings

The ground water quality of the district is greatly influenced by seasonal rainfall.

Remarkable changes in the concentration of electrical conductivity and total dissolved solids are observed during pre-monsoon and post-monsoon seasons.

Seasonal rainfall infiltration into the ground water reduces the pH levels in the central region of the district.

Similarly increase in the sulphate concentration during post-monsoon could be due to the dissolution of minerals by the infiltrating rainwater.

The higher electrical conductivity and higher concentrations of total dissolved solids, sodium and potassium in the central and coastal regions could be due to seawater intrusion in the aquifer.

Assessment of groundwater quality for drinking purpose as indicated by WQI shows that in the pre-monsoon seasonwater quality is dominated by poor and very poor, whereas in the post-monsoon period the quality is dominated by excellent and good.

Seawater Mixing Index indicates that south-central and north-central regions of the district are affected by seawater intrusion and nearly 30% of the samples are affected by the intrusion.

2.3.5. Recommendations

RECOMMENDATIONS

- As seasonal rainfall greatly influences the quality of ground water in the entire Ramanathapuram district, the implementation of various watershed activities will enhance the ground water quality in future.
- Ramanathapuram district has a large number of waterbodies;deepening and desiltation of the existing waterbodies will improve the ground water quality.
- Water harvesting structures, such as recharge structures, rainwater harvesting structures must be constructed in the existing waterbodies and water logging areas.
- Construction of water absorption trenches must be promoted wherever possible.
- Measures must be taken to increase the water levels in the water bodies, which are not completely filled in the present monsoon seasons.
- Existing kanmai's can be rejuvenated through various watershed activities.
- Improving waste water management by providing proper wastewater drains and soak pitswill improve the quality of ground water.
- Filtration and reverse osmosis techniques can be adopted wherever the water quality is poor.
- The existing taruvai can be rejuvenated by the rising of bunds and providing surplus weir wherever necessary.
- As the district hasa long sea coast, sand dune stabilization can increase the coastal aquifer capacity, thereby preventing seawater intrusion and improving ground water quality.
- Coastal bio-shields such as mangroves and associates can be conserved to strengthen the coastal watershed.

CHAPTER 3

COMPOSITE WATER RESOURCE MANAGEMENT PLANNING FOR CLIMATE RESILIENCE

3.1 CWRM PLAN FRAMEWORK

3.1.1. ELEMENTS OF CWRM

The Composite Water Resources Management Planning (CWRMP) designed at a National Level Workshop organised by GIZ in Feb 2020 with participation of all WASCA implementing states and approved by MoRD and MoJS. The principles of CWRM are based on national and internationally approved approaches on Four Waters, Sustainable Development Goals, Nationally Determined Contributions (NDCs) on Climate Change and Integrated Water Resources Management (IWRM) principles.

There are four levels of CWRM Planning under WASCA (Fig 3.1):

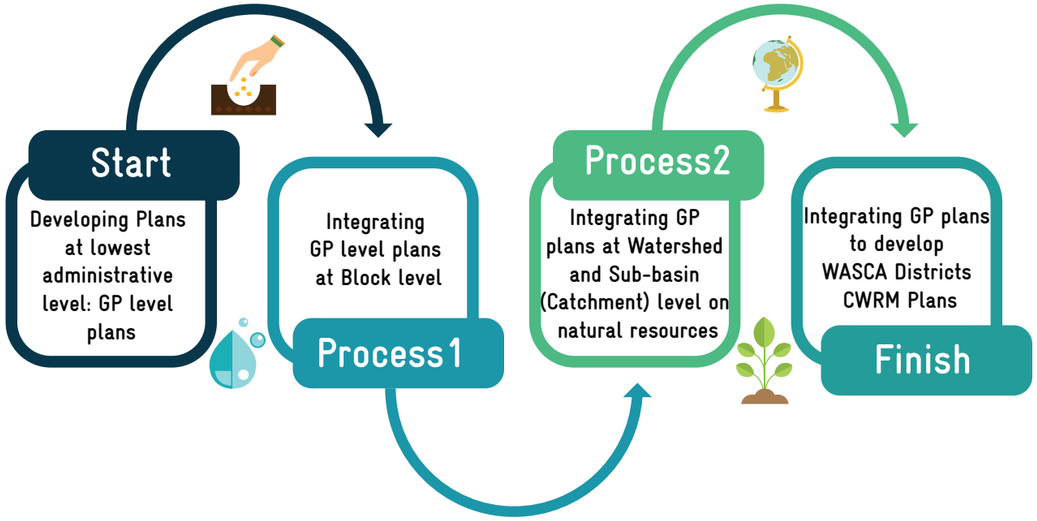


Fig 3.1: Levels of CWRM planning

CWRM approach for Water Security and Climate Adaptation uses simple scientific tools that can help a block level or GP level officer to organize, analyze and prepare draft plan for participatory discussion at Gram Panchayat level. The district WASCA resource centers established in the project area, facilitates this process for planning. There are five major components for CWRM planning exercise as given in below Fig 3.2.

Scientific Planning

- Spatial and non-spatial data collection
- Spatial data: Bhuvan (NRSC) & WRIS
- Non-spatial data(Secondary): Govt. sources(published)
- Non-Spatial data(Primary): Govt. records local level

Gram Panchayat Water Budget

- Analysis of water from supply and demand side
- Water budgeting: Surface & ground water
- Status of soil moisture availability
- Status of evapo-transpiration losses

Deriving GP level Water Actions

- Identification of Key water challenges at GP level
- Identification of location specific actions at GP level
- Integration actions at block, sub-basin and district level
- 261 list of works under Mahatma Gandhi NREGS and
- List of Works -under various schemes

Results

- Works and its impact on augmenting Water
- Works and its impact on conserving water
- Works and its impact promoting efficient use of water

Integrating Plans

- Block level
- Watershed level & Sub-basin level
- District level and
- Baseline for assessing the impact

Fig 3.2: Components of CWRM planning exercise

3.1.2) STEPS IN CWRM PLANNING UNDER WASCA IN TAMIL NADU

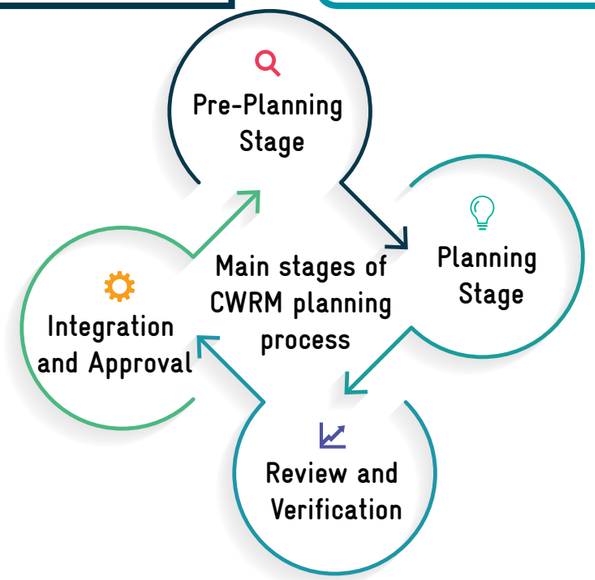
As per the directions of State Level Steering Committee on WASCA, in the state of Tamil Nadu, a five pronged approach is taken up in adopting the CWRM planning. The details are provided in the Fig 3.3.

PRE-PLANNING STAGE

1. Categorizing Villages for planning as per Mahatma Gandhi NREGS guidelines
2. Identification of GP, Block, District officers for planning facilitation
3. Capacity Building and district specific CWRM framework and indicators suitable to the terrain and geography
4. Identification of Phases for planning (4 GP Plans per block) as per DLSC and SLSC

PLANNING STAGE

1. Collection on Non-Spatial Data as per MoRD guidelines and CWRMP
2. Collection of Spatial as per MoRD guidelines and CWRMP
3. Water Budget Estimation (CWRMP)
4. Conducting district specific studies on Ground Water Assessment as per CWRM
5. Inclusion on Non-NRM activities under Mahatma Gandhi NREGS with CWRMP
6. Identification of Key Water Challenges - CWRMP
7. Identification of Key Water Actions - CWRMP



REVIEW AND VERIFICATION

1. Matching spatial data as per Mahatma Gandhi NREGA- MoRD guidelines on GIS based planning
2. Field Verification, GP level Meetings for inclusion in labour budget 2021-22
3. Regular review on progress at all levels

INTEGRATION AND APPROVAL

1. Preparation of Integrated plans (Block, Watershed)
2. District Level WASCA Plan
3. Approval at GP level for preparation of Labour budget using CWRM frame work outcomes
4. Approval of District plan at DLSC
5. Submitting approved District WASCA plan from DLSC to SLSC for financing

Fig 3.3: Main Stages of CWRM Planning Process

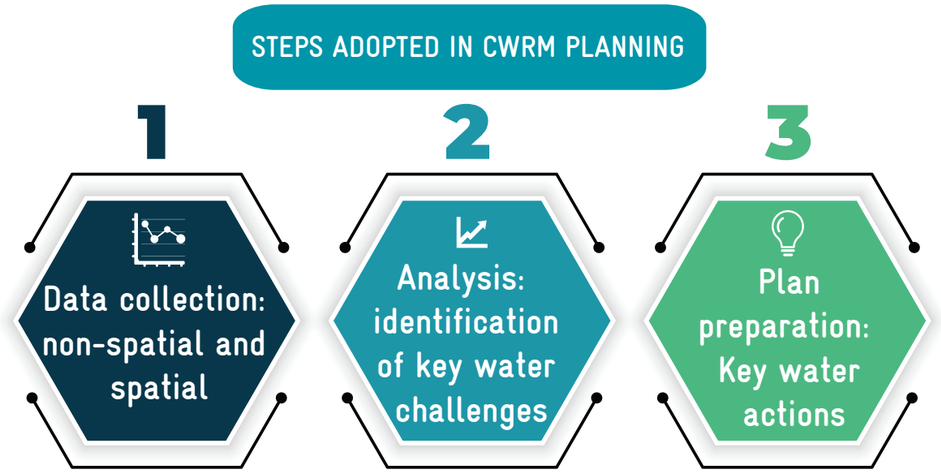


Fig 3.4: Steps Involved in CWRM Planning

3.1.3. CATEGORIZATION OF GP FOR CWRM PLANNING IN THE DISTRICT

The CWRM uses spatial and non-spatial data for developing Gram Panchayat GP level plans. Most of the data for non-spatial are available at revenue village level in the project area. To synchronize planning at GP keeping data availability and administrative boundary for GIS planning, various GP's are categorized based on revenue village boundaries, for collecting and organizing the datasets. Based on the above factors, five different types of GPs are classified as given in table 3.1 and Map 3.1 for Ramanathapuram district and table 3.2 and Map 3.2 for Tiruvannamalai district.

TYPE OF GPS FOR PLANNING

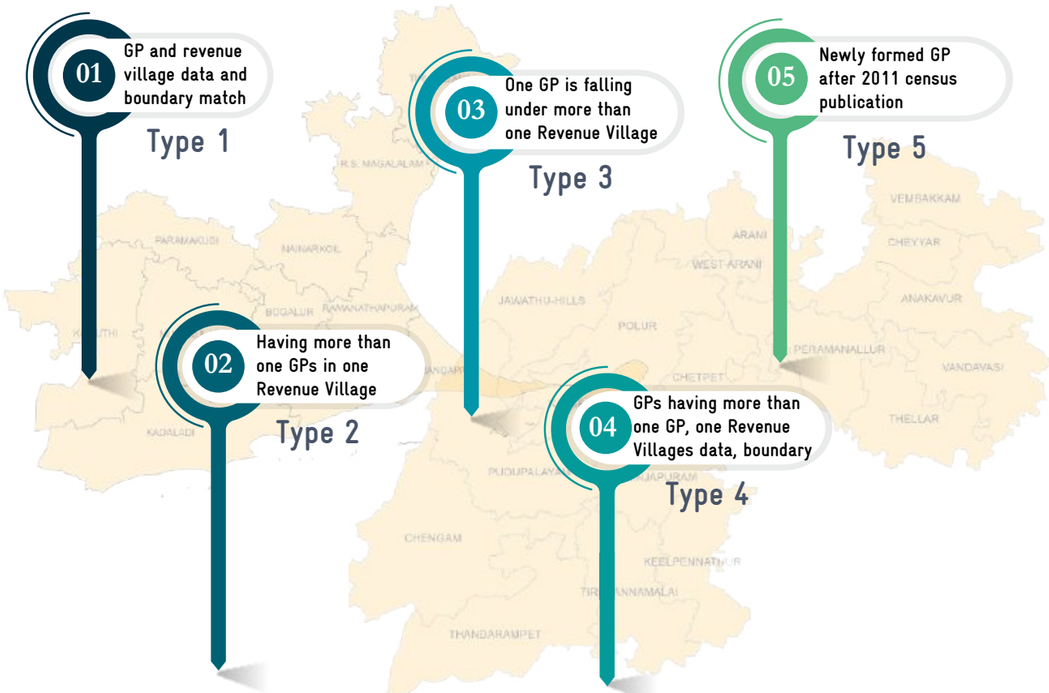
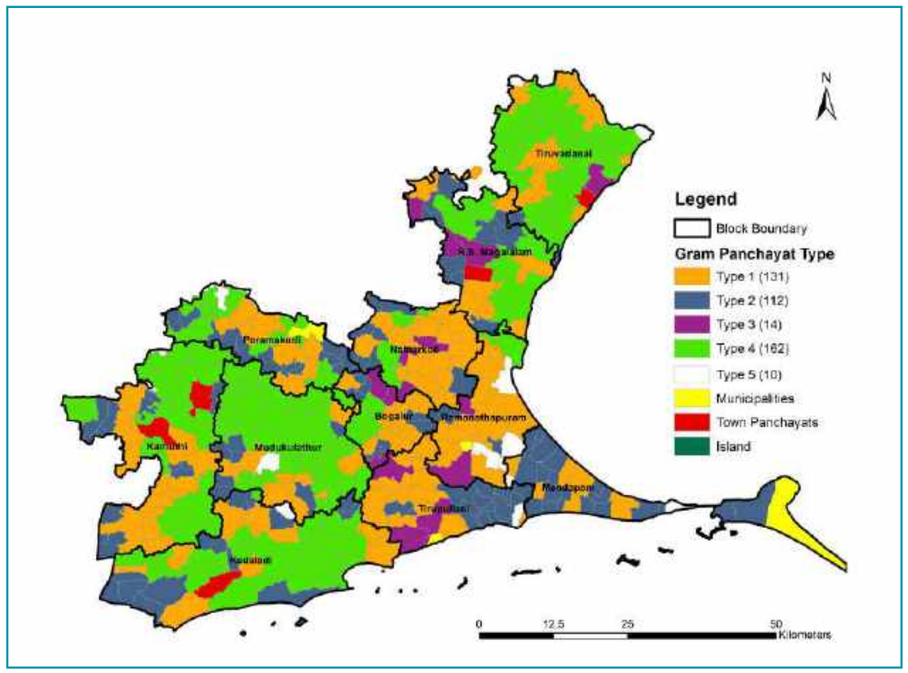


Fig 3.5: Description of GP Types

The above categorization was discussed and approved during second DLSC meeting and various GPs, block details are submitted to DLSC, accordingly type wise distribution of the GPs planning process initiated as given in the table 3.1 below.

TABLE 3.1: CATEGORY OF GPS BLOCK WISE ADOPTED UNDER CWRM PLANNING IN RAMANATHAPURAM DISTRICT

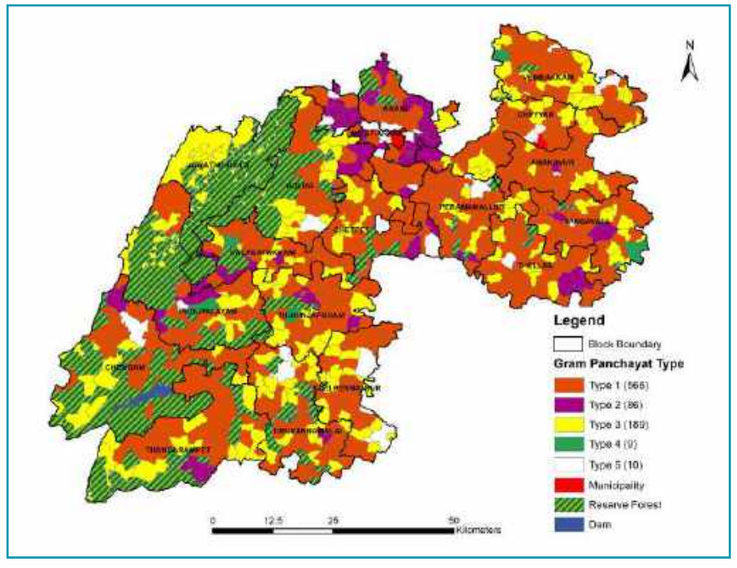
S.No	Name of the Block	Total No of GPs	Type 1	Type 2	Type 3	Type 4	Type 5	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Bogalur	26	8	9	3	6	0	26
2	Kadaladi	60	13	18	0	28	1	60
3	Kamuthi	53	15	12	0	26	0	53
4	Mandapam	28	7	20	0	0	1	28
5	Mudukulathur	46	6	3	0	37	0	46
6	Nainarkoil	37	23	8	2	4	0	37
7	Paramakudi	39	12	14	0	12	1	39
8	R.S. Mangalam	35	9	9	3	14	0	35
9	Ramanathapuram	25	15	3	2	2	3	25
10	Thiruppullani	33	13	16	3	0	1	33
11	Thiruvadanai	47	10	2	1	33	1	47
	Total	**429**	**131**	**114**	**14**	**162**	**4**	**429**



Map 3.1: Types of GPs for CWRM planning, Ramanathapuram district

TABLE 3.2: CATEGORY OF GPS BLOCK WISE ADOPTED UNDER CWRM PLANNING, TIRUVANNAMALAI DISTRICT

	Name of the block	Total No of GPs	Type 1	Type 2	Type 3	Type 4	Type 5	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Anakkavoor	55	47	2	6	0	0	55
2	Arni	38	12	22	1	1	2	38
3	Chengam	44	32	2	10	0	0	44
4	Chetpet	49	34	4	11	0	0	49
5	Cheyyar	53	38	2	12	0	1	53
6	Jawadhu Hills	11	1		10	0	0	11
7	Kalasapakkam	45	25	9	9	2	0	45
8	Kilpennathur	45	29		15	0	1	45
9	Peranamallur	57	47	4	6	0	0	57
10	Polur	40	27	2	11	0	0	40
11	Pudupalayam	37	25	6	6	0	0	37
12	Thandrampet	47	31	3	13	0	0	47
13	Thellar	61	46	5	10	0	0	61
14	Thurinjapuram	47	29	4	12	2	0	47
15	Tiruvannamalai	69	48	2	18	0	1	69
16	Vandavasi	61	43	5	11	2		61
17	Vembakkam	64	38	0	23	2	1	64
18	West Arni	37	14	19	0	0	4	37
	Total	**860**	**566**	**91**	**184**	**9**	**10**	**860**



Map 3.2: Types of GPs for CWRM planning, Tiruvannamalai district

CWRM PLANNING MATRIX FOR DISTRICTS

The CWRM plan is prepared for the lowest scale of administrative unit in the districts which helps to align and harmonize the planning of Mahatma Gandhi NREGA and other government schemes. The CWRM plan has non-spatial and spatial data sets used in the analysis of identifying key water challenges and helping in preparation of water action plans. These plans are presented on GIS platform using the open-source data – Bhuvan and Google Earth Pro, represented in KMZ and KML format.

During April 2020, the non-spatial data sets were collected from different secondary sources and primary sources from the GP office and organized in the shared web platform to work together in completing the data collection process. As a first step the type 1 GPs were chosen for planning subsequently type 2, 3, 4 and finally the type 5 GPs were analyzed.

The CWRM planning process has been initiated in April 2020 and completed in November 2020 in Ramanathapuram district while it was completed in December 2020 in Tiruvannamalai district (Table 3.3 and Fig 3.6).

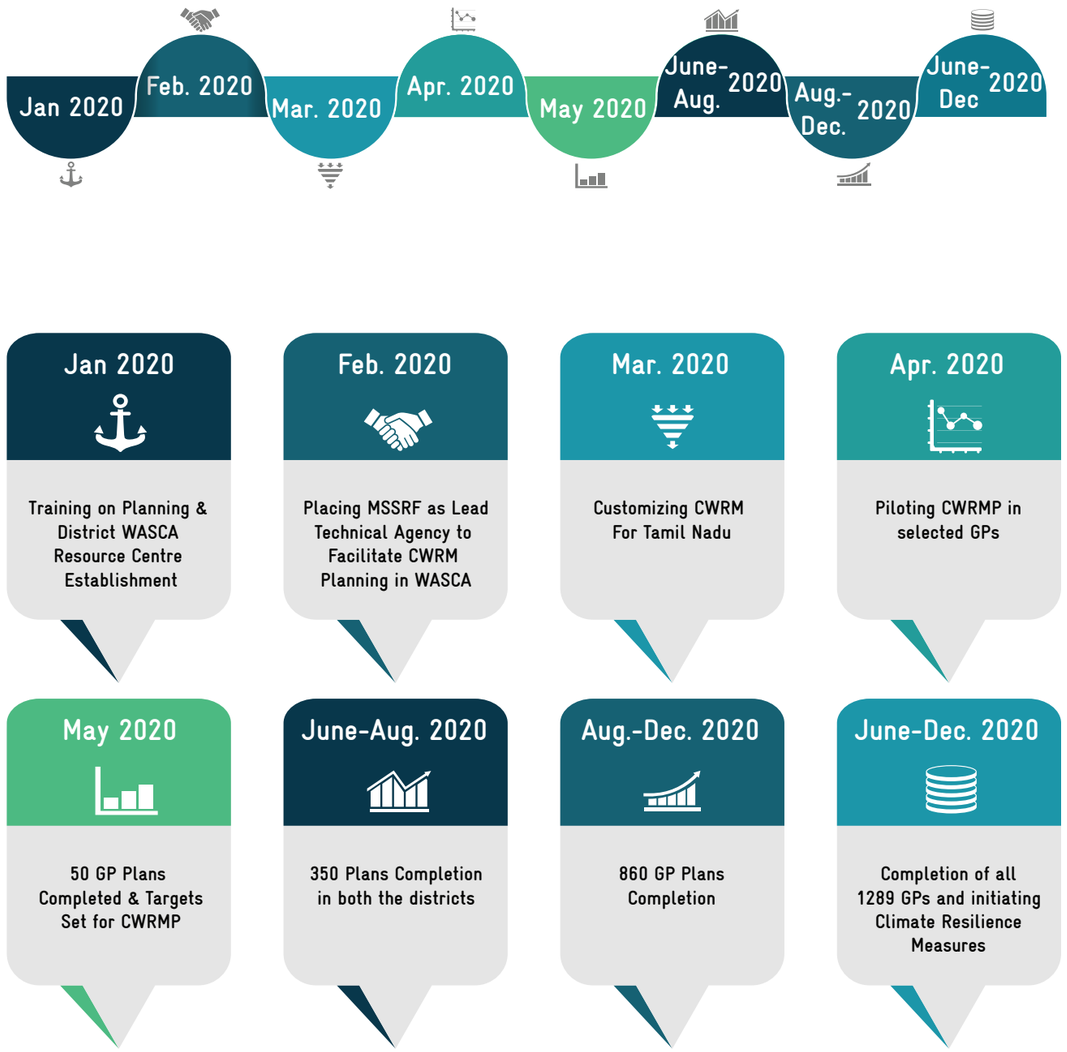


Fig 3.6: Timeline for different stages of CWRM planning process

TABLE 3.4: TIME LINE ADOPTED FOR DIFFERENT STAGES OF CWRM PLANNING IN RAMANATHAPURAM AND TIRUVANNAMALAI DISTRICTS

Name of the Block	No of GPs	Pre-Planning Stage	Planning Stage	Verification	Approval
Ramanathapuram District					
1) Bogalur	26	April - May 2020	May - July 2020	July - Nov 2020	Nov- Dec 2020
2) Kadaladi	60	April - May 2020	May - July 2020	Sep- Nov 2020	Nov- Dec 2020
3) Kamudi	53	April - May 2020	May - July 2020	Sep- Oct 2020	Nov- Dec 2020
4) Mandapam	28	April - May 2020	May - July 2020	Sep- Nov 2020	Nov- Dec 2020
5) Mudukulathur	46	April - May 2020	May - July 2020	Sep- Nov 2020	Nov- Dec 2020
6) Nairnarkoil	37	April - May 2020	May - July 2020	July - Oct 2020	Dec 2020
7) Paramakudi	39	April - May 2020	May - July 2020	Sep- Nov 2020	Dec 2020
8) RS Mangalam	35	May - June 2020	May - July 2020	Sep- Nov 2020	Dec 2020
9) Ramanathapuram	25	May - June 2020	June- July 2020	Oct- Nov 2020	Dec 2020
10) Tiruppullani	33	May - June 2020	June- July 2020	Sep- Nov 2020	Dec 2020
11) Tiruvadanai	47	May - June 2020	June- July 2020	Sep - Nov 2020	Dec 2020
Tiruvannamalai District					
1) Anakavor	55	April - May 2020	May- Oct 2020	Oct 2020	Nov 2020
2) Arni	38	April - May 2020	May - Nov 2020	Dec 2020	Dec 2020
3) Chengam	44	April - May 2020	May - Nov 2020	Nov 2020	Nov 2020
4) Chetpet	49	April - May 2020	May - Nov 2020	Nov 2020	Nov 2020
5) Cheyyar	53	April - May 2020	May - Nov 2020	Nov 2020	Nov 2020
6) Jawadhu hills	11	April - May 2020	May - Nov 2020	Nov-Dec 2020	Dec 2020
7) Kalasapakkam	45	April - May 2020	May - Nov 2020	Nov-Dec 2020	Nov 2020
8) Keelpennathur	45	April - May 2020	May - Nov 2020	Nov-Dec 2020	Dec 2020
9) Pernamallur	57	April - May 2020	May - Nov 2020	Nov-Dec 2020	Dec 2020
10) Polur	40	April - May 2020	May - Nov 2020	Nov-Dec 2020	Nov 2020
11) Pudhupalayam	37	April - May 2020	May - Nov 2020	Nov-Dec 2020	Nov 2020
12) Thandarampet	47	April - May 2020	May - Nov 2020	Nov-Dec 2020	Nov 2020
13) Thellar	61	April - May 2020	May - Nov 2020	Nov-Dec 2020	Dec 2020
14) Tiruvannamalai	47	April - May 2020	May - Nov 2020	Oct- Nov 2020	Nov 2020
15) Thurinjapuram	69	April - May 2020	May - Nov 2020	Nov 2020	Oct 2020
16) Vandavasi	61	April - May 2020	May - Nov 2020	Nov 2020	Nov 2020
17) Vembakkam	64	April - May 2020	May - Nov 2020	Nov-Dec 2020	Nov 2020
18) West Arni	37	April - May 2020	May - Nov 2020	Nov - 2020	Dec 2020

3.1.4) WASCA TN – WATER ACTIONS AND INDICATORS

The indicator for the each of the key water action themes are evolved based on the CWRM planning and the main outcome/ impacts for each of the key water actions are also finalized.

WASCA TN – WATER ACTIONS AND INDICATORS

WASCA CWRM ACTION PLAN

Development of Public and Common Lands

INDICATOR

1. Number of water bodies restored
2. Quantum of water harvested/recharge
3. Proportion of land treated under WASCA
4. Percentage reduction in the annual runoff
5. Area under afforestation
6. Restoration of traditional water bodies and cascade tanks networks

OUTCOMES/ IMPACT

1. Total quantum of water harvested and
2. Green cover or area under afforestation
3. Number of traditional water bodies restored
4. Number of cascade works restored

QUANTUM OF WATER HARVESTED

GREEN COVER OR AREA UNDER AFFORESTATION

NUMBER OF WATER BODIES RESTORED

NUMBER OF CASCADE WORKS

WASCA CWRM ACTION PLAN

Development of Agriculture and Allied Activities

INDICATOR

1. Crop water requirement for major crops
2. Area targeted for improved water use efficiency
3. Climate resilience works under water use efficiency
4. Assessment of sources of water for livestock and agriculture demand
5. Reducing area under fallow lands
6. No of structures established for on-farm (*in-situ*) water harvesting in dry lands
7. Improvement in soil health

OUTCOMES/ IMPACT

1. Number of farmers adopted water efficient technologies and cropping systems
2. Additional area brought under cultivation
3. Number of farmers adopting on-farm water harvesting in drylands
4. Number of farmers adopting composting, mulching, silt application, agro-forestry etc
5. Number of recharge shaft or structures by farmers using ground water

NUMBER OF FARMERS - EFFICIENT USE OF WATER

ADDITIONAL AREA BROUGHT UNDER CULTIVATION

NUMBER OF FARMERS - ON-FARM WATER HARVESTING IN DRYLANDS

NUMBER OF FARMERS - COMPOSTING, MULCHING, SILT APPLICATION, AGRO-FORESTRY ETC

NUMBER OF RECHARGE SHAFT OR STRUCTURES

WASCA CWRM ACTION PLAN

Development of Rural Infrastructure

INDICATOR	OUTCOMES/ IMPACT
1. Number of water bodies and streams freed from waste dumping	1. Number of activities and works taken up treating for grey water management
2. Number of Villages having complete solid and liquid waste management systems	2. Number of units of roof rain water harvesting and storing established
3. Roof rain water harvesting measures	3. Number of households established Nutri gardens
4. Nutri gardens	

NUMBER OF ACTIVITIES AND WORKS - GREY WATER MANAGEMENT

NUMBER OF UNITS - ROOF RAIN WATER HARVESTING

NUMBER OF NUTRI GARDENS

WASCA CWRM ACTION PLAN

Development of Climate Resilient Measures

INDICATOR	OUTCOMES/ IMPACT
1. Number of vulnerable blocks and GPs (Area of Interest) identified in each district	1. Number of Pilot models showing the climate resilient measures grounded
2. Number of climate resilient measures	2. Number of vulnearable families provided with assets
3. Number of vulnearable families in the village	3. Number of vulnearable families given employment in Mahatma Gandhi NREGS
4. Number of community CRM measures and individual CRM measures	4. Number of works taken up in convergence

NUMBER OF CLIMATE RESILIENT MEASURES GROUNDED

NUMBER OF VULNEARABLE FAMILIES - ASSETS

NUMBER OF VULNEARABLE FAMILIES - EMPLOYMENT

NUMBER OF WORKS - CONVERGENCE

The area of interest in each of the districts under the three themes namely public and common land, agriculture and allied sector and rural infrastructure are identified. It has been done based on the assessment of socio-economic, climatic, hydrological and agricultural vulnerabilities in combination and the detailed climate resilient measures are discussed in the following section 3.8. Climate Resilient Measures.

3.2 CAPACITY BUILDING

The capacity building programmes adopted a process-based approach by understanding the need of all associated stakeholders to achieve the goals of WASCA project. The programmes aimed to build the capacity of the whole team starting from the assistant engineers at block level, assistant executive engineers and executive engineers at the district level, overseers and panchayat secretaries at the gram panchayat level and technical resource team at district and state level.

These programmes were planned to strengthen the awareness, knowledge and skills of the district officials in understanding and applying the CWRM approach in their plans and actions. The strategies and competency development methodologies are tailor made for each of the levels on the basis of their roles in CWRM planning process. This includes exposure visit and cross learning, on-site field visits and interaction, in-person and on-line lectures and interaction, hands-on sessions to practice, mentoring on specific aspects of the technical work, sharing learning resources in a structured manner through social media platform etc. In the mentoring process, senior experts who are more experienced in associated domain areas have extended inputs from their experience and knowledge by sharing case stories and inputs at appropriate context to facilitate the learning in to actions.

The WASCA-TN programme started with an orientation on the concept, components, process and expected outputs and outcomes by engaging the district level officials of the state. The programme was organized in a discussion and hands-on session mode to introduce the GIS based planning at the GP level, interpreting spatial tools, analyzing the spatial and non-spatial data to identify the key water challenges and appropriate water actions including the technical aspects of the select climate resilient measures.

3.2.1 GIS TOOLS - CONCEPTS AND METHODS

DETAILS OF THE STATE LEVEL TRAINING PROGRAMME

	Details	No of Persons Trained	Key learning outcomes
01	Orientation to the WASCA – CWRM planning -2 meetings A) Ramanathapuram and south districts on 9-12 Jan 2020, Madurai	86	• Four water concept • Ride to Valley Concept • Framework of Composite water Management Plan and key water challenges • Water budget • Use of Bhuvan, Google Earth Pro • GIS based Planning of works as per MoRD guidelines
02	Orientation to the WASCA – CWRM planning -2 meetings B) Tiruvannamalai and northern districts, 31st Jan – 2nd Feb 2020	140	• Framework of CWRMP and • GIS based Planning

3.2.2 CWRM PLAN: COMPONENTS AND ANALYSIS

DETAILS OF THE TRAINING PROGRAMMES ORGANIZED

	Details	No of Persons Trained	Key learning outcomes
01	Cross learning - Exposure visit to Rajasthan - learning Rajiv Gandhi Jal Sanchay Yojana (formerly MJSA), Four Water Concepts, Water Conservation, Model GP: Piplantri Village, Eco Parks etc, 3-8 March 2020	20	• Four water concept and implementing ridge to valley approach • Developing degraded community lands to pasture and silvi-pastures • Convergent planning and financing mechanisms and state flagship Programs • Innovations in Water Conservations (Tankas, Kadims, Lining of Ponds etc) • Innovations in Plantations (Floriculture, horticulture, road side plantations, silviculture) • Innovation in asset creation (Mini stadium, Model Crematorium, Food Grain storage structures)
02	Online sessions – CWRM plan preparation - three sessions May to June 2020 for both Ramanathapuram and Tiruvannamalai districts	360	• Spatial and Non spatial data sets necessary for CWRM planning Identifying Key water challenges • Identifying appropriate actions and how to do the planning - using a model GP
03	Cascading of tanks - Experience from Andhra Pradesh	60	• How to identify the cascade systems and the processes required for restoration
04	Ground water Assessment, Management & River Sub Basin System - Tiruvannamalai	60	• Status of the saline water issues and possible measures to address
05	Greening of Hillocks Concept - implementation under Mahatma Gandhi NREGS	25	• To identify the potential restoration practices of different types of coastal water resources in the three different pilots
06	Sea water intrusion and management measures	30	• Status of the saline water issues and possible measures to address
07	Activities for Coastal Watersheds	10	• To identify the potential restoration practices of different types of coastal water resources in the three different pilots

08 Avenue plantation

– 12th to 14 Nov 20 and 12th Jan 21 for Panchayat presidents, Panchayat secretary, Mahatma Gandhi NREGS women and Presidents and SHG women

233 No of Persons Trained

- Plantation techniques, post care, watering and management of the trees along with pruning and guarding the trees along with monitoring its growth

09 Cascade tank survey

In R S Mangalam Block to Overseers and technical persons on 21 Dec 2020

20 No of Persons Trained

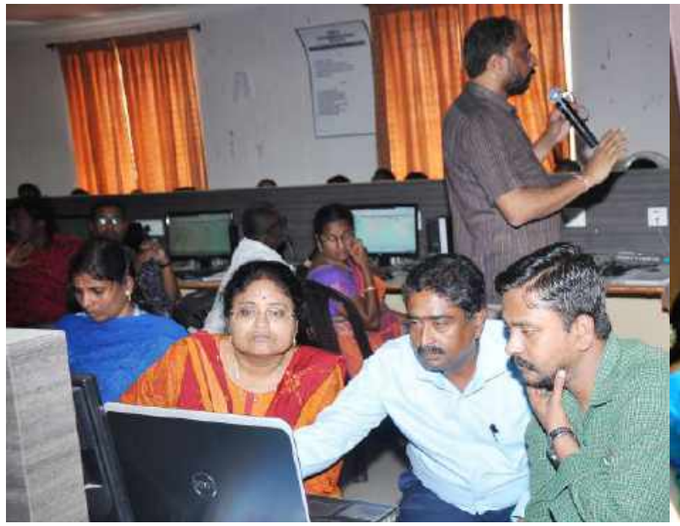
- To collect the details of the tanks in the cascading system, its status and water holding capacity and supply channels

10 SW app usage for Mini forest mapping

to overseers on 24th Dec 2020

40 No of Persons Trained

- To identify the geocodes of mini forest established in each of the GP for monitoring at later stage through RS maps



11 SW app usage for Non NRM activities

mapping for overseers and panchayat assistants

127 No of Persons Trained

- To identify the geo codes for identifying the site and integrate with the CWRM plans KMZ after field verification

12 Non NRM activities planning

- in 11 blocks to AEs, Overseers and Computer assistants on 21-22 Jan 2021

112 No of Persons Trained

- Train the village level representatives to record the geocoded points for all the non-NRM works

13 Village level nursery establishment for important horticulture/fruit trees

- to SHG women members

852 No of Persons Trained

- To establish a village level nursery and propagation of trees

14 MORD planning for the Ervadi panchayat

to Computer assistants and Overseers, 2nd to 7th Feb 21

20 No of Persons Trained

- Built their capacity to complete the KMZ with all identified NRM and Non NRM activities

3.2.3 TRAININGS WITH CGARD-NIRDPR

In addition to WASCA districts in Tamil Nadu, the CWRM planning framework has been shared with district officials from eleven states using a case story of one GP. The programme has been done in partnership with Centre for Geo-informatics Application in Rural Development (CGARD), National Institute of Rural Development and Panchayati Raj (NIRDPR), Hyderabad. Discussion using one GP model helped to demonstrate how the CWRM plan is applied to analyze key water challenges and water actions. In this process, the concept has been shared with 303 official (22% women). The CWRMP handbook has been shared with the participants for future reference.

Batch Date	Total	Female	Batch Date	Total	Female
09-13 November, 2020	62	11	18-22 January, 2021	80	17
23-27 November, 2020	99	22	8-12 February, 2021	62	16

States Covered: Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Haryana, Odisha, West Bengal, Chhattisgarh, Andhra Pradesh, Telangana, Jharkhand and Punjab.

Fig 3.7: Sharing session on GIS based planning training organized by CGARD - NIRD

3.3 ANALYSIS FOR IDENTIFICATION OF KEY WATER CHALLENGES

The CWRM planning framework has four vulnerability areas and integrated 115 non-spatial and 17 spatial parameters with 18 indicators based on the IWRM and climate adaptation principles. The planning process comprised of the following dimensions in a scientific and organized manner to prepare a meaningful plan at the lowest administrative unit *i.e* GP plans:

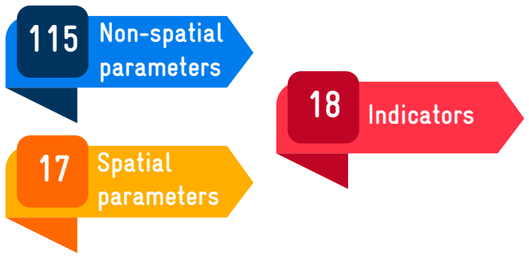


Fig 3.8: CWRM Parameters and Indicators

Spatial data:

The spatial data is supportive evidence to understand the issues in the areas of land use and land cover (LULC), waste land, salt and erosion affected lands, drainage lines, ground water potential, lineament, geomorphology and slope for science-based decision on water actions. The use of different spatial data to assess and confirm the key water challenges along with the non-spatial data given below.

Ten Fold Classification	Type of Run-off	Challenges	Thematic Area
Forest	Good (High Run-off)	Degraded forests, slopes	Land Use Land Cover (LULC), Lineament map
Area under Non Agri Use	Good (High Run-off)	No area for infiltration (built up area, road, drainage lines, water bodies)	LULC
Grazing Lands	Average (Average Run-off)	Middle slopes, medium infiltration	LULC, Geomorphology, Ground water prospects
Tree Crops	Average (Average Run-off)	Low infiltration	LULC, Geomorphology
Culturable Waste Lands	Average (Average Run-off)	Low infiltration	LULC, Geomorphology
Fallow Lands	Bad (Low Run-off)	low infiltration, gentle slopes	LULC, Geomorphology / Ground water prospectus, Lineament map
Current Fallow Lands	Bad (Low Run-off)	Medium infiltration, gentle slopes	LULC, Geomorphology/ Ground water Prospectus
Unirrigated area (NSA)	Bad (Low Run-off)	Soil moisture low, gentle slopes	LULC, Geomorphology, Ground water prospects, Lineament map
Irrigated Area (NSA)	Bad (Low Run-off)	Good infiltration, gentle and low slopes	LULC, Geomorphology, Ground water prospects

Fig 3.9: Use of Spatial data in identifying the key water challenges across different land use

Non-spatial data:

- Characterization of catchment landscapes based on the ten-fold land use classification to know available land area in both public and individual land ownership and its current position interms of available area and use, its links with surface runoff as good, average and bad runoff

- Watershed analysis to understand the hydrological and administrative boundaries, know the vulnerable and good micro watersheds, its location, distribution of different land use within the micro watersheds for planning relevant water actions

- Soil characteristics including the macro and micro nutrient status, physical quality of the land using pH values and textural soil quality to understand its permeability, infiltration and water holding capacity which are crucial for soil moisture content

- The agriculture and livestock datasets help in understanding the quantum of water requirement of the key crops and type of cropping systems adopted, number and type of different livestock resources and its water requirement *vis-a-vis* its linkage to livelihoods of the vulnerable population in the village

- The comprehensive and holistic understanding of the key water challenges adopting the eco-system approach enable to identify water action works in public and common land (afforestation, soil and water conservation, improving the traditional water storage and catchment assets etc), agriculture and allied sector (farm ponds, artificial recharge structures, on-farm plantation, irrigation methods, livestock - fodder development etc) and rural infrastructure (on safe drinking water and efficient handling of grey water)

- Grey water management: The assessment of grey water generation at GP level helps to understand the quantum of grey water available and existing methods of its use. This information is essential to plan the effective strategies for recycle and reuse

- The village level water budget show the sector wise water demand and available water through the traditional water harvesting and storage bodies and the potential runoff that can be conserved through appropriate actions on the supply side. The difference between demand and supply at the GP level helps the communities to understand the gap and practice the necessary water actions.

The figure 3.10 shows the details of the themes, number of non-spatial, spatial and climate indicators used to map out the key water challenges and evolve water actions by considering the multifaceted dimensions of vulnerability.

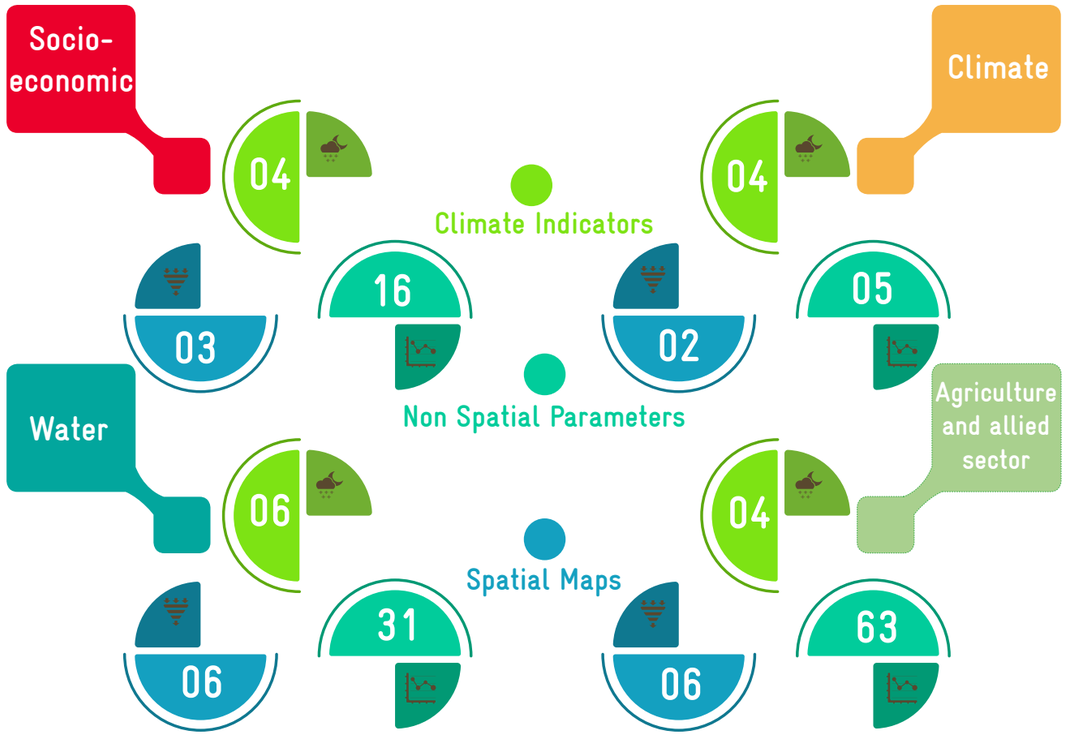


Fig 3.10: Number of parameters used in the CWRM - Analysis of key water challenge

3.3.1. RAMANATHAPURAM DISTRICT

3.3.1.1. SPATIAL DATA- RAMANATHAPURAM

The twelve different spatial parameters (Maps 3.3 to 3.13) are used in identifying key water challenges along with the non-spatial data. The area under soil erosion affected land is 2.74 percent in Ramanathapuram district. The area under soil erosion is almost ten times is less in the district due to very flat topography. Besides the area under waste land is only 0.54 percent, however, the land area affected by salt is 9.19 percent. The percentage of the total number of micro sheds to the total geographical area is 0.24 percent. The lineament parameter shows that it is drainage parallel in the district.

SPATIAL PARAMETERS USED IN THE KEY WATER CHALLENGE ANALYSIS IN RAMANATHAPURAM DISTRICT

Soil erosion | 10601.25 Ha

Waste Lands | 2092.63 Ha

Salt Affected Area | 35565.04 Ha

Micro Watersheds | 910 Nos.

Drainage Density Category | 0.040 km/ha

Lineament
Geomorphic lineaments, drainage parallel

Land use and land cover maps
Area under different land use and water bodies are mapped

Geomorphology Type (Major)
Coastal Origin - Older Deltaic Plain

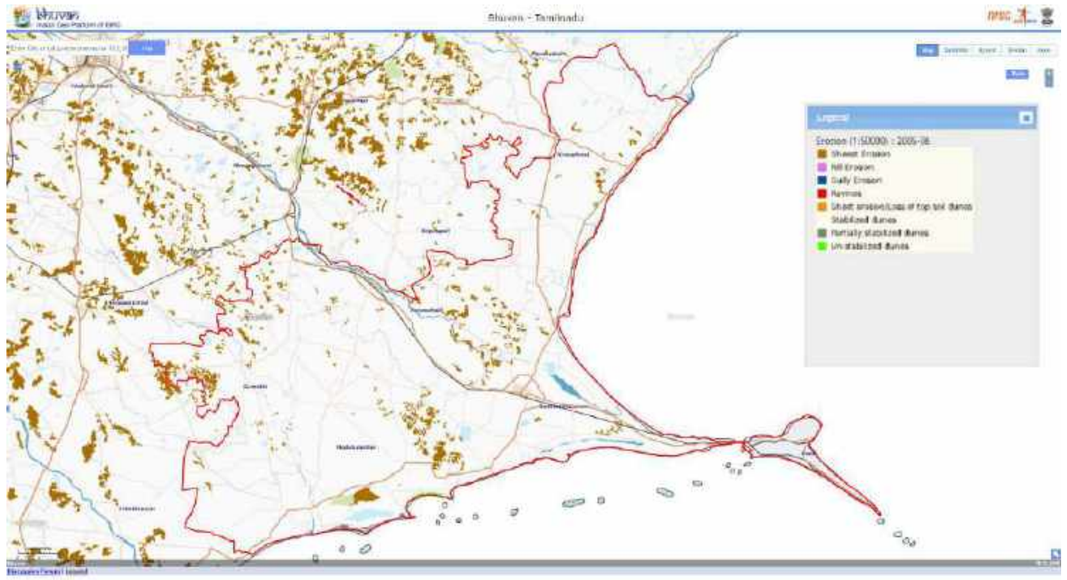
Ground Water Prospectus
<30 m Deep Well - 200 to 400 LPM Yield to >80 m Deep Well - 100 to 200 LPM Yield

Contour
Identification of valleys and hills, and the steepness or gentleness of slopes for planning water actions

Terrain
Undulating terrain with residual hills and intermittent plain lands

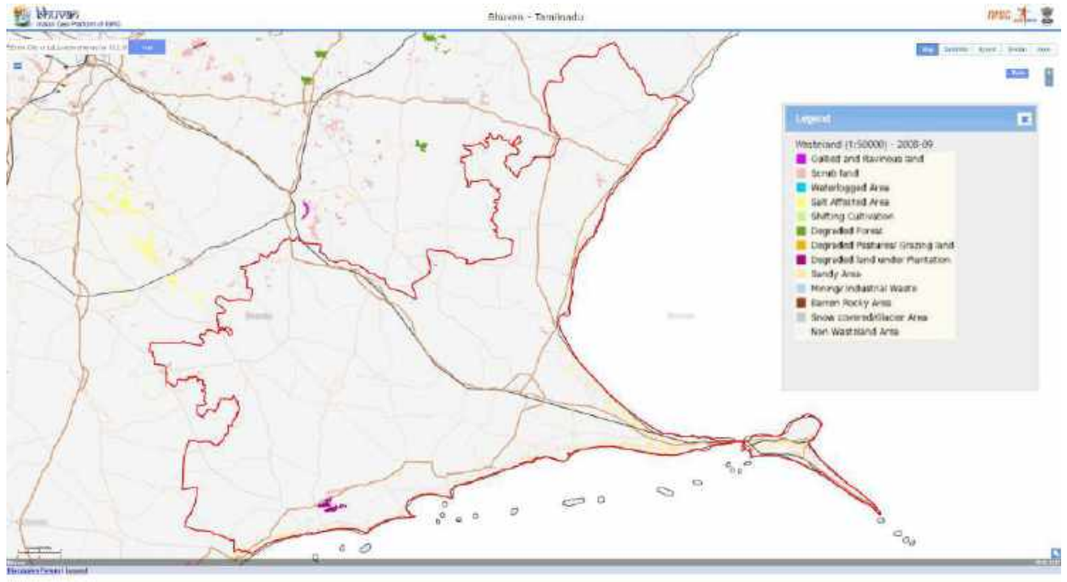
Slope Category
slope, land forms and terrain conditions

Soil erosion: The erosion map shows the soil erosion capacity with respect to rainfall, soil physical properties, terrain slope, land cover of Ramanathapuram district. The soil erosion map used for soil conservation and regional planning and watershed management. In Ramanathapuram district, it is observed that sheet erosion is more predominant so the measures has been planned to arrest further erosion.



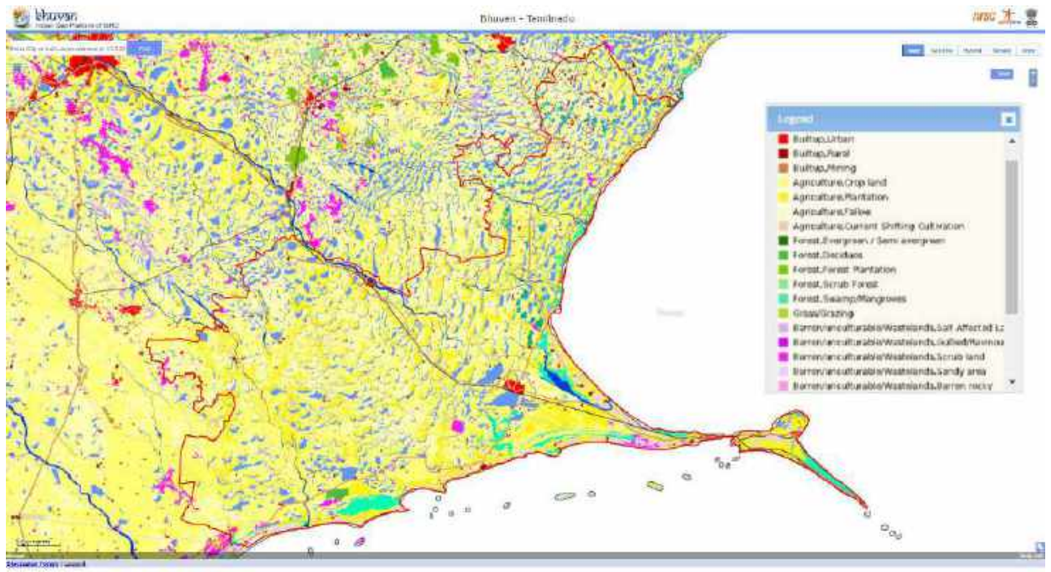
Map 3.3: Soil erosion map of Ramanathapuram

Wasteland: The wasteland map illustrates the availability of the wasteland in Ramanathapuram. Its shows that sand which is categorised as wasteland is spatially spread over coast of Ramanathapuram. During planning the GPs, the plantation measures have been taken up in the identified wastelands to convert into productive land.



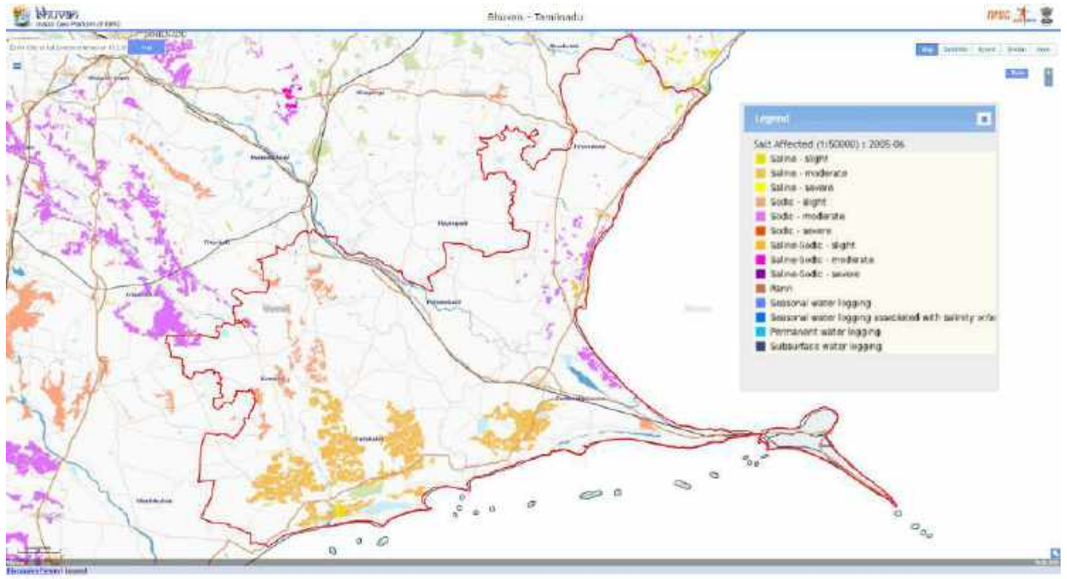
Map 3.4: Wasteland map of Ramanathapuram district

Land use land cover: Land Use Land Cover (LULC) map map clearly shows that the Ramanathapuram district is covered by the agricultural plantation and fallow lands. The map helps the decision makers and planners to concentrate on the fallow land development activities. During the planning of GPs, the more fallow land activities has been proposed in the district.



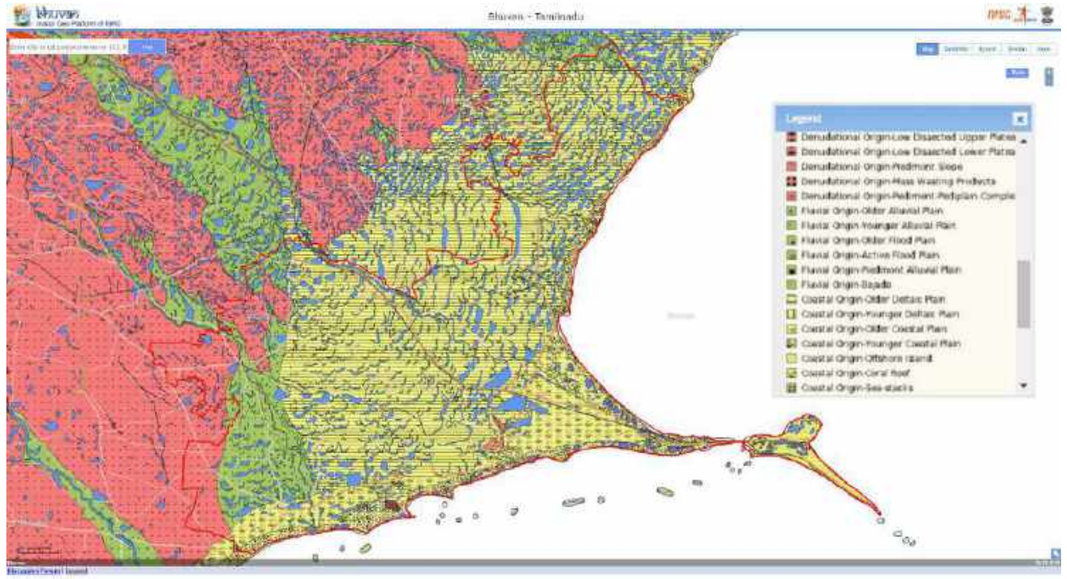
Map 3.5: Land use and land cover map of Ramanathapuram district

Salt affected area: In the district, it is observed that the some parts of the land are moderately saline around the Southern coast of the Ramanathapuram and sodic along the East Coast of Ramanathapuram. While planning the GP, this area has been treated specially and given alternative cropping and other any other steps has been suggested to reduce the salinization.



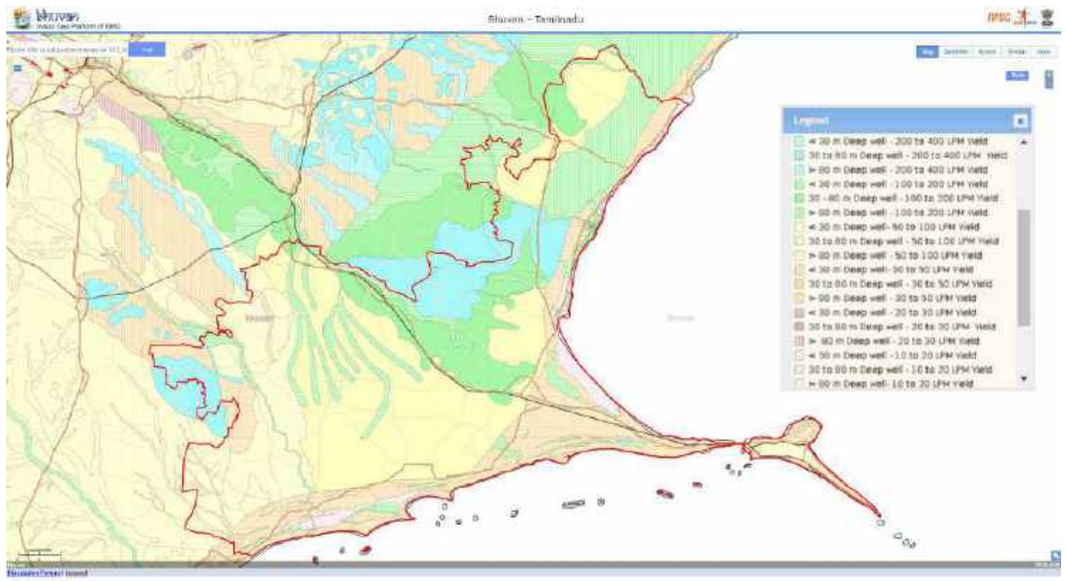
Map 3.6: Salt affected area in Ramanathapuram district

Geomorphology Map: The geomorphology in the district covers under the Coastal origin deltaic and coastal plain category. The geomorphic and geologic conditions is guided us to undertake appropriate work in particular location to reap maximum benefits.



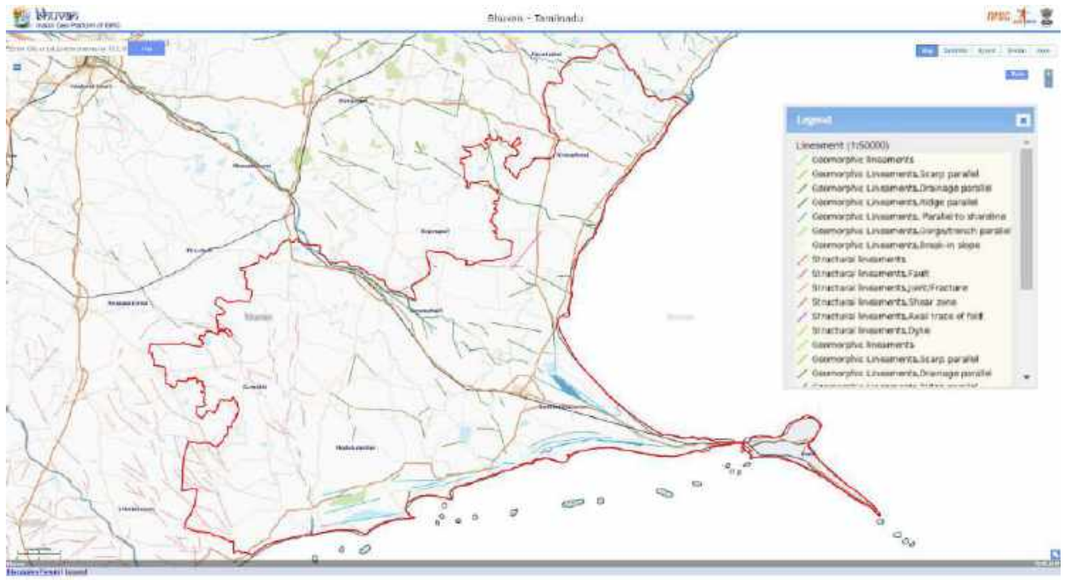
Map 3.7: Geomorphology of Ramanathapuram district

Ground water prospectus: The map provides the required information on geological parameters connected to ground water exploration and the probable ground water prospects and helps in identification of sites for planning recharge structures to address water scarcity in a more effective manner for Ramanathapuram district.



Map 3.8: Ground water prospectus, Ramanathapuram District

Lineament Map: A lineament map shows the linear feature in a landscape that is an expression of an underlying geological structure such as a fault, fracture, or joint in the district. In Ramanathapuram, mostly the lineament drainage parallel is noticed. This map is very useful to decide the suitable water conservation, harvesting and recharge measures in the district.



Map 3.9: Lineament map of Ramanathapuram District

Watershed Map: A watershed map is the area of land where all of the water that falls in it and drains off of it goes into the common outlet. This map is used for the interventions based on ridge to valley concept and sequencing the plan accordingly.

Map 3.10: Watershed map of Ramanathapuram District

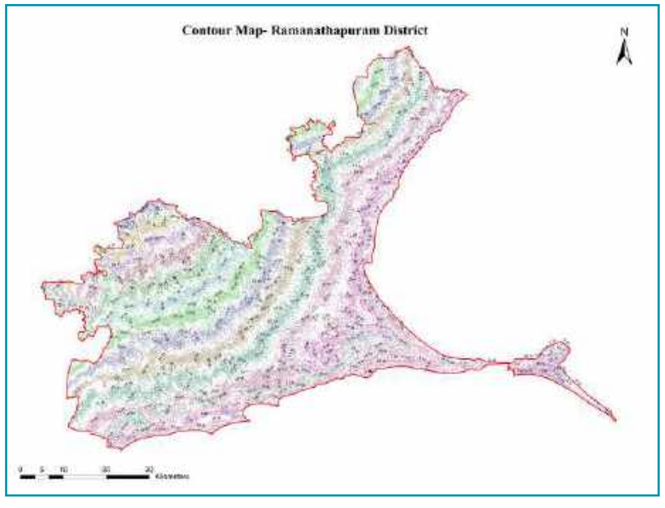
Drainage Map: The drainage map shows the drainage order, pattern and destiny. Also, It shows the spread and extent of surface water bodies in the Ramanathapuram district. This map is widely used to identify the suitable locations for check dams on the drainage, gabion structures and desilting the drains

Map 3.11: Drainage map of Ramanathapuram District

Terrain Map: A terrain map shows an area of land divided into terrain map units defined by similar elevation, slope, landform. This map will be useful to understand the terrain to identify the water and soil conservation related activities in the GPs of Ramanathapuram district.

Map 3.12: Terrain map of Ramanathapuram District

Contour Map: A contour map is illustrated with contour lines which shows valleys and hills, and the steepness or gentleness of slopes. The map clearly shows gentle slope towards the coast. The contour map plays a vital role in planning and identifying the recharge structures, farm ponds and construction of grey water drain network etc.



Map 3.13: Contour map of Ramanathapuram District

3.3.1.2. NON SPATIAL DATA, RAMANATHAPURAM DISTRICT

A) Socio-Economic Vulnerability: The socio-economic vulnerability perpetuates due to existing structural inequalities that continues for long time in the community. This makes the section of the community more vulnerable due to limitation in access to water both quantity and quality in the context of changing climate. The important variables which trigger the inequalities are gender, caste, class and access to employment, safe water resources (Table 3.4).

TABLE 3.4: SOCIO ECONOMIC VULNERABILITY IN RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	District - Total
1	Geographical Area	Ha	S1	386896
2	Male Population	Number	S2	474508
3	Number of marginal and small farmers	Number	S2	315815
4	Total Population	Number	S2,S4	942746
5	SC Population	Number	S2,S4	205328
6	ST Population	Number	S2,S4	501
7	Vulnerable population	Number	S2,S3,S4	205829
8	Households	Number	S2	390750
9	Only one room HH's	Number	S2	120782
10	Female Headed HH's	Number	S2	46726
11	Vulnerable Households	Number	S2	98565
12	% Vulnerability	%	S2	29
13	Registered Job cards	Number of persons	S2	305068
14	Active person Job Cards	Number of persons	S2	229624
15	Drinking Water Sources	Number	S3	61530
16	Greywater Generation	MCM	S2, S3	17

Note: S1 - Rural proportion; S2 - Multi-dimensional poverty index; S3 - source of drinking water within premises in rural and S4 - marginal farmer landholdings

Population Information - gender and caste: The district has the total population of 9.42 lakhs, of which the proportion of men and women are almost equal. While the SC and ST populations are socio-economically in the lower rung, considered as vulnerable categories. In this district about 22 percent of the total population was under SC category and 0.1 percent of the total population was under ST category (Fig 3.11).

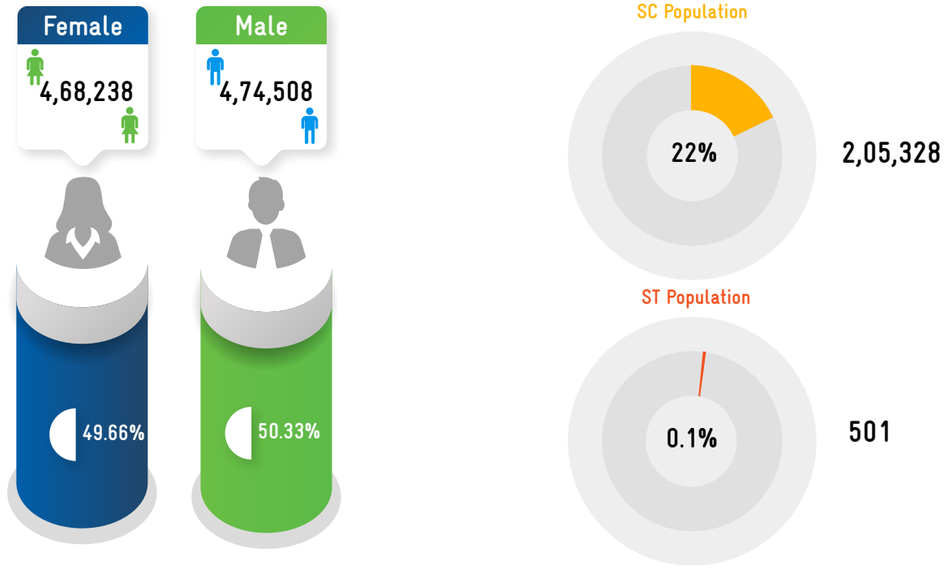


Fig 3.11: Proportion of vulnerable population to the total population of the district

Marginal and small farmers: the district has highest number of farmers under marginal and small category (94%) owning less than two ha of land. This is 68 % of the total land in the district. Also, of the total holdings only 11.3% are from SC and ST communities (Fig 3.12).

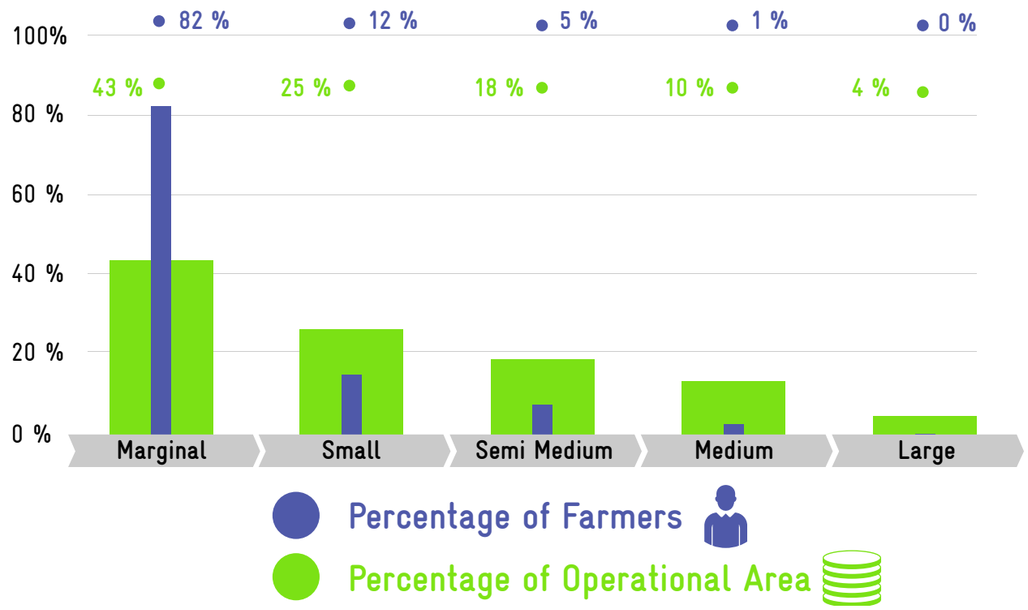


Fig 3.12: Categories of Farmers & Operational area to total (%)

Mahatma Gandhi NREGA Job Card Holder's Information: In the district, of the total population of 9,42,746 persons, 32.35% are registered for job cards in Mahatma Gandhi NREGA scheme. Among the registered job card holders, 75% of the job cards are in active category (Fig 3.13).

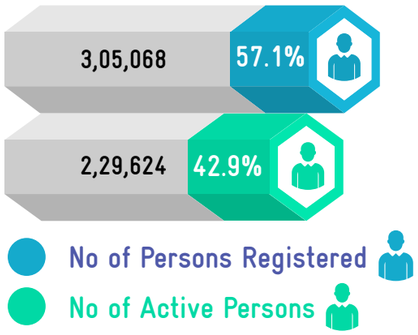


Fig 3.13: Difference between registered job cards and active job cards, Ramanathapuram

Drinking Water Sources and Grey Water Generation Information: The grey water generation estimated across the GPs indicated that 1720.51 Ha M or 17 MCM is being available for reuse or recycle. Also, data was collected on the status of safe disposal of the grey water for recycle/reuse at the GP level which is necessary for the liquid waste management systems in rural areas. The total drinking water sources are 61,530 in numbers for the Ramanathapuram district. The drinking water requirement to the total population is 3459.4 Ha m, of this 86% is met through ground water resources and remaining 14% is met by surface water sources.

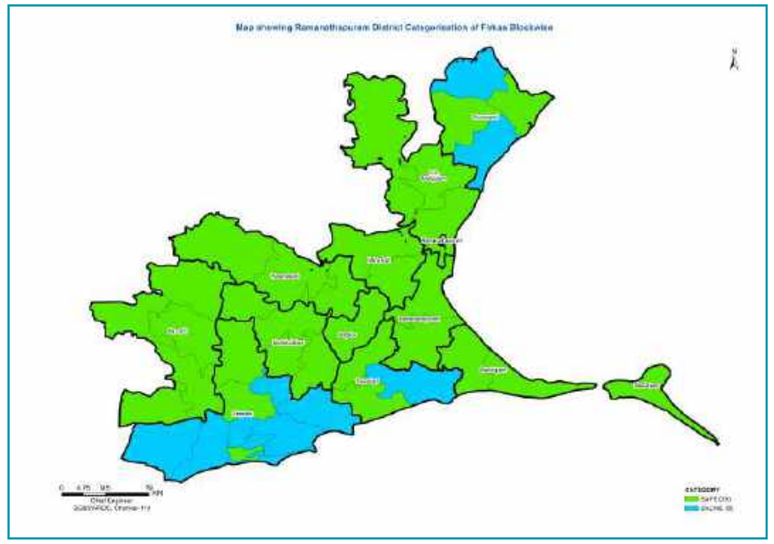
B) Climate vulnerability: Ramanathapuram is one the coastal districts in Tamil Nadu, lies in the southern agro-climatic zone in Tamil Nadu and East Coast Plains and Hill Region as per the agro-climatic regional categorization of Planning Commission of India. It receives an annual average rainfall of 827 mm and North East Monsoon is the main rainy season (501.6 mm). The average temperature of the district ranges from 22.3° C (min) to 37.8°C (max), and the average maximum relative humidity is 79% in interior parts of the district while in coastal region it ranges between 80 and 90%.

Rainfall and Temperature information: The climatic profile considered for the analysis is at the district scale. The annual average rainfall of last 30 years is the primary climatic parameters used in the analysis. The annual average rainfall and annual actual rainfall of the Ramanathapuram district are 821 mm and 473 mm respectively and the average annual mean temperature of the is 28.2°C (Table 3.5).

TABLE 3.5: CLIMATE AND GROUND WATER PROFILE RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	District - Total
1	2	3	4
1	Average Annual Rainfall	mm	821
2	Average Annual Temperature	°C	28.2 °C
3	Ground Water Status*	Over Exploited, Critical, Semi-critical, Safe and Saline	Three Saline block and rest are safe category
4	Ground Water* Availability	MCM	51962.51
5	Ground Water Recharge*	MCM	57736.13

**WASCA- TN Ground water study data – 2019-2020*



Map 3.14: Ground water status across firka's in the Ramanathapuram District

Ground water Profile: The status of the ground water in the Ramanathapuram district is saline (Map 3.14) and the ground water availability and the ground water recharge are 51,962 and 57,736 MCM respectively. Hence, importance for water harvesting with more recharge actions are to be focussed to improve the ground water status in safe conditions without salinity issue (Fig 3.14).

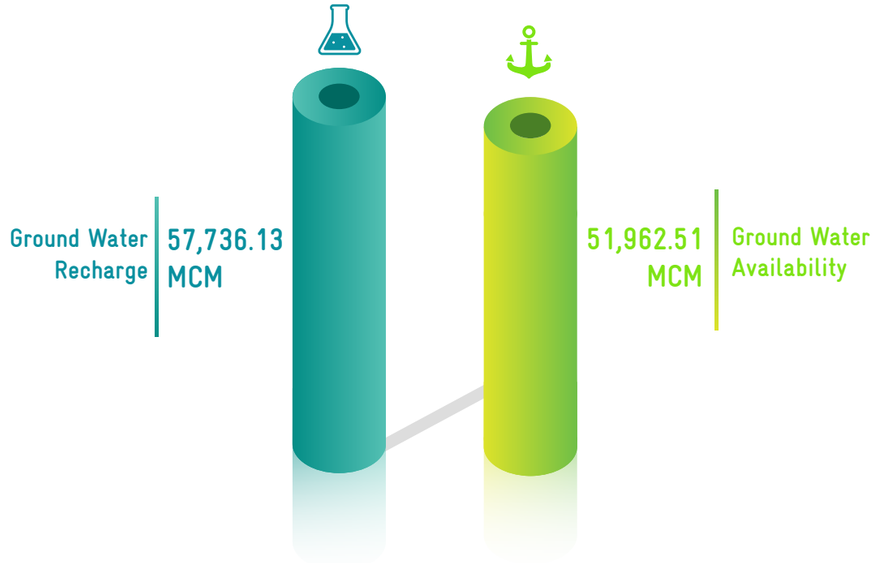


Fig 3.14: Status of ground water availability and recharge potential in the district

C) Water Resources vulnerability

The assessment of supply and demand side of the water sources are necessary to understand the status of water requirement for different sectors as well as available traditional water storage and conveyance structures to enable the harvest of surface runoff effectively. The table 3.6 provides the snap shot of the supply and demand side details for the Ramanathapuram district.

TABLE 3.6: WATER RESOURCES: RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	District - Total
1	2	3	4
	Water Demand		
1	Water Demand for Humans	MCM	40.22
2	Water Demand for Livestock	MCM	4.80
3	Water Demand for Agriculture	MCM	1374.24
4	% G.W Utilization for Drinking	%	5.4%
5	% G.W Utilization for Livestock	%	15.1%
6	% G.W Utilization for Agriculture.	%	0.4%
7	% SW for Drinking	%	94.6%
8	% SW for Livestock	%	84.9%
9	% SW for Agriculture	%	99.6%
	Available Runoff		
10	Good Catchment (Run-off)	MCM	172.81
11	Average Catchment (Run-off)	MCM	49.75
12	Bad Catchment (Run-off)	MCM	268.03
	Run Off Conserved (Existing)		
13	Good Catchment (Run-off)	MCM	137.18
14	Average Catchment (Run-off)	MCM	37.89
15	Bad Catchment (Run-off)	MCM	44.32
	Micro watershed information		
16	Length of Natural Drainage Lines	Km	1476.01
17	Number of Micro Watershed	Number	910
	Canal Network		
18	Main Canal	Km	1097.15
19	Minor	Km	592.15
20	Distributaries	Km	422.46
21	Water Courses (Field Channels)	Km	1575.89
22	Total Length of the canal Network	Km	3687.65
	Traditional water bodies		
23	Number of Tanks	Number	1344
24	Number of Ooranis	Number	3883
25	Other Sources (Ponds)	Number	37
	Irrigation Facilities		
26	Area under Canal Irrigation	Ha	678.09
27	Area under Open well & Tube Well irrigation	Ha	11431.49
28	Area under Tank Irrigation	Ha	52284.76
	Water Quality		
29	Chemical Contaminants	Number	No contamination
30	Bacterial and Other Contaminants	Number	No contamination

Water Demand information: The total demand for water including human, livestock and agriculture is 1419.27 MCM and in that 79% is met through surface water while the balance proportion of 21% is met by ground water resources. Agriculture is the highest user of water which is about 96%, only 2.4% for human and 1.6% for livestock (Fig 3.15).

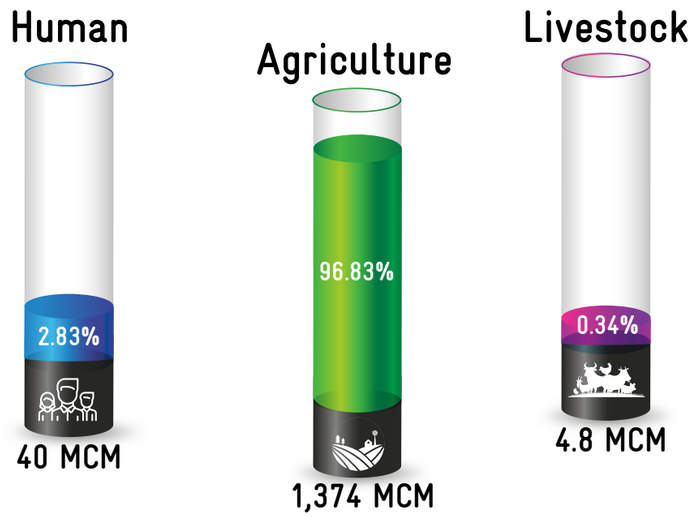


Fig 3.15: Percentage of water demand for agriculture, livestock and human

Ground Water Utilisation: The total demand for ground water including human, livestock and agriculture is 273.62 MCM. and in that 5.40% is utilised by human for domestic purpose and 15.10% is utilised by Animals and while the balance proportion of 0.4% is used for agriculture (Fig 3.16).

Surface water utilisation: The total demand for surface water including human, livestock and agriculture is 1121.36 MCM. and in that 94.60% is utilised by human for domestic purpose and 84.90% is utilised by Animals and while the balance proportion of 99.60% is used for agriculture. Major part of the surface water is utilised for agriculture compare to other two parameters (Fig 3. 16).

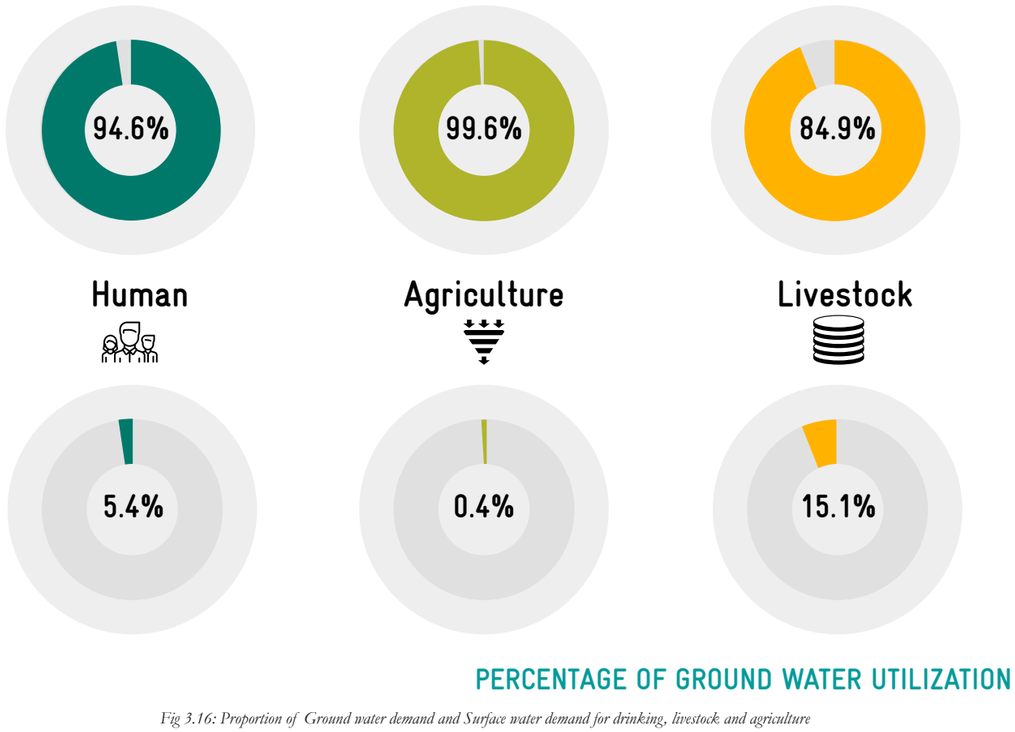


Fig 3.16: Proportion of Ground water demand and Surface water demand for drinking, livestock and agriculture

Available Runoff: The available runoff in catchment area is 490.59 MCM. and in that 35.2 % comes under good catchment area, 10.1% comes under average catchment area and 54.6% comes under bad catchment area. The high amount of runoff generated in bad catchment area compared to other catchment area (Fig 3.17).

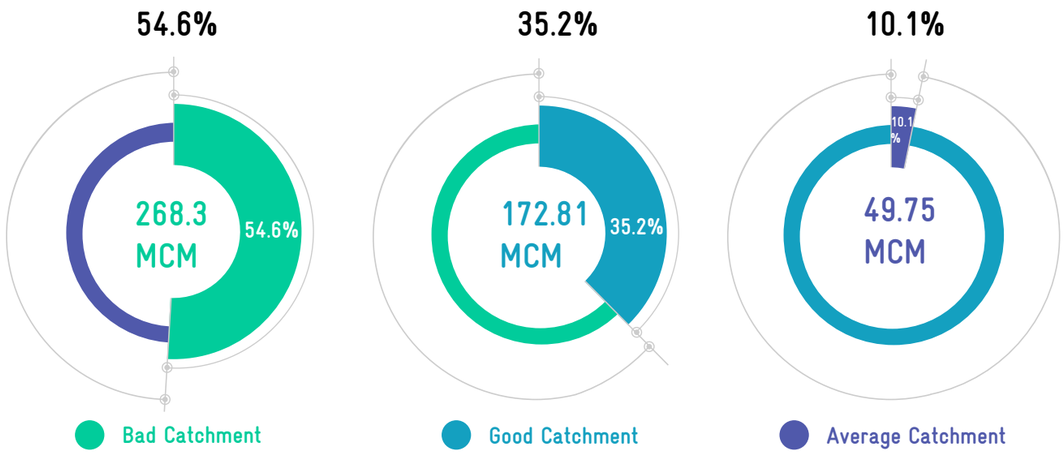


Fig 3.17: Available runoff across different catchment categories

Expected Runoff for Conservation: The expected potential runoff is 219.39 MCM. and in that 35.2 % comes under good catchment area, 10.1% comes under average catchment area and 54.6% comes under bad catchment area. The high amount of runoff generated in bad catchment area compared to other catchment area (Fig 3.18).

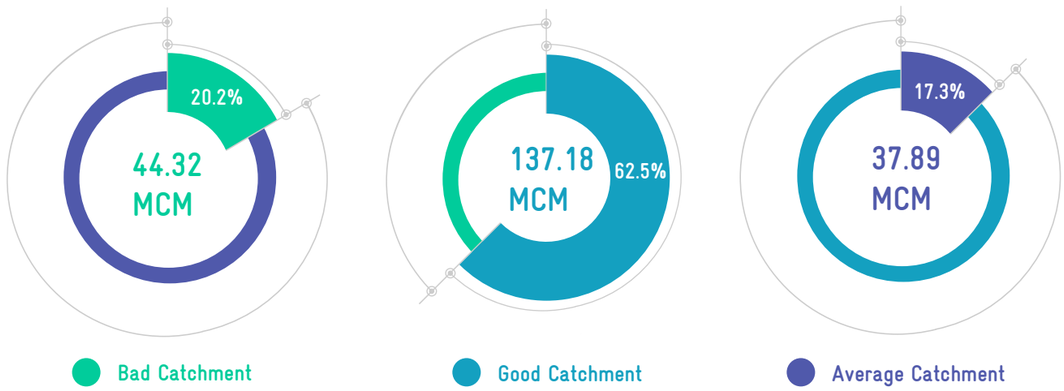


Fig 3.18: Expected runoff across the catchment areas

Drainage line and Watershed Information: The total length of the natural drainage lines in the district is 1,476 km which is significant in regulating the water flow (Table 3.6). Identifying the order of the drain and location in each of the GPs and micro watersheds were delineated to identify the actions like check dam, gully plugs, etc.

The district primarily falls in Gundar-Vaigai river basin. Besides, these two main rivers, Virusuliyaru, Kottakariyaru and Upparu are the other rivers flowing and draining in ramanathapuram district. These rivers are seasonal and considerable amount of water flows during the main monsoon season from October to December. The district has 914 micro watersheds and the details of its are given in table 3.6.

Canal Network: The district has wider network of water supply systems as surface water is the main source for more than 80% of the irrigated land in the district. It has the total length of 1097 km length of main canal, 5921.49 km length of minor canal systems. Further it has 422.46 km of distributaries and 1576 km length of field channels (Fig 3.19).

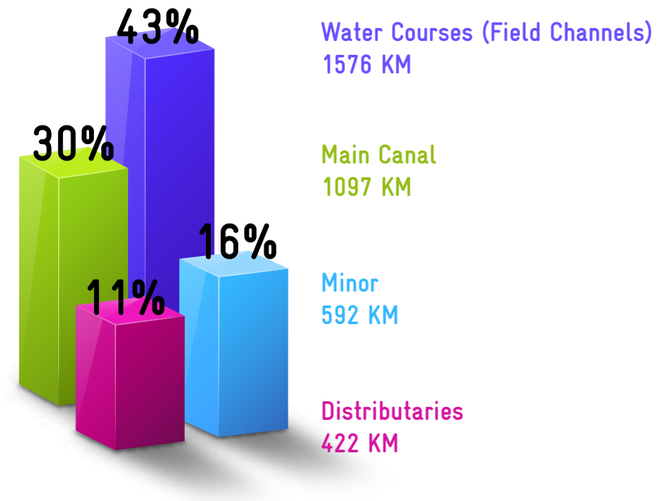


Fig 3.19: Percentage of different categories of canal network in Ramanathapuram district

Existing Water Storage Structures: The district has structured traditional water storage units as tanks, ponds and ooranis which are the life line of local communities for their lives and livelihoods. The district has 1344 tanks and 3883 ooranis with 1576 km length of field channels to distribute water to the agriculture fields (Fig 3.20). Most of the water storage structures needs restoration by increasing the storage capacity and strengthening its distribution structures. On the whole existing water structure, 73.8% of the water structure was covered by ooranis and 25.5% of the water structures was covered by tanks.

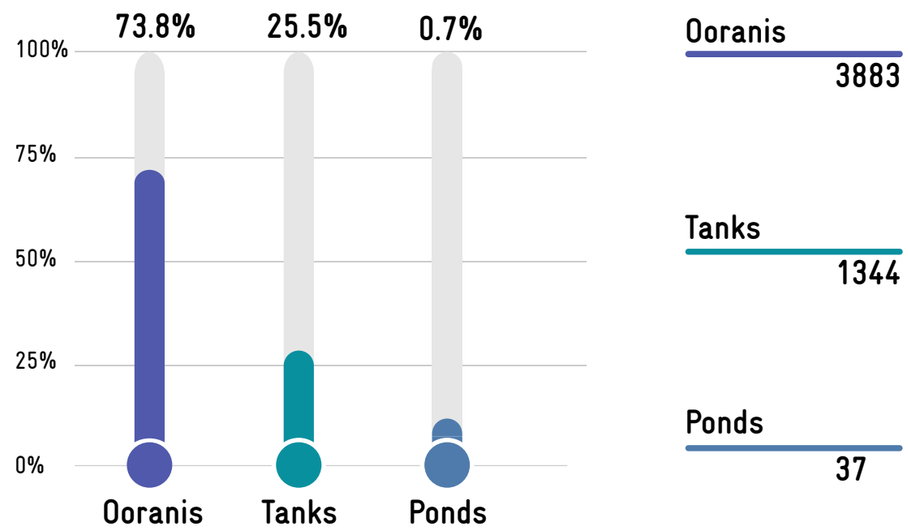


Fig 3.20: Existing water structures in Ramanathapuram District

Irrigation Facilities: The total area under irrigation in the district is 64394 Ha, of which 82% is irrigated through surface water stored in the tanks/lakes and canal area while remaining 18% is through ground water using open/tube wells. Mandapam has the highest area underground water-based irrigation (76%), followed by Thirupullani (46%) and Nainarkovil and Paramakudi accounting each 26% of its total irrigated area. Kadaladi, R.S. Mangalam, Thiruvadanai and Mudukulathur blocks have more 90% of the irrigated area using surface water resources (tanks/lakes/canal) (Fig 3.21).

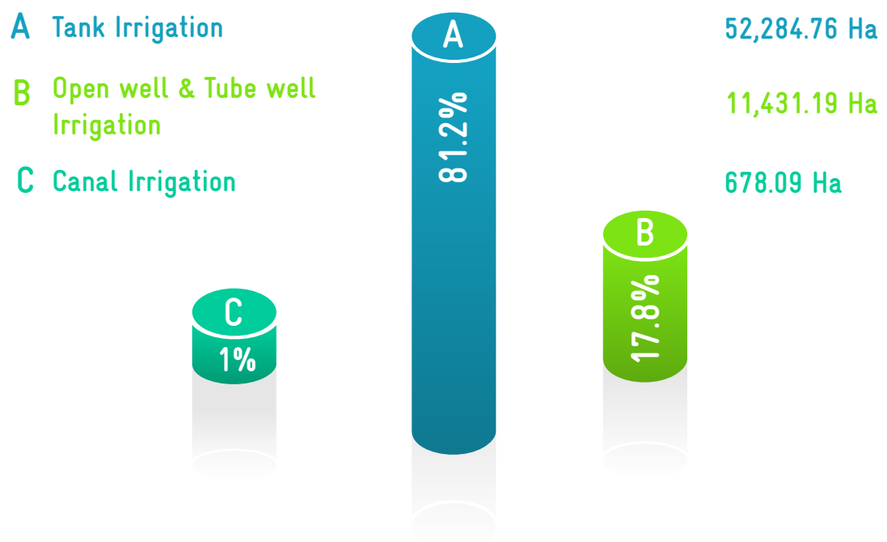


Fig 3.21: Proportion of different irrigation sources in Ramanathapuram district

Water Quality: There were no major issues in both chemical and biological contamination, however, six out of the eleven blocks are located in the coastal area. Here TDS is high in the villages which are closer to the coast line. The recent study of the Prime Meridian also highlighted the increasing number of area's getting salinized and ending up with poor water quality. According to the latest Ground Water assessment out of 39 firkas, 29 firkas falls in safe category and 9 firkas falls in saline category. In order to improve the Ground Water and Quality, check Dams and recharge wells have been Proposed to be constructed in this study.

D) Agriculture vulnerability

Agriculture and fisheries are the primary livelihood sector for about 80% of the labour force in the district. In agriculture, paddy is the main food crop cultivated in 74 percent of the total net sown area cultivated both in irrigated and rainfed conditions. Next to paddy, chilli is the commercial crop cultivated in about 9.40 percent of the net sown area. The other crops cultivated in the district are sorghum, little millet, barnyard millet, gingelly, ground nut, pulses, coconut and vegetable and floriculture crops. The main source of irrigation in the district is tanks and about 32% of the total cropped area is under irrigation. Apart from cropping, allied sectors include cattle, sheep and goat are important sub sector contributes to rural employment and income. The following table 3.7 provide the details of the parameters taken in to account for the CWRM planning at the GP scale.

TABLE 3.7: AGRICULTURE AND ALLIED PROFILE: RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	District - Total
1	2	3	4
	Soil Moisture and Evapo Transpiration		
1	Soil Moisture	%	17%
2	Soil Moisture	MCM	521.53
3	ET Losses	MCM	1095.59
	Soil Resources: Available Nitrogen		
4	Very Low (VL)	%	35%
5	Low (L)	%	56%
6	Medium (M)	%	8%
7	High (H)	%	0%
8	Very High (VH)	%	1%
	Soil Resources: Organic Carbon		
9	Very Low (VL)	%	36%
10	Low (L)	%	32%
11	Medium (M)	%	11%
12	High (H)	%	1%
13	Very High (VH)	%	1%
	Soil Resources: Micro Nutrients		
14	Sufficient	%	67%
15	Deficient	%	33%
	Soil Resources: Physical Parameter - PH		
16	Acidic Sulphate (AS)	%	9.1%
17	Strongly Acidic (SrAc)	%	5.2%
18	Highly Acidic (HAc)	%	9.1%
19	Moderately Acidic (MAc)	%	9.1%
20	Slightly Acidic (SlAc)	%	9.1%
21	Neutral (N)	%	9.1%
22	Moderately Alkaline (MAI)	%	9.1%
23	Strongly Alkaline (SIAI)	%	9.1%
	Soil Profile		
24	% of Clay Soil	%	38.3%
25	% of Fine Soil	%	50.9%
26	% of Coarse loamy	%	10.8%
27	Permeability		Moderate to Low (5-20 mm/hr)
	Land use categories		
28	Area under forest	Ha	Tota2912.54
29	Area under Non-Agricultural Uses	Ha	78661.04
30	Area under Barren & Un-cultivable Land	Ha	4893.9
31	Area under Permanent Pastures and Other Grazing Land	Ha	224.13
32	Area under Land Under Miscellaneous Tree Crops etc.	Ha	29764.29
33	Area under Culturable Waste Land	Ha	4838.45
34	Area under Fallows Land other than Current Fallows	Ha	39357.91
35	Area under Current Fallow land	Ha	45178.76

36	Area under Unirrigated Lands	Ha	116332.66
37	Area Irrigated by Source	Ha	64732.65
	Proposed treatment area under WASCA		
38	Area under forest	Ha	1159.5
39	Area under Non-Agricultural Uses	Ha	5897.31
40	Area under Barren & Un-cultivable Land	Ha	4159.82
41	Area under Permanent Pastures and Other Grazing Land	Ha	190.51
42	Area under Land Under Miscellaneous Tree Crops etc.	Ha	25299.65
43	Area under Culturable Waste Land	Ha	4112.68
44	Area under Fallows Land other than Current Fallows	Ha	5076.75
45	Area under Current Fallow land	Ha	5085.75
46	Area under Unirrigated Lands	Ha	15062.78
47	Area Irrigated by Source	Ha	7700.38
	Total Catchment Area		
48	Good Catchment Area	Ha	86467.48
49	Average Catchment Area	Ha	34826.87
50	Bad Catchment Area	Ha	265601.98
	Means of Water Extraction		
51	Gravity	%	55%
52	Lifting	%	45%
	Irrigation Methods		
53	Wild Flooding	%	75%
54	Control Flooding	%	25%
	Crop Details		
55	Irrigated Area	Ha	62390.96
56	Rainfed Area	Ha	85379.88
57	Area under Paddy Cultivation	Ha	100628.05
58	Crop water requirement – Irrigation	MCM	26828.11
59	Crop water requirement - Rainfed	MCM	34536.16
	Livestock Details		
60	Cattle population	Number	78999.85
61	Goat and Sheep population	Number	421699.58
62	Poultry	Number	293400.60
63	Livestock Water Requirement	MCM	4.82

Evapotranspiration and soil moisture: The total annual evapotranspiration in the district is 522 mm which has negative impact in water budgeting. The annual total ET loss during 2018-19 was 1095.59 MCM with monthly average of 43.5 mm in the district (Fig 3.22). The average percentage area influences the water loss through ET in the district was 54%. The soil is an important medium to store the available water and the storage capacity vary with the type of soil especially its textural composition. In overall composite water budgeting, stored water in the soil assumes greater significance in Ramanathapuram because of its higher proportion of area under rainfed cultivation. The average annual volumetric soil moisture is taken for estimating the amount of water stored as soil moisture which accounts to 521.53 MCM, which is almost equal to the amount of surface runoff (Fig 3.22).

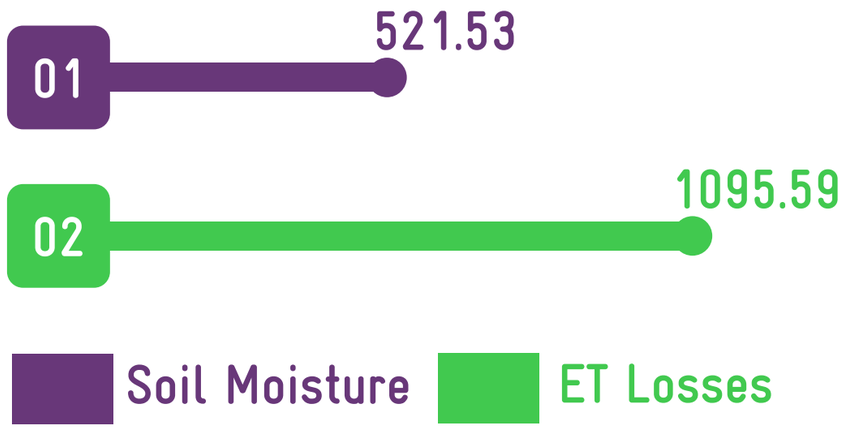


Fig 3.22: Amount of water stored as soil moisture and ET loss in Ramanathapuram district

Soil Resources: The main soil types in the district is clay, coastal alluvium, sandy loam, black cotton soil and red loam. The soil type in the coastal blocks are predominantly saline to alkaline while in the island area it is sand and interior parts of the district a mix of black cotton and red loamy soil.

Macro Nutrients – Nitrogen: The macro soil nutrients such as nitrogen is very low to low category in the total number of soil samples tested. This indicates that the soil fertility is very poor and further intensive practices make soil more vulnerable to degradation over a period of time (Fig 3.23).

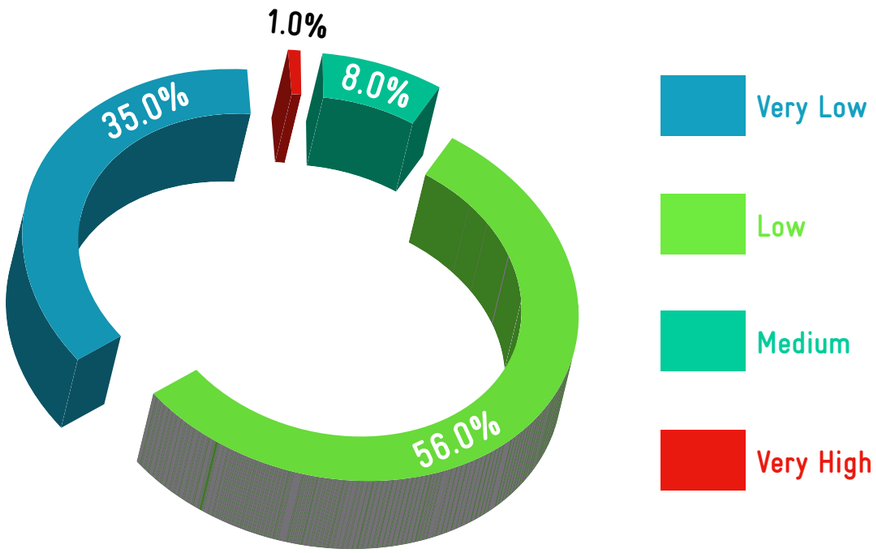


Fig 3.23: Status of Nitrogen content in the soil in Ramanathapuram district

Macro Nutrients – Organic Carbon: The macro soil nutrients such as organic carbon is very low to low category in the total number of soil samples tested. This indicates that the soil fertility is very poor and further land improvement should be needed to reduce the soil erosion (Fig 3.24).

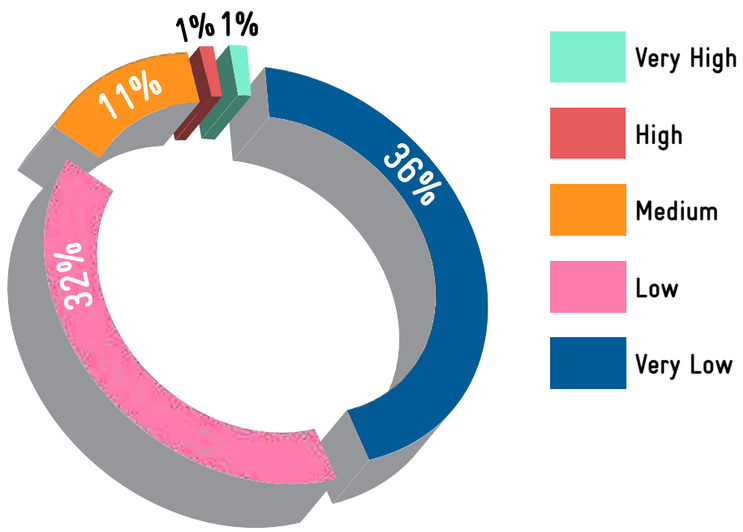


Fig 3.24: Status of organic carbon content in the soil in Ramanathapuram district

Micro Nutrients: The micro nutrient status of the soil with specific reference to Zinc and Boron are deficient in more than 58 to 85% of the soils tested. Similarly, the soils were deficit in Boron content to a range of 77-94%. Remaining other nutrients such as Fe, Cu, Mn and S are sufficient in the soil. On the whole, 67% of the samples are sufficient and 33% of the samples are deficient (Fig 3.25).

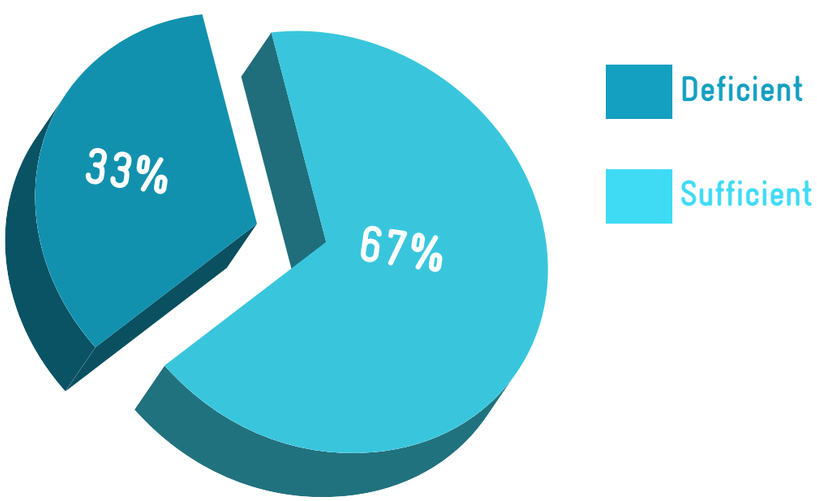
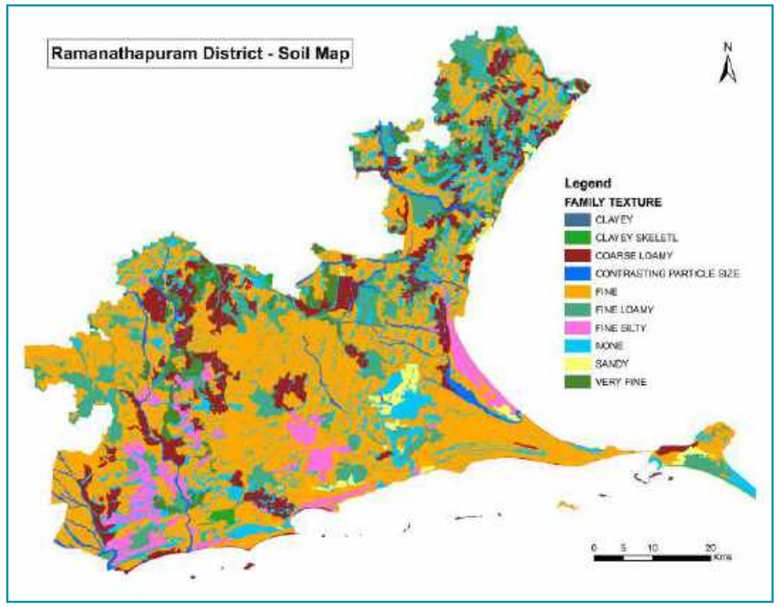


Fig 3.25: Status of soil Micronutrients in Ramanathapuram district

Physical Parameters: With reference to the physical parameters, more than 9 % of the soils are acidic sulphate, highly acidic, moderately acidic, slightly acidic, neutral, moderately alkaline and strongly alkaline in nature and 5.20% of the soils are strongly acidic in nature.

Soil texture: The predominant soil types are vertisol and alfisol and textural classification is dominant with fine texture occupying 82.5 % of the total cultivated area of the district followed by coastal coarse loamy to an extend of 17% in the northern part of the district (Map 3.15).



Map 3.15: Distribution of soil types - textural classification, Ramanathapuram

Land Resource Classification: The standard land use classification helps to understand the distribution and the extend of different land use categories. As the runoff and water harvesting actions are linked to the land use systems, its distributions across the geographical boundary (GP/block/watershed/sub-basins) are necessary to take the decisions. The table 3.7 and figure 3.26 shows the area under different land uses. From the table it is inferred that,

- 31% of the land is under public and common land category
- 69% of the land comes under individual farmers
- In the total public and common land, the highest - 20.3% of the area is non-agricultural land to the total area and lowest percentage (i.e. 0.1% is the permanent pasture land to the total area). Under this category, the district has negligible area under permanent pastures, however the district has considerable number of small ruminants which are normally open grazed
- 46.80% of the total area is currently under cultivation
- Of the individual ownership land, 21.85% is under fallow land other than current fallow and the fallow land

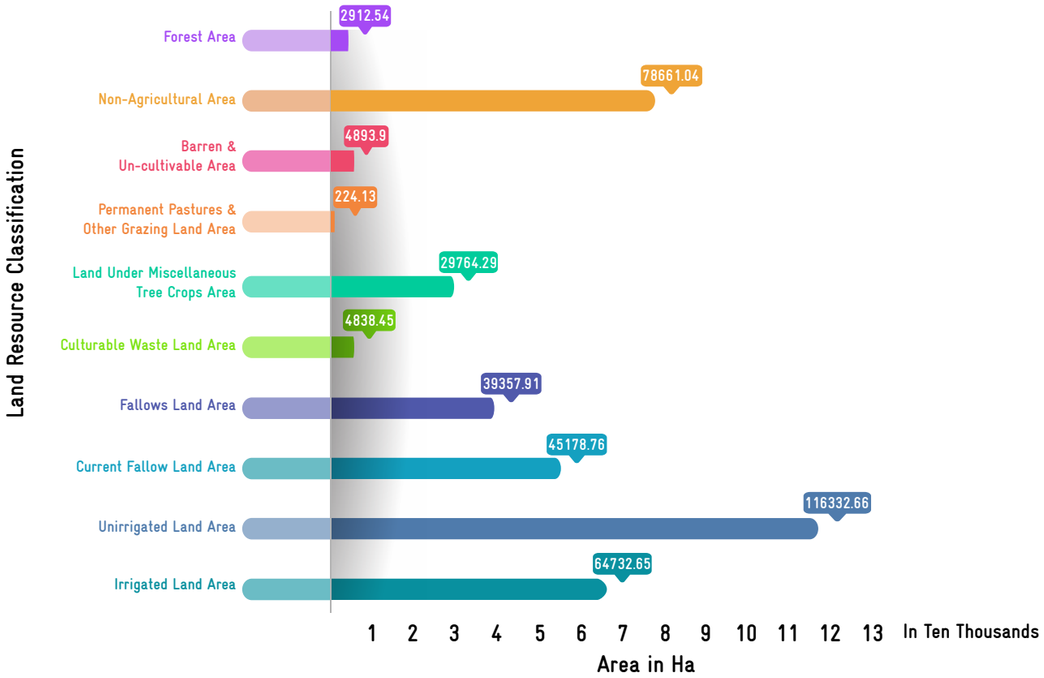


Fig 3.26: Proportion of area under different land use in Ramanathapuram district

Catchment Area: The total catchment area of the district is 3,86,896.33 ha, of which 19% is proposed for treatment under WASCA – CWRM planning. The different land use types in the tenfold classification are categorized into three different runoff types; Good Catchment area, Average Catchment area and Bad Catchment area. From the analysis, it is concluded that about 22.3 % in good catchment, 68.6% in bad catchment area and 9% in average catchment area and from which 51% of the total runoff is expected to be harvested (Fig 3.27).

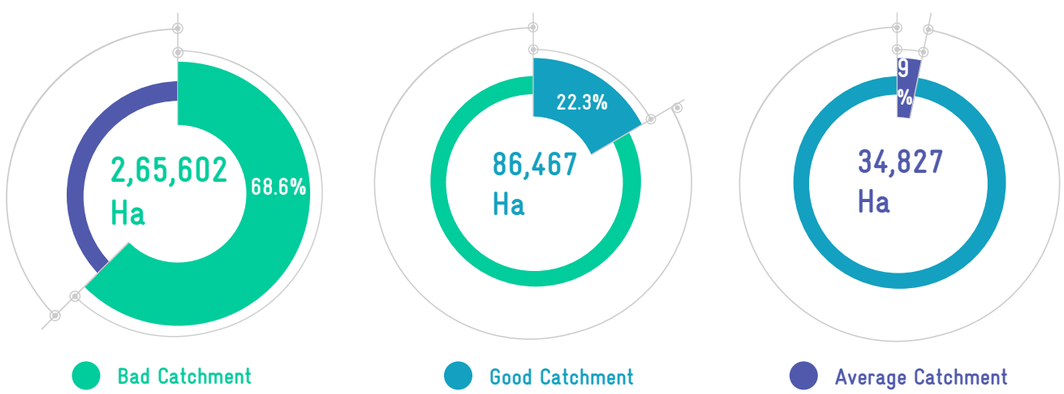


Fig 3.27: Proportion of catchment area under different runoff types in Ramanathapuram district

Land Resource Classification – Treated WASCA Area: Of the total geographical area in the district, 19% of the total area is identified and proposed for different actions to harvest and conserve water from the surface runoff water. The table 3.7 and figure 3.28 shows the WASCA area under different land uses. From the table it is inferred that,

- Under public and common land, 64 % of the land is taken for WASCA treatment area to the total public and common land.
- Under Individual ownership land, 12% of the land is taken for WASCA treatment area to the total individual land.

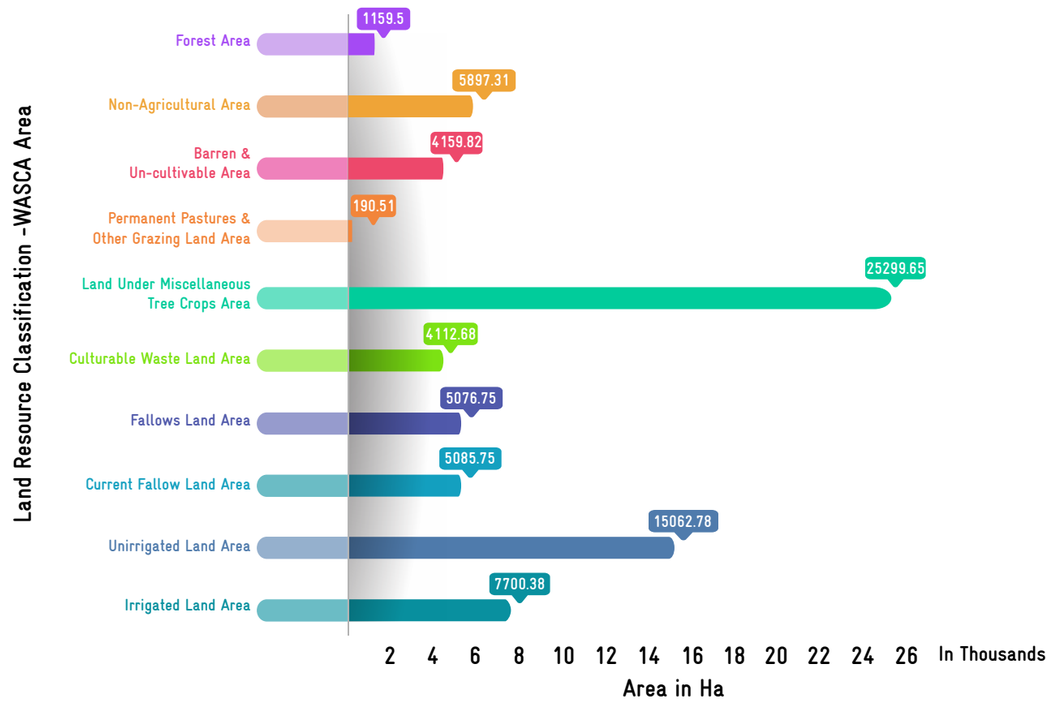


Fig 3.28: Area identified in WASCA for water actions in Ramanathapuram district

Irrigation profile

Means of Water Extraction: The water is mainly extracted by two ways; one is by gravity and another is by lifting. Here, the tanks and ooranis are taken under gravity method and the open well, handpump, bore well are taken under lifting method. In Ramanathapuram district, the tanks and ooranis are high. In the whole, 55% comes under gravity means of extraction and 45% comes under lifting means of water extraction.

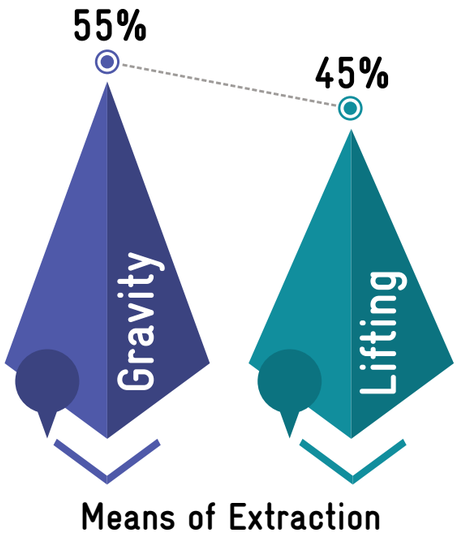


Fig 3.29: Means of water extraction in Ramanathapuram district

Irrigation Methods: In case of the surface water resources, the wild flooding is the primary method of irrigation. But in case of ground water resources, the predominant type of irrigation is controlled flooding. In Ramanathapuram district, 75% of the irrigation is done by wild flooding and 25% of the irrigation is done by control flooding (Fig 3.30).

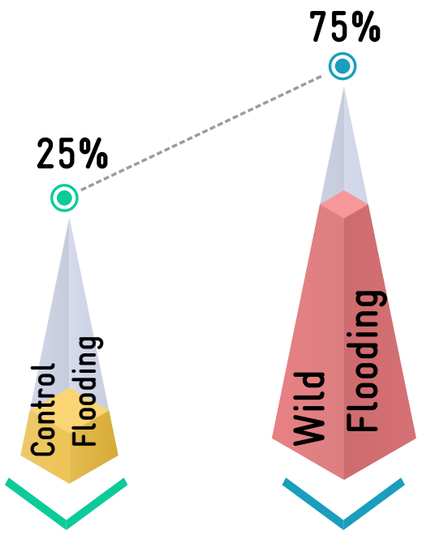


Fig 3.30: Methods of irrigation adopted in Ramanathapuram district

Crop Details: Paddy is the primary crop cultivated in 68% of the total area cultivated followed by dry chilli (8.81%), coconut (4.45%), other pulses (3.28%), Jowar (2.98%) and other crops in 8.81% of the area. Of the total crops, 42% is cultivated under irrigated condition and 58% is under rainfed cultivation. Paddy, being a predominantly cultivated, 41.06% of the area is under irrigation (Fig 3.31) and remaining 58.94% is under rainfed cultivation. With reference to water requirement, of the total water needed for cultivation paddy consumes more than 82.12% followed by chillies (5.55%) (Table 3.8).

TABLE 3.8: MAJOR CROPS AND THE PERCENTAGE AREA UNDER CULTIVATION IN RAMANATHAPURAM DISTRICT

Crops	% of the area to the total cultivation	Crop water requirement-irrigated MCM	Crop water requirement Rainfed - MCM	Total Volume in MCM	Proportion to the total water demand (%)
1	2	3	4	5	6
Paddy	68.10%	619.72	593.14	1212.86	82.12%
Jowar	2.98%	23.40	0.77	24.17	1.64%
Other pulses	3.28%	0.35	16.65	17.00	1.15%
Cotton	2.05%	9.99	13.87	23.86	1.62%
Dry Chilli	8.81%	9.23	72.67	81.90	5.55%
Coconut	4.45%	32.90	0	32.90	2.23%
Other plantation	1.51%	0.55	10.61	11.16	0.76%
Other crops	8.81%	40.45	32.67	73.12	4.95%

Source: CWRM- TN- Ramanathapuram Plan, 2020-21 from G returns, 2018-19, Ramanathapuram

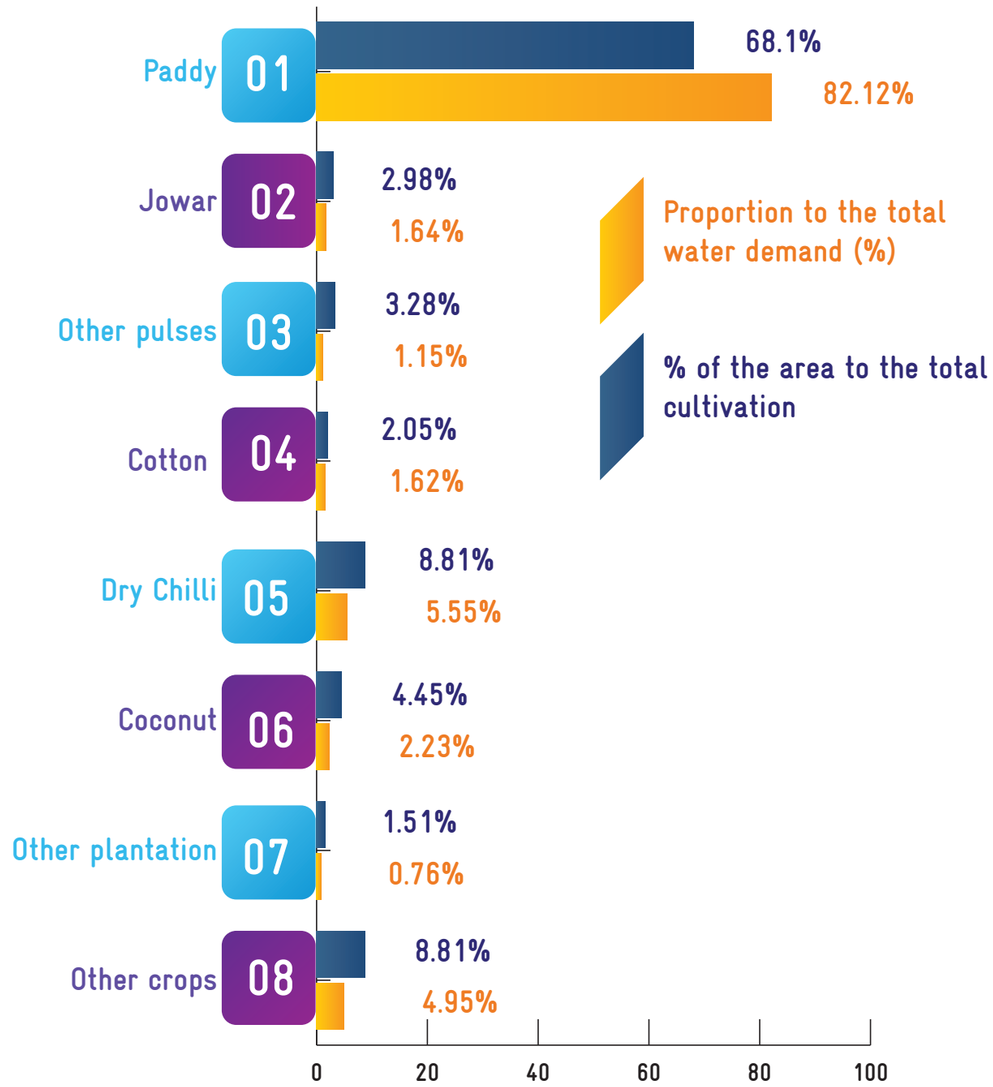


Fig 3.31: Proportion of area under different crops

Livestock Details: Cattle, goat and sheep and poultry are taken as main animals for analysis to find the water requirement. On the whole total number of animals, 10% of the animal comes under cattle, 53% of the animals under sheep and goat while 37% of the animal comes under poultry (Fig 3.32). Backyard poultry is the common type practiced in the district. The livestock water requirement is 4.82 MCM.

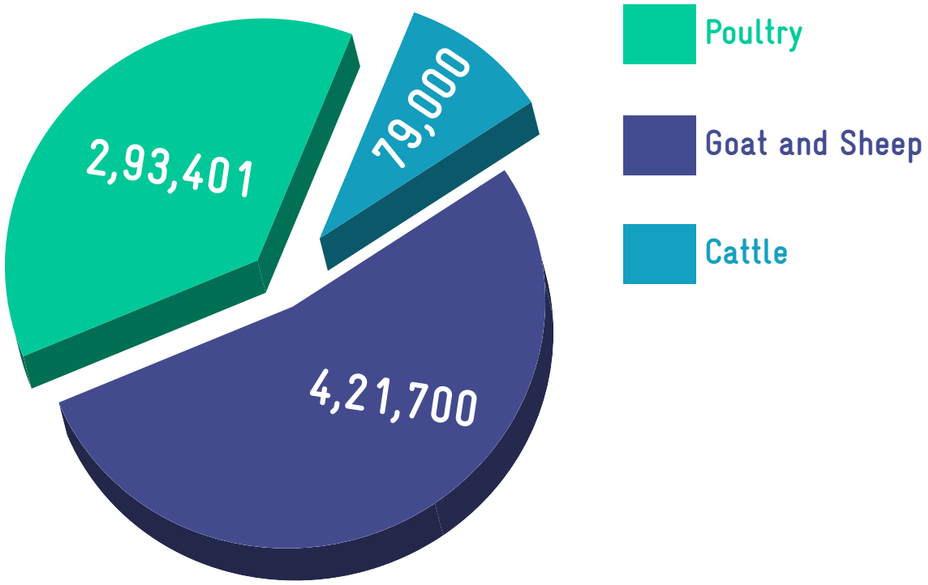


Fig 3.32: Proportion of different livestock population in Ramanathapuram district

3.3.2. TIRUVANNAMALAI

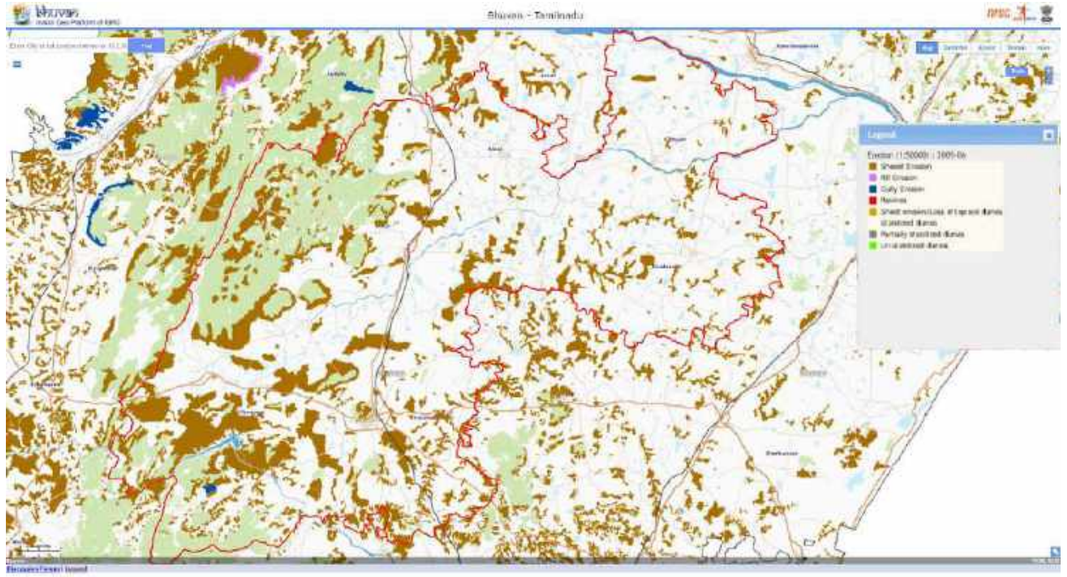
3.3.2.1. SPATIAL DATA

The area under soil erosion affected land is 22.71 percent due to the more area under hilly terrain. Besides the area under waste land is also 3.03 percent. However, the land area affected by salt is 1.15 percent only. With reference to slope category the district had 'undulating terrain with residual hills and intermittent plain lands'. The percentage of the total micro sheds to the total geographical area is 0.40 percent. The lineament parameter shows that it is ridge parallel in Tiruvannamalai (Maps 3.16 to 3.27).

SPATIAL PARAMETERS USED IN THE KEY WATER CHALLENGE ANALYSIS, TIRUVANNAMALAI DISTRICTS

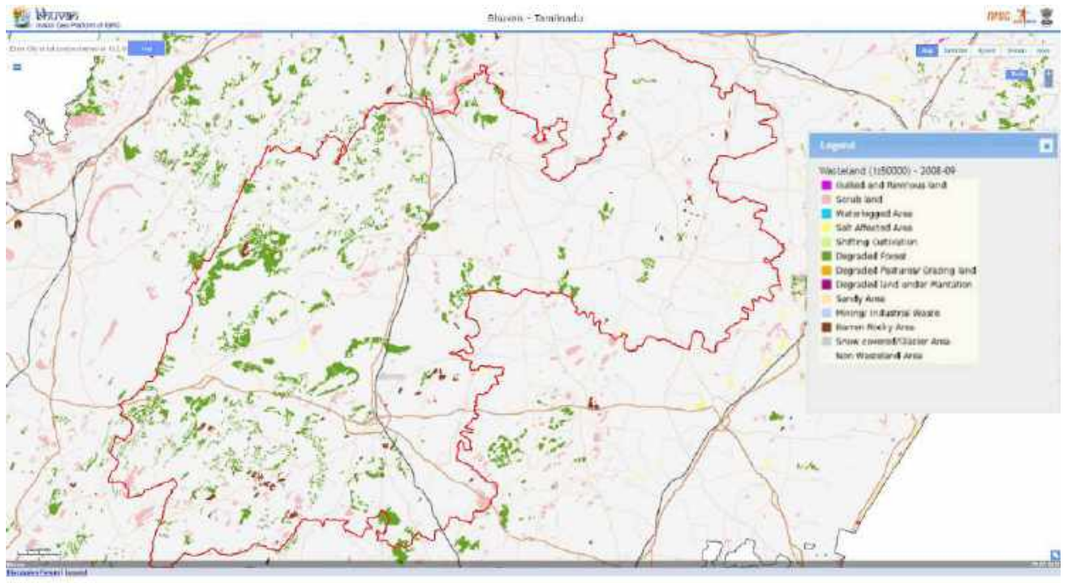
- **Area under erosion** | 104343.78 Ha
- **Waste Lands** | 13929.69 Ha
- **Salt Affected Area** | 5277.95 Ha
- **Micro Watersheds** | 1849.00 Nos
- **Drainage Density Category** | 0.38 Km/ha
- **Lineament** Geomorphic Lineaments, Ridge Parallel
- **Land use and land cover maps** Area under different land use and water bodies are mapped
- **Ground Water Prospectus** > 80 m Deep Well
- **Geomorphology Type (Major)** Denudational Origin- Pediment- Pediplain Complete
- **Contour** Identification of valleys and hills, and the steepness or gentleness of slopes for planning water actions
- **Terrain** Slope, land forms and terrain conditions
- **Slope Category** Undulating terrain with residual hills and intermittent plain lands

Soil erosion: The erosion map shows the soil erosion capacity with respect to rainfall, soil physical properties, terrain slope, land cover of Tiruvannamalai district. The soil erosion map used for soil conservation and regional planning and watershed management. In Tiruvannamalai district, it is observed that sheet erosion is more predominant so the measures has been planned to arrest further erosion.



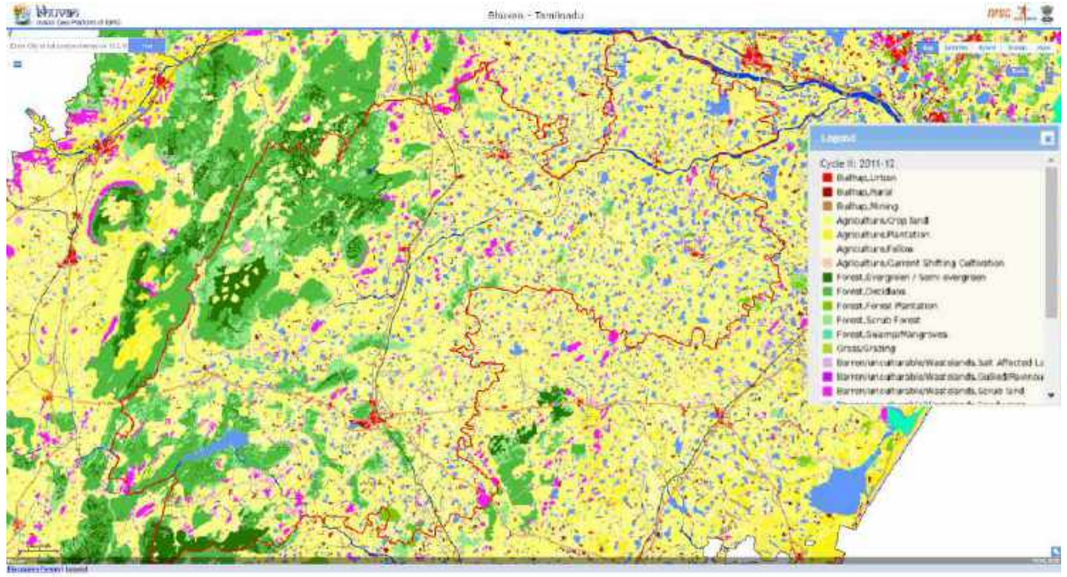
Map 3.16: Soil erosion map of Tiruvannamalai District

Wasteland: There are large number of patches under degraded forest in the district. During planning the GPs, the plantation measures have been taken up in the identified degraded forest to convert into productive land.



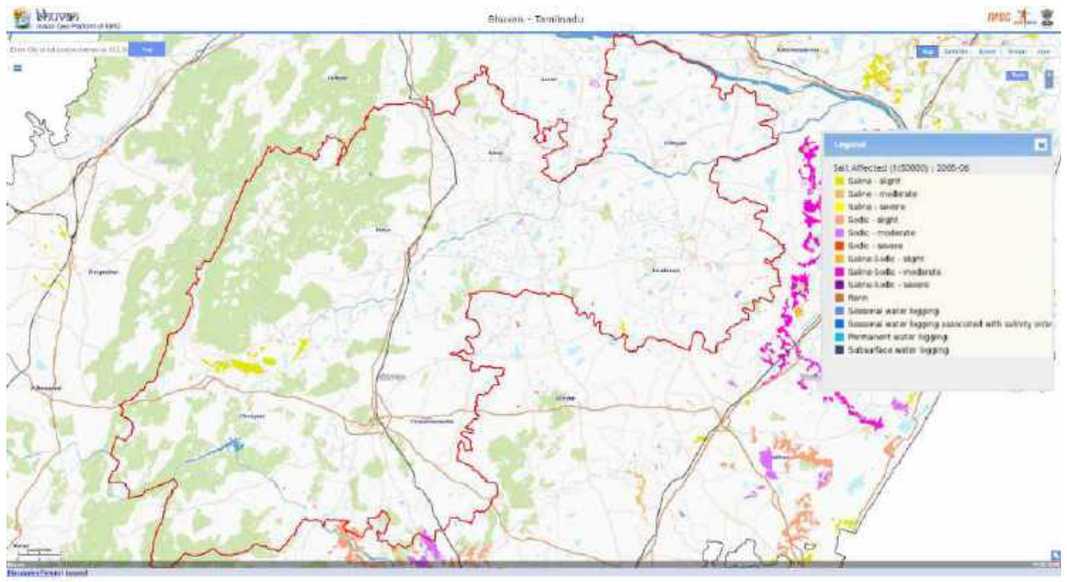
Map 3.17: Wasteland map of Tiruvannamalai district

Land Use Land Cover: The map clearly shows that the Tiruvannamalai district is covered by the agricultural crop land and fallow lands. The map helps the decision makers and planners to concentrate on the fallow land development activities. During the planning of GPs, the more fallow land activities has been proposed in the Tiruvannamalai district



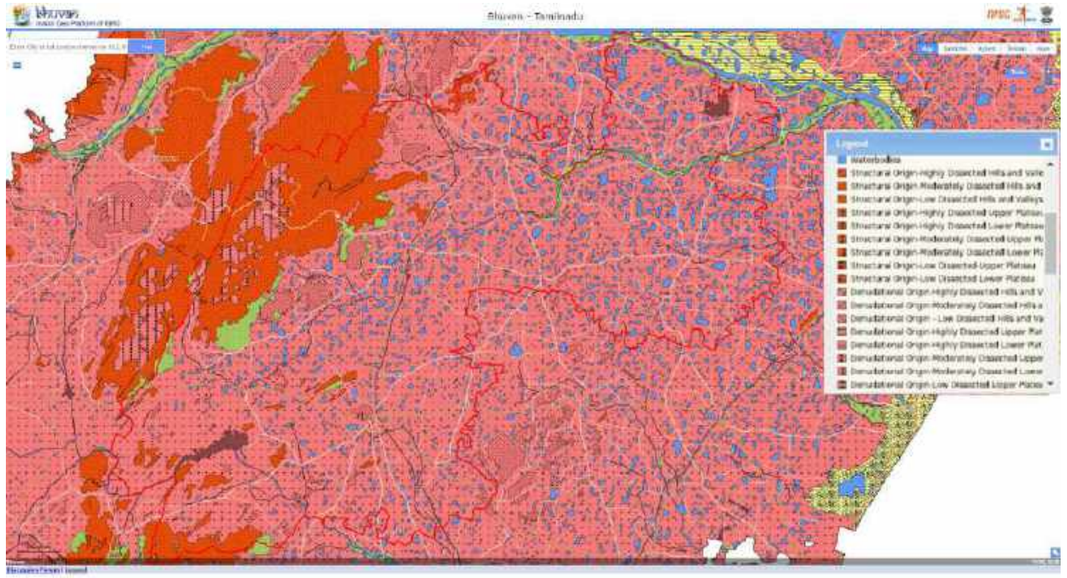
Map 3.18: Land use and land cover of Tiruvannamalai District

Salt affected area: In the district, it is observed that the some parts of the land are slightly saline. While planning the GP, this area has been treated specially and given alternative cropping and other any other steps has been suggested to reduce the salinization.



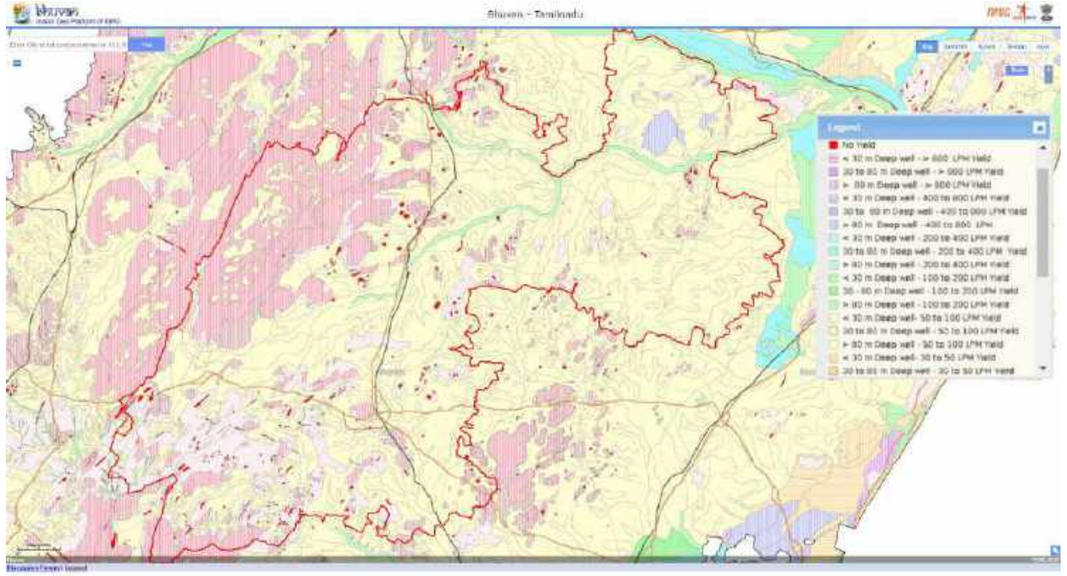
Map 3.19: Salt affected area in Tiruvannamalai District

Geomorphology: The major part of the Tiruvannamalai districts covers under the Denudation origin – pediment- pediplain complex category. The geomorphic and geologic conditions is guided us to undertake appropriate work in particular location to reap maximum benefits.



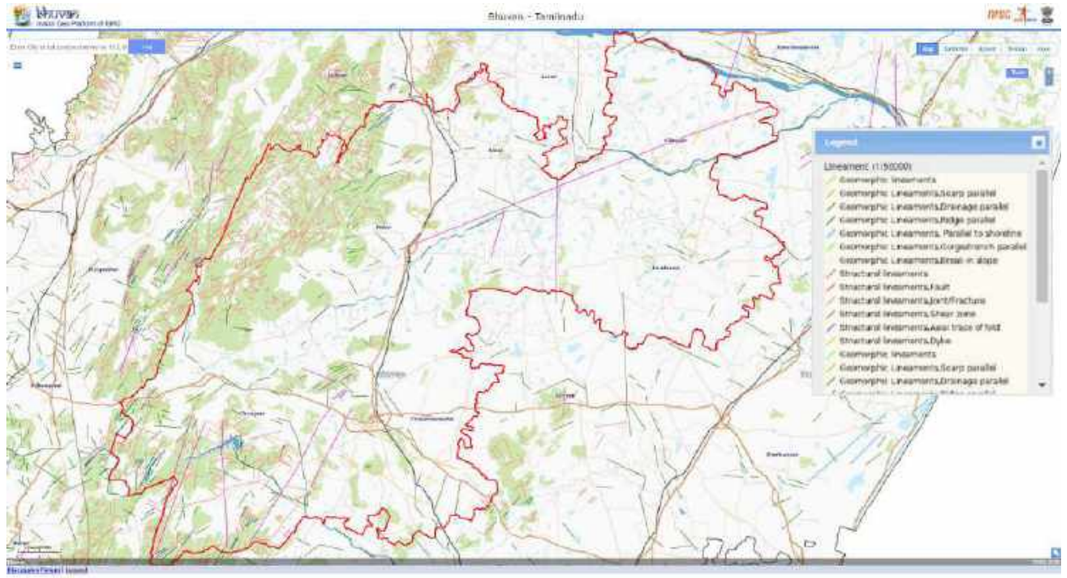
Map 3.20: Geomorphology of Tiruvannamalai District

Ground water prospectus: The map provides the required information on geological parameters connected to ground water exploration and the probable ground water prospects and helps in identification of sites for planning recharge structures to address water scarcity in a more effective manner for Tiruvannamalai district.



Map 3.21: Ground water prospectus map of Tiruvannamalai District

Lineament: The lineament map shows the linear feature in a landscape that is an expression of an underlying geological structure such as a fault, fracture, or joint of Tiruvannamalai district.

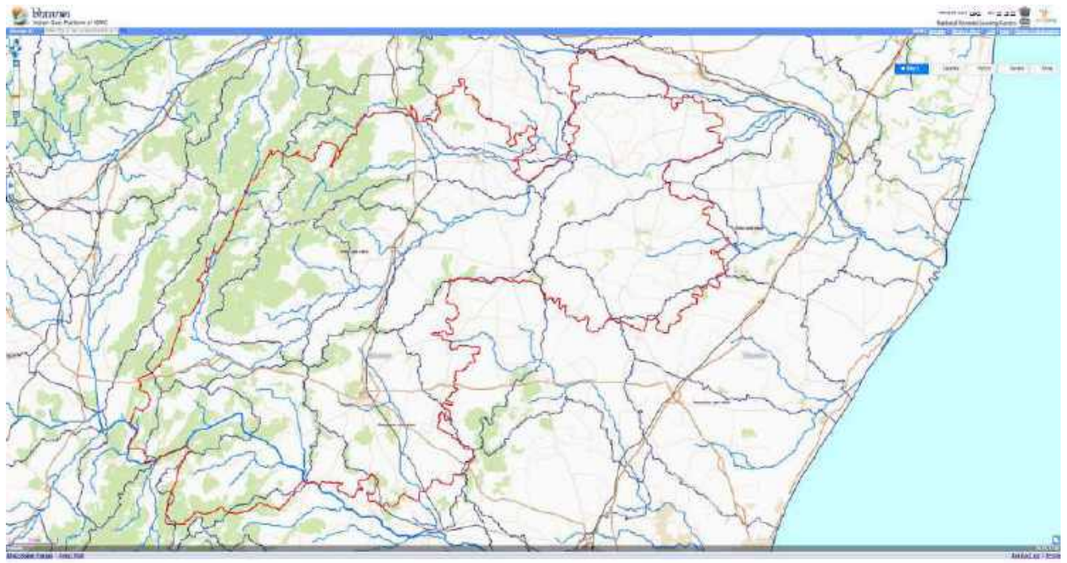


Map 3.22: Lineament map of Tiruvannamalai District

Watershed: A watershed map is the area of land where all of the water that falls in it and drains off of it goes into the common outlet. This map is used for the interventions based on ridge to valley concept and sequencing the plan accordingly.

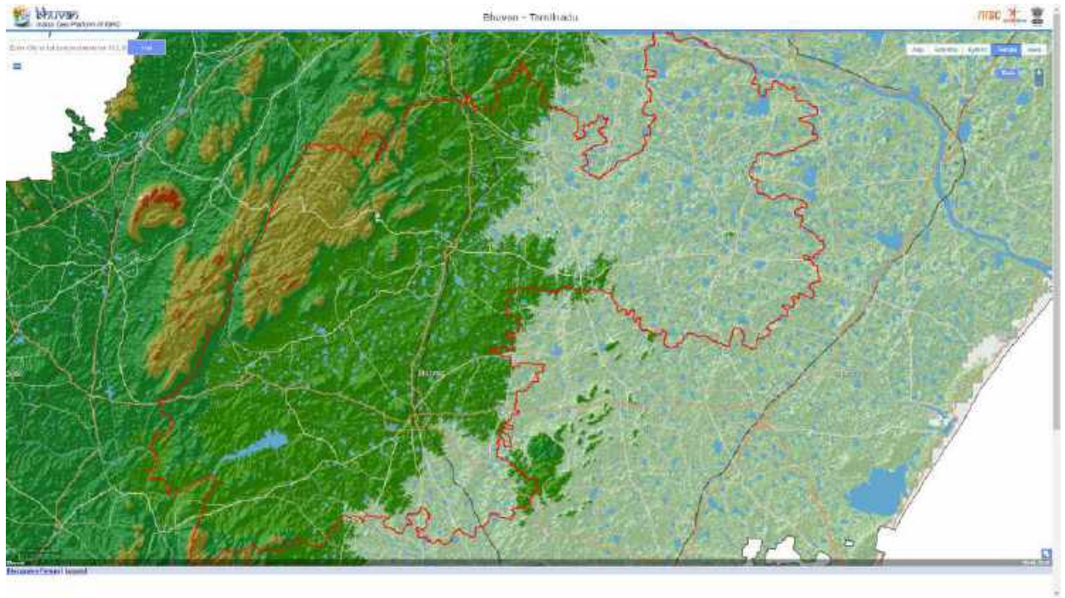
Map 3.23: Watershed map of Tiruvannamalai District

Drainage map: The drainage map shows the drainage order, pattern and destiny. Also, It shows the spread and extent of surface water bodies in the Tiruvannamalai district. This map is widely used to identify the suitable locations for check dams on the drainage, gabion structures and desilting the drains.



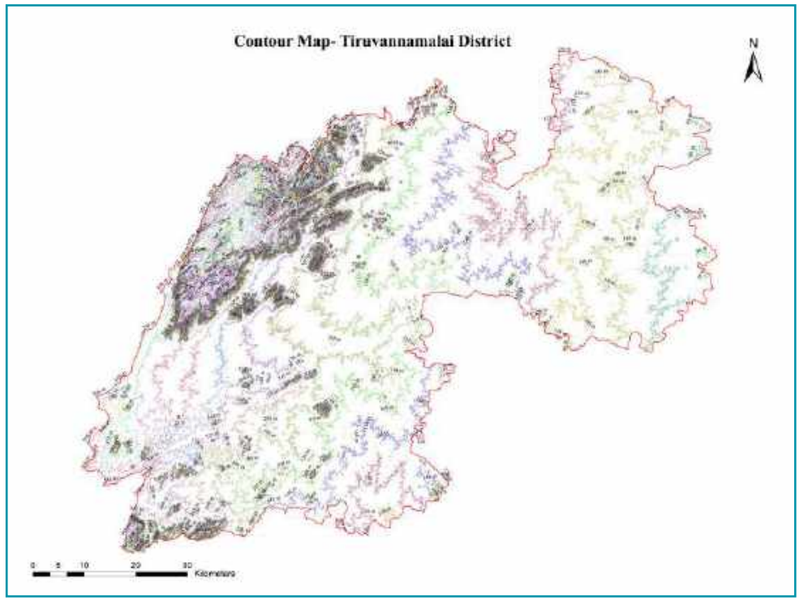
Map 3.24: Drainage map of Tiruvannamalai District

Terrain: The terrain map shows an area of land divided into terrain map units defined by similar elevation, slope, landform. This map will be useful to understand the terrain to identify the water and soil conservation related activities in the GPs of Tiruvannamalai.



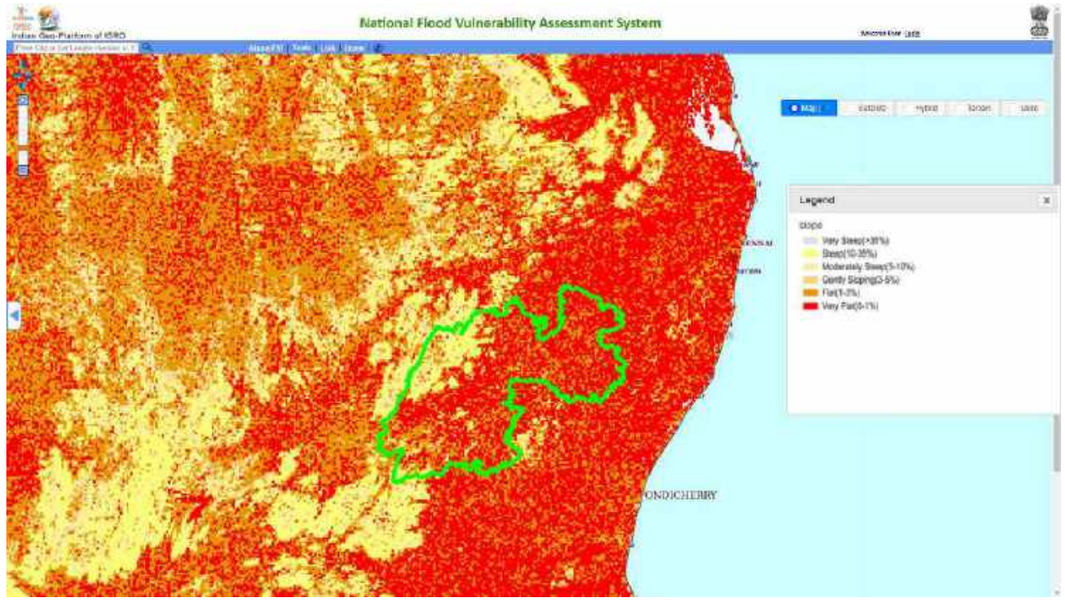
Map 3.25: Terrain map of Tiruvannamalai District

Contour: The contour map shows valleys and hills, and the steepness or gentleness of slopes in the district helps to decide water harvesting structures.



Map 3.26: Contour map of Tiruvannamalai District

Slope Map: Slope map illustrates the measure of steepness or the degree of inclination of a feature relative to the horizontal plane. Slope is typically expressed as a percentage, an angle, or a ratio. The average slope of a terrain feature is calculated from contour lines on a topo map or DEM . It is used for analysing the soil conservation measures and construction of the water recharge structures such as check dam, farm ponds etc.



Map 3.27: Slope map of Tiruvannamalai District

3.3.2.2 NON-SPATIAL DATA:

A) Socio-Economic vulnerability

Population: The district has the total population of 19.6 lakhs, of which the proportion of men and women are almost equal. In the CWRM planning process due attention is given for the intersecting variables such as gender, class, caste and marital status and availability safe drinking water resources. In the district, about 25% of the total population are under vulnerable category due to caste category (Fig 3.33).

Marginal and small farmers: On the basis of households, it is 11.74 percent of the total households. While on the basis of land holding (class) the district has highest number of farmers under marginal category (81%) owning less than one ha of land. This is 47% of the total land in the district. Also, of the total holdings only 12% are from SC and 2% from ST communities (Fig 3.34).

TABLE 3.9: SOCIO ECONOMIC VULNERABILITY IN TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	District - Total
1	Total Geographical Area	Ha	S1	459544
2	Male Population	Number	S2	989663
3	Number of marginal and small farmers	Number	S2	428530
4	Total Population	Number	S2,S4	1969812
5	SC Population	Number	S2,S4	493911
6	ST Population	Number	S2,S4	95998
7	Vulnerable population	Number	S2,S3,S4	589909
8	No. Of. Households	Number	S2	472845
9	Only one room HH's	Number	S2	66060
10	Female Headed HH's	Number	S2	30894
11	Vulnerable Households	Number	S2	55510
12	% Vulnerability	%	S2	12%
13	Registered Job cards	Persons Number	S2	828870
14	Active person Job Cards	Persons Number	S2	618867
15	Drinking Water Sources	Number	S3	472858
16	Greywater Generation	MCM	S2, S3	35.95

Note: S1 - Rural proportion; S2 - Multi-dimensional poverty index; S3 - source of drinking water within premises in rural and S4 - marginal farmer landholdings

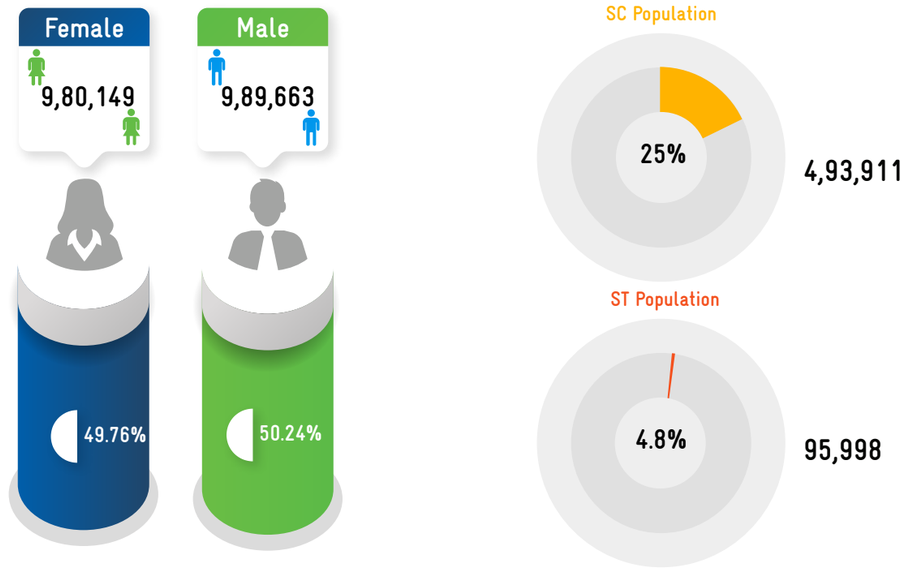


Fig 3.33: Proportion of men and women and SC/ST Population in Tiruvannamalai district

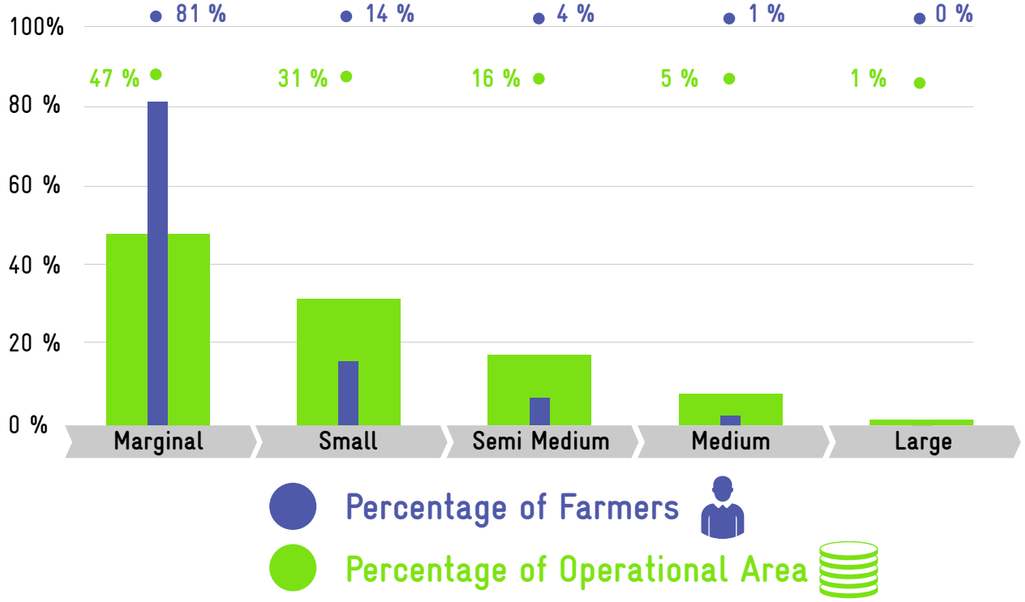


Fig 3.34: Proportion of marginal, small and other categories of farmers in Tiruvannamalai district

Status of Mahatma Gandhi NREGA - Job card status: In the district, of the total population of 19,69,812 persons, 42.08% are registered for job cards in Mahatma Gandhi NREGA scheme. Among the registered job card holders, 74.66% of the job cards are in active category (Fig 3.35)

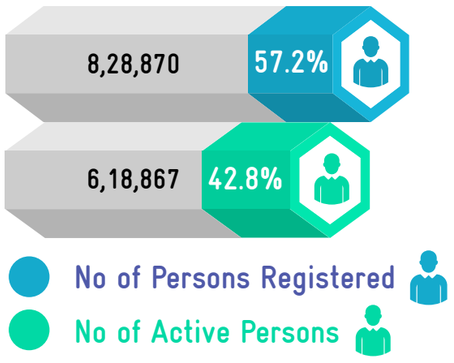


Fig 3.35: Difference between registered job cards and active job cards, Tiruvannamalai district

Drinking Water Sources: The drinking water requirement to the total population is 53.92 MCM, of this 85% is met through ground water resources and remaining 15% is met by surface water sources.

Annual Grey water Generation: The grey water generation estimated across the GPs indicated that 35.95 MCM is being available for reuse or recycle.

B) Climate vulnerability

The district is located in the north eastern zone of the agro-climatic zone of the state and Southern Plateau and Hills region according to the agro climatic regional classification of planning commission. The district has tropical climate and the maximum temperature of the district is 40°C and a minimum of 20°C. The average annual rainfall is 1047 mm and distributed in two seasons. The average relative humidity of the district is 67- 86 percent and during summer it ranges from 47-63 percent. The average rainfall temp and ground water resources are given in table 3.10.

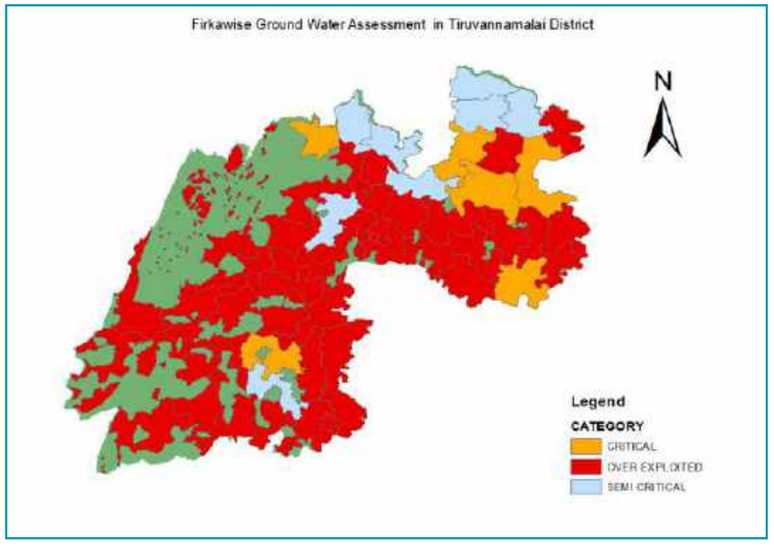
TABLE 3.10: CLIMATE PROFILE: TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	District total
1	2	3	4
1	Average Annual Rainfall	mm	1047
2	Average Annual Temperature	°C	27.9
3	Ground Water Status*	Over Exploited, Critical, Semi-critical and Safe	Nine blocks are Over Exploited
4	Ground Water Availability*	MCM	111687.47
5	Ground Water Recharge*	MCM	124097.19

**WASCA- TN Ground water study data – 2019-2020*

Rainfall and Temperature: The average annual rainfall of the Tiruvannamalai district is 1047 mm and the average annual mean temperature of the district is 28°C. Within the rainfall, number of rainy days and its distribution within the given season plays a crucial part in both water storage and efficient use for productive purposes. The district receives a total of 89 rainy days of in south west monsoon and 72 rainy days in north east monsoon.

Ground water status: According to the WASCA ground water study, out of 18 blocks, five are semi critical, two are critical, nine are over exploited and remaining two blocks are under safe category. The ground water availability is 1,11,687 MCM and the ground water recharge is found to be 1,24,097 MCM. Due to the large-scale extraction of ground water though wells and tube wells, the ground water availability is depleting at a faster rate (Fig 3.36).



Map 3.28: Ground water status across firka's in the Tiruvannamalai District

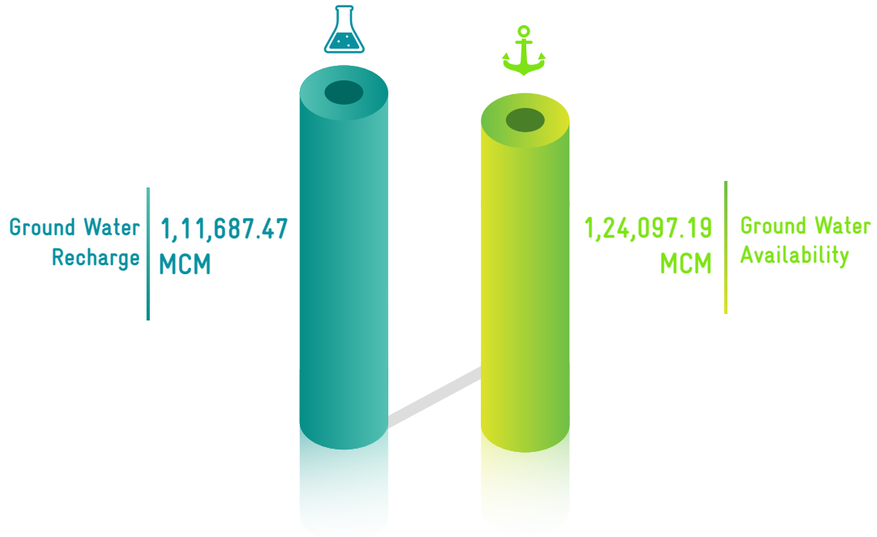


Fig 3.36: Status of ground water availability and recharge potential in the district

3.3.2.2.3. WATER RESOURCE PROFILE:

Assessment of water demand across sectors as well as on supply side in Tiruvannamalai district has been carried out at the GP level and integrated at the block and district level. The key parameters taken in to the CWRM planning in the district is provided in table 3.11.

TABLE 3.11: WATER RESOURCES, TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	District total
1	2	3	4
Water demand			
1	Water Demand for Humans	MCM	53.92
2	Water Demand for Livestock	MCM	79.47
3	Water Demand for Agriculture	MCM	2443.07
4	% G.W Utilization for Drinking	%	85.20%
5	% G.W Utilization for Livestock	%	58.36%
6	% G.W Utilization for Agriculture.	%	89.52%
7	% SW for Drinking	%	15%
8	% SW for Livestock	%	41.64%
9	% SW for Agriculture	%	10.48%
Available runoff			
10	Good Catchment (Run-off)	MCM	416.92
11	Average Catchment (Run-off)	MCM	36.88
12	Bad Catchment (Run-off)	MCM	626.86
Run off analysis			
13	Good Catchment	MCM	214.13
14	Average Catchment	MCM	28.96
15	Bad Catchment	MCM	164.08
Micro watershed information			
16	Length of Natural Drainage Lines	Km	8488.46
17	Number of Micro Watershed	Number	1849.00
Canal network			
18	Canal Network	Km	2003.23
19	Main Canal	Km	978.15
20	Minor	Km	645.36
21	Distributaries	Km	379.72
22	Water Courses (Field Channels)	Km	767.62
Traditional water bodies			
23	Tanks	Number	1966
24	Ooranis	Number	3787
25	Other water bodies	Number	1808
Irrigation facilities			
26	Area under Canal Irrigation	Ha	410
27	Area under Open & Tube Well	Ha	118362.4
28	Area under Tank Irrigation	Ha	19111
Water quality			
29	Chemical Contaminants	Number	No contamination
30	Bacterial and Other Contaminants	Number	No contamination

Water demand and utilization: The total demand for water including human, agriculture and livestock is 2,576 MCM and in that 88% is met through ground water while the balance proportion of 12% is met by surface water resources. Of the total water demand, agriculture is the largest user of water which is about 94.8%, only 2.4% for human and 3.08% for livestock (Fig 3.37). The percentage of ground water and surface water utilized by human, livestock, agriculture are as shown in Fig 3.38.

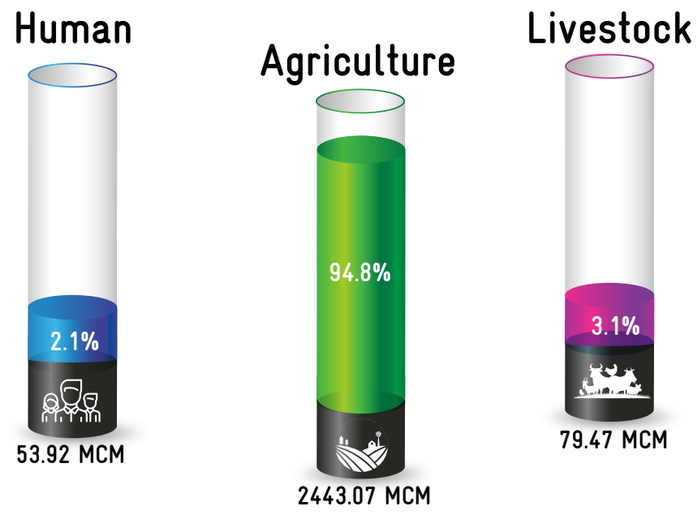


Fig 3.37: Water demand for human, livestock and agriculture in Tiruvannamalai district

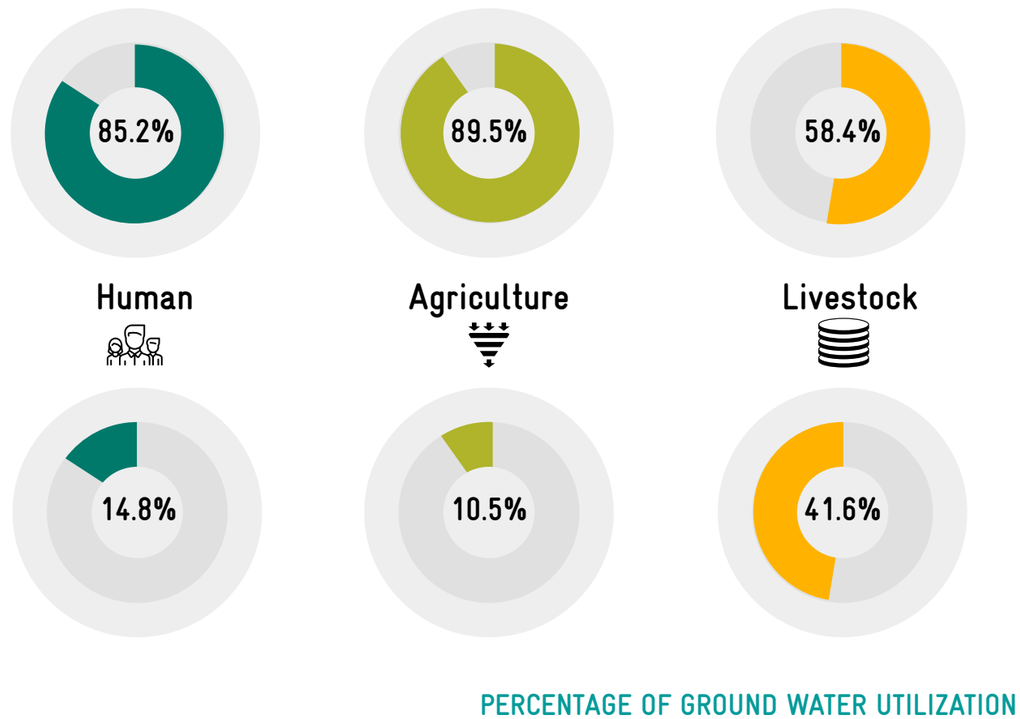


Fig 3.38: Proportion of Ground water demand and Surface water demand for drinking, livestock and agriculture

Available Runoff: The available runoff in catchment area is 1,080.66 MCM. and in that 38.6% comes under good catchment area, 3.4% comes under average catchment area and 58% comes under bad catchment area. The amount of runoff generated in bad catchment area is 1.5 times higher in good catchment and more than 15 time in average catchment areas (Fig 3.39).

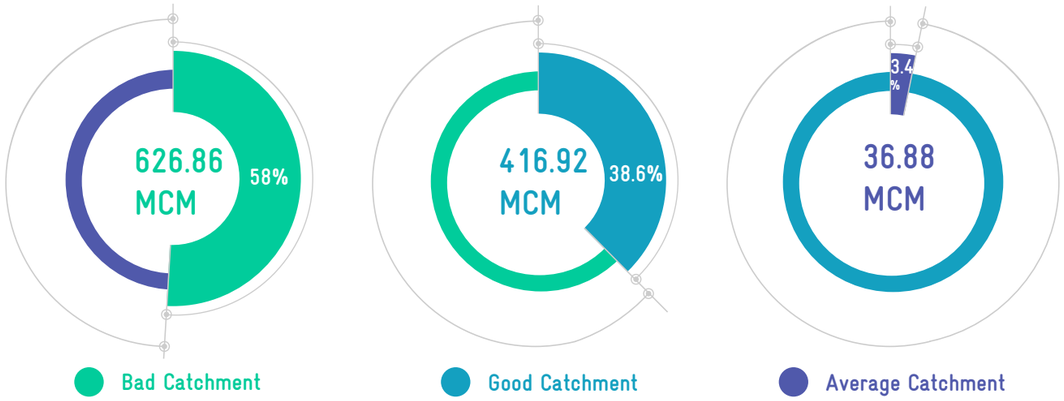


Fig 3.39: Proportion of available runoff from different catchment types

Expected Runoff for Conservation: The expected runoff can be harvested due to WASCA intervention is 407.17 MCM which is 37 percent of the total runoff. Of the expected runoff conservation, 52.6 % comes from good catchment area, 7.1% comes under average catchment area and 40.3% comes under bad catchment area (Fig 3.40)

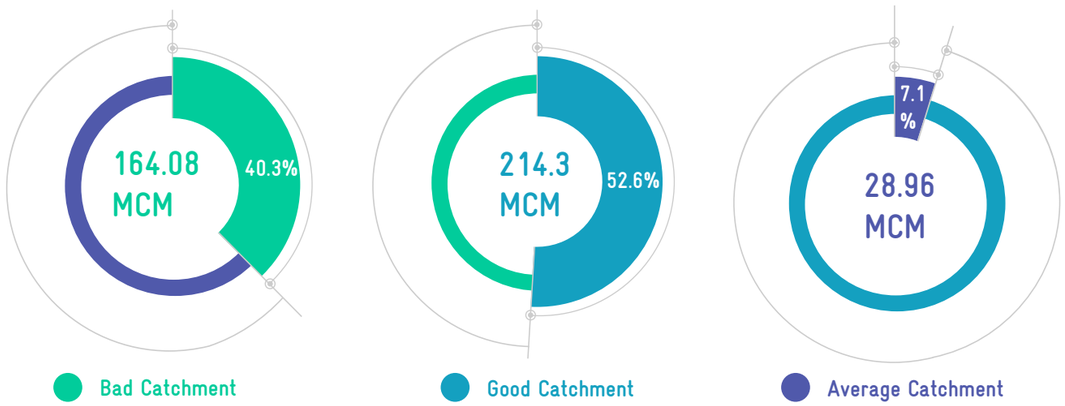


Fig 3.40: Expected runoff from different land catchment categories

Canal Network: The district has a total length of 2003 km length of canal networks. The length of main canal is 978.18 km and minor canal is 645.36 km. Further it has 379.72 km of distributaries and 767.62 km length of field channels. The length of the main channel is 35.30 percent of the total canal network and water courses occupies nearly 28% (Fig 3.41)

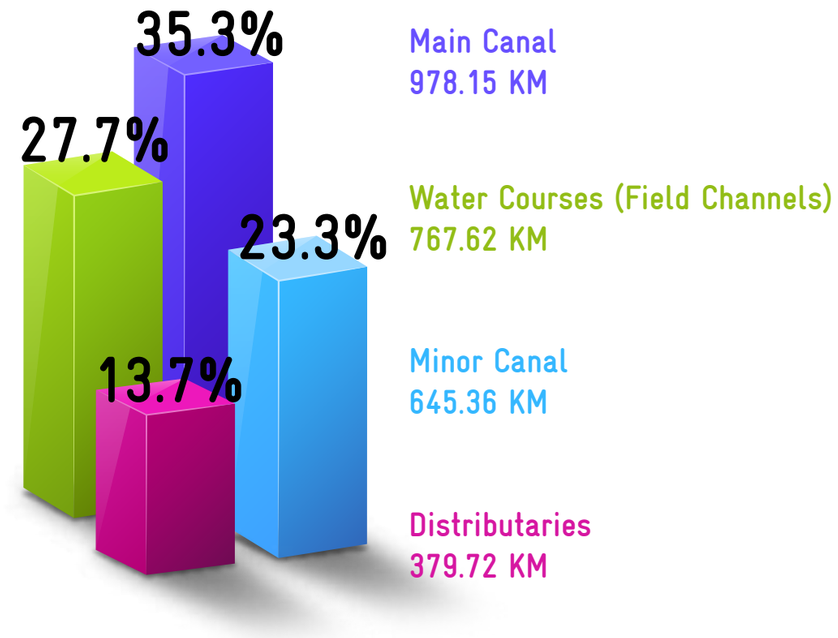


Fig 3.41: Proportion of different types of canal in Tiruvannamalai district

Existing Water Structures: The district has structured traditional water storage units as tanks, ponds and ooranis which are the life line of local communities for their lives and livelihoods. The district has 1966 (26%) tanks and 3787 (50.1%) ooranis and 1808 numbers (23.9%) of other sources as shown in Fig 3.42.

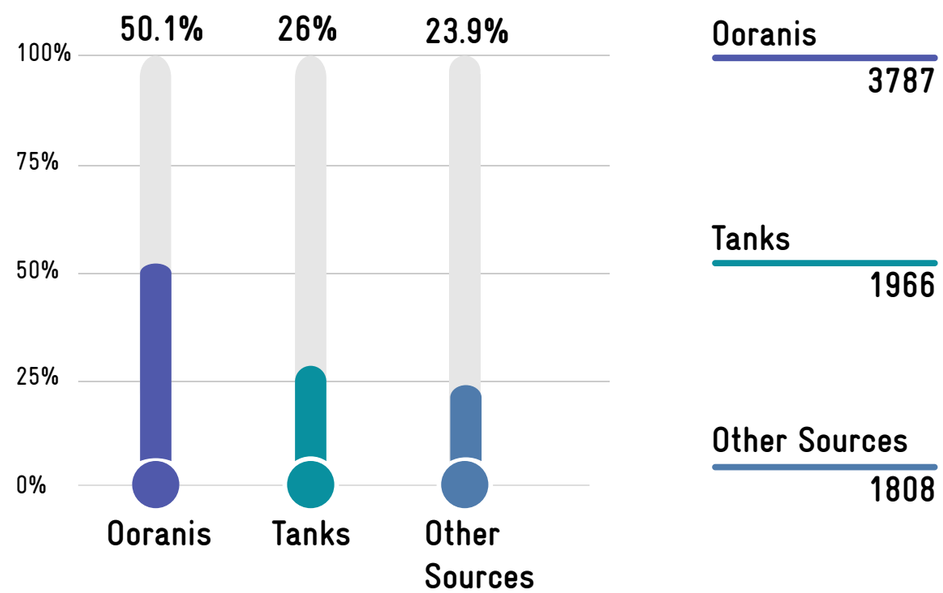


Fig 3.42: Proportion of existing water storage structures in Tiruvannamalai district

Sources of Irrigation: The total area under irrigation in the district is 1,37,883 Ha, of which 86% is irrigated through ground water stored in open/tube wells while remaining 14% is through surface water using the water stored in canals and Tanks as shown in Fig 3.43

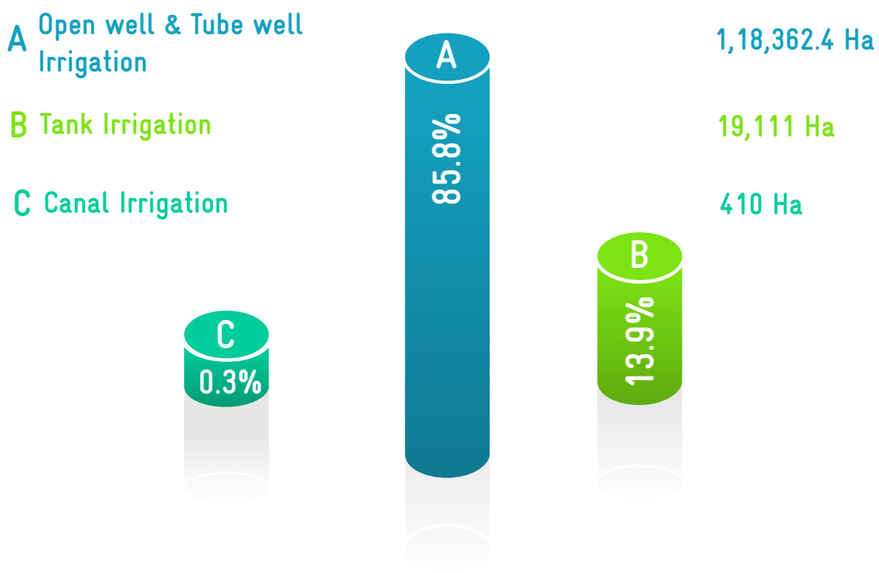


Fig 3.43: Sources of irrigation in Tiruvannamalai district

D) Agriculture and allied vulnerability

Agriculture is the primary livelihood for more than 60% of the households in addition to livestock resources. Water is the critical component for farming and the district receives rain from both south west and north east monsoon 45 and 42% respectively. Following (Table 3.20) are the key soil, land, crop and livestock related parameters employed in CWRM planning.

TABLE 3.12: AGRICULTURE & ALLIED ACTIVITIES TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	District total
1	2	3	4
Soil moisture and evapo transpiration			
1	Soil Moisture	%	23
2	Available Soil Moisture	MCM	2378.32
3	ET Losses	MCM	1606.54
Soil resources: Available Nitrogen			
4	Very Low (VL)	%	21%
5	Low (L)	%	75%
6	Medium (M)	%	5%
7	High (H)	%	0%
8	Very High (VH)	%	0%
Soil resources: Organic Carbon			
9	Very Low (VL)	%	31%
10	Low (L)	%	66%
11	Medium (M)	%	2%
12	High (H)	%	0%
13	Very High (VH)	%	0%
Soil resources: Micro Nutrients			
14	Sufficient	%	57%
15	Deficient	%	43%
Soil resources: Physical Parameter - PH			
16	Acidic Sulphate (AS)	%	0.0%
17	Strongly Acidic (SrAc)	%	0.0%
18	Highly Acidic (HAc)	%	0.0%
19	Moderately Acidic (MAc)	%	2.1%
20	Slightly Acidic (SlAc)	%	5.9%
21	Neutral (N)	%	3.7%
22	Moderately Alkaline (MAI)	%	87.9%
23	Strongly Alkaline (SIAI)	%	0.1%
Soil profile			
24	% of Clay Soil	%	3.6%
25	% of Fine Soil	%	34.90%
26	% of Coarse loamy	%	9.47%
27	Permeability		moderate to low (5-20mm/hr)
Land use category			
28	Area under forest	Ha	1010.12
29	Area under Non-Agricultural Uses	Ha	90862.75
30	Area under Barren & Un-cultivable Land	Ha	19303.45
31	Area under Permanent Pastures and Other Grazing Land	Ha	2907.76
32	Area under Land Under Miscellaneous Tree Crops etc.	Ha	1797.5
33	Area under Culturable Waste Land	Ha	8442.24
34	Area under Fallows Land other than Current Fallows	Ha	25998.92
35	Area under Current Fallow land	Ha	115371.95
36	Area under Unirrigated Lands	Ha	55970.74
37	Area Irrigated by Source	Ha	137883.43

Proposed treatment area under WASCA			
38	Area under forest	Ha	404.05
39	Area under Non-Agricultural Uses	Ha	22916.18
40	Area under Barren & Un-cultivable Land	Ha	14477.59
41	Area under Permanent Pastures and Other Grazing Land	Ha	2180.82
42	Area under Land Under Miscellaneous Tree Crops etc.	Ha	1348.13
43	Area under Culturable Waste Land	Ha	6331.68
44	Area under Fallows Land other than Current Fallows	Ha	6499.73
45	Area under Current Fallow land	Ha	28842.99
46	Area under Unirrigated Lands	Ha	13992.69
47	Area Irrigated by Source	Ha	34470.86
Catchment area			
48	Good Catchment Area	Ha	111177
49	Average Catchment Area	Ha	13125
50	Bad Catchment Area	Ha	335218
Means of water extraction			
51	Gravity	%	1.98%
52	Lifting	%	98.02%
Irrigation methods			
53	Wild Flooding	%	15.57%
54	Control Flooding	%	84.43%
Crop details			
55	Irrigated Area	Ha	180994.7
56	Rainfed area	Ha	59224.5
57	Area under Paddy Cultivation	Ha	93637
58	Crop water requirement (Irrigation)	MCM	2183.65
59	Crops water requirement (Rainfed)	MCM	259.42
Livestock details			
60	Cattle population	Number	622633
61	Goat and Sheep population	Number	874549
62	Poultry	Number	592973
63	Livestock Water Requirement	MCM	134.12

Soil moisture: The soil is an important medium to store the available water and the storage capacity vary with the type of soil especially its textural composition. In overall composite water budgeting estimation of stored water in the soil assumes greater significance in Tiruvannamalai because of its higher proportion of area under rainfed cultivation. The average annual volumetric soil moisture is taken for estimating the amount of water stored as soil moisture which accounts to 2,378 MCM (Fig 3.44).

ET losses: The loss of water through evapo-transpiration is important in the water budgeting. The annual total ET loss during 2018-19 was 805 mm with monthly average of 67.08 mm. The average percentage area influences the water loss through ET in the district was 44% and the total annual losses due to ET alone 1,606.5 MCM in the district (Fig 3.44).

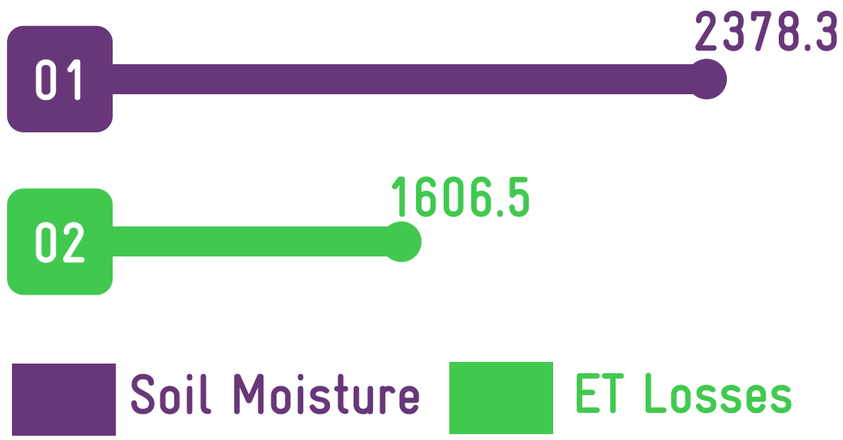


Fig 3.44: Amount of water stored as soil moisture and the annual ET loss in Tiruvannamalai district

Macro nutrients: The macro soil nutrients such as nitrogen and organic carbon is very low to low category in the total number of soil samples tested. The available nitrogen is very low in 21 percent of the samples tested while it was 74.6 percent under low category (Fig 3.45). Similar trend was recorded for soil organic carbon in which 31.3 percent under very low and 66% under low category (Fig 3.46). This indicates that the soil fertility is very poor and further intensive practices make soil more vulnerable to degradation over a period of time.

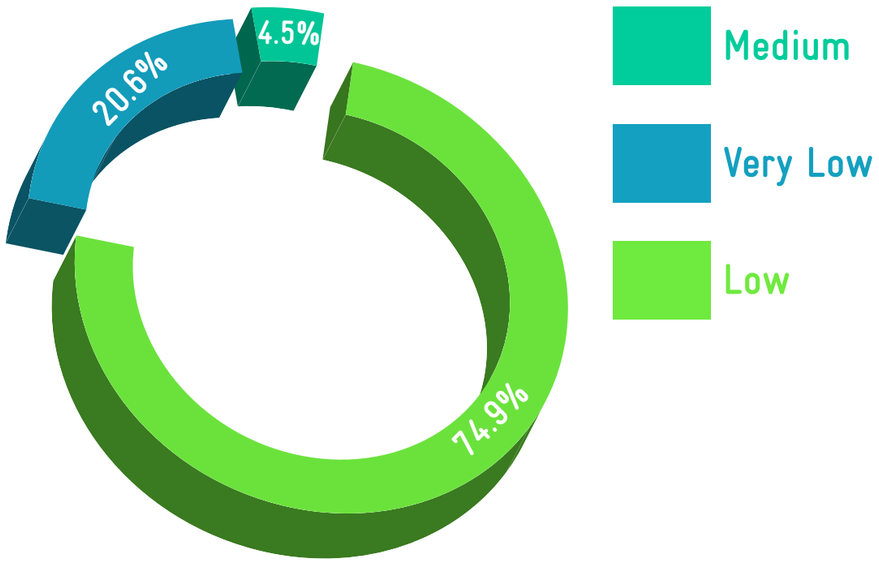


Fig 3.45: Status of available soil nitrogen in Tiruvannamalai district

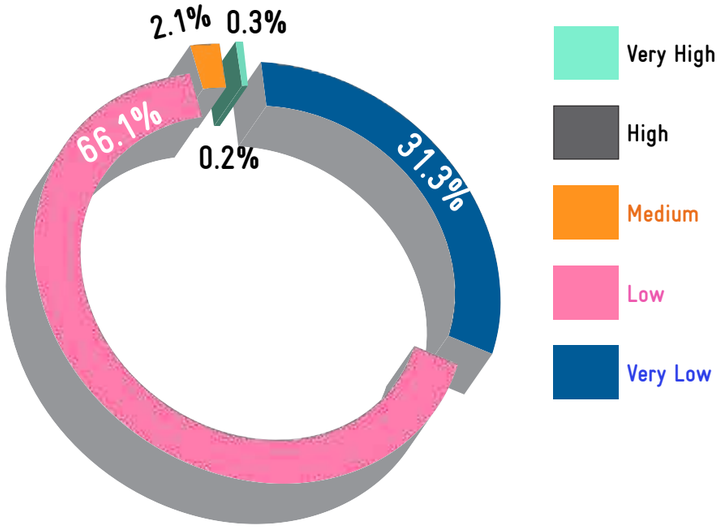


Fig 3.46: Status of soil organic carbon in Tiruvannamalai district

Status of the soil micro nutrients: The micro nutrient status of the soil with specific reference to Manganese, Boron and Zinc are deficient in 42.9% of the soils tested. Remaining other nutrients such as Fe, Cu, and S are 57.1% sufficient in the soil.

Physical parameters – pH status: With reference to the physical parameters, 87.94% of the soils are moderately alkaline in nature and of the remaining 12.06% ,2.06% is moderately acidic, 5.89% is slightly acidic,3.67% is neutral and 0.11% is strongly acidic in nature as shown in Fig 3.47.

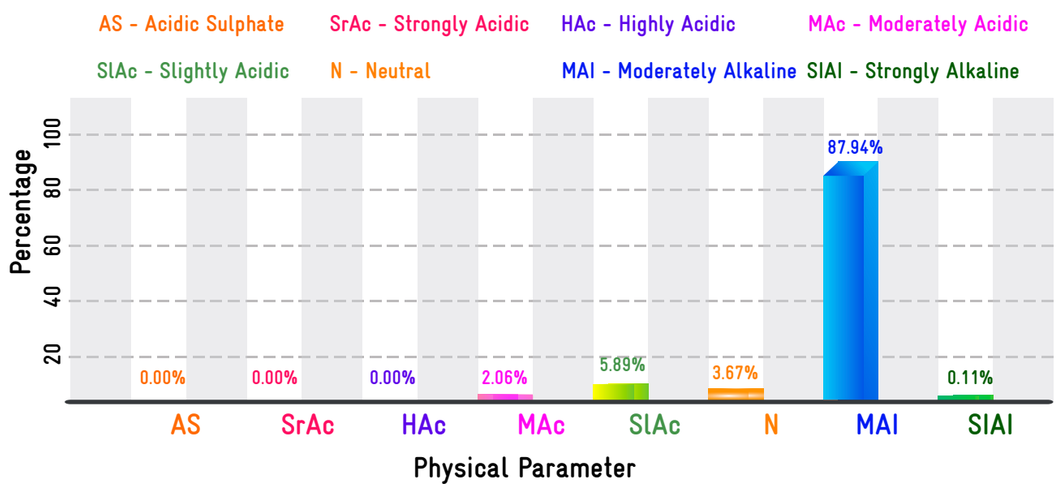
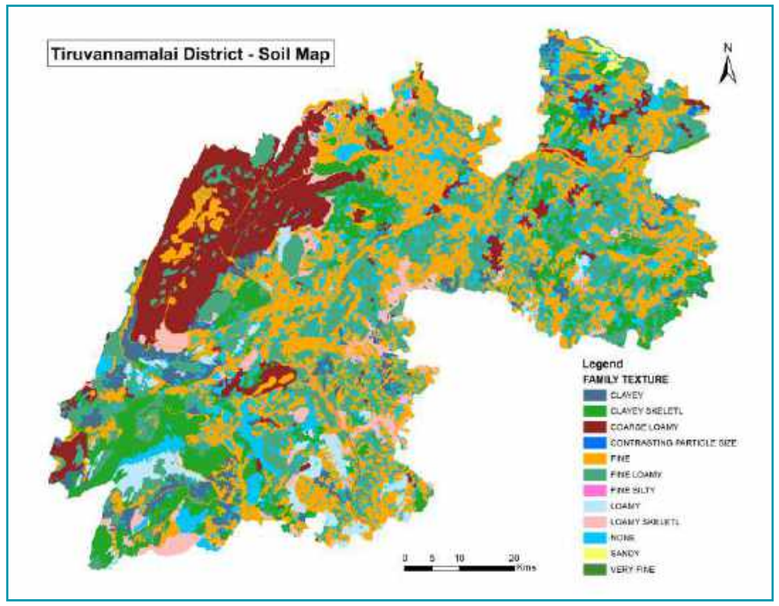


Fig 3.47: Status of soil pH in Tiruvannamalai district

Soil texture: The district has diverse soil types and predominant in vertisol and alfisol, with reference to soil texture the proportion of fine, coarse and fine loamy types are in higher in proportion (Map 3.29).



Map 3.29: Distribution of soil types - textural classification, Tiruvannamalai

Land Use Analysis: The standard land use classification helps to understand the distribution and the extend of different land use categories. As the runoff and water harvesting actions are linked to the land use systems, its distributions across the geographical boundary (GP/block/watershed/sub-basins) are necessary to take the decisions. Of the total land area of 459,520 Ha (Fig 3.48).

- 27.05% of the land is under public and degraded land
- 72.9% of the land is under individual ownership
- Of the individual ownership land, 30.7% is under fallow land other than current fallow and the fallow land
- 42.18% of the total area is currently under cultivation
- Under public and degraded land, the district has negligible area under permanent pastures, however the district has considerable number of small ruminants which are normally open grazed

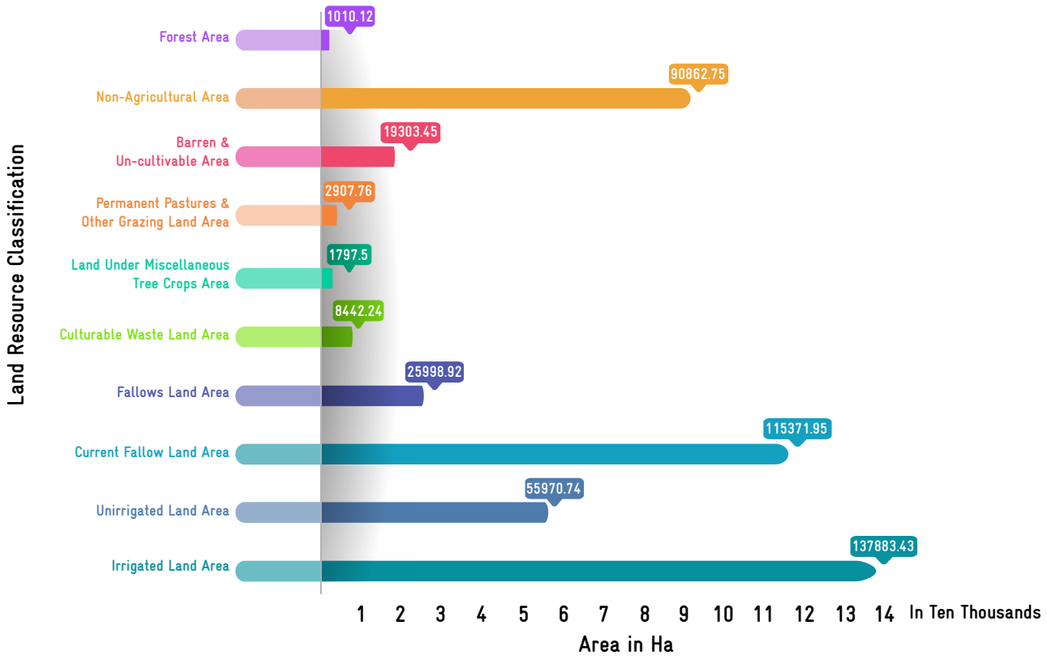


Fig 3.48: Area under different types of land use in Tiruvannamalai district

Area proposed under WASCA for treatment: Of the total area in the district, 29% of the total area is proposed for different actions to conserve water across different land use systems (Fig 3.49).

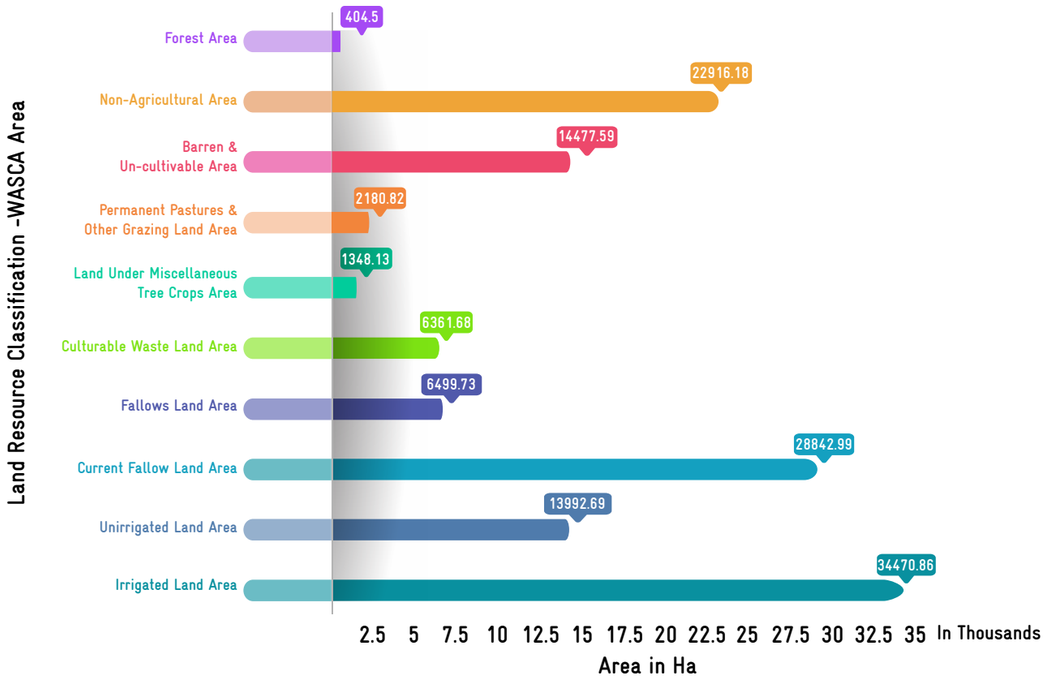


Fig 3.49: Proposed area for treatment under WASCA in Tiruvannamalai district

Cropping pattern and the irrigation: Of the total area under cultivation, 75.34 percent is under irrigation and the remaining 24.66 percent is under rainfed cultivation. Among the crops cultivated under irrigation paddy is predominantly cultivated accounts to about 52% (Fig 3.50). Paddy is the primary crop cultivated in 39.3% of the total area cultivated, groundnut (25.73%), sugarcane (9.14%), pulses (3.7%) and other crops in 4.62% of the area. Of the total crops, 89% is cultivated under irrigated condition and 11% is under rainfed cultivation (Fig 3.51).

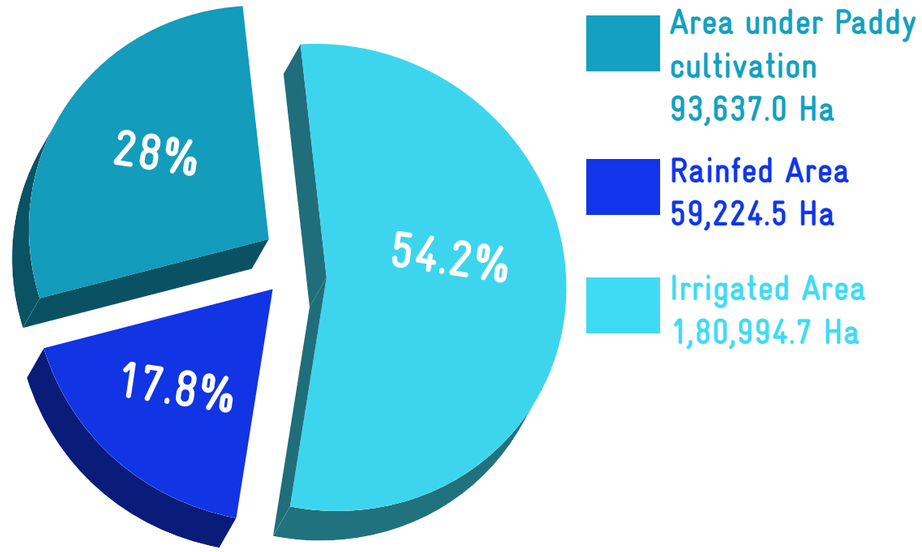


Fig 3.50: Comparison between Rainfed and Irrigated Area in Ha

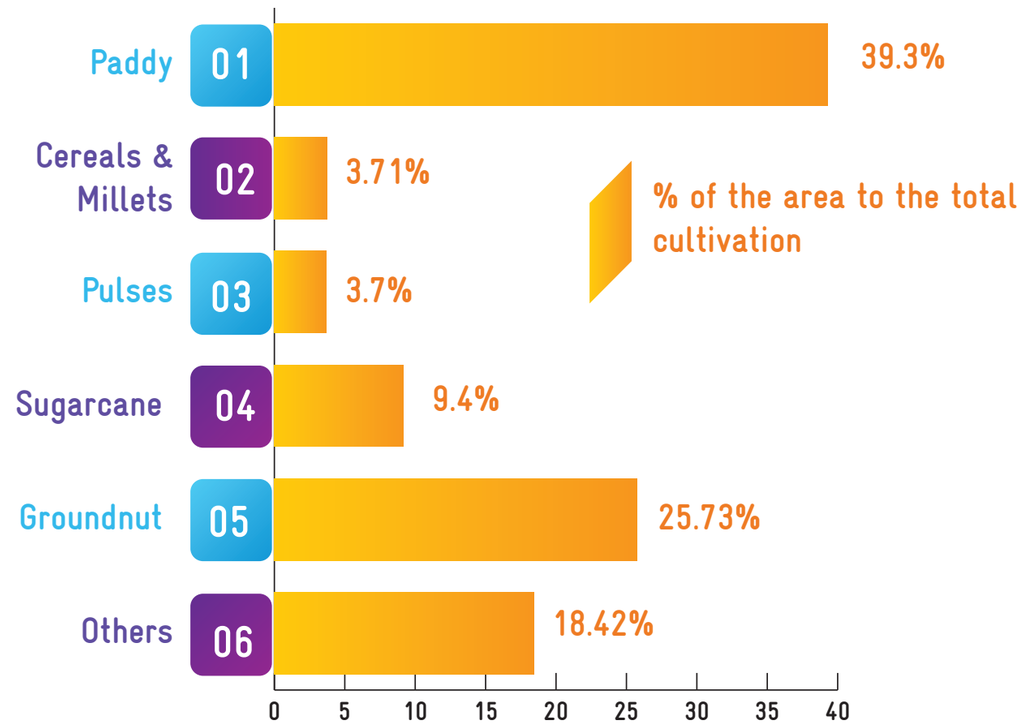


Fig 3.51: Percentage of the area to the total cultivation in Tiruvannamalai district

Catchment Area: The total catchment area of the district is 459,520 ha, of which 29 percent is proposed for treatment under WASCA – CWRM planning. The land use types in each of the GPs are categorized into three different types of runoff types; Good Catchment area, Average Catchment area and Bad Catchment area. The analysis shows that about 24.2 percent is good catchment, 72.9 percent is bad catchment area and only 2.9 percent is under average catchment area. This analysis helps to focus on prioritizing the works in the land use systems under the good and bad catchment areas (Fig 3.52).

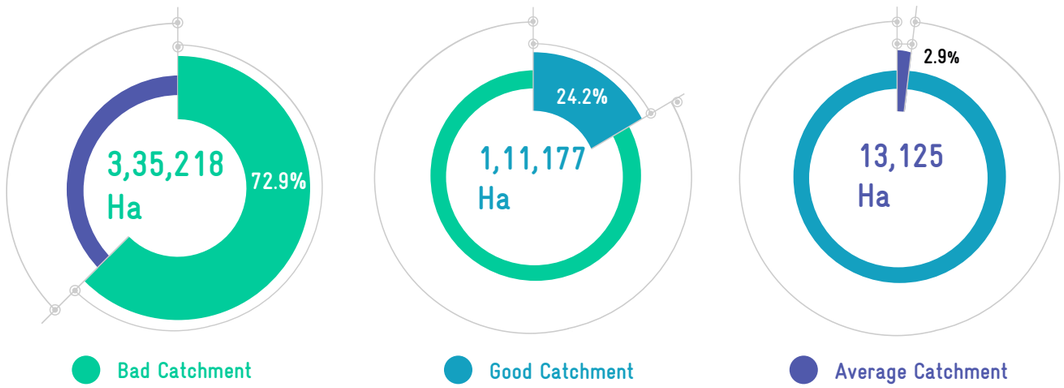


Fig 3.52: Percentage of area identified for WASCA treatment from different catchment category

Means of Water Extraction: The water is extracted by two ways, one is by gravity and another is by lifting. The water is drawn from surface water sources such as tanks, ponds etc, by using gravity method and that of ground water sources such as open well, handpump, bore well by using lifting method. In the district, since the dependence on ground water sources are more, 98 percent of the water extraction methods are under lifting means of extraction and only 2 percent comes under lifting means of water extraction (Fig 3.53).

g) Irrigation Methods: In case of the surface water resources, the wild flooding is the primary method of irrigation. But in case of ground water resources, the predominant type of irrigation is controlled flooding. In the district, 84% of the irrigation is done by control flooding and only 16% of the irrigation is done by wild flooding (Fig 3.54).

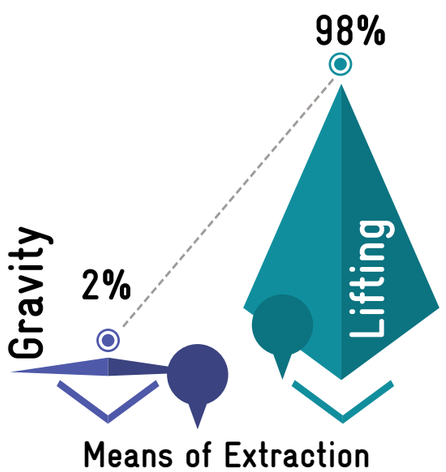


Fig 3.53: Means of water extraction in Tiruvannamalai district

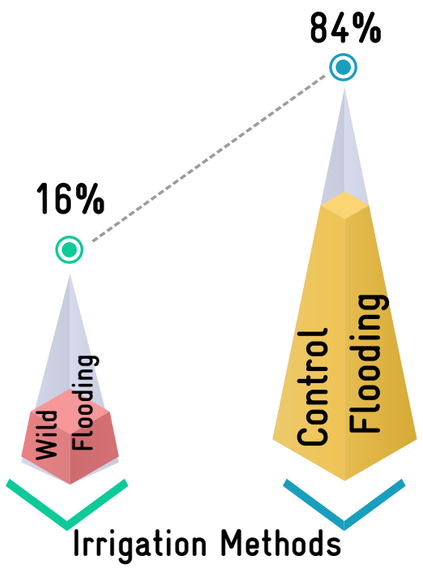


Fig 3.54: Methods of irrigation adopted in Tiruvannamalai district

Livestock Details: The district has considerable proportion of livestock resources of which small ruminants such as sheep and goat constitute 40% of the total followed by poultry (27.2%) and cow (20.9%). The total water requirement for livestock is 79.47 MCM. Of the total water demand of 79.47 MCM for livestock, 42% is met through surface water and remaining 58% is met through surface water resources (Fig 3.55).

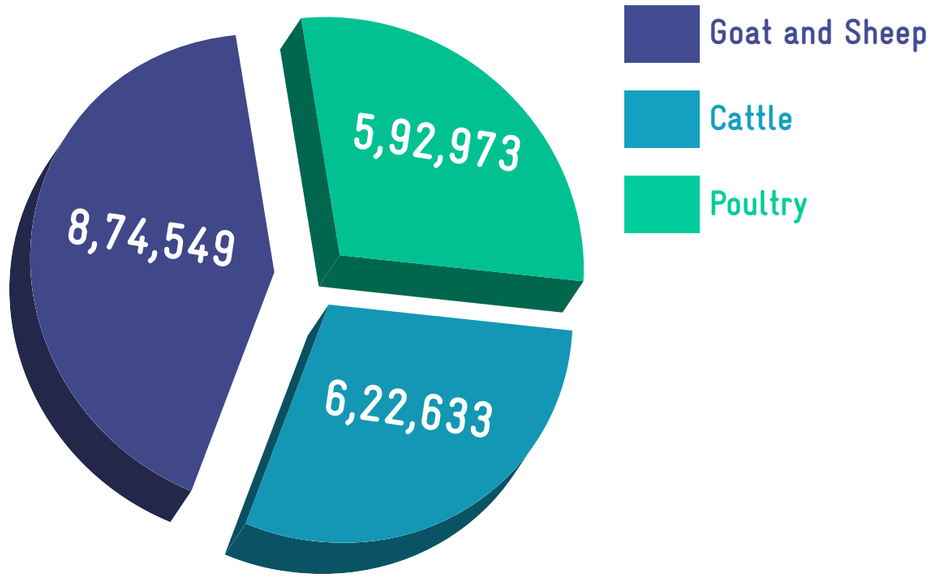


Fig 3.55: Livestock details in Tiruvannamalai district

3.4 CWRM: KEY WATER ACTIONS

The integrated scientific approach has been adopted to identify the suitable water actions for each of the key vulnerable areas to accelerate the resilience measures. The following table 3.21 indicates the key water actions under socio-economic, climate, water and agriculture and allied sectors. The detailed list of activities is given under the four main sub themes namely:

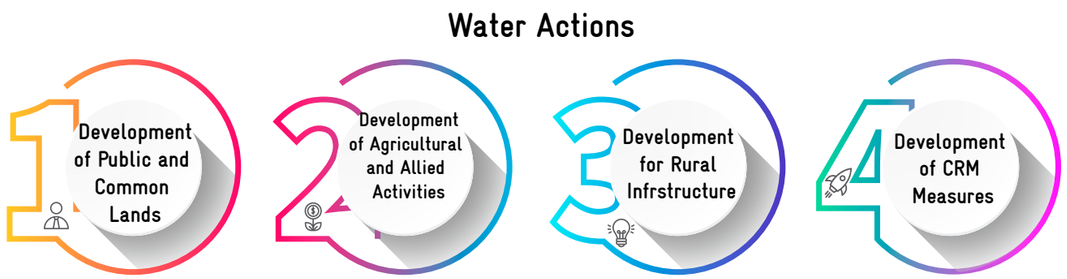


Fig 3.56: CWRM : Key Water Actions

COMPREHENSIVE KEY WATER ACTIONS PROPOSED FOR THE FOUR DIFFERENT VULNERABILITY AREAS

1. Key water actions proposed for addressing development of socio-economic dimensions

1) Ensuring socio-economic equity issues:

- Asset creation for SC and ST are given high priority, including access to safe drinking water, land development and creating additional employment days
- Explore the possibility to bring skilled jobs especially for women
- Marginal farmers are targeted in the individual asset's creation including plantation, farm ponds, compost pits etc.

2. Increasing the rate of active job cards: There is a need for increase the active job holders to the total job cards registered in the village which is one of the strategies to increase work participation rate in the rural area.

- Strategies to build individual assets creation which encourage men and women to access the employment opportunities
- Encouraging the skilled works among the unemployed rural youth's participation will be given attention

3. Access to drinking water:

- Actions to improve the access by roof rainwater harvesting measures at both community and individual houses, models like *tanka* (Rajasthan Model)
- Restoring the traditional water bodies with low cost, simple water treatment plants etc which further ensure their access to drinking water and also
- Convergence under Jal Jeevan Mission (JJM) helps to meet the gaps in the rural areas

4. Grey water management:
Soak pit concept to be used for Grey water management (Community, Individual); Under take nutri gardens with 5 plants per household, focus with SC, ST and other marginal category families under Mahatma Gandhi NREGS with Moringa; Coconut, Papaya, Agathi, Curry leaf plants provided, near border of house- soak pit.

- At community soak pit area; Moringa plantation, Neem plantation and Grass cultivation can be taken up after the soak pit as natural filters, and
- Community soak pits and improvement to existing drains are essential.

2. Key water actions proposed for improving climate

1. Climate resilient measure are being identified based on the hotspots for climate in different GPs and context specific models are piloted considering the key climate risks in different sectors:

DEVELOPMENT OF PUBLIC AND COMMON LAND

- Greening of hillocks & Nursery raising
- Silvi-pasture development
- Invasive species reduction
- Bamboo cultivation in public lands
- Cascade tanks
- River rejuvenation
- Artificial recharge structures
- Spring sheds

DEVELOPMENT OF AGRICULTURE AND ALLIED SECOTRS

- Agroforestry & Integrated farming systems
- Horticulture for fallow land and drylands farmers
- Open wells for irrigation & Water use efficiency
- Borewell recharge structures – Recharge Shaft

DEVELOPMENT OF RURAL INFRASTRUCTURE

- Community Soak pits

3. Key water actions proposed for improving water resources (Hydrological)

Watershed profile including the natural drainage lines:
Ridge to valley approach through watershed analysis at GP level is done to identify the potential areas of interventions

Existing Water Recharge or Storage structures and canal networks:
Restoration of storage structures activities includes deepening and desiliting, providing silt traps at inlets, bund strengthening and planting as well as weir repair and construction

Status of the ground water:
Artificial recharge structures both at common and individual lands, check dams, check walls, percolation tanks, sunken bunds, contour bunds, water absorption trenches, recharge shafts compartmental bunds etc.

Run-Off Management:
The catchment area based planning is proposed by assessing the type of land and its current and past use pattern

Water Demand estimation:
Sector-wise water demand has been done - Human, livestock and agriculture sectors by understanding the area under cultivation by different crops and its water requirement as well as livestock population and its requirements were taken in to consideration

Water budgeting:
Estimated water budget is done for the surface runoff water, ground water, soil moisture and evapo-transpiration with the surface runoff water based village level water budgeting in CWRM approach

4. Key water actions proposed for addressing improving Agriculture and allied sectors

Soil profile:
Measures that improve soil fertility as well as conservation were proposed including composting, bund plantation with fast growing nitrogen fixing plants and mulching, Farm bund with trench cum bund to allow excess water flow out of the farmland, improve moisture conservation and have better drainage are few important illustrations

Land use profile:
Actions for each of the lands types - common and individual with a set of logics were applied to identify the potential areas for actions in each of the land use types. Through these measures 29% of the additional area has been proposed under WASCA with different soil and water conservation actions

Agriculture:

a) crops

- Diversification of cropping system with low water requirement crops and cropping systems
- Increase the water use efficiency within the field
- Crop intensification with inter/mixed crops and agro forestry etc.

b) Livestock resources

Forage needs are crucial for livestock as the district has limited scope for irrigation to raise grasses under irrigated conditions: hence focus is given to actions such as silvi pasture, agro-forestry with trees having forage value, azolla, promoting good rearing practices by ensuring infrastructures like sheds, troughs, composting units etc

Irrigation Profile
Improve the conveyance efficiency by restoring the supply channels, promoting improved irrigation methods including micro irrigation, alternate wetting and drying in paddy etc.

From the above discussion about key water action, the extend as well as number of the works identified and proposed to improve the water resources are given in Table 3.14 to Table 3.19 for both the districts separately. Here equal importance is given to the public and common land management on priority which has higher proportion of good catchment land as well as in bad catchment area where agriculture and allied sector development is happening. The following table 3.13 provides shelf of projects as estimated person days for both the districts.

TABLE 3.13: SUMMARY OF ESTIMATED PERSON DAYS FOR 2021-22 TO 2023-2024

CWRM THEMES	Ramanathapuram	Tiruvannamalai
	Estimated person days	
Development of public and common land	252,916,962	200,498,586
Development of agriculture and allied activities	167,514,607	301,505,399
Development of rural infrastructure	1,238,510	4,017,604
TOTAL	421,670,079	506,021,589

	Estimated person days
RAMANATHAPURAM	421,670,079
TIRUVANNAMALAI	506,021,589

3.4.1. DEVELOPMENT OF PUBLIC AND COMMON LANDS

TABLE 3.14: CWRM WORKS: DEVELOPMENT OF PUBLIC AND COMMON LANDS UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES; RAMANATHAPURAM DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
AFFORESTATION (HA)	11	429	11,217	379,509,916
CONTOUR CONTINUOUS BUNDS (MTS)	11	429	11,217	4,38,941
COMPOSTING (NUMBER)	11	425	32,926	1,78,965
DRAINAGE LINE TREATMENT (MTS)	11	239	9,29,800	1,16,238
SILVI-PASTURE DEVELOPMENT (HA)	11	304	191	1,269,559
LINEAR PLANTATION (KM)	11	390	7,54,175	5,30,185
AVENUE PLANTATION (KM)	11	429	18,01,048	12,66,137
BLOCK PLANTATION (COMMUNITY)- HA	11	374	29,487	127,385,136
RESTOTARATION OF WATER BODIES: A) TANKS	11	390	0	1,075,200
RESTOTARATION OF WATER BODIES: B) OORANIS (NUMBER)	11	390	0	776,600
RESTOTARATION OF WATER BODIES: C) PONDS (NUMBER)	11	390	0	9,400
ARTIFICIAL RECHARGE STRUCTURE(NUMBER)	11	292	11,431	1,809,174
CANAL BUND PLANTATION (HA)	11	269	2,618	7,671,161
WC - IRRIGATION CHANNELS - DESILTING (MTS)	11	261	1,575,888	472,766
WC- IRRIGATION CHANNELS - CANAL SIDE PLANTATION (MTR)	11	261	1,575,888	945,533
AGRO FORESTRY (HA)	11	420	1,614	4,729,577
CHECK DAM (NUMBERS)	11	407	0	6,318

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
MANGROVE PLANTATIONS (HA)	11	388	135	843,375
RIVERSIDE PLANTATION (HA)	11	385	8,193	0
FISH DRYING YARD (NUMBERS)	11	412	0	11,254
NURSERY DEVELOPMENT - PLANTATION(NUMBERS)	11	413	1,548	96,745
SHELTER BELTS (HA)	11	390	16	46,880
COASTAL WETLAND - BUND STRENGTHENING (KMS)	11	390	225,791	22,059,781
BUND PLANTATION WET LANDS (KMS)	11	403	109,640	32,124,520
WETLAND PLANTATION (INNER) (HA)	11	429	2,856	389,823
WETLAND INLET IMPORVEMENT WORKS (NUMBERS)	11	418	2,856	11,153,778

EXTEND (TARGET)

7,088,534

ESTIMATED PERSON DAYS

252,916,962

TABLE 3.15: CWRM WORKS: DEVELOPMENT OF PUBLIC AND COMMON LANDS UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES, TIRUVANNAMALAI DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
AFFORESTATION (HA)	18	696	18,771	62,770,726
CONTOUR CONTINUOUS BUNDS (MTS)	18	458	74,712	467,710
COMPOSTING (NUMBER)	18	851	11,048	1,84,965
DRAINAGE LINE TREATMENT (MTS)	18	585	1,00,335	65,353
SILVI-PASTURE DEVELOPMENT (HA)	18	546	2,841	18,935,423
LINEAR PLANTATION (KM)	18	860	60,379	42,446
AVENUE PLANTATION (KM)	18	860	57,200	40,212
BLOCK PLANTATION (COMMUNITY)- HA	18	704	8,233	35,567,554
RESTOTARATION OF WATER BODIES: A) TANKS (NUMBER)	18	860	0	1,572,800
RESTOTARATION OF WATER BODIES: B) PONDS (NUMBER)	18	860	0	757,400
ARTIFICIAL RECHARGE STRUCTURE (NUMBER)	18	756	30,251	10,210,183
CANAL BUND PLANTATION (HA)	18	552	23,839	69,848,270
WC - IRRIGATION CHANNELS - DESILTING (MTS)	18	520	39,493	11,848
WC- IRRIGATION CHANNELS - CANAL SIDE PLANTATION (MTR)	18	520	39,493	23,696

EXTEND (TARGET)

466,596

ESTIMATED PERSON DAYS

200,498,586

3.4.2. DEVELOPMENT OF AGRICULTURE & ALLIED ACTIVITIES

3.4.2.1. RAMANATHAPURAM

TABLE 3.16: CWRM WORKS: DEVELOPMENT OF AGRICULTURE AND ALLIED ACTIVITIES UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES, RAMANATHAPURAM DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
FARM BUNDING (HA)	11	426	32,926	1,92,94,437
MICRO IRRIGATION (HA)	11	416	7,700	0
CONSTRUCTION OF FARM PONDS (NUMBER)	11	404	32,926	78,75,604
LAND DEVELOPMENT (HA)	11	429	12,668	49,481,325
NURSERY DEVELOPMENT - PLANTATION	11	429	3,90,750	22,897,950
CATTLE SHELTERS (NUMBER)	11	426	19,170	770,899
GOAT SHEEP SHELTERS (NUMBER)	11	425	1,95,713	6,881,675
FODDER DEVELOPMENT FOR CATTLE (HA)	11	426	19,170	5,459,176
AZOLLA UNITS (NUMBER)	11	426	19,170	53,567
CATTLE TROUGH (NUMBER)	11	426	19,170	13,974
POULTRY SHED (NUMBER)	11	426	59,511	59,490
DRY LAND HORTICULTURE/AGRO-FORESTRY (HA)	11	427	16,460	54,663,627
VERMI COMPOST (NUMBER)	11	426	19,170	62,883

EXTEND (TARGET)

844,503

ESTIMATED PERSON DAYS

167,514,607

3.4.2.2. TIRUVANNAMALAI

TABLE 3.17: CWRM WORKS: DEVELOPMENT OF AGRICULTURE AND ALLIED ACTIVITIES UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES, TIRUVANNAMALAI DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
FARM BUNDING (HA)	18	746	14,099	8,262,295
MICRO IRRIGATION (HA)	18	386	2,143	0
CONSTRUCTION OF FARM PONDS (NUMBER)	18	860	19,934	7,405,442
LAND DEVELOPMENT (HA)	18	780	22,483	87,817,309
NURSERY DEVELOPMENT - PLANTATION	18	860	27,865	5,397,536
CATTLE SHELTERS (NUMBER)	18	860	24,243	12,057,668
GOAT SHEEP SHELTERS (NUMBER)	18	860	9,140	6,265,289
FODDER DEVELOPMENT FOR CATTLE (HA)	18	860	23,000	63,501,304
AZOLLA UNITS (NUMBER)	18	860	23,859	774,387
CATTLE TROUGH (NUMBER)	18	860	24,213	182,718
POULTRY SHED (NUMBER)	18	860	21,424	260,060
DRY LAND HORTICULTURE/AGRO-FORESTRY (HA)	18	860	24,892	82,667,428
VERMI COMPOST (NUMBER)	18	860	23,427	1,023,003
CONSTRUCTION OF NEW WELL	18	764	16,126	25,890,960

EXTEND (TARGET)

276848

ESTIMATED PERSON DAYS

301,505,399

3.4.3. DEVELOPMENT OF RURAL INFRASTRUCTURE

3.4.3.1. RAMANATHAPURAM

TABLE 3.18: CWRM WORKS: DEVELOPMENT OF RURAL INFRASTRUCTURE UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES, RAMANATHAPURAM DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
SOAK PITS (COMMUNITY) (NUMBER)	11	429	3,75,519	77,900
SOAK PITS (INDIVIDUAL) (NUMBER)	11	429	3,89,583	623,760
ROOF RAIN WATER HARVESTING (NUMBER)	11	429	25 LITRES / 2 BUILDING	536,250
TANKA - COMMUNITY LEVEL	2	2	30000 LITRES/ UNIT	600

EXTEND (TARGET)

765,102

ESTIMATED PERSON DAYS

12,38,510

RAMANATHAPURAM DISTRICT TOTAL

EXTEND (TARGET)

8,698,139

ESTIMATED PERSON DAYS

421,670,079

3.5.3.2. TIRUVANNAMALAI

TABLE 3.19: CWRM WORKS: DEVELOPMENT OF RURAL INFRASTRUCTURE UNDER MAHATMA GANDHI NREGS AND CONVERGENCE SCHEMES, TIRUVANNAMALAI DISTRICT

	NO OF BLOCKS COVERED	NO OF GPS COVERED	EXTEND (TARGET)	ESTIMATED PERSON DAYS
SOAK PITS (COMMUNITY) (NUMBER)	18	860	13,242	330,936
SOAK PITS (INDIVIDUAL)(NUMBER)	18	860	58,040	786,669
ROOF RAIN WATER HARVESTING (NUMBER)	18	860	25 LITRES/ 2 BUILDING	2,900,000

EXTEND (TARGET)

71,282

ESTIMATED PERSON DAYS

4,017,604

TIRUVANNAMALAI DISTRICT TOTAL

EXTEND (TARGET)

8,698,139

ESTIMATED PERSON DAYS

421,670,079

3.5 MODEL GRAM PANCHAYAT PLANS

WASCA- TN GRAM PANCHAYAT - WATER CLIMATE PLAN UNDER MAHATMA GANDHI NREGS CONVERGENCE

CASE STUDY 1: ERVADI GP, KADALADI BLOCK, RAMANATHAPURAM DISTRICT

Ervadi is situated on the coast, falls in Kadaladi block of Ramanathapuram district situated in Tamil Nadu state, with a population 13366. The male and female populations are 6689 and 6677 respectively. The total geographical area of the village is about 1904 Ha. The total number of households in the village is 2517.

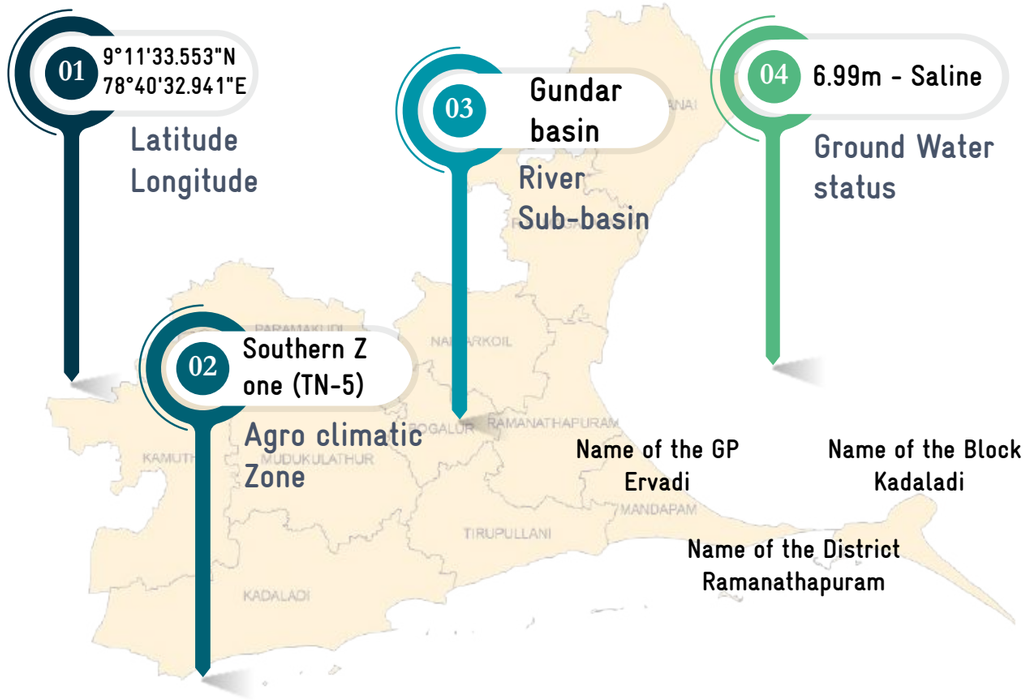


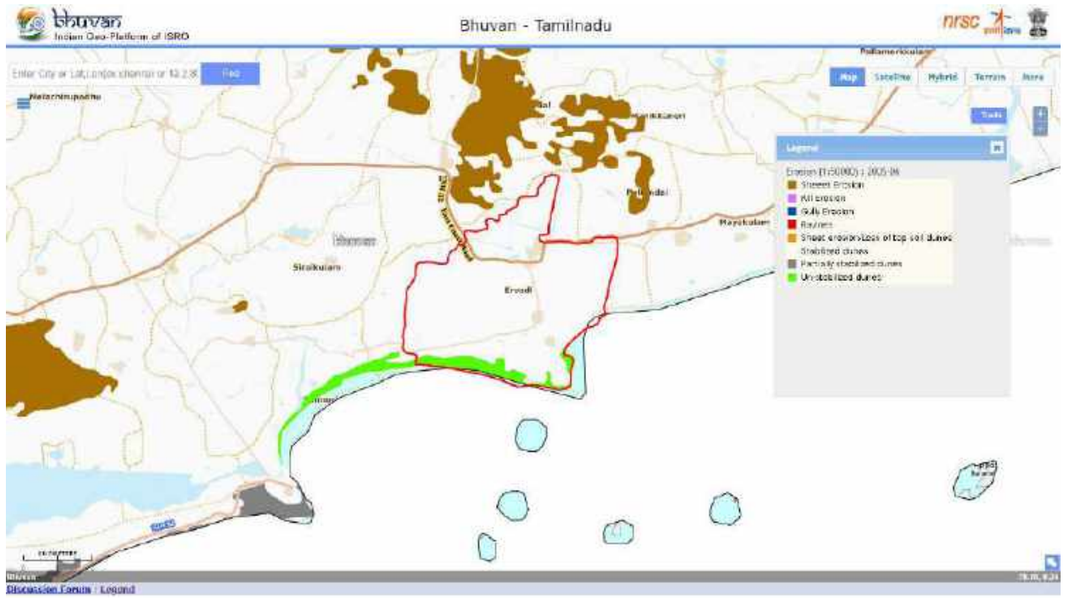
Fig 3.57: General Details of Ervadi GP, Ramanathapuram District

The spatial and non-spatial data employed in identifying the key water challenges are provided in Table 3.20 and 3.21 respectively

TABLE 3.20: SPATIAL DATA UTILIZED IN CWRM PLANNING OF ERVADI GP

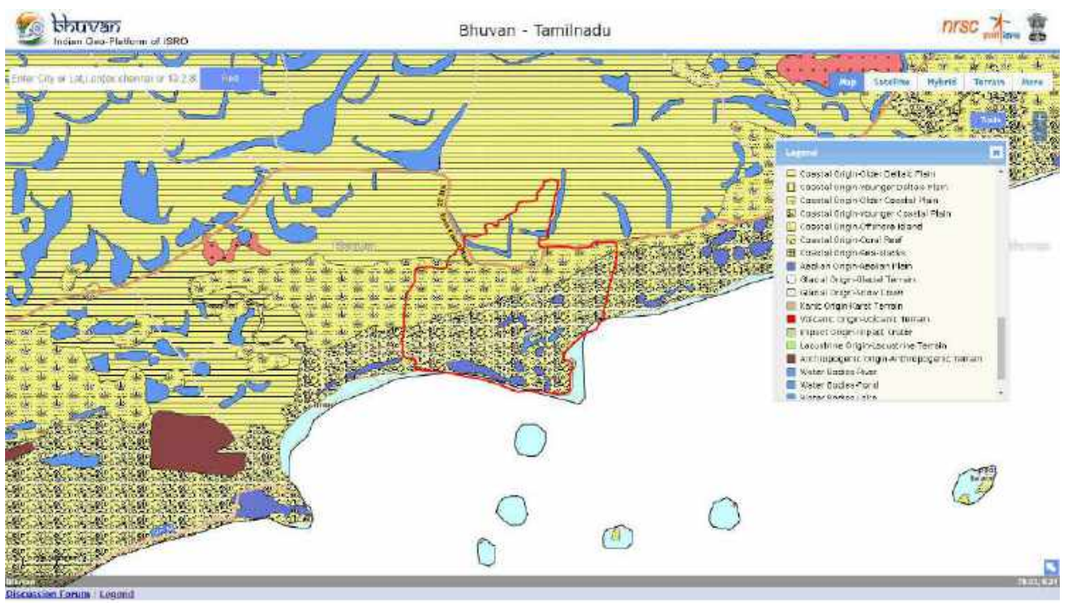
No	Thematic Layer	Data for Ervadi GP
1	Soil erosion map	There is a unstablized dunes in the southern part the GP. The activities has been planned for the sand dune development and shelter belts in this area
2	Geomorphology map	The GP has under the younger coastal planning and coral reef category. The geomorphic is guided us to undertake appropriate work in particular location to reap maximum benefits.
3	Ground water pro-spectus	The ground water prospectus is less than 30m deep well and 30 to 50 litres per minute yield potential in this GP.
4	Land use Land cover	It shows the area under miscellaneous tree crop and fallow land which is useful for planning
5	Lineament	The lineament parallel to shoreline
6	Salt Affected Area map	Salinization of agriculture fields are noticed
7	Drainage density map	Drainage map of Ervadi clearly shows that the Ervadi GP has is less drain-age density.
8	Slope map	For Ervadi GP, it clearly shows very flat slope of 0 to 1 %.
9	Wasteland map	Areas of wasteland such as sandy area idenitifed
10	Watershed map	The map is used for the interventions in the coastal watershed planning

Erosion: The erosion map shows the soil erosion capacity with respect to rainfall, soil physical properties, terrain slope, land cover of Ramanathapuram district. The soil erosion map is used for soil conservation and regional planning and watershed management. In Ervadi GP, it is observed that there is a unstablized dunes in the southern part the GP. The activities has been planned for the sand dune development and shelter belts in this area



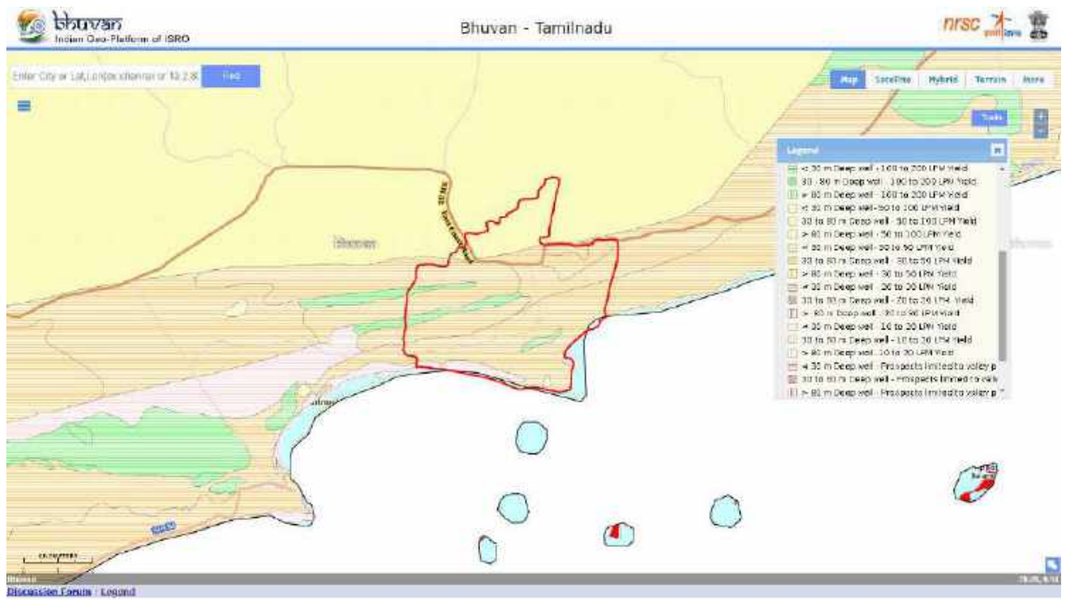
Map 3.30: Soil erosion map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Geomoropholgy : The geomorphology map is the graphical inventories of a landscape depicting landforms and surface as well as subsurface materials. It determines the character of soil, vegetation, water percolation and land cover. The Ervadi GP covers under the younger coastal planning and coral reef category. The geomorphic is guided us to undertake appropriate work in particular location to reap maximum benefits.



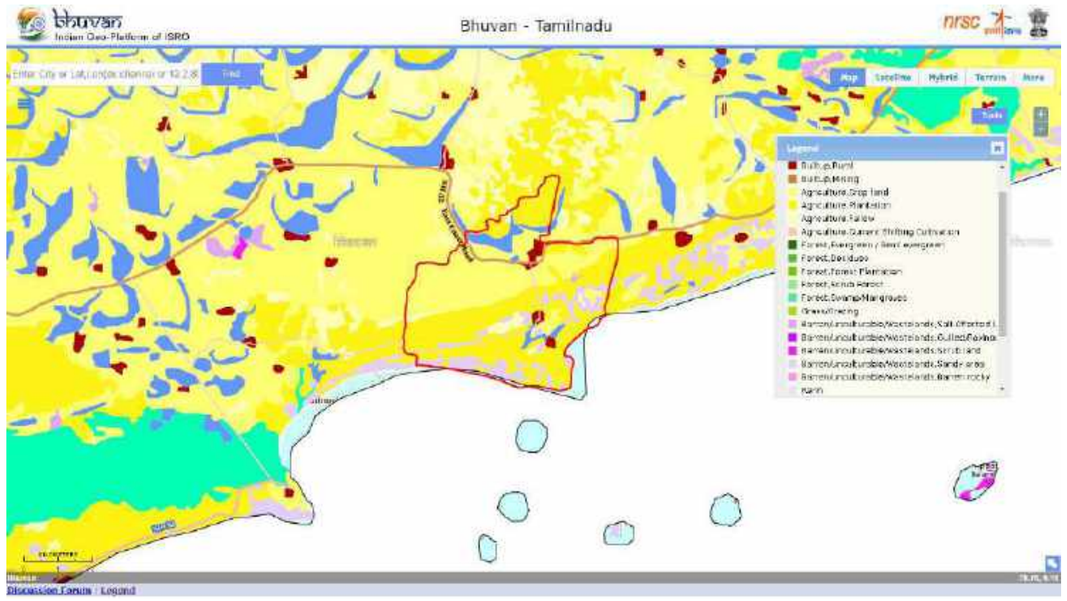
Map 3.31: Geomorphology map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Ground water prospectus: The map provides the required information on geological parameters connected to ground water exploration and the probable ground water prospects and helps in identification of sites for planning recharge structures to address water scarcity in a more effective manner. In Ervadi GP, it is observed that the ground water prospectus is less than 30m deep well and 30 to 50 litres per minute yield potential in this GP.



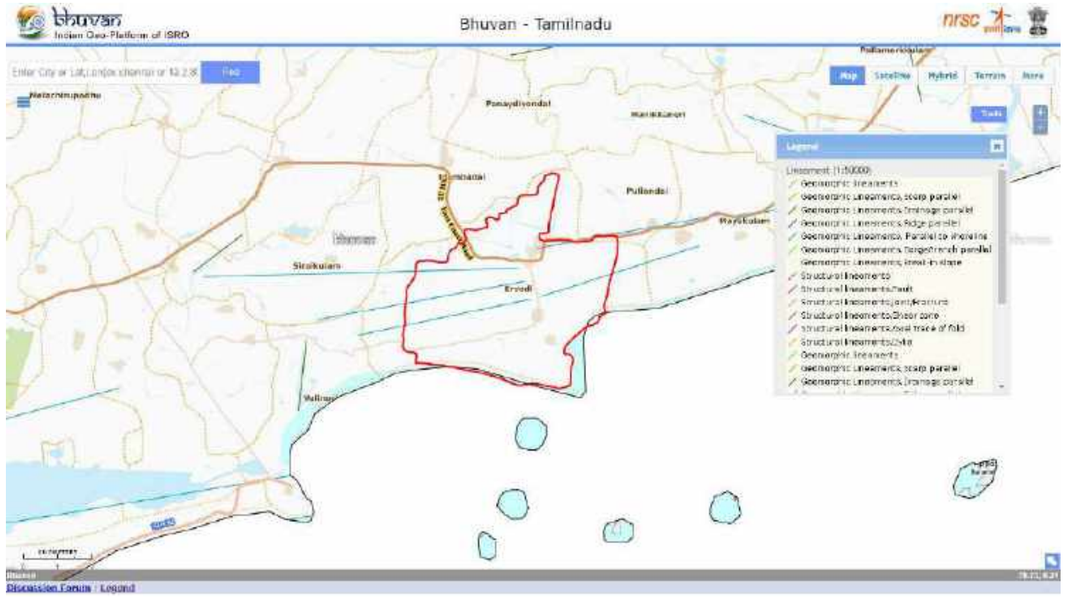
Map 3.32: Ground water prospectus of Ervadi GP, Kadaladi Block, Ramanathapuram district

Land use and land cover: The LULC map provides the information about the current landscape and the existing land use pattern. The map clearly shows that the Ervadi GP is covered by the agricultural plantation, fallow lands and barren lands along the southern coast. The fallow land development activities and barren land to productive land activities has been planned using the CWRM.



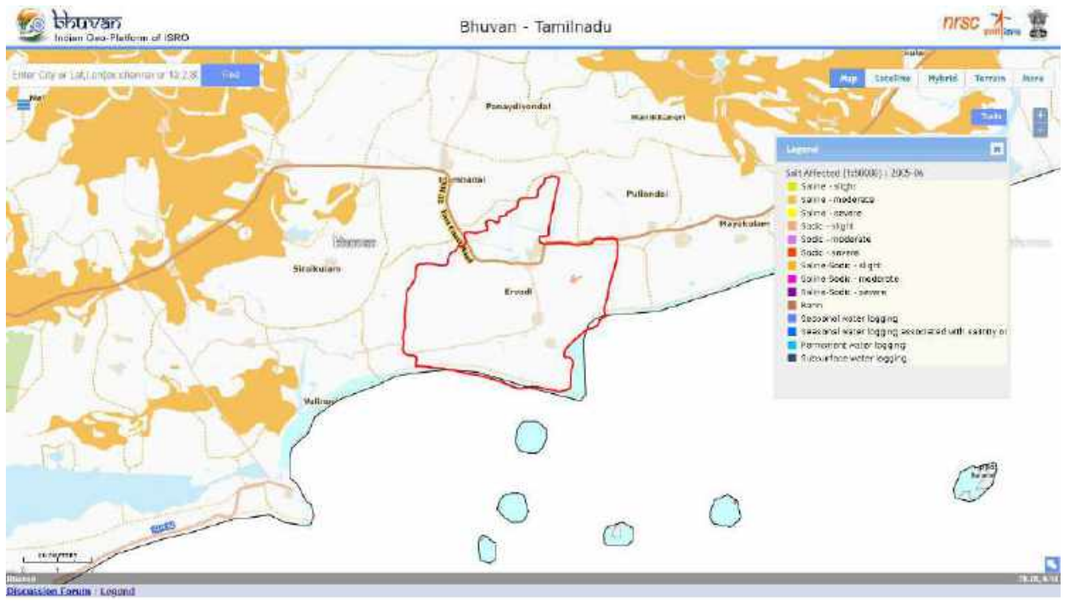
Map 3.33: Land use and land cover map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Lineament: A lineament map shows the linear feature in a landscape that is an expression of an underlying geological structure such as a fault, fracture, or joint. In Ervadi GP, mostly the lineament parallel to shoreline is noticed. This map is very useful to plan the suitable water conservation, harvesting and recharge measures.



Map 3.34: Lineament map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Salt affected area: Salt affected areas are one of the most important degraded areas where soil productivity is reduced due to either salinization or sodicity or both. In Ervadi GP, it is observed that limited part of the land is salinized . While planning the GP, this area has been treated specially and given alternative cropping and other steps has been suggested to reduce the salinization.



Map 3.35: Salt affected map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Drainage: The drainage map of Ervadi clearly shows that the Ervadi GP has is less drainage density. This factor has been considered while planning the water conservation and harvesting structures in the GP

Fig 3.36: Drainage map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Slope: The slope map illustrates the measure of steepness or the degree of inclination of a feature relative to the horizontal plane. Slope is typically expressed as a percentage, an angle, or a ratio. The average slope of a terrain feature is calculated from contour lines on a topo map or DEM . For Ervadi GP, it clearly shows very flat slope of 0 to 1 %. Hence the slope is considered for planning the the soil conservation measures and construction of the water recharge structures such as check dam, farm ponds etc.,

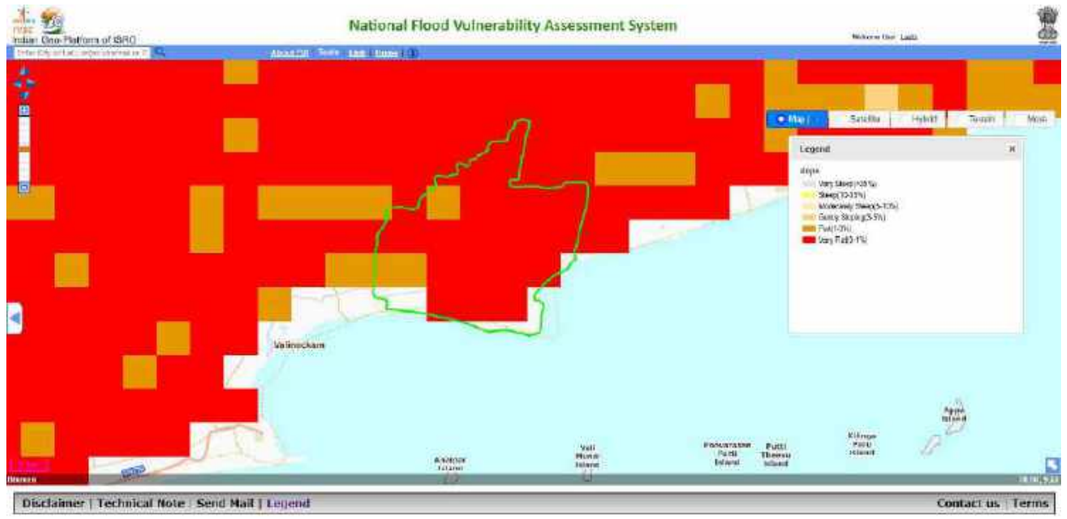
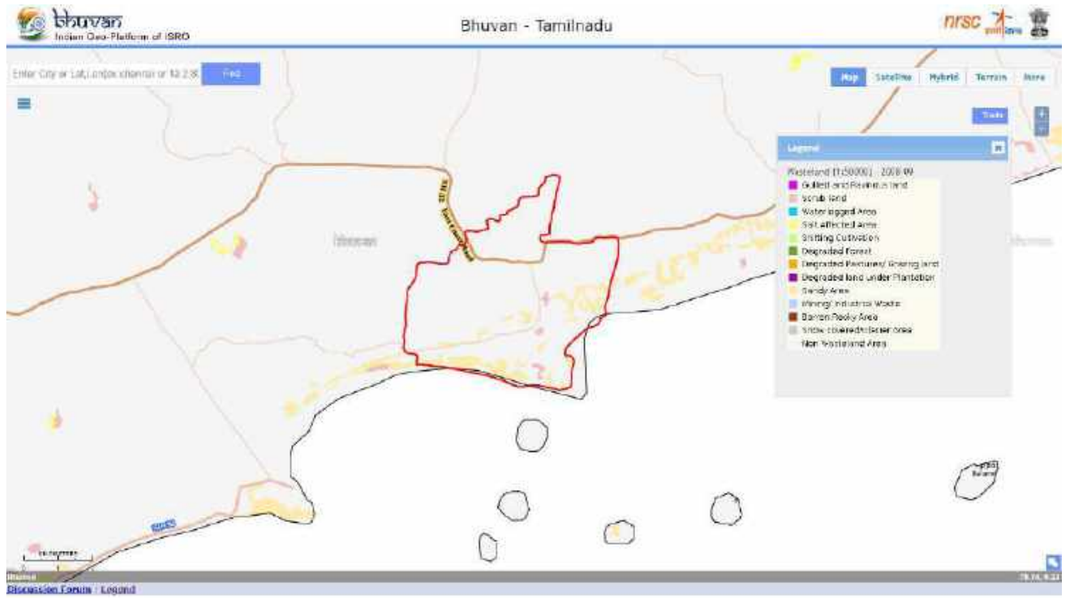


Fig 3. 37: Slope map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Wasteland area: The wasteland map illustrates the availability of the wasteland such as sandy area in Ervadi Gram panchayat. During planning the GPs, the plantation measures have been taken up in the identified wastelands to convert into productive land.



Map 3.38: Wasteland map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Watershed details: A watershed map is the area of land where all of the water that falls in it and drains off of it goes into the common outlet. The map is used for the interventions in the Ervadi GP based on ridge to valley concept and sequencing the plan accordingly.

Map 3.39: Watershed map of Ervadi GP, Kadaladi Block, Ramanathapuram district

Non-spatial data

TABLE 3.21: NON-SPATIAL PARAMETERS, ERVADI GP, RAMANATHAPURAM DISTRICT

	Socio-Economic Profile	
1	Total Geographical Area (Ha)	1904
2	Male Population (Number)	6689
3	Female Population (Number)	6677
4	Total Population (Number)	13366
5	SC Population (Number)	1078
6	ST Population (Number)	0
7	Vulnerable population (Number)	1078
8	No. of. Households (Number)	2517
9	Only one room HH's (Number)	574
10	Female Headed HH's (Number)	125
11	Vulnerable Households (Number)	439
12	Vulnerability (Percent)	17%
13	Registered Job cards (Number of persons)	1892
14	Active person Job Cards(Number of persons)	1270
15	Drinking Water Sources(number)	220
16	Grey water Generation (MCM)	24
	Climate Profile	
1	Average Annual Rainfall (mm)	821
2	Average Annual Temperature (°C)	28.2 °C
3	Ground Water Status - OE,CR,SC, Safe, Saline	Safe
	Water Profile	
1	Water Demand For Humans (MCM)	0.37
2	Water Demand for Livestock (MCM)	0.05
3	Water Demand For Agriculture (MCM)	2.06
4	G.W Utilization for Drinking (percent)	44%
5	% G.W Utilization for Livestock (percent)	68%
6	% G.W Utilization for Agriculture (percent)	1%
7	% SW for Drinking (percent)	9%
8	% SW for Livestock (percent)	32%
9	% SW for Agriculture (percent)	99%
Available runoff		
10	Good Catchment (Run-off) (MCM)	0.24
11	Average Catchment (Run-off) (MCM)	0.72
12	Bad Catchment (Run-off) (MCM)	2.01
Run off conserved (Existing)		
13	Good Catchment (Run-off) (MCM)	0.08
14	Average Catchment (Run-off) (MCM)	0.63

15	Bad Catchment (Run-off) (MCM)	0.27
Micro watershed information		
16	Length of Natural Drainage Lines (KM)	1.30
18	Number of Micro Watershed (Number)	8
Canal network		
19	Main Canal (KM)	0
20	Minor (KM)	3
21	Distributaries (KM)	0
22	Water Courses (Field Channels) (KM)	5
23	Total Length of the canal Network (KM)	8
Traditional water bodies		
24	Number of Tanks (Number)	2
25	Number of Ooranis (Number)	9
26	Other Sources(Ponds) (Number)	0
Irrigation facilities		
27	Area under Canal Irrigation (Ha)	0
28	Area under Open well & Tube Well irrigation (Ha)	5.73
29	Area under Tank Irrigation (Ha)	414.83
Agriculture and Allied Profile		
1	Soil Moisture (percent)	17%
2	Soil Moisture (MCM)	33.03
3	ET Losses(MCM)	9.37
Soil resources - Macro Nutrients- Nitrogen		
4	Very Low (percent)	35%
5	Low (percent)	41%
6	Medium (percent)	0%
7	High (percent)	0%
8	Very High (percent)	0%
Soil resources -Organic Carbon		
9	Very Low (percent)	35%
10	Low (percent)	20%
11	Medium (percent)	47%
12	High (percent)	3%
13	Very High (percent)	0%
Soil Resources - Micro Nutrients		
14	Sufficient (percent)	69%
15	Deficient(percent)	31%
Soil Resources - Physical Parameter - PH		
16	Acidic Sulphate (AS) (percent)	0.0%
17	Strongly Acidic (SrAc) (percent)	0.0%
18	Highly Acidic (HAc) (percent)	1.7%
19	Moderately Acidic (MAc) (percent)	0.0%
20	Slightly Acidic (SlAc) (percent)	0.8%
21	Neutral (N) (percent) (percent)	0.8%
22	Moderately Alkaline (MAI) (percent)	86.4%
23	Strongly Alkaline (SIAI) (percent)	10.2%
Soil resources - Soil profile		
24	% of Clay Soil (percent)	0%
25	% of Fine Soil (percent)	51%
26	% of Coarse loamy (percent)	4%
27	Permeability	Moderate to Low (5-20 mm/hr)
Land use classification		
28	Area under forest (Ha)	0
29	Area under Non-Agricultural Uses (Ha)	108.53
30	Area under Barren & Un-cultivable Land (Ha)	0
31	Area under Permanent Pastures and Other Grazing Land (Ha)	0
32	Area under Land Under Miscellaneous Tree Crops (Ha)	423.75
33	Area under Culturable Waste Land (Ha)	0
34	Area under Fallows Land other than Current Fallows (Ha)	0
35	Area under Current Fallow land (Ha)	0
36	Area under Unirrigated Lands (Ha)	950.86
37	Area Irrigated by Source (Ha)	420.56
Land resources - WASCA Area		
38	Area under forest (Ha)	0.00
39	Area under Non-Agricultural Uses (Ha)	1.85
40	Area under Barren & Un-cultivable Land (Ha)	0.00
41	Area under Permanent Pastures and Other Grazing Land (Ha)	0.00
42	Area under Miscellaneous Tree Crops (Ha)	360.19
43	Area under Culturable Waste Land (Ha)	0.00
44	Area under Fallows Land other than Current Fallows (Ha)	0.00
45	Area under Current Fallow land (Ha)	0.00
46	Area under Unirrigated Lands (Ha)	161.65
47	Area Irrigated by Source (Ha)	71.50
Catchment area		
48	Good Catchment Area (Ha)	108.53
49	Average Catchment Area (Ha)	423.75
50	Bad Catchment Area (Ha)	1371.42
Means of water extraction		
51	Gravity (percent)	5%
52	Lifting (percent)	95%
Irrigation methods		
53	Wild Flooding (percent)	99%
54	Control Flooding (percent)	1%

Crop details		
55	Irrigated Area (Ha)	134.14
56	Rainfed area (Ha)	176.95
57	Area under Paddy Cultivation	81.72
58	Crop water requirement under irrigation(MCM)	0.97
59	Crop water requirement under Rainfed(MCM)	1.09
Livestock details		
60	Number of Cattle (Number)	887
61	Number of Goat and Sheep (Number)	4318
62	Number of Poultry (Number)	3141
63	Livestock Water Requirement(MCM)	0.05
Water Budget		
64	Water Demand (HaM)	247.9
65	Available Run-off (HaM)	297.2
66	Harvested Run-off (HaM)	45.7
67	Potential for Harvesting (HaM)	106.3
68	Total Water Harvested (HaM)	152.0
69	Water Deficiency / Surplus (HaM)	-95.9

Key water challenges: The key water challenges identified based on the non-spatial and spatial data for the Ervadi GPs are given below under four vulnerability themes: socio-economic, climate, water resources and agriculture and allied activities

KEY WATER CHALLENGES IDENTIFIED IN ERVADI GP

AREAS	ERVADI
Socio-economic	8 percent of the population belongs to SC community and according to SECC data 17% of the households are vulnerable in the village. Access to safe drinking water and hygiene environment are a key challenge in the GP. Handling of grey water from the 2517 households living on the coast needs attention
Climate	The increasing extreme events and increase in sea level rise are the key threats for the GP, besides increasing salinization of ground water and sea erosion
Water	Only 28 percent of the land area is under public and common land, of which 6 percent is under non-agriculture use while 22 percent area comes under miscellaneous tree crops. With reference to traditional water bodies, the GP has only two tanks and nine ooranis to meet all water demand. Of the total run off only 15 percent is harvested and stored for use. The water budget is negative to the tune of 96 Ha M. 62 percent of the proposed work is under public and common land development.
Agriculture and allied sector	The soil health is very poor – available Nitrogen and organic matter content is very low to low and more than 80 percent of the land is under moderately saline. 38 percent is under individual land of which 27 percent is in dry lands. In the irrigated land more than 60 percent of the area paddy is the primary crop. Under irrigation wild flooding is adopted. Among the livestock number of goats/sheep and poultry is high compared to cattle.

Perspective plan - works proposed: Water actions

On the basis of the above key water challenges, relevant site specific works are identified for the development of public and common land, agriculture and allied activities, rural infrastructures and climate resilient measure to reduce the vulnerability in the GP (Table 3.22).

TABLE 3.22: CWRM KEY WATER ACTION, ERVADI GP, RAMANATHAPURAM DISTRICT

S.NO	Name of the work	No of Works	Estimated cost in lakhs of Rupees (INR)	Estimated Person Days
CWRM Water Action 1: Improvement of Public & Common Lands Development				
1	2	3	4	5
1	Afforestation in Public/common lands	1	8.60	3344
2	"Contour Continous Bunds (CCB) for Afforestaion area "	1	0.03	10
3	Composting	56	9.52	840
4	Drainage Line Treatment (DLT)	1	0.03	5
5	Check Dam - Common	1	17.10	6664
6	Silvi-pasture Development	1	1.80	703
7	Linear Plantation	3	5.40	2109
8	Aveneu plantation	3	33.30	12960
9	Block Plantation (Community)	1	10.00	3906
10	Restotaration of water bodies:			
11	a.Tanks	2	10.00	1600
12	b. Ooranis	9	18.00	1800
16	Artificial Recharge Structure	2	5.00	782
14	Canal Bund Plantation	1	7.50	2930
15	WC - Irrigation channels - Desilting	2	0.02	6
16	WC- Irrigation channels - canal side plantation	1	0.02	6
	Total	**85**	**126**	**37665**
Coastal Watershed Works				
17	Agro forestry	6	45.00	17580
18	Check Dam	1	1.50	234
19	Fish Drying Yard	5	10.60	1655
20	Nursery development - plantation	0	0.30	115
21	Shelter belts	1	7.50	2930
22	Coastal wetland - Bund strengthening of Wet lands	1	0.06	977
	Total	**14**	**65**	**23491**
	Sub Total Water Action -1	**99**	**191.26**	**61156**
CWRM Water Action 2: Agricultural & allied sector development (Productivity Enhancement)				
1	Farm Bunding	62	93.00	36332
2	Construction of farm ponds	62	124.00	48422
3	Land development	5	50.00	19530
4	Nursery development - plantation	3	45.00	7032
5	Cattle Shelters	22	46.64	7282
6	Goat Sheep Shelters	41	93.07	14555
7	Fodder development for cattle	22	32.56	51568
8	Azolla units	22	3.30	506
9	Cattle Trough	22	1.10	132
10	Poultry shed	16	1.44	160
11	Dry land Horticulture/Agro-forestry	3	25.50	9963
12	Vermi compost	22	3.96	594
	Sub Total Water Action -2	**302**	**520**	**196076**
CWRM Water Action 3: Rural Water Management				
1	Soak pits (Community)	29	3.77	580
2	Soak pits (Individual)	90	9.00	1440
3	Roof rain Water Harvesting - Community	2	8.00	1250
	Sub Total Water Action -3	**121**	**20.77**	**3270**
	Overall Total - GP	**522**	**731.60**	**260,502**

Water actions: With reference to CWRM themes, of the total number of shelf of projects identified, 19 percent works are in public and common land, and 58 percent in agriculture and allied sector while it is 23 percent under rural infrastructure. The table 3.23 provides the detailed perspective plan and estimates of the work, budget and person days for three years from 2021-2022 to 2023-2024 in the Ervadi GP. Since it is coastal village, attention was given to include appropriate works to improve the coastal resources.

TABLE 3.23: SUMMARY OF WORKS IDENTIFIED AND ESTIMATED PERSON DAYS FOR 2021-22 TO 2023-2024 FOR ERVADI GP, RAMANATHAPURAM DISTRICT

CWRM themes	No of works	Estimated budget (INR in lakhs)	Estimated person days
Public and common land development	99	191.26	61156
Agriculture and Allied sector development	302	520	196076
Rural water management	121	20.77	3270
TOTAL	522	731.6	260502

Impacts: The proposed water actions based on the above key water challenges covers three years period from 2021-2022 to 2023-2024. At the end of the implementation period the following impacts are envisaged. It is expected that the impacts have potentially reduce the vulnerability and improve the resilience of the system to the projected climatic change events and ensure water security.

WASCA – WATER ACTIONS AND INDICATORS, ERVADI GP, RAMANATHAPURAM DISTRICT

WASCA CWRM ACTION PLAN
Development of Public and Common Land

INDICATOR

1. Number of water bodies restored in the village
2. Quantum of water harvested/recharge
3. Proportion of land treated under WASCA
4. Area under afforestation
5. Length of drainage line treated

OUTCOMES/ IMPACT

1. 31.26 percent of the total area treated under WASCA (595.18 ha)
2. 97.93 Ham surface runoff is harvested due to WASCA interventions
3. 11 water bodies restored
4. 2 Ha area under afforestation
5. 1307 m length of drainage lines treated

595.18 ha	97.93 Ham	11	2 Ha	1307 m
AREA TREATED	SURFACE RUNOFF HARVESTED	WATER BODIES RESTORED	AREA AFFORESTATION	DRAINAGE LINES TREATED

WASCA CWRM ACTION PLAN
Development of Rural Infrastructure

INDICATOR

1. Number of units having complete liquid waste management systems
2. Roof rainwater harvesting measures
3. Grey water drains
4. Nutri gardens

OUTCOMES/ IMPACT

1. 29 common and 285 individual soak pits established for recycle of grey water benefiting 2853 households
2. 3 common roof rainwater harvesting and storage and 500 individual level roof rainwater harvesting
3. 5 km length of earthen drains improved for safe disposal
4. 2853 Households established nutri-gardens in homesteads

29 COMMON & 285	3	500	5 km	2853
INDIVIDUAL SOAK PITS	COMMON ROOF RAINWATER HARVESTING	INDIVIDULAL RAINWATER HARVESTING	LENGTH OF EARTHEN DRAINS	NUTRI-GARDENS

WASCA CWRM ACTION PLAN
Development of Agriculture and Allied Activities

INDICATOR

1. Assessment of sources of water for livestock and agriculture demand
2. No of structures established for on-farm *(in-situ)* water harvesting in dry lands
3. Improvement in soil health
4. Changes in the irrigation practices
5. Dry land development with agro-forestry
6. Households established fodder plots

OUTCOMES/ IMPACT

1. 133 farm ponds established
2. 65 compost units for soil health improvement
3. 81 Ha Farm bunding with trenches
4. 81 Ha under dry land horticulture
5. 72 Ha covered under micro irrigation
6. 222 vulnerable house holds established fodder plots

133	65	81 Ha	72 Ha	222
FARM PONDS	COMPOST UNITS	DRYLAND HORTICULTURE	UNDER MICRO IRRIGATION	FODDER PLOTS

WASCA CWRM ACTION PLAN
Development of Climate Resilient Measures

INDICATOR

1. Number of climate resilient measures identified

OUTCOMES/ IMPACT

1. Coastal watershed pilot type 2 is being implemented

COASTAL WATERSHED
PILOT TYPE 2

Mahatma Gandhi NREGS Proposals

The following table provides both the perspective plan for three years period and annual plan for the one year period from 2021-2022 on the shelf of projects/number of works and number of person days.

TABLE 3.24: PROPOSAL FOR THE MAHATMA GANDHI NREGS, ERVADI GP, RAMANATHAPURAM DISTRICT

	No of works	No of person days
Perspective plan	522	260,502
Annual plan	158	75,899

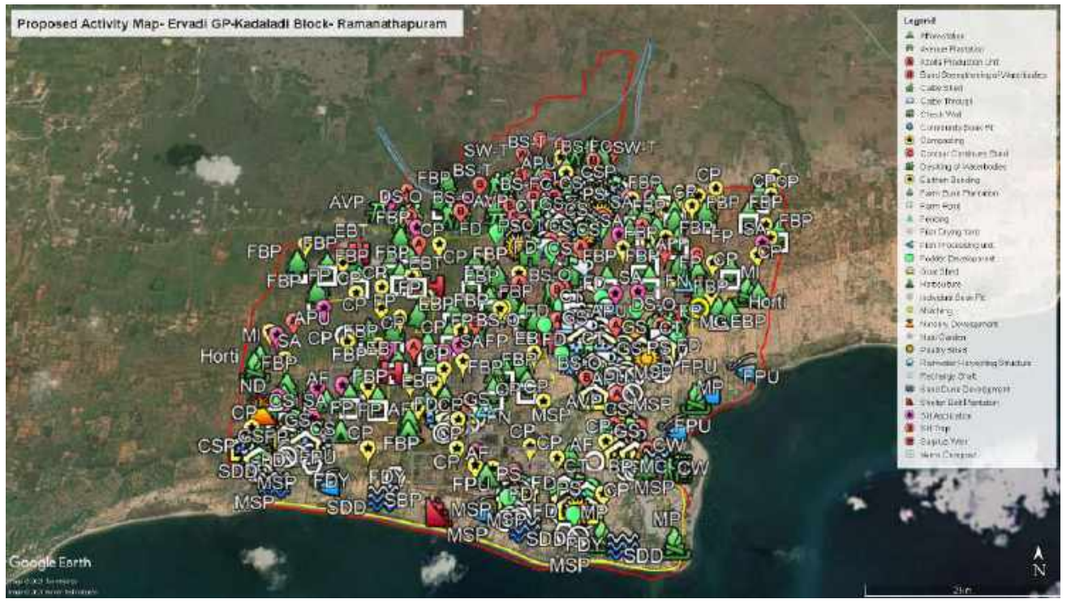


Fig 3.58: Action plan of Ervadi GP, Kadaladi block, Ramanathapuram District

CASE STUDY 2: VADALAPIRANTHAN GP, ANANKAVOOR BLOCK, TIRUVANNAMALAI DISTRICT

Vadalapiranthan is located in Anakavoor block of Tiruvannamalai district, Tamil Nadu with total 202 families residing. The Vadalapiranthan village has population of 764 of which 375 are males while 389 are females as per Population Census 2011. Schedule Tribe constitutes 0.39 % of total population in Vadalapiranthan village. There is no Schedule Caste population in the village.

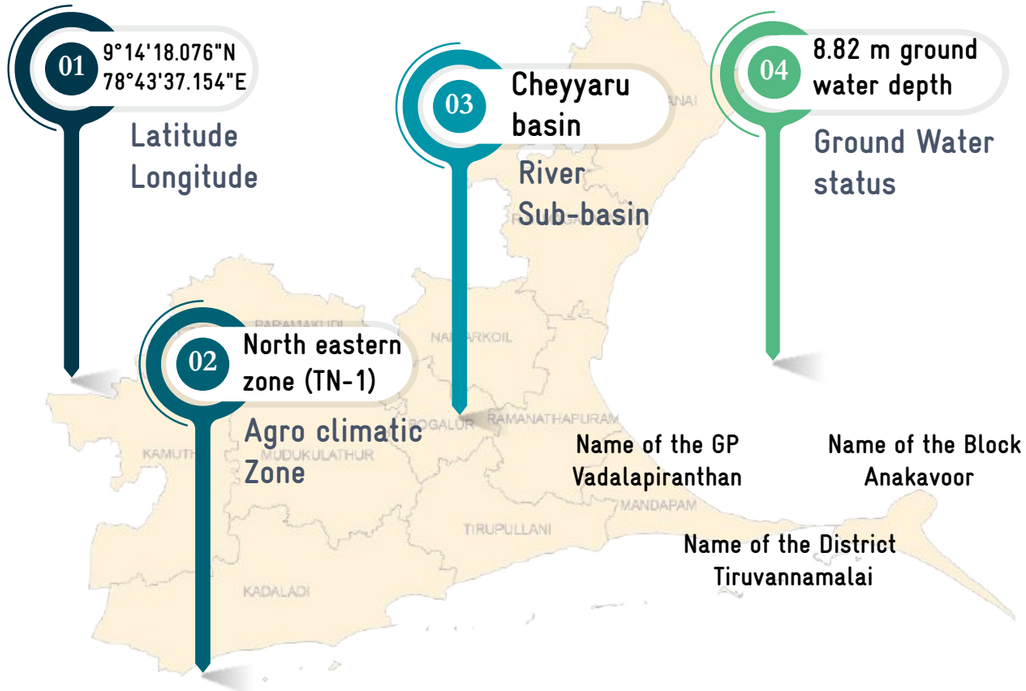
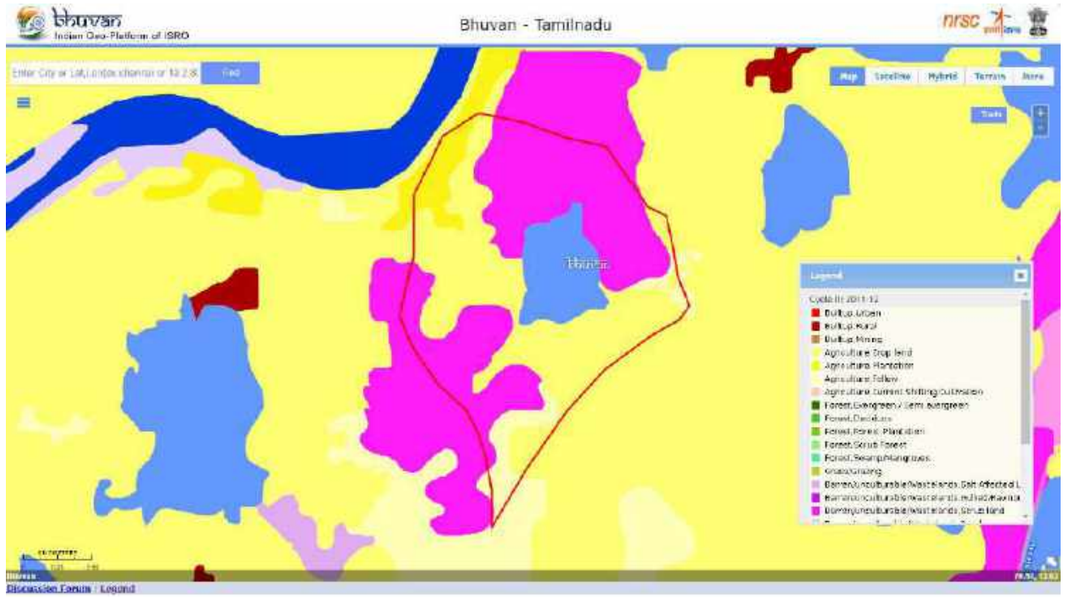


Fig 3.59 General details of Vadalapiranthan GP, Tiruvannamalai district

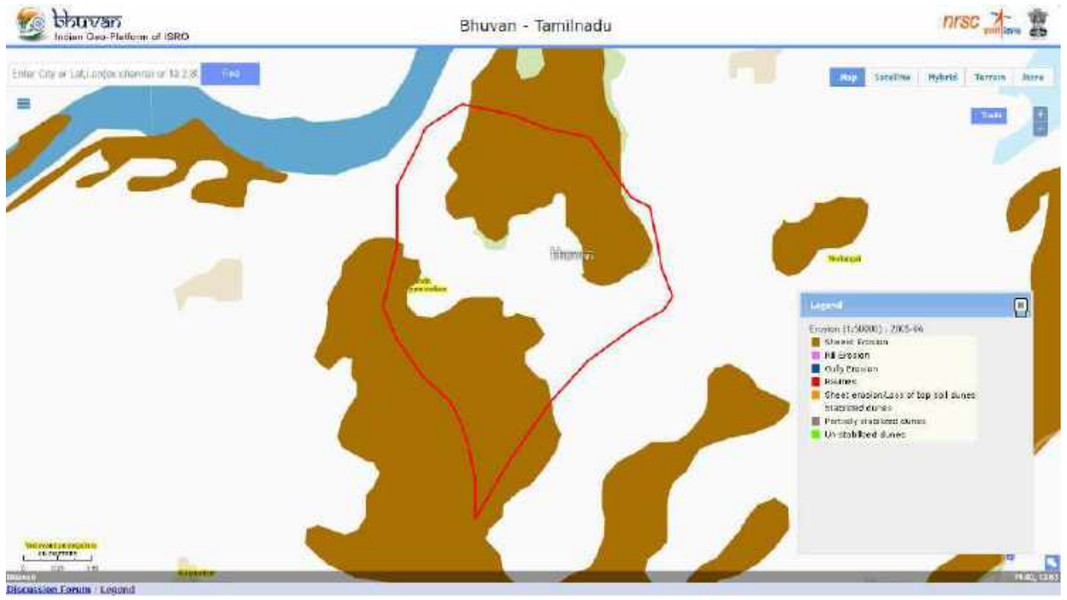
The spatial and non-spatial data employed in identifying the key water challenges are given in Maps 3.40 to 3.48 and Table 3.25

Land and land cover: The map clearly shows that the GP is covered by the agriculture fallow land and barren lands.



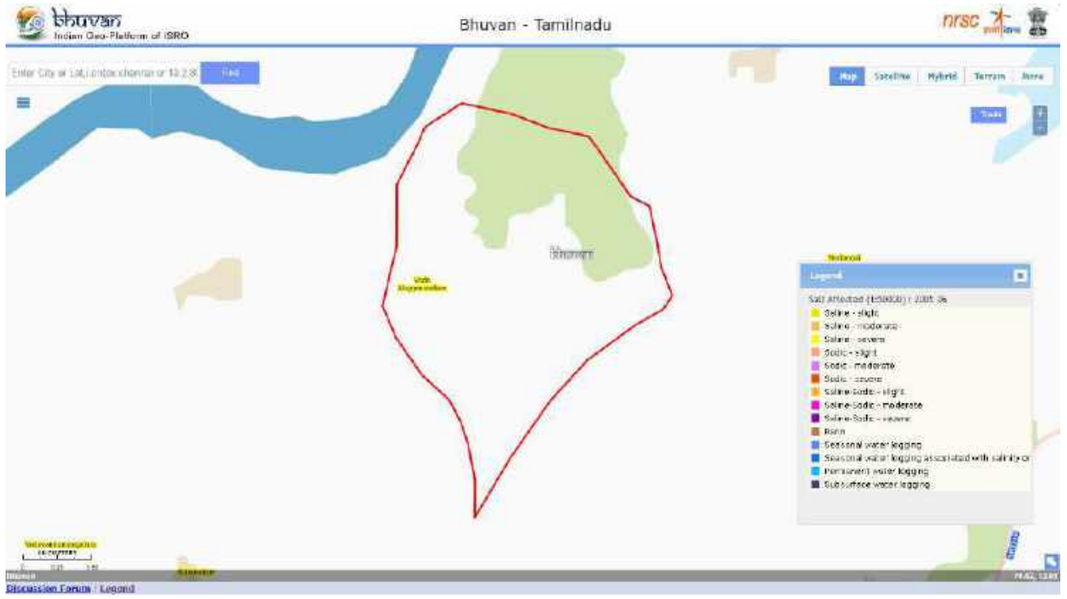
Map 3.40: Land use and land cover map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Area under erosion: The map shows the degree and area under sheet erosion in the GP under different land use categories



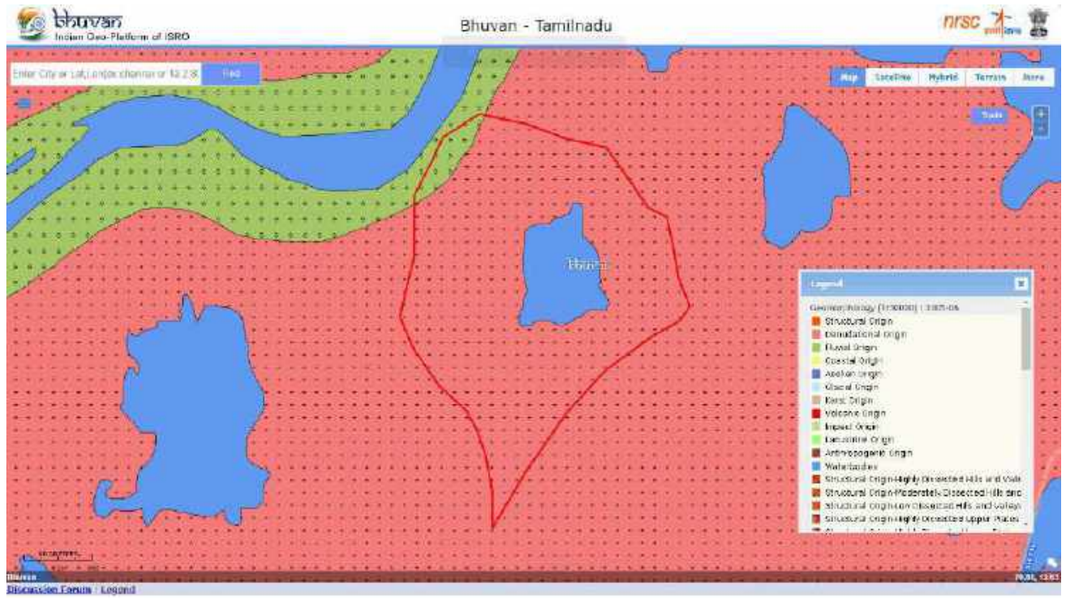
Map 3.41: Soil erosion map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Salt affected area: The map shows there is no major issues due to salt issues in the cultivated land



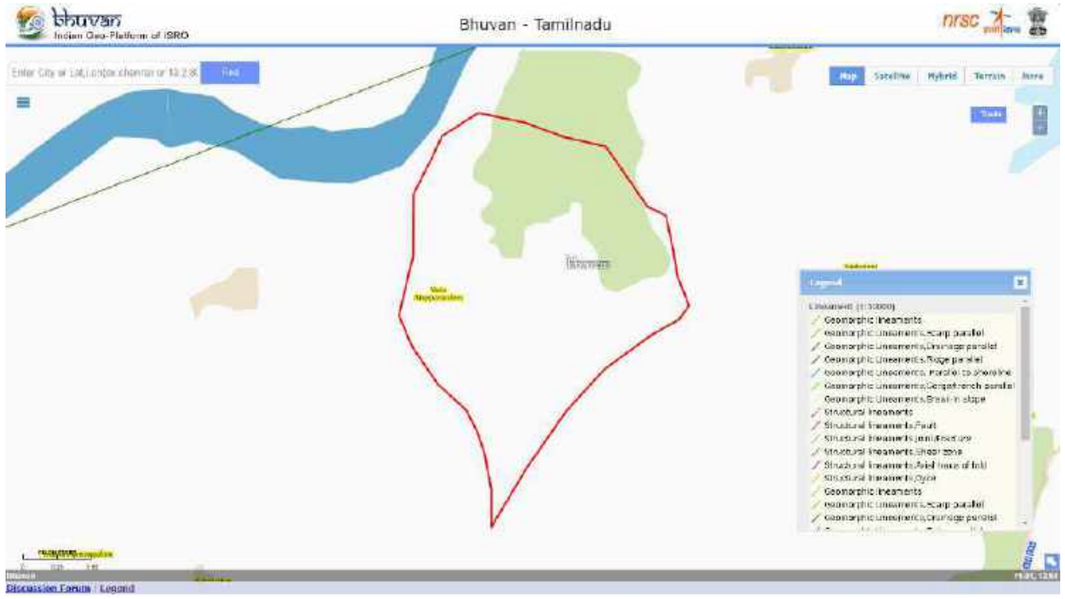
Map 3.42: Salt affected area map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Geomorophology: The major part of the GP covers under the denudation origin – pediment- pediplain complex category.



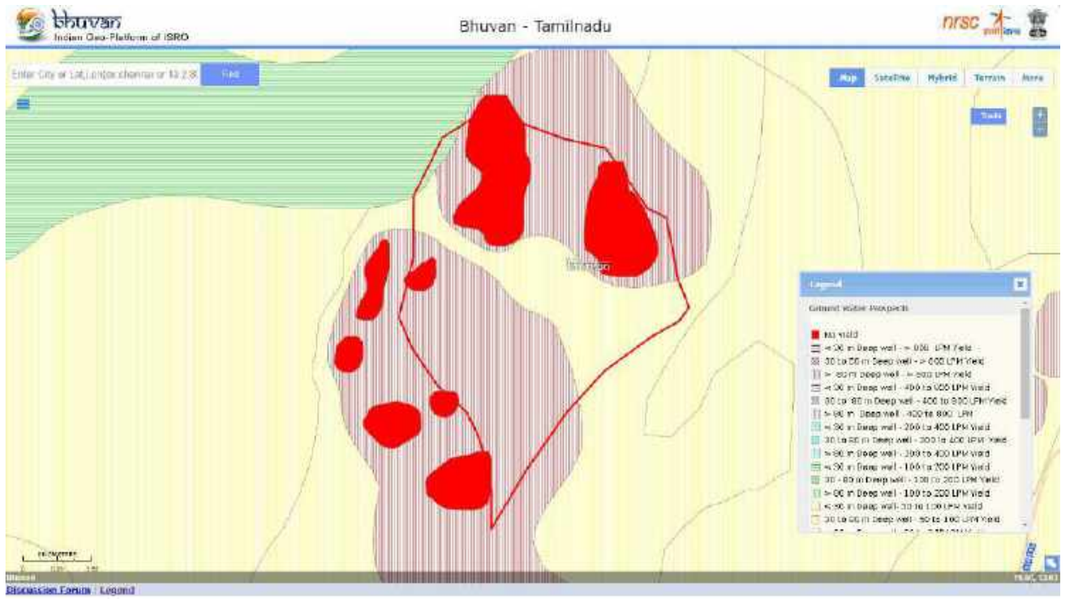
Map 3.43: Geomorphology map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Lineament: There is no lineament present in the village



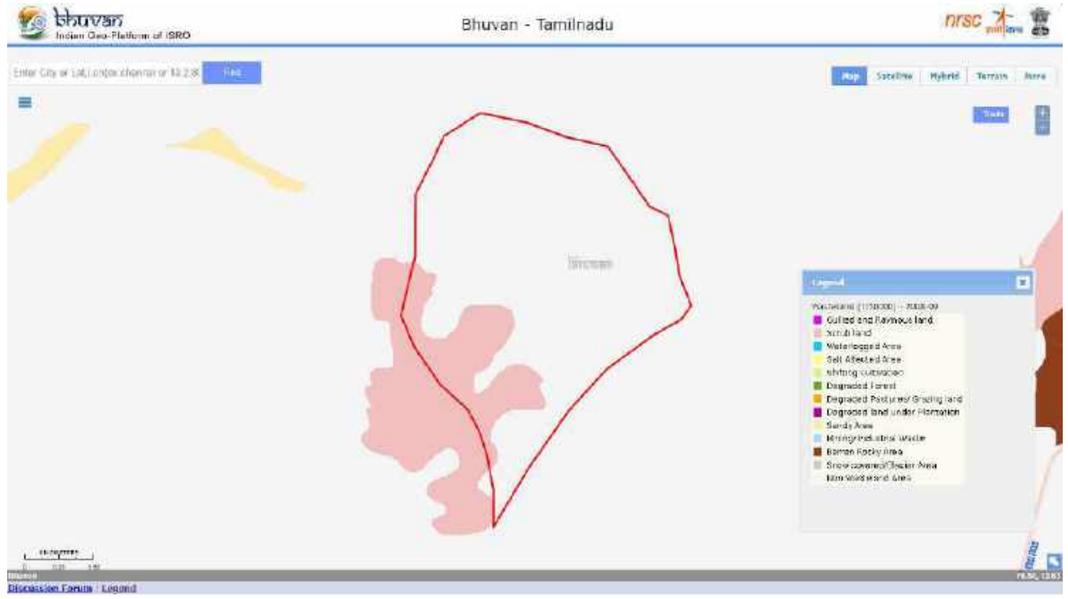
Map 3.44: Lineament map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Ground water prospectus: It is observed that the ground water prospectus is greater than 80m deep well with 20 to 30 litre per minute capacity.



Map 3.45: Ground water map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Wasteland: It is noticed that there are patches of scrub land in the south western side of the GP

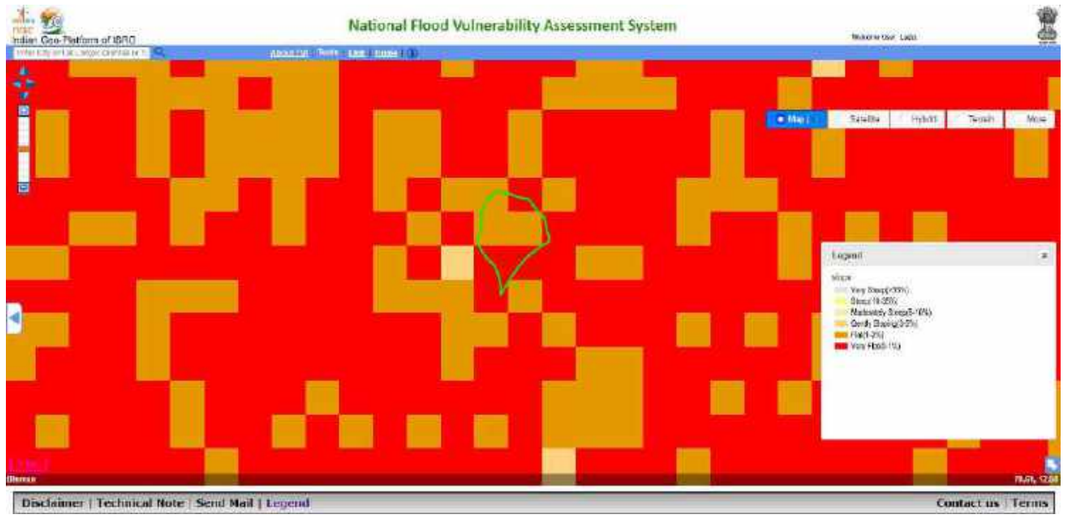


Map 3.46: Wasteland map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Watershed: There are two micro watersheds in the village

Map 3.47: Watershed map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

Slope: It clearly shows that the region is flat to mild slope of 0 to 3 percent



Map 3.48: Slope map of Vadalapiranthan GP, Anakavoor block, Tiruvannamalai district

TABLE 3.25: NON-SPATIAL PARAMETERS OF VADALAPIRANTHAN GP, TIRUVANNAMALAI DISTRICT

	Socio-Economic Profile	
1	Total geographical area (Ha)	345
2	Male population (Number)	375
3	Female population (Number)	389
4	Total population (Number)	764
5	SC population (Number)	0
6	ST population (Number)	3
7	Vulnerable population (Number)	3
8	No. of. households (Number)	206
9	Only one room HH's (Number)	7
10	Female Headed HH'(Number)	140
11	Vulnerable households (Number)	47
12	Vulnerability (Percent)	23%
13	Registered job cards (Number of persons)	589
14	Active person job cards (Number of persons)	312
15	Drinking water sources (number)	15
16	Grey water generation (MCM)	1
	Climate Profile	
1	Average annual rainfall (mm)	821
2	Average annual temperature (ºC)	28.2 °C
3	Ground Water status OE,CR,SC, Safe	Critical

	Water Profile	
1	Water Demand For Humans(MCM)	0.02
2	Water Demand for Livestock(MCM)	0.01
3	Water Demand For Agriculture (MCM)	0.68
4	G.W Utilization for Drinking (percent)	47%
5	% G.W Utilization for Livestock(percent)	87%
6	% G.W Utilization for Agriculture (percent)	100%
7	% SW for Drinking (percent)	13%
8	% SW for Livestock (percent)	13%
9	% SW for Agriculture (percent)	0%
Available Runoff		
10	Good Catchment (Run-off) (MCM)	0.72
11	Average Catchment (Run-off) (MCM)	0.00
12	Bad Catchment (Run-off) (MCM)	0.29
Run Off Conserved (Existing)		
13	Good Catchment (Run-off) (MCM)	0.36
14	Average Catchment (Run-off) (MCM)	0.00
15	Bad Catchment (Run-off) (MCM)	0.09
Micro watershed information		
16	Length of Natural Drainage Lines (KM)	1.96
18	Number of Micro Watershed (Number)	2
Canal Network		
19	Main Canal (KM)	0.83
20	Minor (KM)	0.00
21	Distributaries (KM)	0.00
22	Water Courses (Field Channels) (KM)	1.58
23	Total Length of the canal Network (KM)	2.41
24	Number of Tanks (Number)	1
25	Number of Ooranis (Number)	3
26	Other Sources(Ponds) (Number)	5
Irrigation Facilities		
27	Area under Canal Irrigation (Ha)	0
28	Area under Open well & Tube Well irrigation (Ha)	19.96
29	Area under Tank Irrigation (Ha)	24.13
	Agriculture and Allied Profile	
1	Soil Moisture (percent)	23%
2	Soil Moisture (MCM)	4.87
3	ET Losses(MCM)	1.66
Soil Resources - Macro Nutrients- Nitrogen		
4	Very Low (percent)	0%
5	Low (percent)	40%
6	Medium (percent)	0%

7	High (percent)	0%
8	Very High (percent)	0%
Soil Resources - Macro Nutrients- Organic Carbon		
9	Very Low (percent)	0%
10	Low (percent)	40%
11	Medium (percent)	0%
12	High (percent)	0%
13	Very High (percent)	0%
Soil Resources - Micro Nutrients		
14	Sufficient (percent)	63%
15	Deficient (percent)	38%
Soil Resources - Physical Parameter - PH		
16	Acidic Sulphate (AS) (percent)	0%
17	Strongly Acidic (SrAc) (percent)	0%
18	Highly Acidic (HAc) (percent)	0%
19	Moderately Acidic (MAc) (percent)	0%
20	Slightly Acidic (SlAc) (percent)	0%
21	Neutral (N) (percent) (percent)	0%
22	Moderately Alkaline (MAI) (percent)	100%
23	Strongly Alkaline (SIAI) (percent)	0%
Soil Resources - Soil Profile		
24	% of Clay Soil (percent)	19%
25	% of Fine Soil (percent)	49%
26	% of Coarse loamy (percent)	0%
27	Permeability	Moderate to Low (5-20 mm/hr)
Land Resources Classification		
28	Area under forest (Ha)	151.62
29	Area under Non-Agricultural Uses (Ha)	39.51
30	Area under Barren & Un-cultivable Land (Ha)	0
31	Area under Permanent Pastures and Other Grazing Land (Ha)	0
32	Area under Land Under Miscellaneous Tree Crops (Ha)	0
33	Area under Culturable Waste Land (Ha)	0
34	Area under Fallows Land other than Current Fallows (Ha)	0
35	Area under Current Fallow land (Ha)	100.12
36	Area under Unirrigated Lands (Ha)	9.72
37	Area Irrigated by Source (Ha)	44.09
Land Resources - WASCA Area		
38	Area under forest (Ha)	60.65
39	Area under Non-Agricultural Uses (Ha)	19.76
40	Area under Barren & Un-cultivable Land (Ha)	0.00
41	Area under Permanent Pastures and Other Grazing Land (Ha)	0.00
42	Area under Land Under Miscellaneous Tree Crops (Ha)	0.00
43	Area under Culturable Waste Land (Ha)	0.00
44	Area under Fallows Land other than Current Fallows (Ha)	0.00
45	Area under Current Fallow land (Ha)	23.03
46	Area under Unirrigated Lands (Ha)	2.24
47	Area Irrigated by Source (Ha)	19.96
Catchment Area		
48	Good Catchment Area (Ha)	191.13
49	Average Catchment Area (Ha)	0
50	Bad Catchment Area (Ha)	153.93
Means of Water Extraction		
51	Gravity (percent)	9%
52	Lifting (percent)	91%
Irrigation Methods		
53	Wild Flooding (percent)	55%
54	Control Flooding (percent)	45%
Crop Details		
55	Irrigated Area (Ha)	48.70
56	Rainfed area (Ha)	0.00
57	Area under Paddy Cultivation	41
58	Crop water requirement - irrigation (MCM)	0.68
59	Crop water requirement - rainfed (MCM)	0.00
Livestock Details		
60	Number of Cattle (Number)	337
61	Number of Goat and Sheep (Number)	224
62	Number of Poultry (Number)	0.00
63	Livestock Water Requirement (MCM)	0.01
Water Budget		
64	Water Demand (HaM)	71.5
65	Available Run-off (HaM)	100.5
66	Harvested Run-off (HaM)	0.1
67	Potential for Harvesting (HaM)	41.4
68	Total Water Harvested (HaM)	41.5
69	Water Deficiency / Surplus (HaM)	-31.0

KEY WATER CHALLENGES IDENTIFIED IN VADALAPIRANTHAN GP, TIRUVANNAMALAI DISTRICT

AREAS	VADALAPIRANTHAN
Socio-economic	The village has 27 percent vulnerable families in terms of caste and class and 68 percent of the households are female headed households. Access to safe disposal of domestic grey water is limited
Climate	The ground water development status is critical
Water	There are eight traditional bodies present in the GP, however dependence on ground water is high: 47% for domestic, 87% for livestock and 100 percent for agriculture; 1.01 MCM is available as run off in the village and currently harvested only 0.01 MCM in the traditional water bodies. Hence dependence on ground water is more across the sectors. 55% of the total geographical area under common land of which 44% is predominantly under forest area while remaining 45% is under individual land. There is no land area left in common land which has average catchment.
Agriculture and allied sector	The village has considerable portion under current fallow (29 percent). The area under cultivation is only 16 percent of total geographical area, of which 3 percent under rainfed and remaining 13 under irrigation. The irrigation is completely dependent on ground water and paddy is the main crop. Irrigation is by both control and wild flooding.

Perspective plan - works proposed: Water actions

The appropriate and site specific works are identified for the development of public and common land, agriculture and allied activities, rural infrastructures and climate resilient measure to reduce the vulnerability in the GP. The table 3.26 shows the detailed perspective plan and estimates of the work, budget and person days for three years from 2021-2022 to 2023-2024 in the Ervadi GP. Since it is undulating terrain village, attention was given to include appropriate works to improve the common and public land development.

Estimates for Three Years (2021-22 to 2023-24), Vadalapiranthan GP – Anakavoor Block – Tiruvannamalai District

TABLE 3.26: CWRM KEY WATER ACTION, VADALAPIRANTHAN GP, TIRUVANNAMALAI DISTRICT

CWRM Water Action 1: Improvement of public & common lands development				
S.NO	Name of the work	No of Works	Estimated cost in lakhs of Rupees (INR)	Estimated Person Days
1	2	3	4	5
1	Continous contour trenches (CCT)	4	0.10	40
2	"Contour Continous Bunds (CCB) for Afforestaion area"	2	0.05	20
3	Composting	14	2.38	210
4	Drainage Line Treatment (DLT)	2	0.06	10
5	Brushwood Check Dam	3	4.50	702
6	Silvi-pasture Development	2	34.20	13328
7	Linear Plantation	6	10.80	4218
8	Aveneu plantation	1	1.80	703
9	Block Plantation (Community)	4	44.40	17280
	Restotaration of water bodies:		0.00	0
10	a.Tanks	1	5.00	800
11	b. Ponds	5	5.00	1000
12	Artificial Recharge Structure	8	20.00	3128
13	Canal Bund Plantation	1	7.50	2930
14	WC - Irrigation channels - Desilting	1	0.01	3
15	WC- Irrigation channels - canal side plantation	1	0.02	6
	Sub Total Water Action -1	**55**	**136**	**44378**
CWRM Water Action 2: Agricultural and allied sector development (Productivity Enhancement)				
1	Farm Bunding	7	10.50	4102
2	Construction of farm ponds	31	62.00	24211
3	Land development	27	270.00	105462
4	Nursery development - plantation	206	3090.00	482864
5	Cattle Shelters	47	99.64	15557
6	Goat Sheep Shelters	14	31.78	4970
7	Fodder development for cattle	47	69.56	110168

8	Azolla units	47	7.05	1081
9	Cattle Trough	47	2.35	282
10	Dry land Horticulture/Agro-forestry	2	17.00	6642
11	Vermi compost (Number)	47	8.46	1269
12	Construction of new well	8	40.00	7408
	Sub Total Water Action -2	**530**	**3708**	**764016**
	CWRM Water Action 3: Rural Water Management			
1	Soak pits (Community)	2	0.26	40
2	Soak pits (Individual)	47	4.70	752
3	Roof rain Water Harvesting - Community	2	8.00	1250
	Sub Total Water Action -3	**51**	**12.96**	**2042**
	Overall Total - GP	**636**	**3857.11**	**810,436**

Water actions: With reference to CWRM themes, of the total number of shelf of projects identified, 8.6 percent works are in public and common land and 83.3 percent in agriculture and allied sector while it is only 8 percent under rural infrastructure (Table 3.27).

TABLE 3.27: SUMMARY OF WORKS IDENTIFIED AND ESTIMATED PERSON DAYS FOR 2021-22 TO 2023-2024 VADALAPIRANTHAN GP, TIRUVANNAMALAI DISTRICT

CWRM themes	No of works	Estimated budget (INR in lakhs)	Estimated person days
Public and common land development	55	136	44378
Agriculture and Allied sector development	530	3708	764016
Rural water management	51	13	2642
TOTAL	636	3857	810436

Impacts: The proposed water actions based on the above key water challenges covers three years period from 2021-2022 to 2023-2024, similar to Ervadi GP of Ramanthapuram district. At the end of the implementation period i.e on the year 2024, the following impacts are envisaged. It is expected that the impacts have potentially reduce the vulnerability and improve the resilience of the system to the projected climatic change events and ensure water security.

WASCA TN – WATER ACTIONS AND INDICATORS

WASCA CWRM ACTION PLAN
Development of Public and Common Land

INDICATOR

1. Number of water bodies restored in the village
2. Area under afforestation
3. Percentage reduction in the annual surface runoff
4. Proportion of land treated under WASCA
5. Drainage line treatment

OUTCOMES/ IMPACT

1. Six traditional water bodies restored
2. 60.65 Ha under afforestation
3. 45.16 Ha m surface runoff harvested and stored
4. 41% of the total geographical area of the village treated under WASCA in three years
5. 2 Km length of drainage lines treated

6 TRADITIONAL WATER BODIES RESTORED

60.65 Ha AFFORESTATION

45.16 Ham SURFACE RUNOFF HARVESTED

41% TOTAL AREA TREATED

2 Km DRAINAGE LINES TREATED

WASCA CWRM ACTION PLAN
Development of Agriculture and Allied Activities

INDICATOR

1. No of structures established for on-farm *(in-situ)* water harvesting in dry lands
2. Reducing area under fallow lands
3. Improvement in soil health
4. No of artificial recharge structures proposed

OUTCOMES/ IMPACT

1. 14 farm ponds established
2. 100 Ha under fallow land restored for cultivation
3. 47 units of vermi compost established
4. Eight artificial recharge structures established to replenish ground water flow

14 FARM PONDS

100 Ha FALLOW LAND RESTORED

47 UNITS VERMI COMPOST

8 ARTIFICIAL RECHARGE STRUCTURE

WASCA CWRM ACTION PLAN

Development of Rural Infrastructure

INDICATOR

1. Number of villages having complete solid and liquid waste management systems
2. Roof rainwater harvesting measures
3. Nutri gardens

OUTCOMES/ IMPACT

1. Two community level and 47 individual level soak pits constructed for grey water management to maintain hygiene in the village
2. Two units of roof rain water harvesting and storing established
3. 206 households established nutri garden in homesteads

2
COMMUNITY LEVEL SOAKPITS

47
INDIVIDUAL SOAKPITS

2 units
ROOF RAIN WATER HARVESTING

206
NUTRIGARDENS

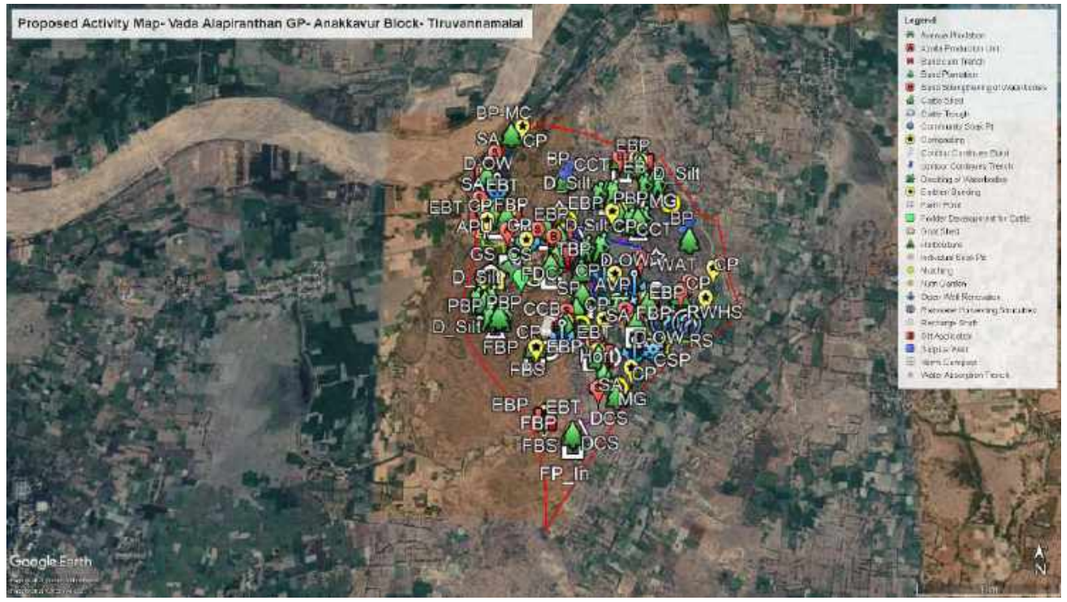


Fig 3.60: Action plan of Vadalapiranthan GP, Anakavoour block, Tiruvannamalai District

The following table 3.28 provides both the perspective plan for three years period and annual plan for the one year period from 2021-2022 on the shelf of projects/number of works and number of person days.

TABLE 3.28: PROPOSAL FOR THE MAHATMA GANDHI NREGS, VADALAPIRANTHAN, TIRUVANNAMALAI DISTRICT

	No of works	No of person days
Perspective plan	636	810,436
Annual plan	263	329,031

3.6 RANKING OF BLOCKS ON VULNERABILITY

The CWRM plan has used 113 non-spatial data parameters to analyse the key water challenges and each of them in different units. Considering the existing heterogeneity of the ecosystem across the blocks in the district, ranking is done to understand the level of vulnerability at block level and prioritise the actions. Similar process can be adopted within the block to assess the vulnerable GPs. Such ranking is useful to target/prioritize the blocks considering hotspots or area of interest based on the socio-economic, climate, water and agriculture and allied sectors. In each of the districts four such vulnerable blocks are identified and attention has been provided to identify more shelf of projects or works in the natural resources management side to reduce the vulnerability.

Ramanathapuram

The ranking of vulnerability on the four key themes which helped to identify more shelf of projects as well as useful to the district officials to prioritize the works in these blocks are provided in the following tables. On the basis of most relevant CWRM parameters, the first three blocks are considered are more vulnerable out of the 11 blocks.

Socio-economic vulnerability blocks: With reference to the socio-economic factors, when SC population is considered compared to the total population, Kadaladi, Kamuthi and Paramakudi are more vulnerable compared to remaining blocks. In terms female headed households, Kadaladi, Kamudhi and Mandapam are the most vulnerable blocks (Table 3.29).

Climate vulnerability blocks: The climate vulnerability parameter analysis shows that on ground water quality the blocks namely Kadaladi, Mandapam and Thirupulani are most vulnerable due to its saline water quality which affects the communities' access to safe drinking water and quality water for irrigation. While ground water availability and recharge data show that blocks namely Bogalur, Kadaladi and Mandapam and Ramanathapuram are highly vulnerable to remaining blocks (Table 3.30).

Water resource vulnerability blocks: The water resources vulnerability theme shows that interms of total demand for agriculture, which is the predominant use of water for its production, the blocks namely Thiruvadanai, R S Mangalam and Nainarkovil blocks are most vulnerable due to its higher demand for water especially surface water resources. The available runoff from both good and bad catchments, dominant catchment types are lesser in Kadaladi, Kamudhi and Thiruvadanai. The traditional water bodies are lesser in Bogalur, Nainarkoil and Ramanathapuram which makes lesser opportunity to store the runoff for use as well as ground water recharge to maintain the fresh water table as the Ramanathapuram and Mandapam are coastal blocks. The coastal blocks namely Thiruvadanai, RS Mangalam, Mandapam, Kadaladi, Ramanathapuram and Thirupulani are facing ground water salinization due to sea water intrusion (Table 3.31).

Agriculture vulnerability blocks: In agriculture and allied sectors, Bogalur, Mandapam and Thiruvadanai are vulnerable due to increasing soil salinization which affects the cultivation practices. The area under public and common land on different types of land uses except Mudhukulathur, remaining all blocks have lesser area, while in the individual land ownership category, the area under current fallow and other than current fallow is higher in Kamuthi, Kadaladi, Thiruvadanai and Ramanathapuram has more area under this category. Area under rainfed cultivation of paddy is higher in Nainarkovil, Tiruvadanai and R S Mangalam which is more vulnerable in the context of changing rainfall pattern and increasing extreme events (Table 3.32).

AREAS		VULNERABILITY BLOCKS		
Socio-economic	More vulnerable when SC population is considered compared to the total population	KADALADI KAMUTHI PARAMAKUDI	Most vulnerable in terms female headed households	KADALADI KAMUTHI MANDAPAM
Climate	Most vulnerable due to its saline water quality	KADALADI MANDAPAM THIRUPULANI	Highly vulnerable while ground water availability and recharge data	BOGALUR KADALADI MANDAPAM
Water	Most vulnerable due to its higher demand for water	THIRUVADANAI RS MANGALAM NAINARKOVIL	Dominant catchment types are lesser BOGALUR NAINARKOIL RAMANATHAPURAM	KADALADI KAMUTHI THIRUVADANAI Traditional water bodies are lesser
Agriculture and allied sector	Vulnerable due to increasing soil salinization	BOGALUR MANDAPAM THIRUVADANAI	Area under current fallow and other than current fallow is higher NAINARKOVIL TIRUVADANAI RS MANGALAM	KAMUTHI KADALADI THIRUVADANAI RAMANATHAPURAM Area under rainfed cultivation of paddy is higher

TABLE 3.29: RANKING OF BLOCKS BASED ON KEY SOCIO-ECONOMIC PARAMETERS, RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	Bogalur	Kadaladi	Kamudi	Mandapam	Mudukulathur	Nairnarkoil	Paramakudi	RS Mangalam	Ramanathapuram	Tiruppullani	Tiruvadanai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Total Geographical Area	Ha	S1	11	1	2	10	5	9	6	8	4	7	3
2	Male Population	Number	S2	10	1	3	2	7	11	8	6	9	5	4
3	Female Population	Number	S2	10	1	3	2	7	11	8	5	9	6	4
4	Total Population	Number	S2,S4	10	1	3	2	7	11	8	6	9	5	4
5	SC Population	Number	S2,S4	7	2	1	11	4	10	3	8	6	5	9
6	ST Population	Number	S2,S4	9	6	11	5	7	8	3	1	4	10	2
7	Vulnerable population	Number	S2,S3,S4	8	2	1	11	4	10	3	7	6	5	9
8	No. Of. Households	Number	S2	11	2	4	1	6	10	7	9	8	3	5
9	Only one room HH's	Number	S2	8	2	1	3	11	10	5	7	9	6	4
10	Female Headed HH's	Number	S2	9	1	3	2	11	10	6	8	7	4	5
11	Vulnerable Households	Number	S2	9	2	1	3	11	10	5	7	8	6	4
12	% Vulnerability	%	S2	2	4	1	10	11	3	6	5	7	9	8
13	Registered Job cards	Persons Number	S2	11	1	2	8	3	10	6	7	9	5	4
14	Active person Job Cards	Persons Number	S2	11	2	1	8	3	10	5	9	7	6	4
15	Drinking Water Sources	Number	S3	3	7	11	10	4	1	5	6	2	9	8
16	Greywater Generation	MCM	S2, S3	10	1	3	2	7	11	8	9	6	5	4

TABLE 3.30: RANKING OF BLOCKS BASED ON KEY CLIMATIC PARAMETERS, RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	Bogalur	Kadaladi	Kamudi	Mandapam	Mudukulathur	Nairnarkoil	Paramakudi	RS Mangalam	Ramanathapuram	Tiruppullani	Tiruvadanai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ground Water(G.W) Status	OE, CR, SC, Safe, Saline	W2,W3	11	2	10	9	8	7	6	5	4	1	3
2	Ground Water Availability	MCM	W2	1	10	4	2	8	6	11	5	9	3	7
3	Ground Water Recharge	MCM	W3	1	10	4	2	8	6	11	5	9	3	7

TABLE 3.31: RANKING OF BLOCKS BASED ON KEY WATER RESOURCES RELATED PARAMETERS

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	Bogalur	Kadaladi	Kamudi	Mandapam	Mudukulathur	Nairnarkoil	Paramakudi	RS Mangalam	Ramanathapuram	Tirippullani	Tiruvadanai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Water Demand For Humans	MCM	W5	1	2	5	3	7	11	8	10	9	4	6
2	Water Demand for Livestock	MCM	W5	10	1	4	9	3	11	8	7	5	6	2
3	Water Demand For Agriculture	MCM	W5	9	8	7	10	11	3	5	6	2	4	1
4	% G.W Utilization for Drinking	%	W2,W3	6	3	5	2	1	10	7	11	8	4	9
5	% G.W Utilization for Livestock	%	W2,W3	7	11	3	6	10	1	5	8	2	4	9
6	% G.W Utilzation for Agriculture.	%	W2,W3	9	4	2	3	1	10	6	11	5	7	8
7	% SW for Drinking	%	W4	6	9	7	10	11	2	5	1	4	8	3
8	% SW for Livestock	%	W4	5	1	9	6	2	11	7	4	10	8	3
9	% SW for Agriculture	%	W4	1	8	10	9	11	2	4	3	7	5	6
						Available Runoff								
10	Good Catchment (Run-off)	MCM	C3,W4	2	11	9	7	6	5	4	3	1	8	10
11	Average Catchment (Run-off)	MCM	C3,W4	10	11	5	9	4	8	6	1	3	7	2
12	Bad Catchment (Run-off)	MCM	C3,W4	2	11	10	4	8	6	3	7	1	5	9
						Run Off Conserved (Existing)								
13	Good Catchment (Run-off)	MCM	C3,W4	3	10	6	11	7	8	1	2	4	5	9
14	Average Catchment (Run-off)	MCM	C3,W4	10	11	5	9	4	8	6	1	3	7	2
15	Bad Catchment (Run-off)	MCM	C3,W4	4	11	10	7	5	8	2	3	1	6	9
16	Length of Natural Drinage Lines	Km	W4	5	10	11	1	9	7	8	3	6	4	2
17	Number of Micro Watershed	Number	C3,W3, W4	2	10	11	1	9	5	4	8	6	3	7
						Canal Network								
18	Main Canal	Km	W4, C1	4	8	9	2	10	7	3	1	5	6	11
19	Minor	Km	W4, C1	5	10	6	1	4	2	8	9	11	3	7
20	Distributaries	Km	W4, C1	6	5	9	1	3	4	8	10	11	2	7
21	Water Courses (Field Channels)	Km	W4,W5	4	9	8	1	10	2	5	7	6	3	11
22	Total Length of the canal Network	Km	W4, C1	4	8	9	1	7	3	5	6	10	2	11
23	Number of Tanks	Number	W3	2	9	7	1	8	5	6	10	3	4	11
24	Number of Ooranis	Number	W3	1	8	6	7	5	3	4	10	2	9	11
25	Other Sources(Ponds)	Number	W3	7	6	5	8	4	3	2	10	9	1	11

							Irrigation Facilities							
26	Area under Canal Irrigation	Ha	W4, C1	8	7	6	11	5	4	3	7	2	10	1
27	Area under Open well & Tube Well irrigation	Ha	W5, S2,S4, C1	5	1	7	10	4	8	9	2	6	11	3
28	Area under Tank Irrigation	Ha	W4,W5,S2	2	10	8	1	7	4	5	11	6	3	9

TABLE 3.32: RANKING OF BLOCKS BASED ON KEY AGRICULTURE AND ALLIED SECTOR PARAMETERS, RAMANATHAPURAM DISTRICT

S No	Key CWRM Parameter	Unit	Climate Vulnerability Indicator	Bog-alur	Kada-ladi	Kamudi	Man-dapam	Muduku-lathur	Nair-narkoil	Para-makudi	RS Man-galam	Ramana-thapuram	Tirup-pullani	Tiruvad-anai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Available Soil Moisture	MCM	A3	1	11	10	2	7	3	5	6	9	4	8
2	ET Losses	MCM	A4	11	1	2	9	4	8	10	6	7	5	3
							Soil Resources: Macro Nutrients- Nitrogen (Sample)							
3	Very Low (VL)	%	C1,C2,A2, A3	11	1	5	4	9	10	6	3	8	7	2
4	Low (L)	%	C1,C2,A2, A3	1	11	7	8	2	3	6	10	5	4	9
5	Medium (M)	%	C1,C2,A2, A3	1	7	11	8	4	2	5	6	3	9	10
6	High (H)	%	C1,C2,A2, A3	1	4	11	10	7	5	2	3	6	9	8
7	Very High (VH)	%	C1,C2,A2, A3	2	4	10	11	6	5	1	3	8	7	9
							Soil Resources: Macro Nutrients- Organic Carbon (Sample)							
8	Very Low (VL)	%	A2, A3	11	1	6	8	10	9	5	2	4	7	3
9	Low (L)	%	A2, A3	11	8	10	4	2	5	3	9	6	1	7
10	Medium (M)	%	A2, A3	3	8	9	6	4	1	2	10	5	11	7
11	High (H)	%	A2, A3	1	5	4	11	3	2	7	9	6	8	10
12	Very High (VH)	%	A2, A3	1	7	5	3	9	11	10	2	8	6	4
							Soil Resources: Micro Nutrients (Sample)							
13	Sufficient	%	A2, A3	7	10	4	3	6	5	8	9	11	1	2
14	Deficient	%	A2, A3	6	2	8	9	5	7	4	3	1	11	10
							Soil Resources: Physical Parameter - PH							
15	Acidic Sulphate (AS)	%	A2	1	7	11	10	9	6	5	2	4	3	8
16	Strongly Acidic (SrAc)	%	A2	1	4	8	7	3	2	10	9	6	5	11
17	Highly Acidic (HAc)	%	A2	1	8	7	9	6	3	4	11	2	5	10
18	Moderately Acidic (MAc)	%	A2	3	7	9	8	6	1	4	10	2	5	11
19	Slighly Acidic (SlAc)	%	A2	5	8	7	4	9	3	6	10	1	2	11
20	Neutral (N)	%	A2	1	11	10	2	7	6	5	8	3	4	9
21	Moderately Alkaline (MAI)	%	A2	2	10	8	3	11	9	7	4	6	5	1
22	Strongly Alkaline (SIAI)	%	A2	4	2	6	3	10	8	11	1	9	7	5
							Soil Profile							
23	% of Clay Soil	%	C3, W3,A3, S4	10	9	8	7	6	11	5	4	3	2	1
24	% of Fine Soil	%	C3, W3,A3, S4	11	6	8	10	7	4	3	2	5	9	1
25	% of Coarse loamy	%	C3, W3,A3, S4	3	6	5	2	9	7	11	8	4	1	10
26	Permeability		C3, W3,A3, S4											
							Land Resources							
27	Area under forest	Ha	C1,C2,C3, W3	4	1	5	6	7	8	9	10	2	11	3
28	Area under Non-Agricultural Uses	Ha	C1,C2,C3, W3	11	1	2	6	9	7	5	10	8	4	3
29	Area under Barren & Un-cultivable Land	Ha	C1,C2,C3, W3	6	10	7	9	5	8	3	1	4	11	2
30	Area under Permanent Pastures and Other Grazing Land	Ha	C1,C2,C3, W3	2	4	5	8	3	7	9	10	6	11	1
31	Area under Land Under Miscella-neous Tree Crops etc.	Ha	C1,C2,C3, W3,S2	7	2	9	5	8	4	6	1	11	3	10
32	Area under Culturable Waste Land	Ha	C1,C2,C3, W3,S2	11	1	8	3	5	10	9	2	6	7	4
33	Area under Fallows Land other than Current Fallows	Ha	W5,S4	8	1	2	11	6	7	5	9	3	10	4
34	Area under Current Fallow land	Ha	W5,S4	5	8	1	4	7	6	2	9	3	11	10
35	Area under Unirrigated Lands	Ha	W5,S4	10	1	2	6	3	7	11	9	5	8	4
36	Area Irrigated by Source	Ha	W5,S4	10	2	6	11	8	9	5	7	1	4	3
							Land Resources - WASCA Treatment Area							
37	Area under forest	Ha	C1,C2,C3, W3	4	1	5	6	7	8	9	10	2	11	3
38	Area under Non-Agricultural Uses	Ha	C1,C2,C3, W3	11	1	8	4	10	6	3	9	7	2	5

39	Area under Barren & Un-cultivable Land	Ha	C1,C2,C3, W3,S2	6	10	7	9	5	8	3	1	4	11	2
40	Area under Permanent Pastures and Other Grazing Land	Ha	C1,C2,C3, W3	2	4	5	8	3	7	9	10	6	11	1
41	Area under Land Under Miscellaneous Tree Crops etc.	Ha	C1,C2,C3, W3,S2	7	2	9	5	8	`4	6	1	11	3	10
42	Area under Culturable Waste Land	Ha	C1,C2,C3, W3,S2	11	1	8	3	5	10	9	2	6	7	4
43	Area under Fallows Land other than Current Fallows	Ha	W5,S4	8	2	1	11	7	5	6	10	3	9	4
44	Area under Current Fallow land	Ha	W5,S4	7	6	1	3	11	4	2	9	5	8	10
45	Area under Unirrigated Lands	Ha	W5,S4	11	2	1	5	4	8	10	9	7	6	3
46	Area Irrigated by Source	Ha	W5,S4	11	4	5	10	9	6	8	7	2	1	3
	Catchment Area													
47	Good Catchment Area (Ha)	Ha	C3,W4	1	11	9	5	2	3	7	6	4	8	10
48	Average Catchment Area (Ha)	Ha	C3,W4	4	10	2	8	5	6	7	11	1	9	3
49	Bad Catchment Area (Ha)	Ha	C3,W4	2	10	11	3	7	5	6	1	9	4	8
	Means of Water Extraction													
50	Gravity	%	W4	6	10	7	2	8	4	3	9	5	1	11
51	Lifting	%	W2	6	2	5	10	4	8	9	3	7	11	1
	Irrigation Methods													
52	Wild Flooding	%	W4	5	11	7	1	8	4	3	10	6	2	9
53	Control Flooding	%	W2	7	1	5	11	4	8	9	2	6	10	3
	Crop Details													
54	Irrigated Area	Ha	A2	3	4	5	2	1	11	6	10	8	7	9
55	Rainfed area	Ha	A1	2	6	8	3	1	10	5	9	4	7	11
56	Area under Paddy Cultivation	Ha	A2	4	5	3	2	1	9	7	10	6	8	11
57	Agriculture Water Volume (Irrigated)	MCM	A2, A4	3	4	5	2	1	11	6	10	8	7	9
58	Agriculture Water volume (Rainfed)	MCM	A1, A3	2	6	8	3	1	10	5	9	4	7	11
	Livestock Details													
59	Number of Cattle	Number	W1,S4	1	8	9	5	3	2	4	10	7	6	11
60	Number of Goat and Sheep	Number	C1,S2,S4	6	10	11	5	9	2	8	1	4	7	3
61	Number of Poultry	Number	A3,A4,S4	3	10	11	5	7	1	9	2	4	6	8
62	Livestock Water Requirement	MCM	W1, W5,S2,C3	2	8	11	3	9	1	4	7	5	6	10

Linking the vulnerability with Climate Resilient Measures in Ramanathapuram district:

The block level vulnerability assessment on the four themes supported to identify the area of interest to pilot the climate resilient measures (CRM) to address the key issues. Following are the few CRM measures identified in Ramanathapuram district (Table 3.33).

TABLE 3.33: BLOCK LEVEL VULNERABILITY, AREA OF INTEREST AND RELEVANT CRM IN RAMANATHAPURAM DISTRICT

Sl.No	Block	Area of interest/hotspot	Climate resilient measure
1	Kadaladi and RS Mangalam	Increasing salinization of ground water - impact on access to safe drinking water	Tanka - Roof Rain Water Harvesting and Storage
2	RS Mangalam	Catchment area treatments to harvest more surface runoff and improve the traditional water storage structures	Cascade of tanks to restore the linkages among the tanks
3	Ramanathapuram, Mandapam, Kadaladi, Paramakudi, Mudukulathur, Kamuthi, Thiruvadanai, Thirupullani, Nainarkovil, RS Mangalam, Bogalur	Area under public and common land: Degradation of the common land, soil erosion and reduced vegetation	Mini forest Dry land horticulture Silvi-pasture models
4	Thiruvadanai, Mandapam, Kadaladi, Thirupullani, Ramanathapuram and RS Mangalam	Increasing soil and water salinization, reduced water flow from upstream to downstream, increasing land under fallow category due to ground water salinization, degradation of coastal natural resources including sand dune, wetlands, mangroves and no mangrove plantations etc	Coastal watershed concept comprising upstream and downstream watersheds with attention to both public and private land development
5	Kamuthi, Mudukulathur, Paramakudi, Nainarkovil and RS Mangalam	More area under fallow land and other than current fallow land category	Dryland horticulture and agriculture with soil and water conservation with drip irrigation
6.	RS Mangalam	Degradation of the traditional water storage and conveyance systems at the sub basin level	Kottakariyar river sub basin: Artificial recharge structures and check dams - potential sites have been identified
7	Paramakudi and Thiruvadanai blocks	Area under tree cover crops and access to quality plantation saplings of the locally suitable tree crops	Block level nurseries with tree species of the locally adapted tree species

Tiruvannamalai District

The ranking of vulnerability on the four key themes which helped to identify more shelf of projects as well as useful to the district officials to prioritize the works in these blocks are provided in the following tables. On the basis of most relevant CWRM parameters, the first four blocks are considered are more vulnerable out of the 18 blocks.

Socio-economic vulnerability blocks: With reference to the socio-economic factors, Thandrampet, Polur, Tiruvannamalai and Chengam are more vulnerable compared to remaining blocks (Table 3.34).

Climate vulnerability blocks: The climate vulnerability parameter analysis shows that on ground water status the blocks namely Chengam, Kalasapakkam, Kilpenathur, Polur, Pudupalayam, Thandarampet, Thiruvannamalai, Thurinjipuram and Vandavasi are the most vulnerable owing to the over exploitation of the ground water resources. While, the ground water availability and recharge data shows that blocks namely Pudupalayam, Kalasapakkam, Arni and West Arni are highly vulnerable to remaining blocks (Table 3.35).

Water resources vulnerability blocks: The water resources vulnerability theme shows that in terms of total demand for agriculture, which is the predominant use of water for its production, the blocks namely Polur, Thandrampet, Chetpet and Tiruvannamalai blocks are most vulnerable due to its higher demand for water especially ground water resources. The blocks; Jawathu hills, Polur, Pudupalayam and Kalasappkkam which are having larger proportion of undulating terrain has least numbers of traditional water storage structures compared to remaining blocks. The number of micro watersheds are least in Anakavoor, Arni, Cheyyar and Pernamallur. Beside total number of open/bore wells are higher in Thandarampet, Polur, Tiruvannamalai and Cheyyaru blocks(Table 3.36).

Agriculture vulnerable blocks: In agriculture and allied sectors, Thandarampet, Thiruvannamalai, Polur and Kalasapakkam are vulnerable due to increasing use of ground water for paddy cultivation. Under the individual land ownership category, the area under current fallow is more in Vembakkam, Chengam, Thiruvannamalai and Thellar blocks and the area under fallow land and other than current fallow is higher in Thandrampet, Vembakkam, Chengam and Cheyyar blocks. The two blocks; Chengam and Cheyyar have both the types of fallow lands accounting to higher proportion under the individual level cultivable land. Area under rainfed cultivation of paddy is higher in Thiruvannamalai, Chengam, Keelpenathur and Jawadu hills which is more vulnerable in the context of changing rainfall pattern and increasing extreme events (Table 3.37).

AREAS	VULNERABILITY BLOCKS	
Socio-economic	More vulnerable compared to remaining blocks	THANDRAMPET, POLUR, TIRUVANNAMALAI, CHENGAM
Climate	Over exploitation of the ground water resources	THIRUVANNAMALAI, THURINJIPURAM, VANDAVASI, CHENGAM, KALASAPAKKAM, KILPENATHUR, POLUR, PUDUPALAYAM, THANDRAMPET
	Highly vulnerable while ground water availability and recharge data	PUDUPALAYAM, KALASAPAKKAM, ARNI, WEST ARNI
Water	Most vulnerable due to its higher demand for water	POLUR, THANDRAMPET, CHETPET, TIRUVANNAMALAI
	Least numbers of traditional water storage structures	JAWATHU HILLS, POLUR, PUDUPALAYAM, KALASAPPKKAM
	Micro watersheds are least	ANAKAVOOR, ARNI, CHEYYAR, PERNAMALLUR
	No of open/bore wells are higher	THANDARAMPET, POLUR, CHEYYARU, TIRUVANNAMALAI
Agriculture and allied sector	Increasing use of ground water for paddy	THANDARAMPET, POLUR, KALASAPAKKAM, THIRUVANNAMALAI
	Area under current fallow are more	VEMBAKKAM, CHENGAM, THELLAR, THIRUVANNAMALAI
	Area under fallow land	THANDRAMPET, VEMBAKKAM, CHENGAM, CHEYYAR
	Area under rain-fed cultivation of paddy is higher	KEELPENATHUR, CHENGAM, TIRUVANNAMALAI, JAWADU HILLS

TABLE 3.34: SOCIO-ECONOMIC VULNERABILITY RANKING, TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	CVI	Anakavoor	Arni	Chengam	Chetpet	Cheyyar	Jawathu hills	Kalasapakkam	Keelpennathur	Pernamallur	Polur	Pudupalayam	Thandarampet	Thellar	Thiruvannamalai	Thurinjapuram	Vandavasi	Vembakkam	West Arni
1	Total Geographical Area	Ha	S1	9	15	4	13	12	18	14	11	10	8	16	1	5	7	3	6	2	17
2	Male Population	Number	S2	17	11	3	12	15	18	7	9	16	4	13	1	10	2	5	8	6	14
3	Female Population	Number	S2	17	11	3	12	15	18	7	9	16	4	14	1	10	2	5	8	6	13
4	Total Population	Number	S2,S4	17	11	3	12	15	18	7	9	16	4	13	1	10	2	5	8	6	14
5	SC Population	Number	S2,S4	14	13	1	17	12	18	6	10	15	11	8	3	7	2	9	4	5	16
6	ST Population	Number	S2,S4	3	15	6	17	12	1	16	5	11	14	13	2	7	4	9	8	10	18
7	Vulnerable popupation	Number	S2,S3, S4	9	15	2	18	14	3	7	10	16	13	12	1	8	4	11	5	6	17
8	Total Households	Number	S2	17	11	3	12	14	18	7	10	15	4	16	1	9	2	5	8	6	13
9	Only one room HH's	Number	S2	14	16	5	7	13	18	2	15	9	1	12	8	4	10	11	3	6	17
10	Female Headed HH's	Number	S2	5	9	10	11	3	18	4	16	15	2	17	14	8	6	12	7	1	13
11	Vulnerable households	Number	S2	14	15	6	7	12	18	2	16	10	1	13	9	5	8	11	3	4	17
12	Vulnerability%	%	S2	9	14	12	4	10	7	5	15	1	6	11	18	3	16	17	2	8	13
13	Registered Job cards	Persons Number	S2	15	13	2	11	16	18	4	10	14	6	12	1	8	3	5	9	7	17
14	Active person Job Cards	Persons Number	S2	17	11	2	12	15	18	3	13	14	6	8	1	9	4	5	10	7	16
15	Drinking Water Sources	Number	S3	2	7	16	8	5	1	12	9	4	15	3	18	10	17	14	11	13	6
16	Greywater Generation	MCM	S2, S3	17	11	3	12	15	18	7	9	16	4	13	1	10	2	5	8	6	14

TABLE 3.35: RANKING OF BLOCKS BASED ON KEY CLIMATIC PARAMETERS, TIRUVANNAMALAI

S No	Key CWRM Parameter	Unit	CVI	Anakavoor	Arni	Chengam	Chetpet	Cheyyar	Jawathu hills	Kalasapakkam	Keelpennathur	Pernamallur	Polur	Pudupalayam	Thandarampet	Thellar	Thiruvannamalai	Thurinjapuram	Vandavasi	Vembakkam	West Arni
1	Ground Water(G.W) Status	OE,CR, SC,Safe, Saline	W2, W3	14	15	1	16	17	12	2	3	4	5	6	7	8	9	10	11	18	13
2	Ground Water Availabilty	MCM	W2	7	3	11	9	6	10	2	8	5	14	1	18	12	13	15	17	16	4
3	Ground Water Recharge	MCM	W3	7	3	11	9	6	10	2	8	5	14	1	18	12	13	15	17	16	4

TABLE 3.36: RANKING OF BLOCKS BASED ON KEY WATER RESOURCES, TIRUVANNAMALAI

S No	Key CWRM Parameter	Unit	CVI	Anakavoor	Arni	Chengam	Chetpet	Cheyyar	Jawathu hills	Kalasapakkam	Keelpennathur	Pernamallur	Polur	Pudupalayam	Thandarampet	Thellar	Thiruvannamalai	Thurinjapuram	Vandavasi	Vembakkam	West Arni
1	Water Demand For Humans	MCM	W5	17	11	3	12	15	18	7	9	16	4	13	1	10	2	5	8	6	14
2	Water Demand for Livestock	MCM	W5	16	13	6	3	10	18	7	9	17	1	4	2	15	5	8	11	12	14
3	Water Demand For Agriculture	MCM	W5	2	9	4	17	3	18	6	15	7	5	13	14	12	11	16	8	1	10
4	% G.W Utilization for Drinking	%	W2, W3	5	8	11	17	15	1	14	13	3	16	18	10	2	9	12	6	4	7
5	% G.W Utilization for Livestock	%	W2, W3	18	10	11	1	15	9	8	6	16	3	2	5	14	7	4	13	17	12
6	% G.W Utilzation for Agriculture	%	W2, W3	1	9	5	18	3	11	10	14	4	12	15	16	7	13	17	6	2	8
7	% SW for Drinking	%	W4	8	11	17	10	6	18	9	5	3	12	4	13	1	15	2	14	16	7
8	% SW for Livestock	%	W4	6	2	7	16	9	12	5	4	17	14	1	3	10	8	15	18	13	11
9	% SW for Agriculture	%	W4	14	12	1	9	8	3	15	2	17	10	5	16	6	4	18	13	7	11

	Available Runoff																				
10	Good Catchment (Run-off)	MCM	C3, W4	8	18	13	5	3	9	4	10	11	16	1	17	15	14	12	7	6	2
11	Average Catchment (Run-off)	MCM	C3, W4	8	2	9	10	15	12	6	1	13	18	4	14	11	7	5	17	16	3
12	Bad Catchment (Run-off)	MCM	C3, W4	7	2	16	6	9	1	5	11	8	10	4	18	13	17	15	12	14	3
	Run Off Conserved (Existing)																				
13	Good Catchment	MCM	C3, W4	8	18	13	5	3	9	4	10	11	16	1	17	15	14	12	7	6	2
14	Average Catchment	MCM	C3, W4	8	2	9	10	15	12	6	1	13	18	4	14	11	7	5	17	16	3
15	Bad Catchment	MCM	C3, W4	7	2	16	6	9	1	5	11	8	10	4	18	13	17	15	12	14	3
16	Length of Natural Drinage Lines	Km	W4	4	6	16	5	1	18	14	10	2	15	12	17	9	11	13	8	7	3
17	Number of Micro Watershed	Number	C3, W3, W4	3	1	16	9	2	18	13	12	4	15	8	17	7	5	14	6	11	10
18	Canal Network	Km	W4, C1	8	11	3	18	12	1	7	15	5	14	2	17	13	10	4	9	16	6
19	Main Canal	Km	W4, C1	11	15	8	4	9	1	12	17	3	16	5	18	6	14	7	13	10	2
20	Minor Canal	Km	W4, C1	11	14	6	18	16	3	7	10	4	15	2	13	9	1	5	8	17	12
21	Distributaries	Km	W4, C1	3	4	6	13	11	2	5	12	17	15	1	10	18	9	14	7	8	16
22	Water Courses (Field Channels)	Km	W4, W5	14	12	5	15	3	2	9	10	4	6	1	7	17	18	13	11	16	8
23	Number of Tanks	Number	W3	11	8	5	10	12	1	4	14	15	3	2	6	17	13	7	18	16	9
24	Number of Ooranis	Number	W3	17	3	12	6	10	1	9	14	16	2	8	4	15	11	13	5	18	7
25	Other Sources	Number	W3	16	3	10	7	17	2	12	9	5	14	11	4	6	15	13	8	18	1
	Irrigation Facilities																				
26	Area under Canal Irrigation	Ha	W4, C1	15	14	13	12	11	10	9	8	7	6	5	18	4	17	3	2	16	1
27	Area under Open well & Tube Well irrigation	Ha	W5, S2,S4, C1	2	5	15	12	6	1	13	11	10	17	8	18	9	16	14	7	3	4
28	Area under Tank Irrigation	Ha	W4, W5,S2	18	4	5	11	6	2	14	9	1	7	16	10	13	8	12	15	17	3

TABLE 3.37: RANKING OF BLOCKS BASED ON KEY AGRICULTURE AND ALLIED PARAMETERS , TIRUVANNAMALAI DISTRICT

S No	Key CWRM Parameter	Unit	CVI	Anakavoor	Arni	Chengam	Chetpet	Cheyyar	Jawathu hills	Kalasapakkam	Keelpennathur	Pernamallur	Polur	Pudupalayam	Thandarampet	Thellar	Thiruvannamalai	Thurinjapuram	Vandavasi	Vembakkam	West Arni
1	Soil Moisture	MCM	A3	7	4	17	6	9	1	5	10	8	11	3	18	13	16	14	12	15	2
2	ET Losses	MCM	A4	12	18	9	10	13	16	8	7	11	4	14	1	5	3	2	6	15	17
	Soil Resources																				
	Macro Nutrients- Nitrogen(Sample)																				
3	Very Low (VL)	%	C1, C2, A2,A3	17	9	15	16	3	11	2	5	7	14	10	4	6	12	8	18	13	1
4	Low (L)	%	C1, C2, A2,A3	7	6	8	5	16	9	17	13	14	2	12	15	3	4	10	1	11	18
5	Medium (M)	%	C1, C2, A2,A3	3	17	6	12	8	9	7	13	2	15	10	4	18	16	14	11	1	5
	Macro Nutrients- Organic Carbon(Sample)																				
6	Very Low (VL)	%	A2, A3	9	18	11	16	3	7	2	14	1	13	8	4	5	12	10	17	15	6
7	Low (L)	%	A2, A3	12	1	9	2	16	11	17	4	18	7	10	15	13	6	8	3	5	14
8	Medium (M)	%	A2, A3	4	18	11	12	7	9	3	14	6	15	10	1	16	17	13	8	5	2
	Micro Nutrients(Sample)																				
9	Sufficient	%	A2, A3	16	3	18	4	10	12	13	9	15	2	8	11	7	6	5	1	17	14
10	Deficient	%	A2, A3	3	16	1	15	9	7	6	10	4	17	11	8	12	13	14	18	2	5

Physical Parameter - PH																					
11	Moderately Acidic (MAc)	%	A2	6	12	11	2	5	15	1	4	18	10	3	17	9	8	7	14	16	13
12	Slighly Acidic (SlAc)	%	A2	3	2	16	7	10	18	14	6	12	13	1	17	4	5	9	8	11	15
13	Neutral (N)	%	A2	2	17	16	9	1	18	5	13	8	15	12	4	7	11	14	10	3	6
14	Moderately Alkaline (MAI)	%	A2	18	12	2	15	17	1	11	14	7	5	16	3	13	10	9	6	8	4
Soil Profile																					
15	% of Clay Soil	%	C3, W3, A3,S4	12	5	18	11	6	4	3	8	9	2	16	17	7	13	15	10	14	1
16	% of Fine Soil	%	C3, W3, A3,S4	16	18	2	8	12	1	5	14	10	7	4	3	9	11	15	13	6	17
17	% of Coarse loamy	%	C3, W3, A3,S4	9	7	13	6	11	18	16	5	10	15	17	2	1	8	3	4	12	14
Land Resources																					
18	Area under forest	Ha	C1, C2, C3, W3	1	8	9	7	10	2	11	12	13	4	14	3	5	15	6	16	17	18
19	Area under Non-Agricul-tural Uses	Ha	C1, C2, C3, W3	1	16	17	8	6	18	11	14	4	9	13	5	7	12	10	3	2	15
20	Area under Barren & Un-cultivable Land	Ha	C1, C2, C3, W3,S2	17	1	3	10	16	6	8	7	12	5	18	2	9	4	14	11	13	15
21	Area under Permanent Pastures and Other Graz-ing Land	Ha	C1, C2, C3, W3	5	13	17	1	7	14	9	16	6	11	18	15	4	8	12	2	3	10
22	Area under Land Under Miscellaneous Tree Crops etc.	Ha	C1, C2, C3, W3,S2	2	16	17	8	1	18	6	10	5	11	13	15	7	9	14	4	3	12
23	Area under Culturable Waste Land	Ha	C1, C2, C3, W3,S2	17	13	4	15	10	3	14	18	8	1	12	2	7	9	11	5	6	16
24	Area under Fallows Land other than Current Fallows	Ha	W5,S4	8	14	4	10	3	5	11	18	12	15	7	1	6	17	13	9	2	16
25	Area under Current Fallow land	Ha	W5,S4	5	14	2	13	6	18	16	7	12	15	11	17	4	3	9	8	1	10
26	Area under Unirrigated Lands	Ha	W5,S4	9	16	15	8	7	2	17	5	6	12	18	14	3	10	1	4	13	11
27	Area Irrigated by Source	Ha	W5,S4	14	16	5	7	15	18	4	10	12	3	8	1	9	2	6	11	13	17
Land Resources - WASCA Area																					
28	Area under forest	Ha	C1, C2, C3, W3	1	8	9	7	10	2	11	12	13	4	14	3	5	15	6	16	17	18
29	Area under Non-Agricul-tural Uses	Ha	C1, C2, C3, W3	10	8	9	15	13	14	17	6	7	3	16	1	2	5	4	12	11	18
30	Area under Barren & Un-cultivable Land	Ha	C1, C2, C3, W3,S2	17	1	3	10	16	6	8	7	12	5	18	2	9	4	14	11	13	15
31	Area under Permanent Pastures and Other Graz-ing Land	Ha	C1, C2, C3, W3	5	13	17	1	7	14	9	16	6	11	18	15	4	8	12	2	3	10
32	Area under Land Under Miscellaneous Tree Crops etc.	Ha	C1, C2, C3, W3,S2	12	3	4	14	9	7	15	13	11	5	10	6	18	1	8	17	16	2
33	Area under Culturable Waste Land	Ha	C1, C2, C3, W3,S2	17	13	4	15	10	3	14	18	8	1	12	2	7	9	11	5	6	16

34	Area under Fallows Land other than Current Fallows	Ha	W5,S4	8	14	4	10	3	5	11	18	12	15	7	1	6	17	13	9	2	16
35	Area under Current Fallow land	Ha	W5,S4	5	14	2	13	6	18	16	7	12	15	11	17	4	3	9	8	1	10
36	Area under Unirrigated Lands	Ha	W5,S4	9	16	15	8	7	2	17	5	6	12	18	14	3	10	1	4	13	11
37	Area Irrigated by Source	Ha	W5,S4	14	16	5	7	15	18	4	10	12	3	8	1	9	2	6	11	13	17
	Catchment Area																				
38	Good Catchment Area (Ha)	Ha	C3, W4	16	17	7	10	9	1	6	4	12	13	3	18	11	8	5	14	15	2
39	Average Catchment Area (Ha)	Ha	C3, W4	8	2	9	10	15	12	6	1	13	18	4	14	11	7	5	17	16	3
40	Bad Catchment Area (Ha)	Ha	C3, W4	7	2	16	6	9	1	5	11	8	10	4	18	13	17	15	12	14	3
	Means of Water Extraction																				
41	Gravity	%	W4	17	11	5	9	15	1	6	10	13	2	3	4	14	7	8	18	16	12
42	Lifting	%	W2	2	8	14	10	4	18	13	9	6	17	16	15	5	12	11	1	3	7
	Irrigation Methods																				
43	Wild Flooding	%	W4	18	4	1	11	8	12	13	9	2	5	16	6	14	7	10	15	17	3
44	Control Flooding	%	W2	1	15	18	8	11	7	6	10	17	14	3	13	5	12	9	4	2	16
	Crop Details																				
45	Irrigated Area (Ha)	Ha	A2	2	9	10	16	8	1	13	11	4	18	14	17	3	12	15	6	7	5
46	Rainfed area	Ha	A1	1	3	17	11	12	15	4	16	8	9	14	10	5	18	13	7	2	6
47	Area under Paddy Cultivation	Ha	A2	17	11	6	14	10	2	15	1	8	16	13	5	9	3	4	7	18	12
48	Volume in HaM (Irrigated)	MCM	A2, A4	4	7	12	16	9	1	13	6	2	18	15	17	3	14	11	8	10	5
49	Volume in HaM ((Rainfed)	MCM	A1, A3	1	3	17	11	12	14	4	16	8	9	15	10	5	13	18	6	2	7
	Livestock Details																				
50	Numbe of Cattle	Number	W1,S4	16	7	18	6	14	1	4	8	12	3	15	13	2	5	11	10	17	9
51	Number of Goat and Sheep	Number	C1, S2,S4	17	11	15	4	16	1	5	3	12	8	7	6	9	13	2	14	18	10
52	Number of Poultry	Number	A3,A4 S4	15	9	13	5	16	3	18	10	12	17	4	6	7	2	1	11	14	8
53	Livestock Water Requirement	MCM	W1, W5, S2,C3	17	12	15	2	16	1	8	4	13	11	7	5	6	9	3	14	18	10

Linking the vulnerability with Climate Resilient Measures in Tiruvannamalai district:

The block level vulnerability assessment on the four themes supported to identify the area of interest to pilot the climate resilient measures (CRM) to address the key issues. Following are the few CRM measures identified in Ramanathapuram district (Table 3.38).

TABLE 3.38: BLOCK LEVEL VULNERABILITY, AREA OF INTEREST AND RELEVANT CRM IN TIRUVANNAMALAI DISTRICT

Sl.No	Block	Area of interest/hotspot	CRM Pilots
1	Jawadhu hills, Polur, Cheyyaru, Kalasappakkam, Vandavasi	Catchment area treatments to harvest more surface runoff and improve the traditional water storage structures	Cascade of tanks to restore the linkages among the tanks
2	Tiruvannamalai, West Arni, Polur, Kalasapakkam, Thellar, Thandrampet	Area under public and common land: Degradation of the common land, soil erosion and reduced vegetation	Mini forest Dry land horticulture Silvi-pasture models
3	Tiruvannamalai, Jawadhu hills, West Arni, Polur, Cheyyaru, Vandavasi	Degradation of the traditional water storage and conveyance systems at the sub basin level	Kamandalaru river sub basin: Artificial recharge structures and check dams - potential sites have been identified
4	Polur, Kalasapakkam, West Arni, Arni and Vandavasi	Area under tree cover crops and access to quality plantation saplings of the locally suitable tree crops	Block level nurseries with tree species of the locally adapted tree species
5	Chengam, Kalasapakkam, Kilpenathur, Polur, Pudupalayam Thandaranpattu, Thiruvannamalai, Thurinjipuram and Vandavasi	Increasing salinization of soil, declining ground water resources and crop productivity - impact on on-farm livelihoods and rural migration	Water use efficiency - Improved irrigation practices
6	Anakavoor, Chetpet, Polur, Chengam, Kalasapakkam, Kilpenathur, Polur, Pudupalayam, Vandavasi, Thandaranpattu, Thiruvannamalai, Thurinjipuram	High water requiring crops cultivation using ground water resources - Declining ground water resources and soil degradation	Change in the cropping system with less water requiring crops - medicinal plants and floriculture
7	Vembakkam, Chengam, Thiruvannamalai, Thandrampet and Cheyyaru	More area under fallow land and other than current fallow land category - leading land degradation with high soil erosion and silting of water bodies, reduced water storage and infiltration in the soil	Dryland horticulture and agriculture with soil and water conservation with drip irrigation

3.7 CLIMATE RESILIENCE MEASURES

3.7.1. APPROACH OF CRM FOR ASSET CREATION TO REDUCE THE CLIMATE RISKS

The Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report clearly stated that climate change over the twenty-first century is projected to reduce renewable surface water and ground water resources significantly in most dry subtropical regions, intensifying competition for water among sectors and water is to adaptation, as energy is to mitigation. Under WASCA project in Tamil Nadu state is taken up with a call for "Climate Resilience for Future Livelihoods". In Rural areas, the livelihoods are closely attached with land use and land management as part of the natural capital. However, the vulnerability is high among many landless families who depend on common property resources for livelihoods, besides the land owners, vast majority of them are marginal and smallholders. Hence, while designing Climate Resilience Measures under WASCA in the state of Tamil Nadu, different approaches of community ownership and individual ownership perspectives are undertaken.

3.7.1.2. CLIMATE RESILIENCE MEASURE AT COMMUNITY LEVELS

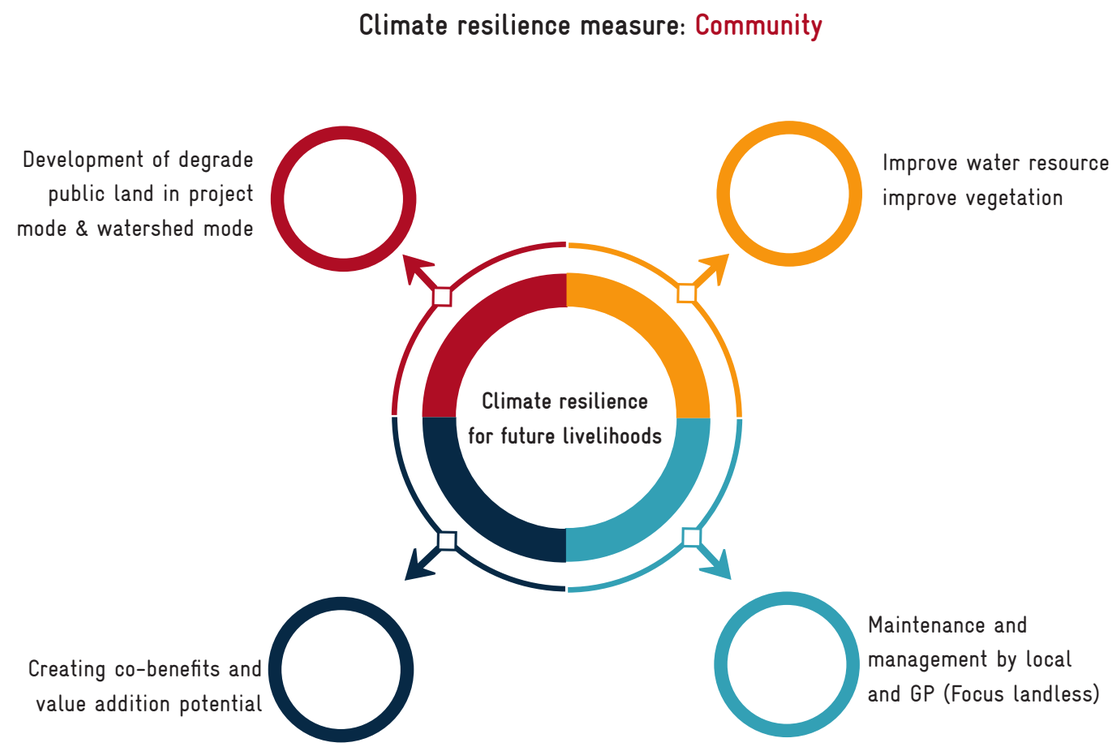


Fig 3.61: Climate resilience measure: Community

A.
Steps in for identification of Climate Resilience Measures (Community)

1. Listing out the key water challenges identified under ten-fold land classification under public and common land
2. Assessment of Good and Average catchment area run-off scenarios,
3. Analysis of micro-watershed and priority watershed for saturation
4. Assessment of parameters under socio-economic vulnerability area
5. Assessment of parameters under water sector vulnerability areas
6. Understanding projections and scenarios

B.
Approaches of Management – CRM (Community)

1. Developing under saturation mode
2. Watershed model
3. Applying four waters concept

A.
Steps in for identification of Climate Resilience Measures (Individual)

1. Identification of vulnerable population using SECC data
2. Analysis of run-off generated under bad catchment area
3. Analysis of micro-watershed
4. Assessment of parameters under Agriculture vulnerable area
5. Ground water scenario
6. Crop water requirement
7. Climate projections

B.
Approaches of Management – CRM (Individual)

1. Adaptation to reduce risks and increase capability
2. Diversification of assets and production systems
3. *In-situ* conservation techniques to harness water
4. *In-situ* conservation measures to soil health
5. Micro climate creation for circular economy

3.7.1.3. CLIMATE RESILIENCE MEASURE AT INDIVIDUAL LEVEL

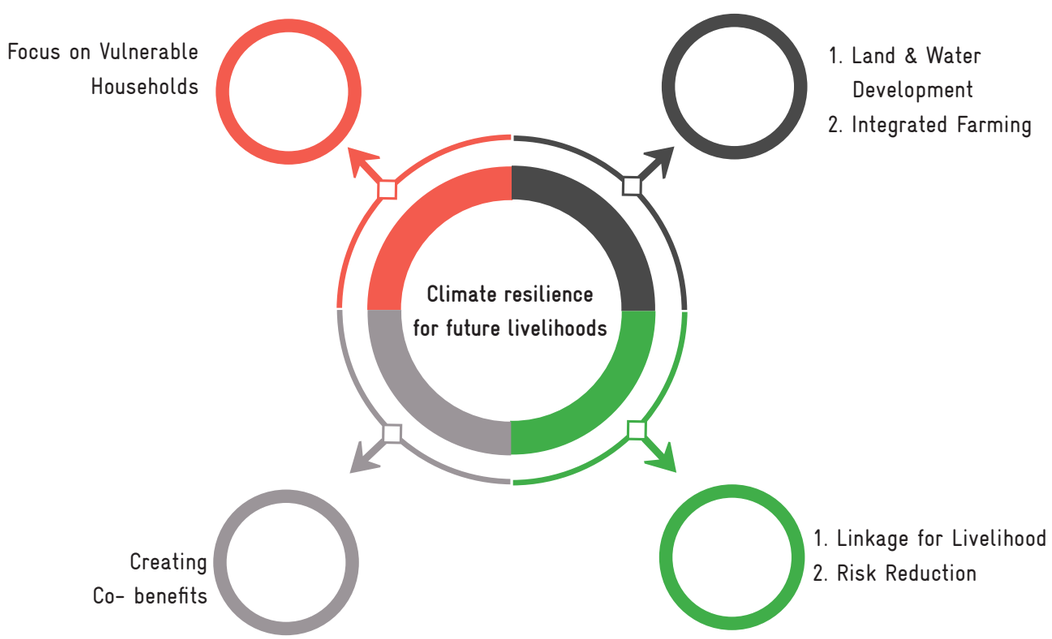


Fig 3.62: Climate resilience measure: Individual

3.7.2. CLIMATE RESILIENT MEASURES - SITE-SPECIFIC MODELS

3.7.2.1. RAMANATHAPURAM DISTRICT

On the basis of the block level vulnerability to the social, climatic, hydrologic and agriculture and allied parameters, 13 area of interest/hotspots are identified. Site-specific solutions with an approach of four waters concept and saturation mode integrating risk mitigating measures, different climate resilient measures have been facilitated as pilots across the blocks in the district. Of the total number of CRM's facilitated till now, majority of the models are focusing on the development of public and common land while one model each is identified for the agriculture and allied sector development with a focus to entrepreneurship and multiple livelihoods perspective and rural infrastructure development for safe drinking water (Table. 3.39)

TABLE 3.39: CLIMATE RESILIENT MEASURES IN RAMANATHAPURAM DISTRICT

CWRM WATER ACTION 1.
Development of Public and Common Land

Name of the CRM	GP and block
MINI FOREST (500 saplings/unit)	• 1000 mini forest units in 11 blocks across 429 GPs • Area covered is 100 Ha • 162 mini forest are promoted in government schools and maintained by students

Name of the CRM	GP and block
MEGA FOREST (5000 saplings/unit)	Implemented in four GPs of RS Mangalam, Thiruvadanai, Kamuthi and Mudukulathur blocks
AVENUE PLANTATION (5000 saplings/unit)	**370 Km** length of road side plantation is completed covering Paramakudi, Kadaladi and RS Mangalam blocks
BLOCK PLANTATION Block plantation with Bamboo and Moringa plantations	Pilot in **4 Ha (8000 trees)** of land at Ramanathapuram block
THEMATIC PARKS Livelihood Thematic Parks for land less, focus on women	**11 thematic parks in 11 blocks** with focus to integrated farming, silvi-pasture development, dry land horticulture, dry land annual crops with SHG women management
RIVERBANK Riverbank stabilization through plantation	Covering 3 GPs in Paramakudi block to help flood control and reduce siltation through riverbank stabilization with natural vegetation adopting relevant afforestation plantation to conserve vaigai river ecosystem

Name of the CRM	GP and block
NURSERY	Block level central nursery established at Vendoni GP in Paramakudi block to cater the needs of saplings within district and adjoining districts
MINI NURSERY	**429** mini nursery promoted fruit and flower seedlings in **429** panchayats to establish a garden in the homesteads
CASCADE OF TANKS	R.S. Mangalam block is selected for cascade tank - Planned to work in **15** cascade tanks
WATERSHEDS Coastal watersheds	List of villages are identified
LIFE PARK Traditional life park	Mandapam block - Developing model covering five types geo-based land (Kurunji, Mullai, Marutham, Neithal and Palai)

CWRM WATER ACTION 2
Development of agriculture and allied activities

Name of the CRM

MINI FOREST

(NRM based Livelihood Activity centers

GP and block

Planned to promote 50-60 types of enterprises covering one Livelihood activity in each GP (in **429** GPs)

CWRM WATER ACTION 3
Development of rural infrastructure

Mini forest

LIFE PARK

TANKA - Community level for drinking water (Rain Water Harvesting) Catch the Rain Campaign

GP and block

Chitturvadi in R.S. Mangalam and Thillainendhal in Thiruppullani blocks

Mini forest: Planted 5 lakh native trees adopting "Miyawaki" technique. It is one of the afforestation methods that has been promoted with 33 locally adapted tree species planted under ultra-high-density plantation with multi-layer system. Proven as a best model for the degraded land development, helps to reduce soil erosion, improve the soil moisture and soil health by building organic matter and fixing soil organic carbon, build micro climate and promote biodiversity.

Mini Forest

Mega forest: A horizonal upscaling strategy of the Mini forest plantation to restore the degraded public and common dry land, thus reduce the soil erosion, improve the infiltration of water and ecosystem service of the land for farming and natural resources conservation.

Mega Forest

Livelihood thematic parks focusing on women: Demonstrated as a method to restore the degraded public land adopting locally relevant themes like Integrated Farming System, trees suitable for dry land horticulture, Agro forestry, silvi pasture, bamboo plantation and food crops with a focus to millets and grain legumes. An innovative approach the revive the locally adapted trees and crops by efficiently harvesting and conserving surface runoff water, soil moisture and reduce land degradation.

Livelihood parks

Nursery: Central nursery has been established as a pilot, produced 15 lakh quality tree seedlings of 20 native tree species within one year and demonstrated as one of the resource mobilization strategy to the Gram Panchayat. The common degraded land has been restored and a scientific nursery management skill is promoted among Mahatma Gandhi NREGS job card holders.

Nursery

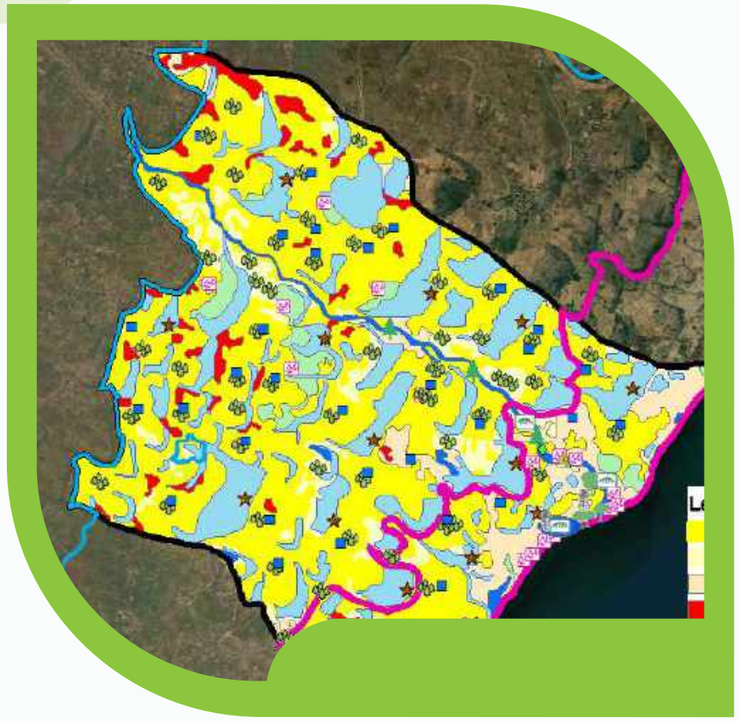
Decentralized mini nursery: 429 mini nurseries have been established to produce 4.5 lakhs of tree seedlings that promote the nutrition tree garden at the household level. This helps to effectively recycle the grey water generated at home, increase the area under "Trees Outside the Forest" and reduce the soil erosion

Mini Nursery

Avenue plantation: Four lakh tree species that are suitable to the local agro-climate has been planted on the road side with a combination of 100 big and 200 small trees per 1000 m on both the sides of the road, managed by women SHG members of the respective Gram Panchayat. It helps to reduce the soil erosion by binding the soil on the sides of the road and the trees support to improve the water infiltration and recharge the ground water in the long run.

Avenue plantation

Coastal watersheds: It is one of the nature-based solution to improve the ecosystem services encompassing coastal natural resources such as wetlands, coastal bio-shields, mangroves, coastal sand dune management, coastal plantation, river creek management, eco-tourism, local sea grass cultivation etc. The innovative action helps meeting the objectives, commitments of India, to UN Framework Convention on Climate Change (UNFCCC), and Sustainable Development Goals for safeguarding coastal resources. Three major watersheds are identified in the district with a goal of augmenting its ecosystem services and improve the rural livelihoods.



Coastal watersheds

Tanka - A gender sensitive and climate responsive solution to tackle water insecurity among vulnerable communities: Tanka is a traditional rainwater storage practice being replicated from Rajasthan to Ramanathapuram in the place of Ooranis, a traditional small pond to ensure safe drinking water. It is an underground, impermeable cistern on shallow ground for collection of rainwater built using either brick or concrete and demonstrated in two panchayats in coastal blocks where salinity of water is a critical issue for drinking water.

Tanka

Block plantation linked with enterprise development to build rural entrepreneurship: Block plantation of commercially valued, fast growing tree species like Bamboo and Moringa is planted in public and common land with value addition infrastructure to diversify and strengthen the local rural livelihoods

Cascade of tanks for improved rural livelihoods and enhanced environmental services: The scientific restoration of traditional cascading of tank systems is planned to cover a stream of 15 tanks by improving both catchment and storage area. It helps to effectively harvest and store the surface runoff, reduce the soil erosion by plantation on bunds and silt traps at the inlets and increase the ground water tables.

Kottakariyar river rejuvenation: Reviving the Kottakariyar river sub-basin is being done with artificial recharge structures and check dams at an appropriate site before the river joins the sea in Thiruvadani block. The pilot helps to effectively harvest and store surface runoff and recharge the ground water resources. Thereby it improves the local livelihoods by augmenting water resources for on-farm activities.

Reducing Sea water intrusion: The pilot helps to reduce the rate of ground water salinization near the coastal areas and activities such as restoration of sand dunes and coastal wetlands aims to increase the fresh water storage and thereby enhance quality of water and supports the rural livelihoods.

Livelihood support centre: Aimed to diversify the rural livelihoods by creating multiple livelihood opportunities with necessary backward and forward linkages. About 50 different livelihood enterprises are identified which generate additional local employment opportunities and income of the associated members.

3.8.2.2. TIRUVANNAMALAI DISTRICT

Analogous to Ramanathapuram district, in Tiruvannamalai district on the basis of context specific area of interest 13 CRMs have been identified. Of these nine pilots are focused on public and common land development while three on individual land and livelihood development and one on rural infrastructure enhancement (Table 3.40).

TABLE 3.40: CLIMATE RESILIENT MEASURES IN TIRUVANNAMALAI DISTRICT

CWRM WATER ACTION 1.
Development of Public and Common Land

CRM pilots	Progress
GREENING OF HILLOCKS	• 14 hillocks in Kattukannaur GP, West Arni block • 7 hillocks in Kalpattu GP, Polur block • 20,000 saplings planted with staggered contour trenches in upper slopes • Water conservation measures such as LBDs, gabions, percolation pond and check dams in lower slopes
Silvi-pasture SILVI-PASTURE DEVELOPMENT	• 31 location identified with extent of 2-5 Ha per unit • The seedlings are being raised in Nursery
CRM pilots NURSERY Nursery - block level	• 31 block nurseries • 5 district nurseries • Target to raise 27 lakhs plants • So far 4 lakh saplings raised
CRM pilots PLANTATION Bamboo plantation	17 field sites were identified for Bamboo plantation in convergence with forest department

CRM pilots	Progress
MINI FOREST Livelihood Thematic Parks for land less, focus on women	12 field sites were selected for creation of mini forest

CRM pilots	GP and block
RIVER REJUVENATION Kamandalar River sub basin	• 9 blocks in Tiruvannamalai • 6 blocks in Arni with check dams and artificial water recharge structures in convergence with Water Resources Organization
CRM pilots CASCADE OF TANKS	8 system tanks were identified
CRM pilots TANK RESTORATION Restoration of MI Tanks - PPP model	8 MI Tanks
CRM pilots FISH CULTURE Inland fish culture	5 tanks for raising of fish culture in convergence with Dept of Animal Husbandry

CWRM WATER ACTION 2.
Development of agriculture and allied sector

CRM pilots

FALLOW LAND

Fallow land development - Saturation approach

Progress

Identification of farmers are in progress for this year and last year **314** Ha covered for Rs **34.6** lakhs invested by Dept of Agriculture in West Arni, Arni and Polur blocks

CRM pilots

WATER USE EFFICIENCY

Water use efficiency:
A) Medicinal Plants cultivation

Progress

One GP in Arni division and one GP in Tiruvannamalai division is selected with the technical guidance of Dept of Horticulture and Agriculture College and Research Institute, Tamil Nadu Agriculture University, Tiruvannamalai

CRM pilots

FLORICULTURE

Water use efficiency:
A) Medicinal Plants cultivation

Progress

7 GPs were identified for floriculture in Vandavasi, Cheyyaru and Arni blocks

CWRM WATER ACTION 3.
Development of rural infrastructure

CRM pilots

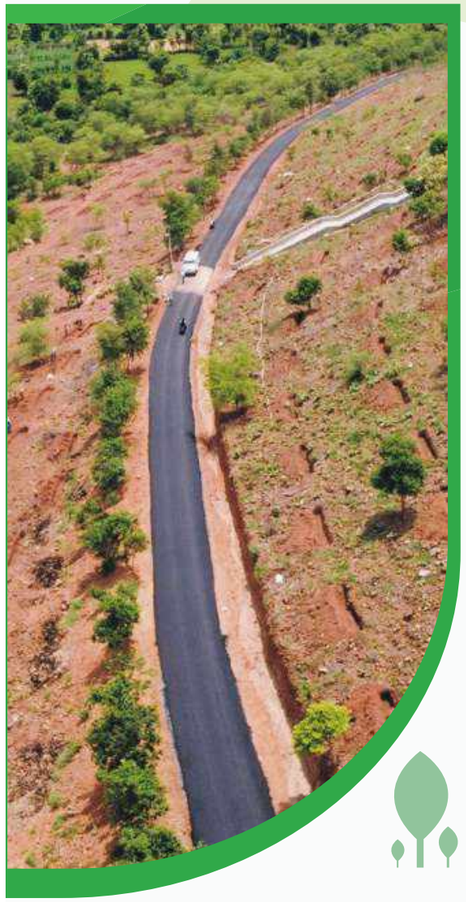
RAINWATER

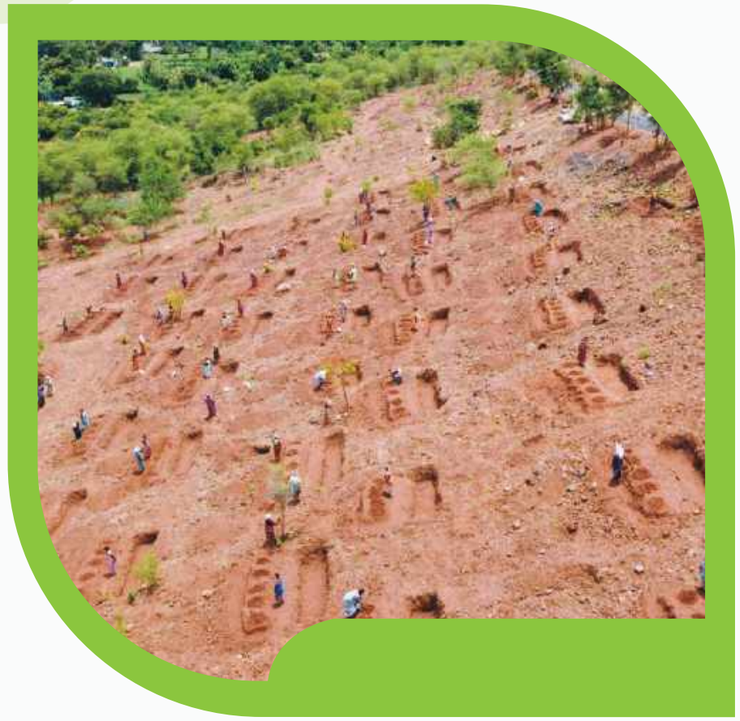
Roof Rainwater Storage - Catch the Rain Campaign

Progress

5 locations in the geographically isolated hill GPs to establish access to secured water resources for domestic and productive use

Greening of Hillocks: Greening of the denuded hill slopes with 20,000 drought resistant locally adaptable native plant species under high planting densities on the mounds of continuous contour trenches (CCTs) in the upper slopes of hills. It is being piloted in West Arni and Polur blocks. It aims to address the land degradation, increase soil moisture, reduce the speed of surface runoff and increase infiltration of water, lower soil erosion and rejuvenate natural vegetation. The pilot combines check dams and gabions on the stream flows to impound water and reduce soil erosion, percolation tanks in common land and farm ponds on individual lands on the lower slopes to improve the ground water recharge.





Greening of Hillocks

Nursery: Four block level nurseries at block level, produced 20 lakh quality tree seedlings of 14 native tree species. The common degraded land has been restored and a scientific nursery management skill is promoted among Mahatma Gandhi NREGS job card holders.

Nursery

Fallow land development: 314 ha of fallow individual land has been restored for cultivation which improve land productivity by enhancing *in-situ* water harvesting and storage within the field and reducing soil degradation and erosion. Adopting a saturation approach combination of water actions are promoted - field bunding with trenches and bund plantation, application of tank silts, agro-forestry with dry land horticulture tree species with annual crops such as groundnut, cow-pea, millets and black gram.

Fallow land development

Catch the rain: The flagship programme of National Water Mission operates with a tagline of "catch the rain, where it falls and when it falls" to improve the water security for better livelihoods in the hilly terrain of Jawadhu hills dominated by vulnerable ST communities. The programme nudges all partners and stakeholders to establish appropriate rain water harvesting structures on the basis of subsoil strata and climate. The pilot promotes integrated approach of both saturation and watershed in augmenting soil moisture and ground water storage.

Fallow land development

Silvi-pasture Development: Planting 20 lakh native trees in the degraded public land with trees having fodder value as well as addressing the issues on soil erosion soil moisture and soil health by fixing soil organic carbon.

River Rejuvenation: Reviving the Kamandalar river sub-basin covering 14 blocks in the district with increased subsoil water storage adopting artificial recharge structures and check dams at an appropriate site before the river joins the main river Palar. The pilot helps to effectively harvest and store surface runoff and recharge the ground water resources. There by it improves the local livelihoods by augmenting water resources for on-farm activities and drinking water resources.

Cascade of tanks for improved rural livelihoods and enhanced environmental services: The scientific restoration of traditional cascading of tank systems is planned to cover a stream of 22 tanks by improving both catchment and storage area in Kamandalar sub basin. It helps to effectively harvest and store the surface runoff, reduce the soil erosion by plantation on bunds and silt traps at the inlets and increase the ground water tables.

3.8 ALIGNMENT OF WASCA IN TAMIL NADU WITH SDGS, NDCS AND SAPCC

Climate change, a phenomenon of international concern, poses a serious threat to human existence. As this phenomenon is constantly evolving and changing, responses to mitigation must also be dynamic, scalable and in line with new national and international threats and structures. Individual structures, such as the "Paris Agreement", have led the countries around the world to implement their own measures to reduce emissions, take mitigation and adaptation measures reflected in the "Nationally Determined Contributions" (NDC). The UNFCCC and IPCC recommends that the mitigation and adaptation measures must consider the development needs of the country and the state in order to ensure a sustainable development pathway for a country. National Action Plan on Climate Change (NAPCC) and State Action Plan on Climate Change (SAPCC) provides guidance on long term strategy to address climate change at National and State levels respectively.

Since the adoption of NAPCC & SAPCC in by many

states in India, important developments and changes have occurred in the broad domain of climate change. Not only have the science, knowledge and understanding of climate change evolved at the global and regional levels, so has the policy context. Notable in this context is the ratification of important development and climate goals at the International level such as the Sustainable Development Goals (SDGs) and the Paris Agreement that aims at checking the global warming (temperature. target of 1.5° C). Related Indian Government commitments, such as those recorded in the Nationally Determined Contribution and corresponding goals of individual State pose the need for an evolving, appropriate climate change action planning process.

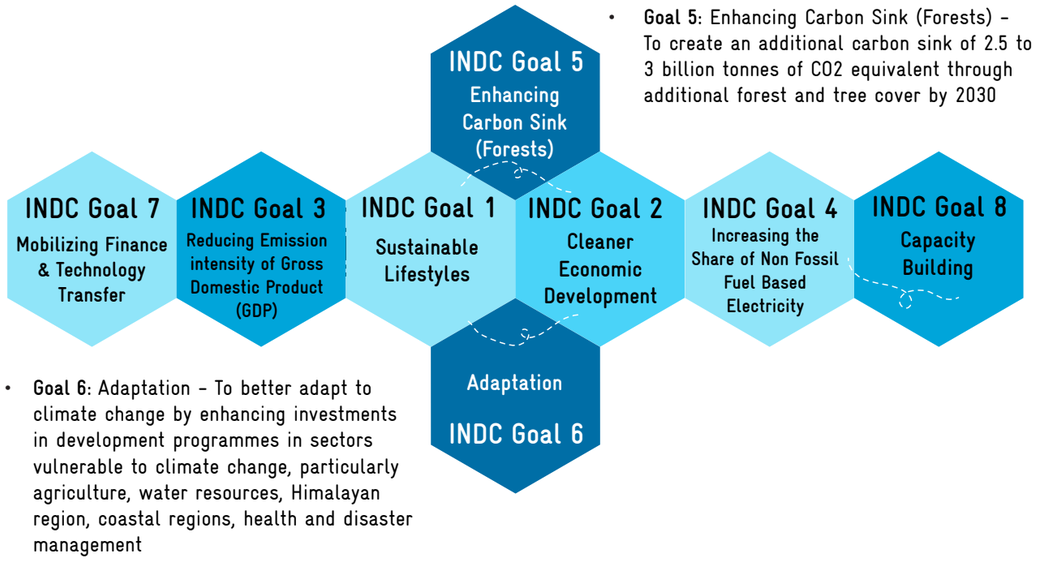
3.8.1. INTENDED NATIONALLY DETERMINED CONTRIBUTION GOALS AND LINKAGES WITH WASCA-TN

2015 was a historic year in which 196 Parties came together under the Paris Agreement to transform their development trajectories so that they set the world on a course towards sustainable development, aiming at limiting warming to 1.5 to 2 degrees C above pre-industrial levels. Through the Paris Agreement, Parties also agreed to a long-term goal for adaptation – to increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production. Additionally, they agreed to work towards making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive NDCs that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

India committed to cut its "carbon intensity" by up to 35 per cent from 2005 levels by 2030, Eight India's NDC (INDC) Goals

Two prioritized INDC Goal by WASCA –TN to address water security – INDC Goal 5 & 6



- **Goal 5**: Enhancing Carbon Sink (Forests) – To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030
- **Goal 6**: Adaptation – To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management

3.8.2. SUSTAINABLE DEVELOPMENT GOALS – LINKAGES WITH WASCA- TN

WASCA – TN working on four major Actions for making "Climate Resilience for Future Livelihoods". These water actions are:

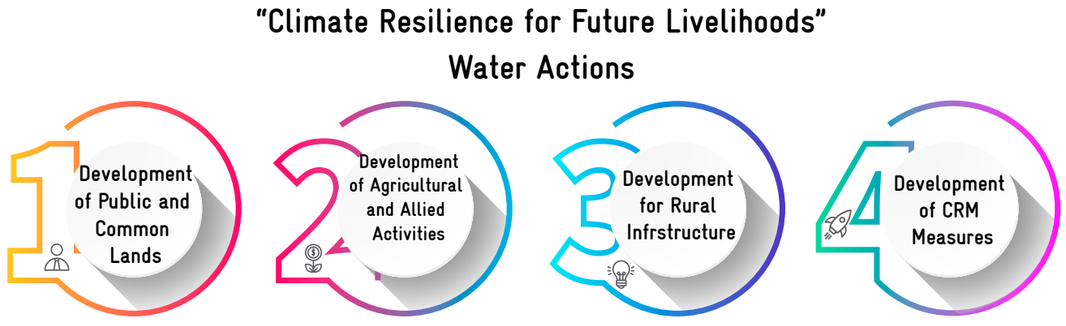


Fig 3.63: Four Major Water Actions

WASCA TN to achieve the above works closely with Mahatma Gandhi NREGA programme of Ministry of Rural Development and National Water Mission programme of Ministry of Jal Shakti are key stakeholders for WASCA. Apart from these two ministries, the works under WASCA are closely linked with Agriculture, MoEF&CC.

Hence the commitments of the ministries on SDG goals achievements are mapped in the tables given in this section. The interventions under WASCA Tamil Nadu will have direct and indirect contribution to the SDGs. The SDGs are as per NITI Aayog agreed targets set for the country.

WASCA TN to achieve the above works closely with Mahatma Gandhi NREGA programme of Ministry of Rural Development and National Water Mission programme of Ministry of Jal Shakti (MoJS). These two ministries are key stakeholders for WASCA. Apart from these two ministries, in addition to these two ministries, the works under WASCA TN are closely linked with Ministry of Agriculture and Ministry of Environment Forest and Climate Change (MoEFCC).

Hence the commitments of the above mentioned four ministries commitments towards SDG goals achievements are mapped in the tables given in this section linking them with the interventions under WASCA Tamil Nadu. The intervention under WASCA TN has direct and indirect contribution to the SDGs. And its national targets set as per NITI Aayog.

SDG GOAL 1

Improved economic performance coupled with concerted interventions by the government towards poverty eradication has led to decline in poverty rates across all economic, social and religious groups at the national level and in all States.

The Mahatma Gandhi NREG Act, 2005- The Mahatma Gandhi NREG Act, 2005 aims to provide hundred days of guaranteed wage employment in every financial to every rural household whose adult member volunteers' who demanded employment under this ACT were provided the same, in the year 2017-18. WASCA interventions will expected to lead betterment of the districts.

SUSTAINABLE DEVELOPMENT GOALS (SDGS):1 TARGETS, WASCA TARGETS

India's Commitment to SDG: Nodal Ministry: MoRD

SDG 1: End Poverty in all its forms every where

1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day

1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions

1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable

1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance

1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

1.a Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions

1.b Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions

WASCA TN interventions will be impacted all targets (1.1-1.5)

India has targeted initiatives, both at the national as well as State level, aiming to achieve this Goal. The National Food Security Act, 2013, which mandates provision of food grains to nearly 75 percent of the population in rural areas and 50 percent of the population in urban areas at affordable prices under the targeted public distribution system.

SDG GOAL 2

SUSTAINABLE DEVELOPMENT GOALS (SDGS):2 TARGETS, WASCA TARGETS

India's Commitment to SDG Nodal Ministry: Agriculture & Farmers welfare

SDG 2:End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

WASCA TN interventions will be impacted all targets (Targets 2.1-2.5)

SDG GOAL 6

India's SDG 6 The overall proportion of Indian households with access to improved water sources increased from 68% in 1992-93 to 89.9% in 2015-16. However, in 2015-16, 63.3% of rural households and 19.7% of urban households were not using improved sanitation facilities. According to the World Bank, more than 520 million in India were defecating in the open – the highest number in the world. This figure is expected to have reduced significantly given that improving sanitation is a key priority of the government which has introduced several flagship programmes, WASCA will also help to achieve the bel ow targets.

SUSTAINABLE DEVELOPMENT GOALS (SDGS):6 TARGETS, WASCA TARGETS

India's Commitment to SDG Nodal Ministry: Ministry of Water Resources, MoJS

SDG 6: Ensure availability and sustainable management of water and sanitation for all

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

WASCA TN interventions will be impacted Targets 6.1, 6.3, 6.5 & 6.6

SDG GOAL 13

India has great geographic diversity, and a variety of climate regimes and regional and local weather conditions, which are vulnerable to climate change. This is manifested in floods, droughts as well as the risk from tsunamis and cyclones experienced in coastal areas.

SUSTAINABLE DEVELOPMENT GOALS (SDGS):13 TARGETS, WASCA TARGET

India's Commitment to SDG: Nodal Ministry: MoEF&CC

SDG 13: Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a Implement the commitment undertaken by developed- country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries, and small islands of developing States, including focusing on women, youth and local and marginalized communities

WASCA TN interventions will be impacted Targets 13.1 & 13.2

SDG GOAL 15

Goal 15 India's progress on this Goal is important globally, since the country is home to 8 percent of the world's biodiversity, including numerous species that are unique to the country. India's global leadership on biodiversity is reflected in the pivotal role it played in facilitating the implementation of the Nagoya Protocol — one of the global Aichi Biodiversity Targets. The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of benefits.

SUSTAINABLE DEVELOPMENT GOALS (SDGS): 15 TARGETS, WASCA TARGETS

India's Commitment to SDG: Nodal Ministry: MoEFF&CC

SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

15.3 By 2020, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land- degradation-neutral world

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

WASCA TN interventions will be impacted Targets 15.1, 15.2 & 15.8

3.8.3. ALIGNMENT WITH CWRM PLAN OF WASCA-TN

The water actions proposed in the composite water resources management plan assessed based on the four vulnerability dimensions across GPs are compared and aligned with the Climate Vulnerability Index of WASCA TN scoping study at the district and state level, NDCs at the national level and SDGs at global level. The detailed matrix for both the districts are provided in Table 3.41 and 3.42. The detailed assessment of how CWRM outcomes lead to larger level impacts under National Adaptation Fund for Climate Change and Green Climate Funds are discussed in Chapter 4.

TABLE. 3.41: WASCA TN: MAPPING OF COMPOSITE WATER RESOURCES MANAGEMENT WORKS WITH CLIMATE VULNERABILITY AREA, CLIMATE VULNERABILITY INDICATOR, SDG AND INDC- RAMANATHAPURAM

S. NO	Name of the Work	Climate Vulnerability Area	No of Works Identified CWRM	Climate Vulnerability Index Impacting (WASCA TN)	SDG Goals	India's NDC
1	2	3	4	5	6	7
Water Action 1: Improvement of Public & Common Lands Development						
1	Afforestation	Climate, Water Resource and socio-economic	11,217	C1,C2.C3, W3,S2	SDG 1, 2,6,13&15	1) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 through additional forest and tree cover by 2030
2	Contour Continuous Bunds	Water Resource	43,894	W3	SDG 1,2, 6,13&15	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources 2) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 through additional forest and tree cover by 2030
3	Composting	Water Resources	11,931	W1	SDG1& 6	
4	Drainage Line Treatment	Water Resource	23,248	W1,W3,W4	SDG1 & 6	
5	Silvi-pasture Development	Agriculture, Climate and Socio-economic	191	C1,C2.C3. W3,	SGG 6,12&13	
6	Linear Plantation	Climate, Water Resources and socio-Econimic	754	C1,C2.C3. W3,S2	SDG 1,2,6,12&13	
7	Avenue plantation	Climate, Water Resource and socio-economic	1,801	C1,C2.C3. W3,S2	SDG 1, 6&13	
8	Block Plantation (Community)	Climate, Water Resource and socio-economic	29,487	C1,C2.C3. W3,S2	SDG 1,6&13	
9	Restotaration of water bodies: a) Tanks	Agriculture, Climate, Water Resource and Socio-economic	1,344	C1,W3,W4,W5,S2,S4	SDG 1,2&6	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources 2) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture and allied activities
10	Restotaration of water bodies: b) Ooranis	Agriculture, Climate, Water Resource and Socio-economic	3,883	C1,W3,W4,W5,S2,S4	SDG 1,2&6	
11	Restotaration of water bodies: c) Ponds	Agriculture, Climate, Water Resource and Socio-economic	47	C1,W3,W4,W5,S2,S4	SDG 1,2&6	
12	Artificial Recharge Structure	Water Resource &Agriculture	4,627	W3	SDG 1,2& 6	

13	Canal Bund Plantation (Ha)	Climate and Water Resources	2,618	W4, C1,S2	SDG 6 &15	
14	WC - Irrigation channels - Desilting	Water Resources &Agriculture	157,589	W4,W5	SDG 6& 2	
15	WC- Irrigation channels - canal side plantation	Climate and Water Resources	157,589	W4, C1	SDG 6 &15	
16	Agro forestry: Coastal Watershed	Climate, Water Resource and social	1,614	C1,C2.C3. W3,S2, S4,	SDG 1, 6,13 &15	1) To create additional carbon sink of 2.5 to 3 billion tones of CO2 equivalent through additional forest and tree cover by 2030 2) By 2030,programmes will be implemented to achieve the sustainable natural resource management and efficient utilization of natural resources, leading to a reduction in the "ecosystem footprint"
17	Check dam	Socio Economic	27	C1, W3,S2	SDG 1,6&15	
18	Mangrove plantations	Climate and Socio-economic	135	C1,C2.C3. W3,S2,	SDG 1,15&13	
19	Riverside plantation	Climate and Socio-economic	0	C1,C2.C3. W3,S2,	SDG 1& 15	
20	Fish Drying yard	Socio Economic	34	S4,S1,S2	SDG1& 14	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly coastal areas
21	Nursery development - plantation	Socio Economic	12	S2,S4	SDG 1& 15	1) To create additional carbon sink of 2.5 to 3 billion tones of CO2 equivalent through additional forest and tree cover by 2030 2) By 2030,programmes will be implemented to achieve the sustainable natural resource management and efficient utilization of natural resources, leading to a reduction in the "ecosystem footprint"
22	Shelter belts	Climate and Socio-economic	16	C1,C2,C3,S2,S4	SDG 1& 15	
23	Coastal wetland - Bund strengthening	Water Resources and Climate	22,579	C1,C2,W3, S2	SDG 1& 15	
24	Bund Plantation wet lands	Water Resources and Climate	10,964	C1,C2 W3,S2	SDG 1& 15	
25	Wetland plantation (inner)	Water Resources and Climate	133	C1,C2, W3,S2	SDG 1,13&15	
26	Wetland Inlet improvement works	Water Resources and Climate	2,856	C1, W3,S2	SDG 1,13&15	
		Sub Total Works	**488,590**			

Water Action 2: Agricultural and allied Sector development (Productivity Enhancement)						
1	Farm Bunding	Water Resources, Agriculture	32,926	A1,A3,W1,W3,S2	SDG 1,2&6	1) For better adaptation to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture & allied activities
2	Micro Irrigation	Water Resources, Agriculture & Climate	3,081	A1,A3,A5,W5,S2	SDG 1, 2&6	
3	Construction of farm ponds	Water Resources, Agriculture & Climate	10,084	A1,A3,W5,W1, W3,S2	SDG 2& 6	
4	Land development	Agriculture, Water Resources, Socio-Economic & Climate	12,668	W1,W5,A1,A3,S2,S4	SDG 2, 6&13	
5	Nursery Development - Plantation	Agriculture &socio economic	9,769	A1,A2,S2	SDG 2& 6	
6	Cattle Shelters	Socio Economic	2,329	S2, S4	SDG 1& 2	
7	Goat Sheep Shelters	Socio Economic	19,385	S2,S4	SDG 1& 2	
8	Fodder development for cattle	Agriculture and Socio Economic	2,329	A3, S2, S4	SDG 1& 2	
9	Azolla units	Agriculture and Socio Economic	2,329	A3,A4,S4,S2	SDG 1& 2	
10	Cattle Trough	Water Resources and Socio Economic	2,329	W5, S2,S4	SDG 1& 2	
11	Poultry shed	Socio Economic	5,949	S2,S4	SDG 1& 2	
12	Dry land Horticulture/ Agro-forestry	Agriculture, Water Resources, Socio-Economic and climate	16,460	A1,A3,A4,W1,S4,S2,C1	SDG 1& 2	
13	Vermi compost	Agriculture, water and Socio Economic	2,329	A3, W1, S2,S4	SDG 1& 2	
		Sub Total Works	**121,966**			
Water Action 3: Rural Water Management						
1	Soak pits (Community) (Nos)	Water Resources and Socio-Economic	3,895	W3,S2	SDG 1& 6	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources
2	Soak pits (Individual) (Nos)	Water and Socio-Economic	38,985	W3,S2	SDG 1& 6	
3	Roof rain Water Harvesting (Nos)	Water Resources	858	W3,S1,S3	SDG 1& 6	
4	Tanka - community level		2			
		Sub Total Works	**43,740**			
		Total Works	**654,296**			

Note: SDG 1, Poverty Eradication; SDG 2: Zero Hunger; SDG 6: Clean Water and Sanitation, SDG 13: Climate Action, SDG 15: Life on Land, SDG- Sustainable Goal Development

TABLE 3.42: WASCA TN: MAPPING OF COMPOSITE WATER RESOURCES MANAGEMENT WORKS WITH CLIMATE VULNERABILITY ARE, CLIMATE VULNERABILITY INDICATOR, SDG AND INDC - TIRUVANNAMALAI

S. NO	Name of the Work & Unit	Climate Vulnerability Area	No of Works Identified CWRM	Climate Vulnerability Index Impacting (WASCA TN)	SDG Goals	India's NDC
1	2	3	4	5	6	7
Water Action 1: Improvement of Public & Common Lands Development						
1	Afforestation	Climate, Water Resource and socio-economic	18,771	C1,C2.C3. W3,S2	SDG 1, 2,6,13&15	1) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 through additional forest and tree cover by 2030
2	Contour Continuous Bunds	Water Resource	46,771	W3,S2	SDG 1,2, 6,13&15	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources 2) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 through additional forest and tree cover by 2030
3	Composting	Water Resources	12,331	W1,S2	SDG1& 6	
4	Drainage Line Treatment	Water Resource	13,071	W1,W3,W4	SDG1 & 6	
5	Silvi-pasture Development	Agriculture, Climate and Socio-economic	2,841	C1,C2.C3. W3,S2	SGG 6,12&13	
6	Linear Plantation	Climate, Water Resources and socio-Economic	60	C1,C2.C3. W3,S2	SDG 1,2,6,12&13	
7	Avenue plantation	Climate, Water Resource and socio-economic	57	C1,C2.C3. W3,S2	SDG 1, 6&13	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources 2) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 through additional forest and tree cover by 2030
8	Block Plantation (Community)	Climate, Water Resource and socio-economic	8,233	C1,C2.C3. W3,S2	SDG 1,6&13	
9	Restotaration of water bodies: a) Tanks	Agriculture, Climate, Water Resource and Socio-economic	1,966	C1,W3,W4,W5,S2,S4	SDG 1,2&6	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources 2) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture and allied activities
10	Restotaration of water bodies: b) Ponds	Agriculture, Climate, Water Resource and Socio-economic	3,787	C1,W3,W4,W5,S2,S4	SDG 1,2&6	
17	Artificial Recharge Structure	Water Resources and Climate	26,113	W5, S2,S4, C1	SDG 6	
18	Canal Bund Plantation	Climate and Water Resources	23,839	W4, C1,S2	SDG 6 &15	
19	WC - Irrigation channels - Desilting	Water Resources &Agriculture	3,949	W4,W5	SDG 6& 2	
20	WC- Irrigation channels - canal side plantation	Climate and Water Resources	3,949	W4, C1	SDG 6 &15	
		Sub Total Works	**165,738**			
Water Action 2: Agricultural and allied Sector development (Productivity Enhancement)						
21	Farm Bunding	Water Resources, Agriculture	14,099	A1, A3, W1, W3, S2	SDG 1,2&6	1) For better adaptation to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture & allied activities
22	Micro Irrigation	Water Resources, Agriculture & Climate	1,451	A1, A3, A5, W5	SDG 1, 2&6	
23	Construction of farm ponds	Water Resources, Agriculture & Climate	9,482	A1,A3,W5,W1, W3,S2	SDG 2& 6	
25	Land development	Agriculture and Socio Economic	22,483	S2,S4,A1,A3,A4	SDG 2& 6	
26	Nursery Development - Plantation	Agriculture, Water Resources, Socio-Economic & Climate	2,303	W1,W5,A1,A3,S2,S4	SDG 2, 6&13	
27	Cattle Shelters	Agriculture and Water Resources	36,428	W1, S2,S4	SDG 1&2	
28	Goat Sheep Shelters	Socio Economic	17,649	C1,S2,S4	SDG 1,2	
29	Fodder development for cattle	Socio Economic	27,091	S2,S4	SDG 1& 2	
30	Azolla units	Socio Economic	33,669	S2, S4	SDG 1& 2	
31	Cattle Trough	Agriculture and Socio Economic	30,453	A3, S2,S4	SDG 1& 2	
32	Poultry shed	Agriculture and Socio Economic	26,006	A3,A4, S2,S4	SDG 1& 2	
33	Dry land Horticulture/ Agro-forestry	Water Resources and Socio Economic	24,892	W5, S2,S4	SDG 1& 2	
34	Vermi compost	Socio Economic	37,889	S2,S4	SDG 1& 2	
35	Construction of new well	Water Resources and Socio Economic	27,960	S3,W5,W1	SDG 1& 6	
		Sub Total Works	**311,855**			

Water Actions 3: Rural Water Management						
36	Soak pits (Community) in Nos	Water Resources and Socio-Economic	16,547	W3,S2	SDG 1&6	1) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources
37	Soak pits (Individual) in Nos	Water and Socio-Economic	49,167	W3,S2	SDG 1&6	
38	Roof rain Water Harvesting in Nos	Water Resources	4,640	W3,S1,S3	SDG 1& 6	
		Sub Total Works	**70,354**			
		Total Works	**547,947**			
Note: SDG 1: Poverty Eradication; SDG 2: Zero Hunger; SDG 6: Clean Water and Sanitation, SDG 13: Climate Action, SDG 15: Life on Land , SDG- Sustainable Development Goal						

TABLE 3.43: WATER SECURITY & CLIMATE ADAPTATION: TAMIL NADU: VULNERABILITY INDEX & KEY WATER ACTIONS

S NO	Vulnerability Area	WASCA Vulnerability Indicators	Vulnerability Indicator	Unit for Assessment
1	Climate vulnerability	Changes in maxT	C1	Degree Celsius
2		Changes in minT	C2	Degree Celsius
3		Changes in RF	C3	%
4		Excess rainfall years	C4	No. of Years
5	Water resource vulnerability	Deficient rainfall years	W1	No. of Years
6		Ground water extraction	W2	%
7		Ground water Recharge	W3	in cubic meter
8		Surface water availability	W4	Mm
9		Water gap	W5	MCM
10		% of contamination	W6	%
11	Agriculture vulnerability	Rainfed area	A1	%
12		Cropping intensity	A2	%
13		Soil moisture	A3	kg/m2
14		Evapo-transpiration	A4	kg/m2/s
15	Socio-economic vulnerability	Rural proportion	S1	%
16		Multi-dimensional poverty index	S2	Index Value
17		Source of drinking water within premises in rural	S3	%
18		Marginal farmer landholdings	S4	%

3.9 CONCLUSIONS IMPACTS

The impacts of the different water actions taken under WASCA initiatives in the public and common land, agriculture and allied sector, rural infrastructure and climate resilient measures contributes in reducing the vulnerability and building the resilience of the local communities at the system level. The GP based planning and integration at the block and watershed/sub-basin levels enable to adopt ecosystem approach in promoting nature based solutions. The detailed account of indicators and the envisaged impacts at the end of the three years of implementation by adopting saturation and convergence approach in mobilizing necessary finance, knowledge and technologies.

WASCA – WATER ACTIONS AND INDICATORS IN RAMANATHAPURAM DISTRICT

WASCA CWRM ACTION PLAN
Development of Public and Common Land

INDICATOR

1. Number of water bodies restored in the village
2. Area under afforestation
3. Area under linear plantation (tank bunds and avenue)
4. Percentage reduction in the annual surface runoff
5. Proportion of land treated under WASCA
6. Drainage line treatment
7. Area under silvi-pasture development
8. Number of vulnerable families benefitted through plantation

OUTCOMES/ IMPACT

1. 7,561 number of traditional water bodies (ponds, ooranis and tanks) restored for effective storage of runoff water
2. 40,704 Ha brought under tree cover through different afforestation methods
3. 2,555 Km length of linear plantation established
4. 219.38 MCM runoff harvested and stored
5. 1476 Km length of drainage lines treated
6. 19 percent of the total geographical area of the village treated under WASCA in three years
7. 191 Ha brought under silvi- pasture development
8. 40,704 vulnerable families guaranteed employment throughout the year for three consecutive years

7,561 WATER BODIES RESTORED

40,704 Ha AFFORESTATION

2,555 Km LINEAR PLANTATION

219.38 MCM RUNOFF HARVESTED & STORED

1476 Km DRAINAGE LINES TREATED

19 % OF THE TOTAL AREA TREATED

191 Ha SILVI-PASTURE DEVELOPMENT

40,704 FAMILIES EMPLOYMENT

WASCA CWRM ACTION PLAN

Development of Agriculture and Allied Activities

INDICATOR

1. No of structures established for on-farm *(in-situ)* water harvesting in dry lands
2. Reducing area under fallow lands
3. Improvement in soil health - with saturation approach
4. Area covered under micro irrigation for improved water use efficiency
5. Number of vulnerable households benefitted through fodder production and azolla cultivation
6. Amount of area brought under agro-forestry in the dry land (unirrigated) land use category

OUTCOMES/ IMPACT

1. 10,084 farm ponds established in dry lands
2. 84,537 Ha of fallow land restored for cultivation (22 percent of total geographical area of the district)
3. Soil health improvement - 2329 units of vermi compost established, 12,268 ha land improved through silt application, 32,926 Ha area improved by farm bunds cum trench and planting, 16,149 Ha area covered under mulching and 12,668 ha of area improved under land development category of work
4. 7,700 Ha area adopting micro irrigation practices
5. 19,170 vulnerable households established fodder production units and 2,329 units of Azolla production established among vulnerable households
6. 1,16,332 Ha area under dry lands are diversified in to agro- forestry with horticulture trees

10,084 FARM PONDS

84,537 Ha FALLOW LAND RESTORED

2329 UNITS OF VERMI COMPOST

12,268 Ha LAND - SILT APPLICATION

32,926 Ha FARM BUNDS

16,149 Ha MULCHING

12,668 Ha LAND DEVELOPMENT

7,700 Ha MICRO IRRIGATION

19,170 FODDER PRODUCTION UNITS

2,329 AZOLLA PRODUCTION

1,16,332 Ha AGRO-FORESTRY

WASCA CWRM ACTION PLAN

Climate Resilient Measures

INDICATOR

1. Number of vulnerable blocks (Area of Interest) identified in each district
2. Number of climate resilient measures identified

OUTCOMES/ IMPACT

1. All eleven blocks are vulnerable to the four studied factors of vulnerability at different scales
2. 13 models showing the climate resilient measures grounded

All 11 BLOCKS ARE VULNERABLE

13 MODELS CLIMATE RESILIENT MEASURES

WASCA CWRM ACTION PLAN

Development of Rural Infrastructure

INDICATOR

1. Number of Villages having liquid waste management systems
2. Roof rainwater harvesting measures
3. No of tanks planned
4. Nutri gardens

OUTCOMES/ IMPACT

1. 3,895 community level and 38,985 individual level soak pits constructed for grey water management to maintain hygiene in the village
2. 858 units of roof rain water harvesting and storing established
3. 3,90,750 households established nutri garden in homesteads (100 percent coverage in the district)

3,895 COMMUNITY LEVEL SOAK PITS

38,985 INDIVIDUAL LEVEL SOAK PITS

858 units OF ROOF RAIN WATER HARVEST

2 TANKS

3,90,750 NUTRI GARDEN (100%)

WASCA CWRM ACTION PLAN

Development of Public and Common Land

INDICATOR

1. Number of water bodies restored in the village
2. Area under afforestation
3. Area under linear plantation (tank bunds and avenue)
4. Percentage reduction in the annual surface runoff
5. Proportion of land treated under WASCA
6. Drainage line treatment
7. Area under silvi-pasture development
8. Number of vulnerable families benefitted through plantation

OUTCOMES/ IMPACT

1. 5,264 number of traditional water bodies (ponds, ooranis and tanks) restored for effective storage of runoff water
2. 26.8 percent brought under tree cover through different afforestation methods
3. 2,641 Km length of linear plantation established
4. 4)407 MCM runoff harvested and stored
5. 8488 Km length (14.70 percent) of drainage lines treated
6. 6)29 percent of the total geographical area of the village treated under WASCA in three years
7. 2907 Ha brought under silvi-pasture development
8. 45,477 vulnerable families guaranteed employment throughout the year for three consecutive years

5,264 WATER BODIES RESTORED

26.8 % AREA - AFFORESTATION

2,641 Km LINEAR PLANTATION

407 MCM RUNOFF HARVESTED & STORED

8488 Km DRAINAGE LINES TREATED

29 % OF THE TOTAL AREA TREATED

2907 Ha SILVI PASTURE DEVELOPMENT

45,477 FAMILIES EMPLOYMENT

WASCA CWRM ACTION PLAN

Development of Agriculture and Allied Activities

INDICATOR

1. No of structures established for on-farm *(in-situ)* water harvesting in dry lands
2. Reducing area under fallow lands
3. Improvement in soil health - with saturation approach
4. Area covered under micro irrigation for improved water use efficiency
5. Number of vulnerable households benefitted through fodder production and azolla cultivation
6. Amount of area brought under agro-forestry in the dry land (unirrigated) land use category

OUTCOMES/ IMPACT

1. 9,482 farm ponds established in dry lands
2. 1,41,370 Ha of fallow land restored for cultivation (31 percent of total geographical area of the district)
3. Soil health improvement - 37,889 units of vermi compost established, 22,483 ha land improved through silt application, 14,099 Ha area improved by farm bunds cum trench and planting, 52,989 Ha area covered under mulching
4. 20,143 Ha area adopting micro irrigation practices
5. 27,091 vulnerable households established fodder production units and 33,669 units of Azolla production established among vulnerable households
6. 24,892 Ha area under dry lands are diversified in to agro-forestry with horticulture trees

9,482 FARM PONDS

1,41,370 Ha FALLOW LAND RESTORED

37,889 UNITS OF VERMI COMPOST

22,483 Ha LAND - SILT APPLICATION

14,099 Ha FARM BUNDS

52,989 Ha MULCHING

20,143 Ha MICRO IRRIGATION

27,091 FODDER PRODUCTION UNITS

33,669 AZOLLA PRODUCTION

24,892 Ha AGRO-FORESTRY

WASCA CWRM ACTION PLAN

Development of Rural Infrastructure

INDICATOR

1. Number of villages having liquid waste management systems
2. Roof rain water harvesting measures
3. Nutri gardens

OUTCOMES/ IMPACT

1. 16,547 community level and 49,169 individual level soak pits constructed for grey water management to maintain hygiene in the village
2. 1640 units of roof rain water harvesting and storing established
3. 4,72,845 households established nutri garden in homesteads (100 percent coverage in the district)

16,547
COMMUNITY LEVEL SOAK PITS

49,169
INDIVIDUAL LEVEL SOAK PITS

1640 units
OF ROOF RAIN WATER HARVEST

4,72,845
NUTRI GARDEN (100%)

WASCA CWRM ACTION PLAN

Climate Resilient Measures

INDICATOR

1. Number of vulnerable blocks (Area of Interest) identified in each district
2. Number of climate resilient measures identified

OUTCOMES/ IMPACT

1. All eleven blocks are vulnerable to the four studied factors of vulnerability at different scales
2. 13 models showing the climate resilient measures grounded

All 18
BLOCKS ARE VULNERABLE

13 MODELS
CLIMATE RESILIENT MEASURES

CHAPTER 4

FINANCING AND PARTNERSHIPS

PREAMBLE

Harnessing water for people to use is one of the greatest development challenges. Investments in water projects are hence very key, Under **'Mission Water Conservation'**, started in the year 2016, Mahatma Gandhi NREGA improved its focus on asset creation for water in rural areas and this led to a transformation in planning for water assets. The Gram Panchayats started to identify various works listed under Mahatma Gandhi NREGA.

The investments increased over the period and the scheme has become a prime investor on rural water resource development. But to meet demand and ensure sustainable resource management, the financing under rural employment scheme is not just sufficient. Various other schemes, projects and initiatives in public and private sector need to converge to ensure the rural water assets. In addition to restoration, equal attention is necessary for management, with a sustained flow of financial resources along with technical and community centered managerial systems. In this backdrop, GIZ partnered with International Water Management Institute (IWMI) in developing a resource knowledge product on convergence and co-financing opportunities for climate resilient water management.

In Ramanathapuram district the key focus water action works for convergence are:

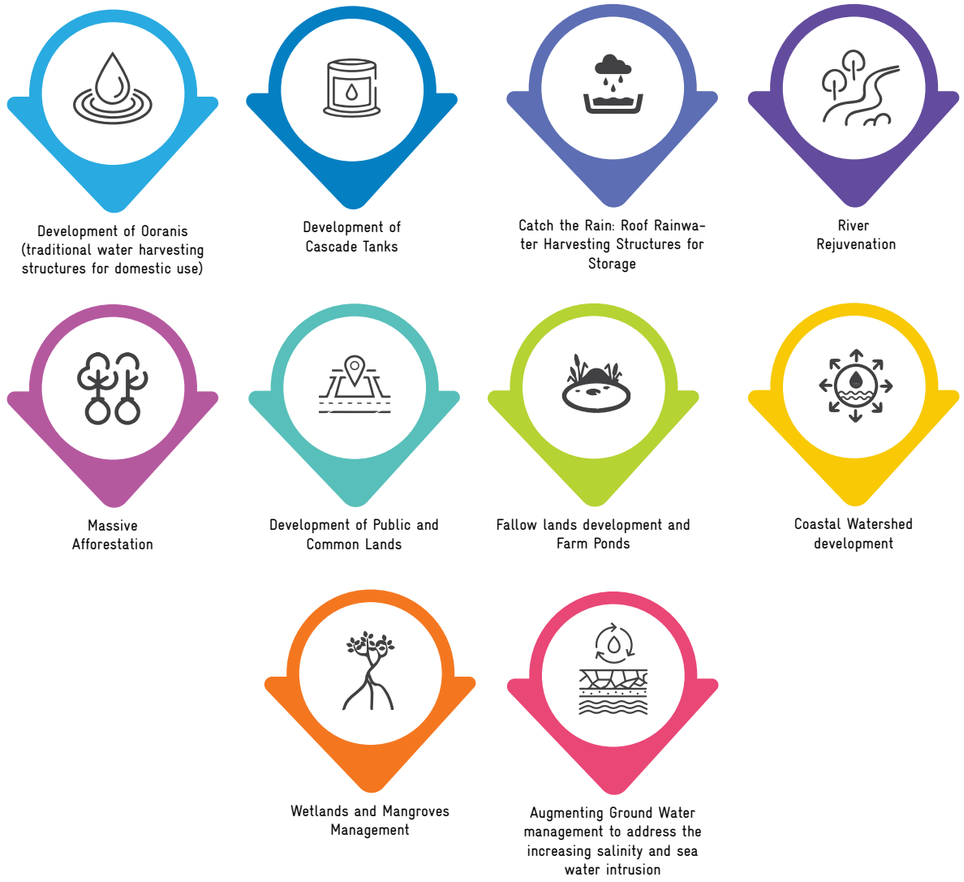


Fig 4.1: Key Focus Water Action Works for Convergence in Ramanathapuram District

In Tiruvannamalai district the key focus for convergence are:

Fig 4.2: Key Focus Water Action Works for Convergence in Tiruvannamalai District

4.1 CONVERGENCE WITH SCHEMES & PROJECTS

Under WASCA TN, the following key convergence are being promoted:

a) Kudimaramath

The Kudimaramathu scheme flagship programme of Government of Tamil Nadu aims at integrating funds from various departments to rejuvenate irrigation tanks, ponds and ooranis. Convergence under Mahatma Gandhi NREGA ensures activities for inlet, outlet, surplus weir strengthening, bund strengthening through plantation and channel works, connecting cascade tanks.

Water demand management is essential for effect water use and to enhance the benefits of water supply augmentation. In the demonstration districts of WASCA: Ramanathapuram and Tiruvannamalai the demand is maximum for agriculture sector (85-90% of overall demand). Improved irrigation efficiency of the production systems is therefore important and effective way to increase crop water productivity and extent large coverage under irrigation from the same source.

b) Sahi Fasal : National Water Mission

The Goal of National Water Mission (NWM) is "increasing water use efficiency by 20%" in agriculture, here the schemes such as sahi fasal becomes vital. Sahi Fasal' campaign was launched by NWM on 14.11.2019 to nudge farmers in the water stressed areas to grow crops which are not water intensive, but use water very efficiently; and are economically remunerative; are healthy and nutritious; suited to the agro-climatic-hydro characteristics of the area; and are environmentally friendly. Creating awareness among farmers on appropriate crops, micro-irrigation, soil moisture conservation etc; weaning them away from water intensive crops like paddy, sugarcane, banana etc to crops like sorghum, pearl millet, maize, pulses etc which require less water; assisting policy makers to frame policies that make effective pricing of inputs (water and electricity); improve procurement and market for these alternate crops; create appropriate storage them etc ultimately leading to increase in the income of farmers are the key elements of "Sahi Fasal".

c) Catch the Rain: National Water Mission

The NWM's campaign "Catch The Rain" with the tagline "Catch the rain, where it falls, when it falls" is to nudge the states and stakeholders to create appropriate Rain Water Harvesting Structures (RWHS) suitable to the climatic conditions and sub-soil strata before monsoon season.

Under this campaign, drives to make check dams, water harvesting pits, rooftop RWHS etc; removal of encroachments and de-silting of tanks to increase their storage capacity; removal of obstructions in the channels which bring water to them from the catchment areas etc; repairs to step-wells and using defunct bore-wells and unused wells to put water back to aquifers etc are to be taken up with the active participation of people.

To facilitate these activities, WASCA Resource centres located at DRDA acts as "Rain Centers" in each district manned by an engineer and GIS expert well trained in RWHS. This centre act as a technical guidance centre to all in the district as to how to catch the rain, as it falls, where it falls.

d) Sub-Mission on Agroforestry (SMAF)

The Government of India has implemented the Sub-Mission on Agroforestry (SMAF) under the National Mission for Sustainable Agriculture (NMSA) to promote tree plantation on farmland along with the productivity enhancement of crops and cropping systems. The principal objective of implementing this scheme is to address the development of agroforestry practices for the increased crop production and economic gain in the country. Under SMAF, the following activities can be taken up:

- Enhancing the coverage of tree plantations in the lands that are suitable to local agro-climatic and land use conditions to create protection on their livelihood, environmental and biodiversity by encouraging all the farmers to plant trees in their farmland along with crops and cropping systems and/ or livestock as an integral element of the farming system.
- This mission promotes the setting up from small nurseries to hi-tech big nurseries for the producing quality planting materials to meet the requirement of the planting material / seeds for the farmers.
- On promoting various Agroforestry practices or methods suitable to various changes will support the adaptation and mitigation efforts during the climatic conditions changes.
- It promotes sustainable Agri-silvicultural systems, Agri-silvi-pastoral system, Silvi-pastoral systems and other systems of agroforestry through Apiculture with Trees, Aqua forestry etc.
- Promoting Boundary and Peripheral Plantation on farms will serve as follows:
  - Fencing of farm
  - Improving soil moisture
  - Stabilizing farm bunds
  - Demarcation of farm boundary
  - Protecting from soil erosion
  - Enrichment of soil organic matter without changing the coverage under crops.
- Low-Density Plantation on Farmlands that includes the intermediate or strip plantations.
- High-Density Block Plantation will also be supported along with the crops and cropping system as agroforestry system.

e) Mission for Integrated Development of Horticulture (MIDH)

Centrally Sponsored Scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. Under WASCA TN specially focus is provided on floriculture, vegetable and fruit crops cultivation is Tiruvannamalai district, cashew cultivation in coastal and semi-arid districts of Ramanathapuram.

f) Pradhan Mantri Krishi Sinchayee Yojana - Per Drop More Crop PMKSY – PDMC

The approaches under Per Drop More Crop becomes important ensuring the water assets created are judiciously used with sustained productivity and incomes to the vulnerable population.

Convergence for assets created in developing individual lands tied up with technological interventions like drip and sprinkler irrigation, root zone water harvesting availing subsidies and financing through various line department schemes becomes prominent.

g) National Livestock Mission: Sub Mission on Fodder and Feed Development:

Address the problems of feed and fodder in order to give a push to the livestock sector making it a competitive enterprise for India, and to harness its export potential. The major objective is to reduce the deficit to nil. In both the WASCS -TN districts development of fodder, pastures are proposed in community and individual lands to increase both production and productivity of fodder by adopting suitable technologies and species suited to the local agro-ecology.

h) Fisheries

The Government of Tamil Nadu's policy note 2020-21 on Animal Husbandry, Dairying and Fisheries department has recognized and taken efforts to promote climate resilient fisheries. As a part of it, to enhance the fishery resources, deployment of artificial reefs in inshore waters, promotion of code of conduct for responsible fishing, sea weed farming etc are given adequate importance. Through the central scheme of Prime Minister Matsya Sampada Yojana, sustainable sea weed farming programme is being promoted among women as an alternate livelihoods.

The convergence with line departments has been started on the main schemes in both the districts. The following table 4.1 provides the details of the convergence themes with different line departments in the districts.

TABLE 4.1: DETAILS OF THE DEPARTMENT AND IDENTIFIED AREAS FOR CONVERGENCE BASED ON CWRMP

S No	Name of the Department	Areas of Convergence
1	Department of PWD – WRO and CGWB	Traditional water harvesting structures restoration, canal network improvements
2	Department of Agriculture	Fallow land – individual development, IFS and Water management – Micro irrigation
3	Department of Agriculture Engineering	Farm ponds and Micro watersheds
4	Department of Horticulture	Dryland horticulture – fallow land development, crop diversification with reduced water resources
5	Department of Forest	Plantations in public land
6	Department of Animal Husbandry	Silvi-pasture development in common lands, livelihood activity centres – technical support for fodder development in individual lands
7	Department of Fisheries	Alternate livelihoods
8	NABARD	Horticulture Development

Besides, efforts have been taken to identify the possible partnership with on-going schemes based on the key water challenges and prioritized water actions.

- Government Departments
- Fallow land development: Agriculture / Horticulture Department
- Mission on Sustainable Dryland Agriculture: Agriculture Department
- Farm Ponds- Agriculture Engineering Department
- IFS Technologies : ARS TNAU
- Invasive species reduction & afforestation (Bamboo cultivation): Forest Department
- Tank Cascades: PWD and TWAD Board
- Artificial Recharge Structures: PWD & Central Ground Water Board
- Silvi-pasture development: Agriculture & Horticulture Department

4.2 PUBLIC PRIVATE PARTNERSHIP

Public Private Partnership is important in water resources management. WASCA TN organised a Southern India Public Private Partnership summit in October 2019 in collaboration with CII and Government of Tamil Nadu.

WASCA working closely with District Administration and CII regional office at Chennai and CII, New Delhi has worked towards promoting PPP for various water conservation works. The following table 4.2 shows the areas of potential partnership.

TABLE 4.2: KEY AREAS FOR PARTNERSHIP – WASCA - TN

S NO	Technology and Knowledge Management	Water Management	Climate Resilience for Future Livelihoods
1	Management Skills	Improvement of Cascade Tanks Systems	Coastal Watershed
2	Business model development	Restoration and River Rejuvenation	Water- Energy nexus and development
3	Mapping of Areas for A.I and IT application & implementation	Ground Water development and artificial recharge	Livelihoods linked with land Development
4	Community Participation in Technology development	Water Use Efficiency and cropping pattern change	Promotion of integrated farming, agro-forestry
5	Traditional knowledge mapping in technology development	Soil improvement and composting	Afforestation
6	Strengthening WASCA District Resource Centre (GIS Centre)	Water Use Efficiency – Sahi Fasal Scheme	Ground Water Development and Artificial Recharge
7	Capacity Development of FPOs	Water- Energy nexus	Skill development
8	Agriculture Information Systems	Skill Development	Drinking Water: Technologies – Rainwater harvesting

The District Administration implementing WASCA actively engaging PPP for various initiatives (Table 4.3). In Tiruvannamalai district PPP models for adopting Tanks has been initiated. Under WASCA it is planned to undertake 10 PPP models for Tank rejuvenation. CSR wing of TVS Company are actively involved in plantation and afforestation works in the district of Tiruvannamalai.

In Ramanathapuram district working with Thiagarajar School of Management in developing business models for improving livelihoods through land development of public and fallow lands are undertaken. Exploring tie up with other CSR, PSU and industry discussions are under various stages. CII is actively involved in the discussions to promote participation of Industry and Private sector in WASCA TN (Table 4.3).

TABLE 4.3: POTENTIAL PRIVATE PARTNERS EXPLORED FOR SELECT WATER ACTIONS

Tiruvannamalai	Ramanathapuram
Plantations, Agro-forestry- Wadi models - TVS group (CSR)	Plantations – Agro-Forestry and shelterbelts - Indian Oil Corporation Limited, Bharathi Biotech Ltd
River Rejuvenation - Art of Living Foundation	Cascade of Tanks – In partnership with Pradhan and an industry partner
CII Partnership - Rajashree Sugars (exploring partnership)	

4.3 ACCESS TO CLIMATE FINANCING

4.3.1 MANAGING CLIMATE RISKS OF FLOODS AND DROUGHTS

Increasingly unpredicted weather and extreme events are becoming a major hazard. To build resilience of farmers to the changing climate and shifting weather conditions, there is a need for convergence in the areas of monitoring, forecasting extreme events. The following table 4.4 provides an indicative area of convergence for extreme event management.

TABLE 4.4: INDICATIVE AREAS OF CONVERGENCE FOR CLIMATE RISKS

Component	Focus Area	Sources of Convergence
Risk Assessment & Monitoring	Vulnerability Mapping and Forecasting	NICRA, IMD, WRIS, CGWB, CCCDM-Anna University
Building Resilience	Insurance	PMFBY
Ecosystem based approach	Nature based solutions	Mahatma Gandhi NREGA, NWM, MIDH, NABARD – NRM programmes
	Seasonal drought/flooding	NFSM, NRLM/SRLM

4.3.2 NATIONAL ADAPTATION FUND ON CLIMATE CHANGE – POTENTIAL PROJECTS – WASCA - TN

The National Adaptation Fund for Climate Change (NAFCC) is a Central Sector Scheme which was set up in the year 2015-16. The overall aim of NAFCC is to support concrete adaptation activities which mitigate the adverse effects of climate change. The activities under this scheme are implemented in a project mode. The projects related to adaptation in sectors such as agriculture, animal husbandry, water, forestry, tourism etc. are eligible for funding under NAFCC. The National Bank for Agriculture and Rural Development (NABARD) is the National Implementing Entity (NIE).

The broader objectives are:

- Funding concrete adaptation projects/programmes aligned with the relevant Missions under National Action Plan on Climate Change (NAPCC) and the State Action Plan on Climate Change (SAPCCs) in agriculture, horticulture, agro-forestry, environment, allied activities, water, forestry, urban, coastal and low-lying system, disaster management, human health, marine system, tourism, habitat sector and other rural livelihood sectors to address climate change related issues
- Preparing and updating climate scenario, assessing vulnerability and climate impact assessment
- Capacity building of various stakeholders on climate change adaptation and project cycle management and developing knowledge network
- Mainstreaming the approaches/ learnings from project/programme implementation through knowledge management

Outcome Frame work: The fund level outcome parameters will consist of the following:

- Reduced key risks and adverse impacts of climate change in water and agriculture sectors
- Maximised multi-sectoral, cross-sectoral benefits/co-benefits to meet the challenges of water and food security
- Human development, poverty alleviation, livelihood security is an enhanced awareness of community
- Strengthened institutional & individual capacity to reduce risks associated with climate-induced socio-economic and environmental losses
- Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level. Increased adaptive capacity within relevant development and natural resource sectors
- Increased ecosystem resilience in response to climate change and variability-induced stress
- Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas
- Improved policies and regulations that promote and enforce resilience measure

Implementation

- The States/UTs are required to prepare the project proposal in consultation with NIE, NABARD.
- The project proposals are required to be approved by the State Steering Committee on Climate Change to be eligible for consideration under NAFCC.
- It is the discretion of the State Government to engage any organization to assist in project preparation, as per their requirement.

NAFCC PROJECT LIFE CYCLE

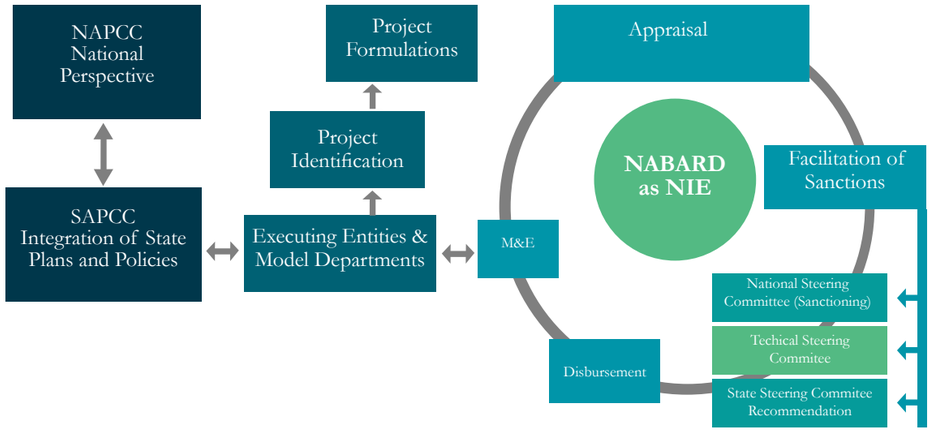


Fig 4.3: Project life cycle of National Adaptation Fund for Climate Change

The scope under WASCA TN for NAFCC are

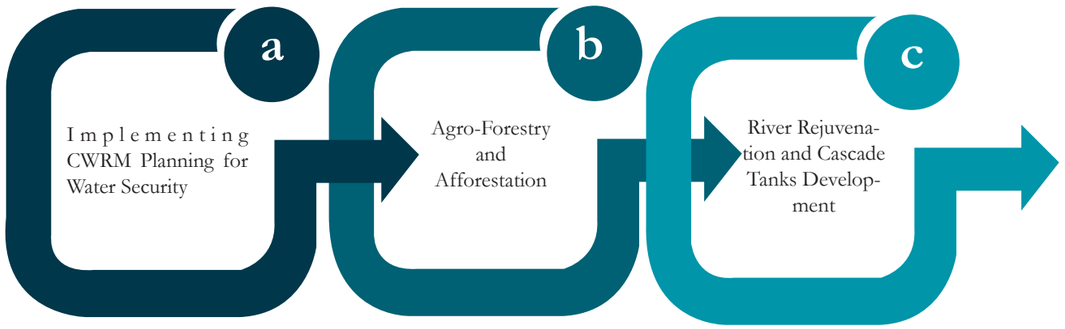


Fig 4.4: Scope areas for WASCA under NAFCC

4.3.3 GREEN CLIMATE FUND (GCF) - POTENTIAL PROJECTS UNDER WASCA-TN

GCF is a unique global platform to respond to climate change by investing in low-emission and climate-resilient development. GCF was established by 194 countries to limit or reduce greenhouse gas (GHG) emissions in developing countries, and to help vulnerable societies adapt to the unavoidable impacts of climate change. Given the urgency and seriousness of this challenge, GCF is mandated to make an ambitious contribution to the united global response to climate change.

GCF transformative approach: GCF goals by investing across four transitions – built environment; energy & industry; human security, livelihoods and wellbeing; and land-use, forests and ecosystems – and employing a four-pronged approach:

- **Transformational planning and programming:** by promoting integrated strategies, planning and policymaking to maximise the co-benefits between mitigation, adaptation and sustainable development.
- **Catalysing climate innovation:** by investing in new technologies, business models, and practices to establish a proof of concept.
- **De-risking investment to mobilize finance at scale:** by using scarce public resources to improve the risk-reward profile of low emission climate resilient investment and crowd-in private finance, notably for adaptation, nature-based solutions, least developed countries and small island developing states.
- Mainstreaming climate risks and opportunities into investment decision-making to align finance with sustainable development: by promoting methodologies, standards and practices that foster new norms and values.

Potential areas under GCF support for WASCA – TN are

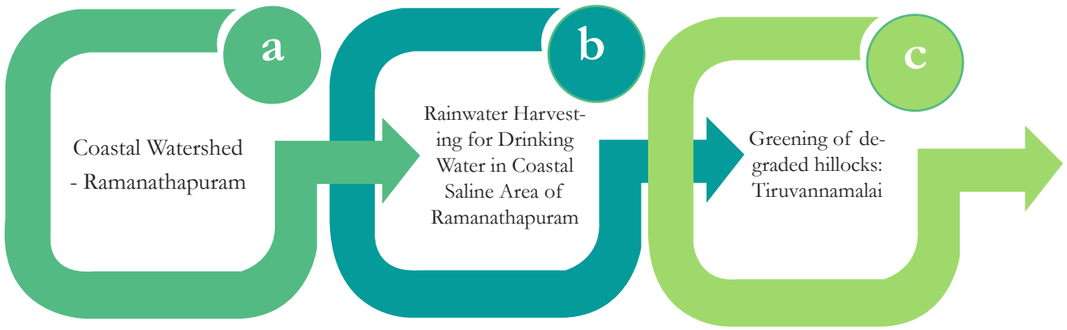


Fig 4.5: Scope areas for WASCA under GCF

CHAPTER 5

CAPACITY DEVELOPMENT AND COOPERATION STRATEGY

Any work related to water management for enhancing water security gives better results if it takes into consideration at the appropriate river sub-basin level. This is possible if a good convergence of hydrological science, administrative unit of governance and community are organized in developing, implementing programmes on water. This has been demonstrated well, under Water Security and Climate Adaptation (WASCA), in Tamil Nadu, implemented through scientific planning with bottom up approach.

In the pilot districts of Ramanathapuram and Tiruvannamalai, all the 1289 GP level plans were developed based on nationally accepted Composite Water Resources Management (IWRM principles) and stand approved at GP level. These plans are integrated at hydrological levels and higher administrative levels. District reports are prepared based on these integration principles and approved at District Level Steering Committees.

PILOT DISTRICTS

RAMANATHAPURAM AND TIRUVANNAMALAI

NO OF GPs

1,289

For 2021-22, the final year of WASCA TN bilateral project, it is important to capitalize on its gains. The Department of Rural Development, Government of Tamil Nadu, along with GIZ have developed a Capacity Development and Cooperation strategy for scaling up this successful approach to the whole state. In this section, the state macro scenario, the crucial role of Rural Development Department in water security and the specific learnings from WASCA for Capacity Development are dealt in detail, and include:

- Understanding water security in Tamil Nadu
- River Basins and Sub-basins in Tamil Nadu
- Demand and Supply Issues in ensuring water security
- Policy of Rural Development Department Tamil Nadu
- GIZ India Approach and Strategy
- Capacity Development & Cooperation Strategy under WASCA

5.1 WATER SECURITY IN TAMIL NADU AND CHALLENGES

WASCA- TN undertook a detailed study in 2019 for understanding the issues of water security in state of Tamil Nadu. The study was supported by GIZ, conducted by CCCDM, Anna University under the guidance of Department of Rural Development.

Tamil Nadu is one of the most water-stressed states in India. The state accounts for 6 per cent of the national population (Census of India, 2011) but is endowed with only 3 per cent of the water resources of India.

1

Tamil Nadu can be grouped into 17 major river basins, and majority are water stressed. Most of the rivers which drain into Tamil Nadu originate from Western Ghats uplands and Eastern Ghats. Tamil Nadu has no perennial river - they are all rain-fed. These rivers have to cross in from other state boundaries before they irrigate the fields in TN.

2

The state has a centuries old and rich tradition of tank irrigation with tanks, that are used for harvesting and preserving the local rainfall as well as storing water from streams and rivers for later use.

3

The per capita availability of water in Tamil Nadu has come down from 1492 cubic meter in 1951 to 723 cubic meter in 2001 (Palanisami et al., 2011) and 590 cubic meter in recent period (Natarajan et al., 2017), which is 39.5% of the amount 60 years back

1951 1,492 M^3 | 2001 723 M^3 | 2017 590 M^3

1951-2011 (60 YEARS) 39.5 % come down

4

As per the Falkenmark Water Stress Indicator, 'a country or region is said to experience "water stress" when annual water supplies drop below 1,700 cubic meter per person per year. The state's per capita deficit is below the national annual per capita water availability by 923 cubic meters (59 per cent) .

WATER STRESS

annual water supplies drop below 1,700 M^3 per person per year

5

Approximately 37 per cent of the state's total geographical area is used under net sown area in 2015-16.

6

The land put to non-agricultural purposes have significantly gone up from 15.3 per cent in 2000-01 to 16.8 per cent in 2015-16.

2000-01 15.3% — The land put to non-agricultural purposes — 2015-16 16.8%

7

Wasteland comprising cultivable waste, current fallows and other fallows have increased from 20.1 per cent in 2000-01 to 23.1 per cent in 2015-16. Its share in the geographical area has gone up to 23.1 per cent indicating its potential to be tapped.

2000-01
20.1%

Wasteland comprising cultivable waste, current fallows and other fallows

2015-16
23.1%

8

There is a steady decline in the extent of land under barren and uncultivable lands in the state. With the increase in wasteland, the relative share of net area sown in total geographical area of the state has come down from 40.8 per cent in 2000-01 to 37 per cent in 2015-16.

2000-01
40.8%

net area sown in total geographical area of the state

2015-16
37%

9

Area under permanent pastures and grazing lands are shrinking; it is a sign of a decline in village common land due to encroachment and neglect. However, total area under these categories is very small.

10

The area under miscellaneous tree crops and groves has also decreased from 2 to 1.8 per cent in 2015-16.

2015-16
2% to 1.8%

11

The total area irrigated through well irrigation including open, tube and other well in 2015-16 are 17.20 lakh hectares. After well (open and tube) irrigation, irrigation through canals contributes to nearly 23.72 per cent of the total irrigation and irrigated around 6.72 lakh hectares. Tank irrigation also have a significant role, that contributes 15.5 per cent (4.38 lakh hectare) the total irrigation.

The total area irrigated through

2015-16

17.20 lakh Ha (60.78%)

6.72 lakh Ha (23.72%)

4.38 lakh Ha (15.5%)

12

District-wise groundwater categorisation shows all firkas (100 per cent) in Chennai district are overexploited followed by Salem (81.8 per cent firkas), Tiruppur (78 per cent firkas), Thiruvannamalai (71 per cent firkas), Namakkal (66 per cent firkas), Coimbatore and Dharmapuri districts (65 per cent firkas), Perambalur and Vellore districts (66 per cent firkas). The Nilgiris and Ramanathapuram districts have more firkas in safe zone as compared to other districts .

CHENNAI	100%
SALEM	81.8%
TIRUPPUR	78%

THIRUVANNAMALAI	71%
NAMAKKAL	66%
COIMBATORE & DHARMAPURI	65%
PERAMBALUR & VELLORE	66%

Nilgiris & Ramanathapuram districts have more firkas in safe zone as compared to other districts

13

More than 150 per cent groundwater extraction is underway in Chennai and Salem districts. Figure 5.1 shows the spatial map of ground water categorisation. The brown colour shows the over-exploited firkas and red colour denotes the critical firkas. Safe firkas are shown in green colour. This recent assessment by CGWB emphasises that adoption of groundwater resource developmental activities are much needed at present and need to be scaled up to meet the future demand.

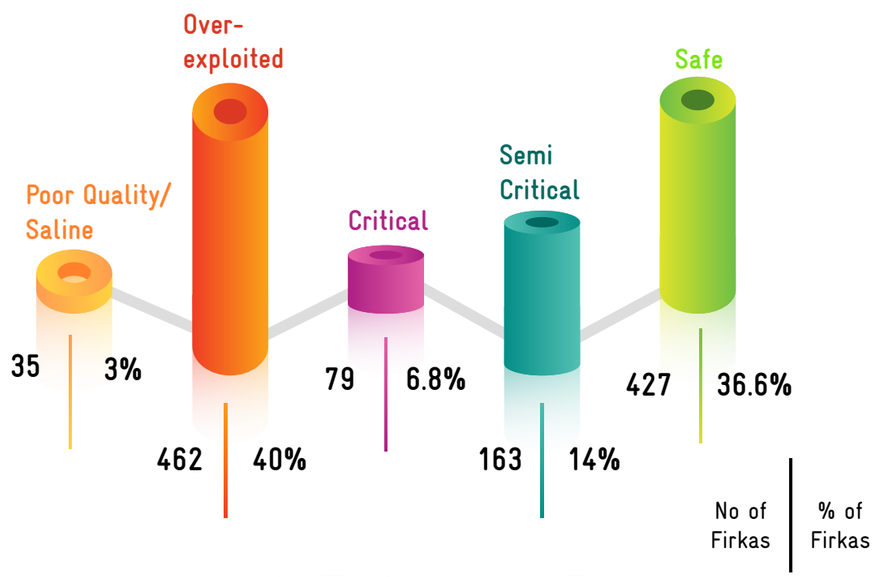
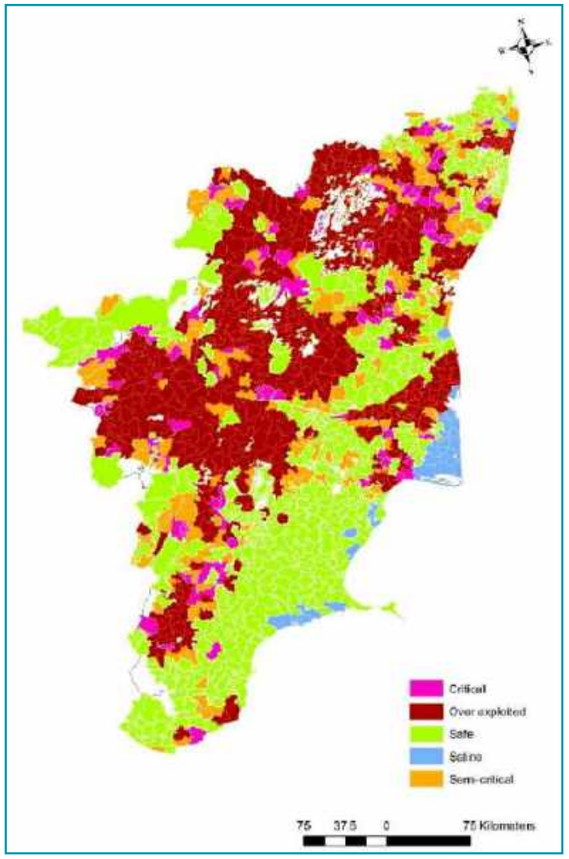


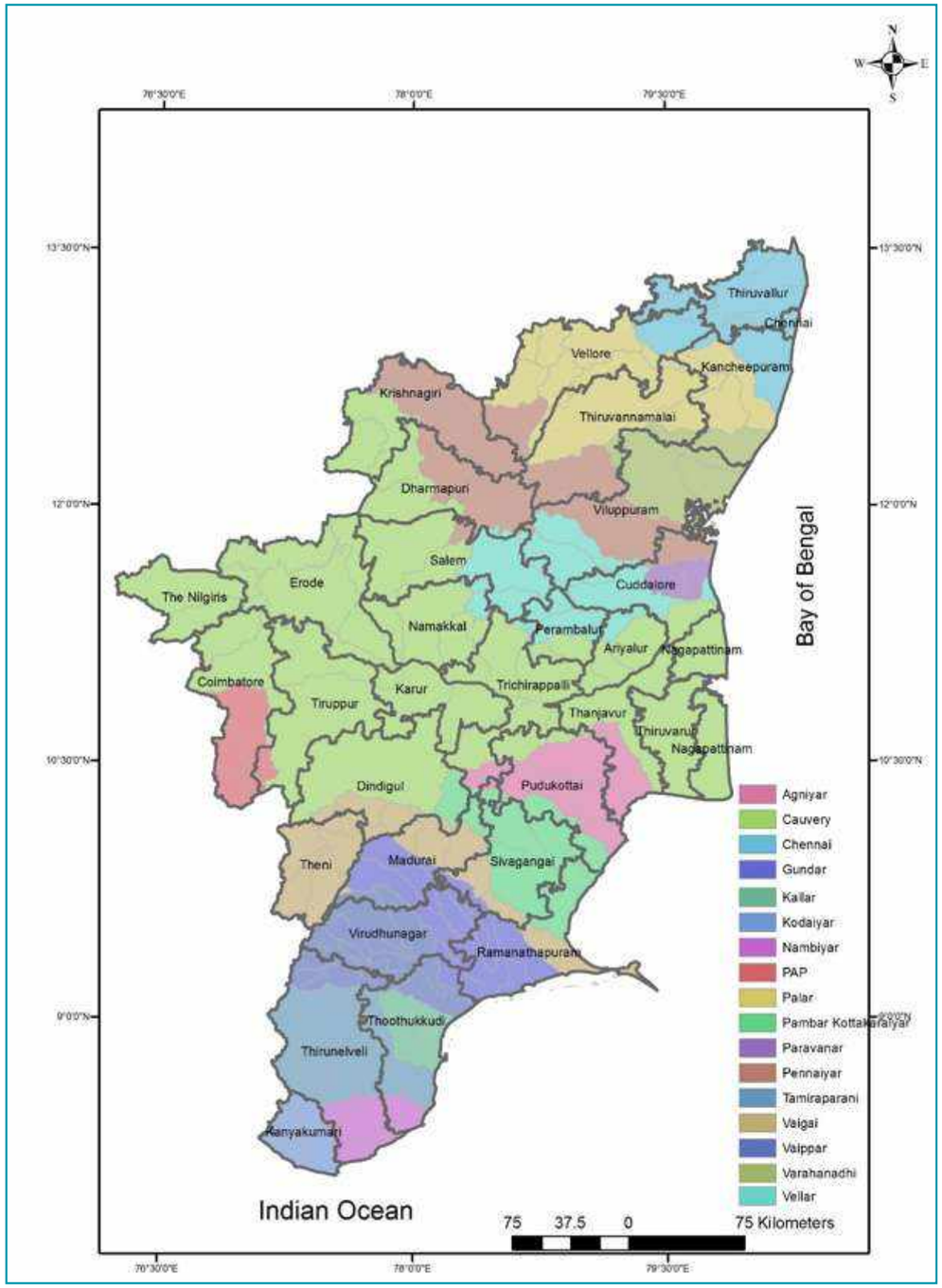
Fig 5.1: CGWB: 2017 Assessment Data on Ground Water Status



Map 5.1: Firka-wise groundwater extraction - 2017

5.2 RIVER BASINS AND SUB BASINS IN TAMIL NADU

- The river basins in Tamil Nadu are grouped into 17 major river basin groups (Map 5.2), comprising 34 river basins, which is further divided in to 127 sub basins.
- The major river basin groups are Chennai basin, Palar basin, Varahanadhi basin, Pennaiyar basin, Vellar basin, Paravanar basin, Cauvery basin, Agniyar basin, Pambar and Kottakaraiyar basin, Vaigai basin, Gundar basin, Vaippar basin, Kallar basin, Thambaraparani basin, Nambiar basin, Kodaiyar basin and Parambikulam Azhiyar Project (PAP) basin.
- The 17 river basins ground (34 river basins) which is flowing in the state of Tamil Nadu are transboundary ones and involve interstate operations. Cauvery is the only major river basin. Of the others, 13 basins are medium and 3 are minor river basins. The districts covered by each basin are tabulated in Table 5.1 and geospatially represented in Map 5.2.



Map 5.2: Map showing the river basins in Tamil Nadu

TABLE 5.1: LIST OF RIVER BASINS, AREA AND DISTRICTS COVERED IN TAMIL NADU STATE

S.No.	River Basin Group	Area in Sq.km	Districts Covered
1	Agniyar	4663.04	Pudukottai, Thanjavur, Trichirappalli,Sivagangai, Dindigul
2	Cauvery	43867	Namakkal, Dindigul, Salem, Thanjavur, Nagapattinam, Tiruppur, Thiruvarur, Coimbatore, Erode, The Nilgris, Karur, Trichirappalli, Perambalur, Ariyalur
3	Chennai Basin group	6118.34	Chennai, Kancheepuram, Thiruvallur, Vellore
4	Gundar	5684.32	Madurai, Sivagangai, Virudhunagar, Ramanathapuram and Thoothukudi
5	Kallar	1509	Thoothukudi
6	Kodaiyar	1646.964	Kanyakumari and a small portion in Thirunelveli district
7	Nambiar	2018.4	Thirunelveli, Thoothukudi and Kanyakumari districts
8	Palar	10217.18	Vellore, Thiruvannamalai, Kancheepuram, Thiruvallur, Vilupuram, Krishnagiri
9	Pambar Kottakaraiyar	5910.877	Sivagangai, Ramanathapuram, Pudukottai, Dindigul, Madurai,Trichy
10	Parambikulam-Aliyar basin	2388.7	Coimbatore
11	Paravanar	864.059	Cuddalore
12	Pennaiyar	11375	Krishnagiri, Dharmapuri, Salem, Vellore, Thiruvanamalai, Vilupuram, Cuddalore
13	Thamirabarani	5717.08	Thirunelveli, Thoothukudi
14	Vaigai	6823	Theni, Dindigul, Madurai, Sivagangai, Ramanathapuram
15	Vaippar	5,288	Thirunelveli, Virudhunagar, Thoothukudi
16	Varahanadhi	4499	Vilupuram, Thiruvannamalai, Kancheepuram,Cuddalore
17	Vellar	7530.53	Dharmapuri, Salem, Namakkal, Trichirappalli, Perambalur, Ariyalur, Vilupuram, Cuddalore

5.3 DEMAND AND SUPPLY SITUATION OF WATER

- With rapid economic and demographic change, water demand of all the sectors is increasing, particularly in the agriculture, domestic and industrial sectors. The sectorial demand for water in 2017 and 2040 and current water availability are taken from Central Water Commission's Tamil Nadu basin reports and are presented in Table 5.2
- Cauvery basin and Vaippar basin reports are not available in the CWC report. The water demand for Vaippar basin from TNAU's report to State Planning Commission is presented in the table 5.2 for visualisation purpose. The details on Cauvery basin is not presented and discussed here. So, the total water demand and its surplus/deficits are discussed for 15 river basins only
- Based on CWC's report, the total water demand in 2017 was 24,004.08 MCM
- Of this the demand for irrigation sector was 19,003.31 MCM in 2017, which is 79.16% of the total water demand of the state.
- The water demand for domestic purpose was 1,147.56 MCM
- The water demand for industrial purposes was nearly 1,392.94 MCM in Chennai basin followed by Vaigai basin (302.31 MCM) and Palar basin (258.38 MCM)
- The demand for non-agricultural purposes in the year 2040 would be about 20,745 MCM and demand for agriculture purposes will be about 19,879 MCM. This leaves a supply-demand gap of about 41 per cent in 2040 (Table 5.2)
- The domestic and industrial and energy sectors are also going to need additional water

TABLE 5.2: SECTORIAL DEMAND FOR WATER IN 2017 AND 2040 AND DEMAND AND SUPPLY GAP IN TAMIL NADU

Major Basin-Group	Year	Demand of water in various sectors (MCM)					Water availability (MCM)					Surplus/ Deficit in MCM
		Irrigation	Domestic	Industries	Livestock	Total	Surface water potential	Ground water poten-tial	Quantity of recy water from Sewage	Quantity of water from desil-ting	Total	
Agniyar	2017	1882.96	38.08	129.98	89.185	2140.21	1136	893.892	-	0	2029.89	-110.31
	2040	1882.96	0	763.25	108.335	2754.55						-724.65
Chennai	2017	1359	335.51	1392.94	85.66	3173.11	1062	743.632	-	49.32	1854.95	-1318.16
	2040	1359	519.28	8180.72	100.502	10159.5						-8304.6
Gundar	2017	731.38	40.69	153.8	55.49	981.36	549	578.89	-	-	1127.89	146.54
	2040	731.38	54.88	903.37	57.16	1746.79						-618.9
Kallar	2017	100.2	24.52	38.26	11.67	174.65	128	57	247.56	---	432.56	257.91
	2040	100.2	37.8	225.81	11.27	375.08						57.48
Kodaiyar	2017	728	50.12	70.28	14.57	862.98	916	239.59	---	---	1155.59	292.61
	2040	728	76.22	415.07	15.29	1234.58						-79
Nambiar	2017	356.88	14.47	40.61	7.49	419.45	203	780.98	117.57	0.89	984.87	565.42
	2040	356.88	20.47	235.92	7.44	620.71						364.16
Palar	2017	1950.59	142.68	258.39	120.794	2472.45	1392.3	891.669	-	181.21	2465.18	-7.28
	2040	1950.59	209.17	1516.51	221.74	3898.01						-1432.8
Pambar & Kottakaraiyar	2017	1460	43.08	98.85	72.654	1674.58	648	811.966	-	-	1459.97	-214.62
	2040	1460	61.91	581.43	75.296	2178.64						-718.67
Parambikulam-Aliyar	2017	840	18.38	117.15	11.47	987.001	675	450.02	-	116.908	1241.9	-254.92
	2040	840	27.5	689.42	11.43	1568.35						326.43
Paravanar	2017	1738.65	13.97	64.037	18.26	1834.92	379	1284.95	-	3.686	1667.64	-167.29
	2040	1738.65	19.29	375.99	19.5	2153.44						-485.8
Pennaiyar	2017	2076.33	102.06	300.2	33.82	2478.59	1319.58	766.77	4.1	59.23	2149.68	-328.91
	2040	2076.33	145.34	1760.66	36.26	3982.33						-1891.9

Thamirabarani	**2017**	1054.57	79.56	63.24	59.57	1256.94	883	812.08	123.81	44.88	1739.96	483.02
	2040	1054.57	119.66	371.06	58.93	1604.22						135.74
Vaigai	**2017**	1802	133.32	302.31	35.57	2273.2	1371	548.99	0	32.01	1952	-321.2
	2040	1802	202.24	1772.82	37.66	3814.72						-1862.7
Varahanadhi	**2017**	1250.75	40.62	100.26	94.98	1391.634	428	1256	3.65	3.09	1690.74	299.11
	2040	1250.75	58.12	589.8	95.35	1898.67						-211.02
Vellar	**2017**	1672	70.5	122.236	18.26	1883	981	864.85	-	29.532	1875.39	-7.62
	2040	1672	94.17	717.71	19.5	2503.38						-628
***Cauvery & Vaippar Basins reports are not available in Central Water Commission's Basin Report**												
Vaippar	**2044**	1386.15	152.01	103.1	13.76	1654.92					1783	128

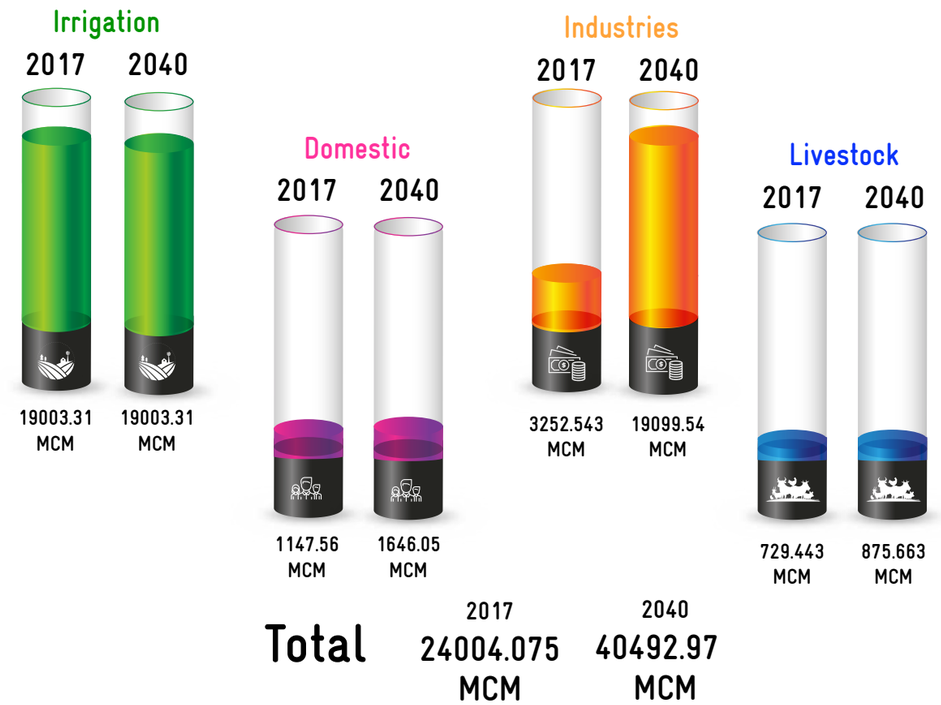


Fig 5.2: Sectoral Water Demand Situation in MCM

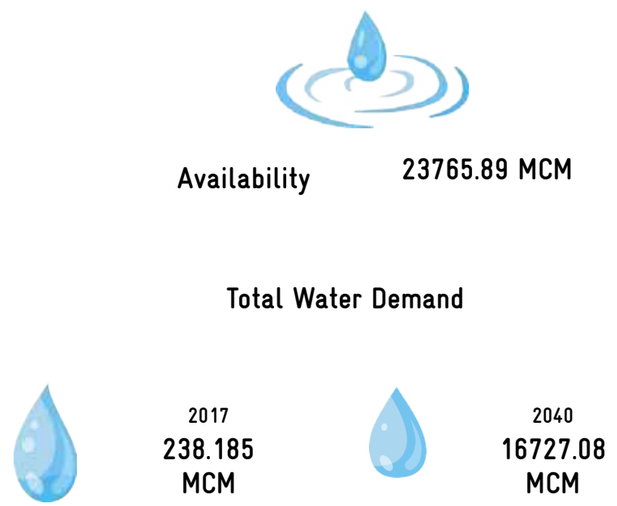


Fig 5.3: Current water availability and demand and future demand in 2040, Tamil Nadu

5.4 RURAL DEVELOPMENT POLICIES AND PROGRAMMES OF GOVERNMENT OF TAMIL NADU

Rural Development occupies one of the highest priorities of government of Tamil Nadu for the development of rural areas. Government of Tamil Nadu's endeavour is to provide:

1. Basic amenities
2. Infrastructure facilities
3. Expand livelihood opportunities
4. Improve rural connectivity, housing
5. Enable a clean and sanitized environment
6. Improvement in the quality of life

1) MAHATMA GANDHI NREGS

The Mahatma Gandhi National Rural Employment Guarantee Scheme provides several legal entitlements to rural workers through a series of provisions in the MGNREG Act and it is the only social security scheme for poverty alleviation:

- Mahatma Gandhi NREGS focus in Tamil Nadu is to augment the Ground Water Recharge and to ensure soil moisture and water conservation
- In Tamil Nadu, more than 65% of the expenditure under this scheme are related to Natural Resources Management (NRM) works
- More than 60% of the NRM expenditure are related to agriculture & allied works. Natural Resources Management works like check dam, farm pond, earthen bunding, stone bunding, dug well, recharge shaft, recharge pit ,individual and community soak pit, continuous trenches, staggered trenches etc have been taken up under
- Some of the noble objectives and goals of Sustainable Development of United Nations is effectively achieved by the successful implementation of MGNREGS by the State of Tamil Nadu. The goals of 'No Hunger' and 'No Poverty' is achieved through the provision of employment to the unskilled rural household for a maximum of 100 days in a year thereby plays a vital role in provision of livelihood for rural poor. 'Gender Equality' is ensured through the disbursement of equal wages for both men, women without any disparity of wages among them.
- 'Climate Change / action' is controlled through the soil and moisture conservation works like rainwater harvesting works through earthen bunding, check dams, renovation / rejuvenation of traditional water bodies and drought proofing and plantation works in public and private lands.

2) TAMIL NADU STATE RURAL LIVELIHOODS MISSION (TNSRLM)

TNSRLM is being implemented in 12,525 Village Panchayats in all 388 Blocks. The aim of TNSRLM is empowering women and reducing poverty in the rural areas through a multi-pronged Community Driven Development (CDD) approach.

The Participatory Identification of Poor (PIP) process pioneered by the erstwhile World Bank funded Pudhu Vazhvu Project lays the foundation of the CDD approach, by which the target people - Poor, Very Poor, Vulnerable and Differently abled are identified and assisted.

Creating, nurturing and developing sustainable Community Based Organizations (CBOs) such as Self Help Groups, Village Poverty Reduction Committees, Panchayat Level Federations, Block Level Federations, Producer Groups, Producer Collectives and Producer Organisations is the main strategy for livelihood promotion.

TNSRLM and its sub-components are:

- Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY)
- Start–up Village Entrepreneurship Programme (SVEP)
- Mahila Kisan Sashaktikaran Pariyojana (MKSP)

3) WASCA IN TAMIL NADU

Under Mahatma Gandhi NREGS, Mission Water Conservation is a convergence framework with scientific planning and execution of water management works with the use of latest technology. 'Water Security and Climate Adaptation in rural India" (WASCA) is a new MoRD-GIZ (an Indo-German Corporation) bi-lateral project that was started in 2019-22, for a period of 3 years. It is aimed to strengthen on going rural development initiatives in water security with a climate lens. Hence, the focus of WASCA in state of TN is on "Climate Resilience for Future Livelihoods". Under WASCA, for the first time bottom up planning using GIS and scientific data is carried out covering all GPs (1289 Nos) in Tiruvannamalai and Ramanathapuram. This unique exercise is carried out with active participation of officials and community from GP level to district level and convergence with line departments as per requirement.

5.4 CAPACITY DEVELOPMENT & COOPERATION STRATEGY (CDC STRATEGY) UNDER WASCA

The objective of Capacity Development and Cooperation Strategy under WASCA are:

a. CDC Strategy 1: Outputs

i. Focus is in two implementing districts: Ramanathapuram & Tiruvannamalai. Steered by DLSC under leadership of District Collectors.
ii. Planning water security interventions at a sub-basin level in a phase wise to develop and demonstrate replicable models
iii. Effective implementation in pilot districts through convergence
iv. Timelines:
    1. Phase 1: 15 April – 30 November 2021 (Works)
    2. Phase 2: 1 December 2021 to 20 March 2022 (Results and Impact Assessment)

b. CDC Strategy 2: Mainstreaming

i. Document the approach, tools and learnings
ii. Uptake in other districts of Tamil Nadu
iii. Timeline: 3 November 2021 – 15 February 2022

5.4.1 CDC STRATEGY 1: OUT PUTS

Capacity Development and cooperation strategy success depends on the stakeholder ownership. The various stakeholder involved in WASCA is represented in the chart given below. These stakeholders in WASCA are involved at all stages in the process of preparing Composite Water Resource Management Plans (CWRMPs).

CDC strategy for outputs is through implementing the plans focused to conserve and recharge water, land, soil and vegetation. The necessary mechanisms provided under the steering structures enabled actively engaging stakeholders in achieving the objectives. The tools are tested and developed – the CWRM guidebook[1] and also various crucial studies that provide the scientific inputs (you could list them and give their links)

The Capacity Development Strategy therefore revolves around main streaming WASCA Climate Vulnerability Area, Planning and Implementation frame works with all stakeholders. It is essential to involve all stakeholders through various steering mechanisms to have say in implementation of the project.

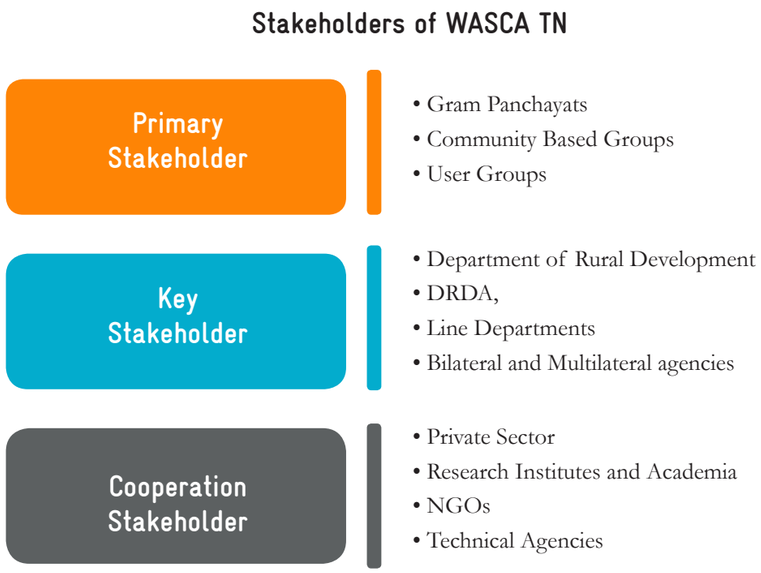


Fig 5.4: Stakeholders of WASCA Tamil Nadu

1 *https://www.everydrop-counts.org/imglib/pdf/WASCA-Handbook.pdf*

In the output stage of current works of WASCA, Department of Rural Development has set the priorities and focus. The focus are:

1 Integrating all the CWRM GP level plans merging into NREGA Soft of MoRD on GIS based planning
2 Integrating CWRM GP level plans into line departments planning for 2021-22 and subsequent years
3 Common portal for WASCA to enable all line department, stake holders and community access scientific data, plans and GIS information for decisions and administrative and technical sanctions
4 Development of Model GPs on saturation mode (6 Model GPs per block) in Ramanathapuram and Tiruvannamalai implementing all the components under CWRM, document the learnings and community uptake. Based on the learning and feedback, a comprehensive "Composite Water Resources Management Implementation Frame Work" will be developed.
5 Development of Climate Resilience Measures taking into account the goals and commitments of State, National governments and local conditions as per the IPCC frame work for climate action (28 such actions are at various levels of implementation) . Under Climate Resilience measures, the actions will be:
   a. Developing of Climate Monitoring Tool useful for guiding the outcomes of work and its linkages for future livelihoods and sustainable resource management
   b. 30 Models in two districts based on Climate Vulnerability (discussed in detail in Chapter 3)
   c. Monitor the impact and out come using the climate tool on the 5 Climate Vulnerable Areas, 18 Climate Vulnerable Indicators, 115 Non Spatial Parameters and 15 Spatial Parameters on future projection and adaptation
   d. Develop district specific proposals for NAFCC and GCF financing

To achieve above set outputs, a Capacity development and Cooperation strategy for Out Puts phase, following actions are planned: :

1 Develop methodologies for convergence at block, district and state levels
2 Develop process for partnerships working with CII, NABARD and District Administration.
3 Formats and tools for monitoring are being developed to support review at all levels
4 Promote use of Information Technology, AI & ML tools for strengthening outputs
5 Documenting the process of implementation
6 Training block / GP level functionaries with knowledge and techniques on implementation
7 Establish interface for effective community involvement and ownership
8 Establishment of advisory support systems for converting outputs for a climate resilience project with co-financing
9 Mechanisms for capturing community learning, technical knowledge network building
10 Development of knowledge products facilitating the implementation of outputs
11 Mechanisms for leveraging Schemes, projects, and programmes at national and state level

Capacity Development Strategy Improving existing planning and financing mechanisms

Stake Holders

1 Participatian
2 Decision making
3 Monitoring
4 Scale Up
5 Awareness on climate Financing

Convergence

1 Schemes and Programmes
2 Public Private Partnership
3 Pllot Innovative works
4 Model GPs
5 Integrating to NREGS soft (D-29)
6 Non-NRM works Inclusion
7 Design Projects for Climate Financing

Communication

1 Use of ICT tools
2 Case Study Preparation
3 IEC
4 Podcast

Cooperation Strategy: Improving existing planning and financing mechanisms

Institutional

- Target Setting for Convergence at district level
- Identify Areas for Technical Cooperation
- Identify Areas for Knowledge Sharing
- Monthly Block level convergence meetings
- Developing SoPs

Individual

- Building Resource Pool and expertise sector wise across board
- Pool of Advisors
- Joint Field Visits

2 *https://everydrop-counts.org/imglib/pdf/WASCA-Opportunities.pdf*

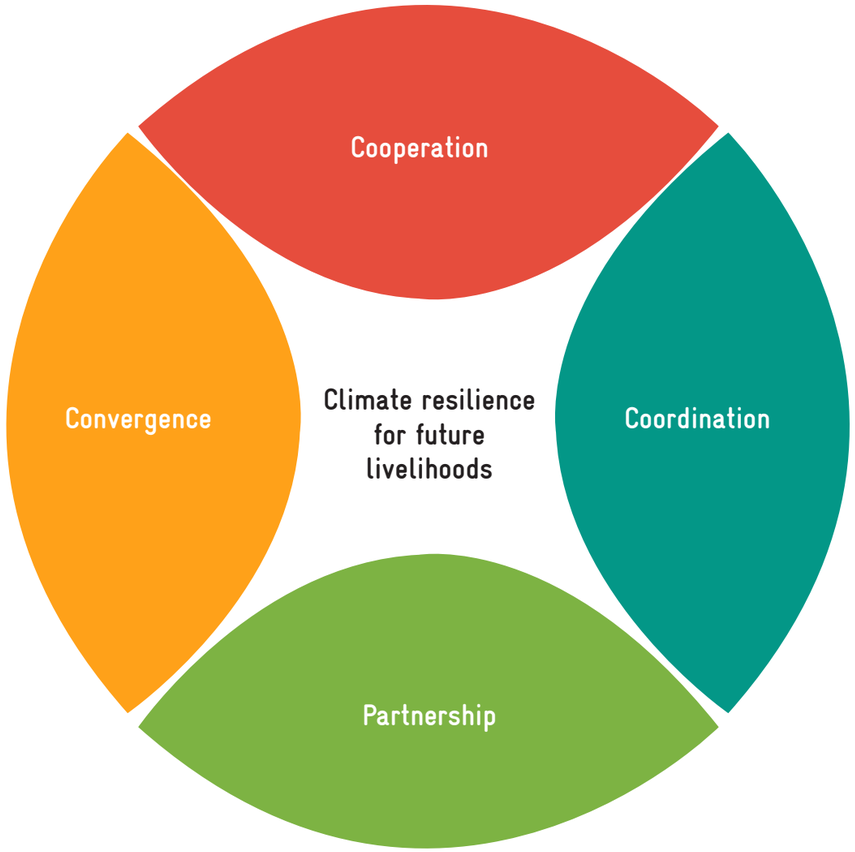


Fig 5.5: Key approaches - Climate resilience for future livelihoods

TABLE 5.3: AREAS OF CO-ORDINATION AND CO-OPERATION REQUIRED FOR CAPACITY DEVELOPMENT

Basis	Co-ordination	Co-operation
Process	Through DLSC bring all line departments came together to achieve a common goal (at GP, Block and District level). 1289 CWRM plans forms the foundation.	Through trainings, joint field visits members of various departments and community came forward as individuals & experts to mutual help willingly for meeting objectives of WASCA.
Scope	Knowledge, information, working on common guidelines, approaches	Bringing technical strength, domain knowledge on table, specially at GP level during implementation of works.
Procedure	Nodal officers appointed for the purpose at district/state levels (two at each level)	Co-operation is achieved by consultation and by persons and individuals at all levels through team building. District Collector played key role in ensuring high level of participation.
Need	To remove duplicity, bring commonality and harmony	Enable willingness of officers, community working together for creating durable assets
Connection	Schemes, Policies related to Water and Land	Making Village and community benefit through collective work
Governance	It is planned and entrusted through DLSC and SLSC	Joint Working and Joint action groups
Support	It seeks wholehearted support from various people working at various levels.	Co-operation without co-ordination is fruitless & therefore it may lead to unbalanced developments.

Partnership

There are 28 number of works related to water security and climate proofing currently identified under WASCA in the state. The water security and climate related works carried out in partnership with comprehensive management of river basin and natural resources conservation.

Comprehensive Management of River Sub- Basins through watershed management and CWRM approach

- Overall plan document for the sub-basin developed, GIS based and from village to sub-basin/district level
- Desilting of tanks
- Clearing & widening drainage carriers to original standards
- Check dams across river courses with necessary scour vents for recharging the downstream stretches

Natural Resources Conservation

- Improving Inflow Channels
- Watershed development
- Micro irrigation
- Rainwater harvesting
- Artificial recharging of ground water
- Prevention of sea water intrusion
- Eco restoration of marsh lands, estuaries & creeks
- Conservation and restoration of creeks, marshlands and wetlands

The partnerships between community, schemes, programmes and investors like private sector, NABARD are enabled through following acts:

- The Tamil Nadu Additional Assessment and Additional Water Cess Act, 1963
- The TWAD Board Act (Investigation, Execution and Maintenance of Water Supply Scheme and Drainage Scheme) Rules, 1973
- State Water Policy, 1994
- The Tamil Nadu Panchayat Act, 1994
- The Tamil Nadu Farmers Management of Irrigation Systems Act, 2000
- Tamil Nadu State Groundwater Development and Management Act, 2003
- The Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007A document analysing the financing potentials of various programmes and institutions has been developed[2]

Convergence

Convergence is the process that results in the achievement of common objectives through value addition, targeted and efficient use of financial and human resources. Coordinated planning and service delivery ensures timely inputs from multiple sources, simultaneously avoiding duplication and redundancies. The planning process drawing in from mutually agreed programmes, underlines clarity regarding targets, time frames, shared responsibilities and monitoring parameters. Specific convergence initiatives could be of a complementary or supplementary nature, aimed at either more comprehensive treatment, adding productive value to assets created, ensuring sustainability or up-scaling successful initiatives.

Convergence should use the WASCA - CWRM frame work in prioritisation the work implementation which is based on scientific data and Identify cadastral level (village level) vulnerable areas for water security action and assets creation.

Framework for Implementation

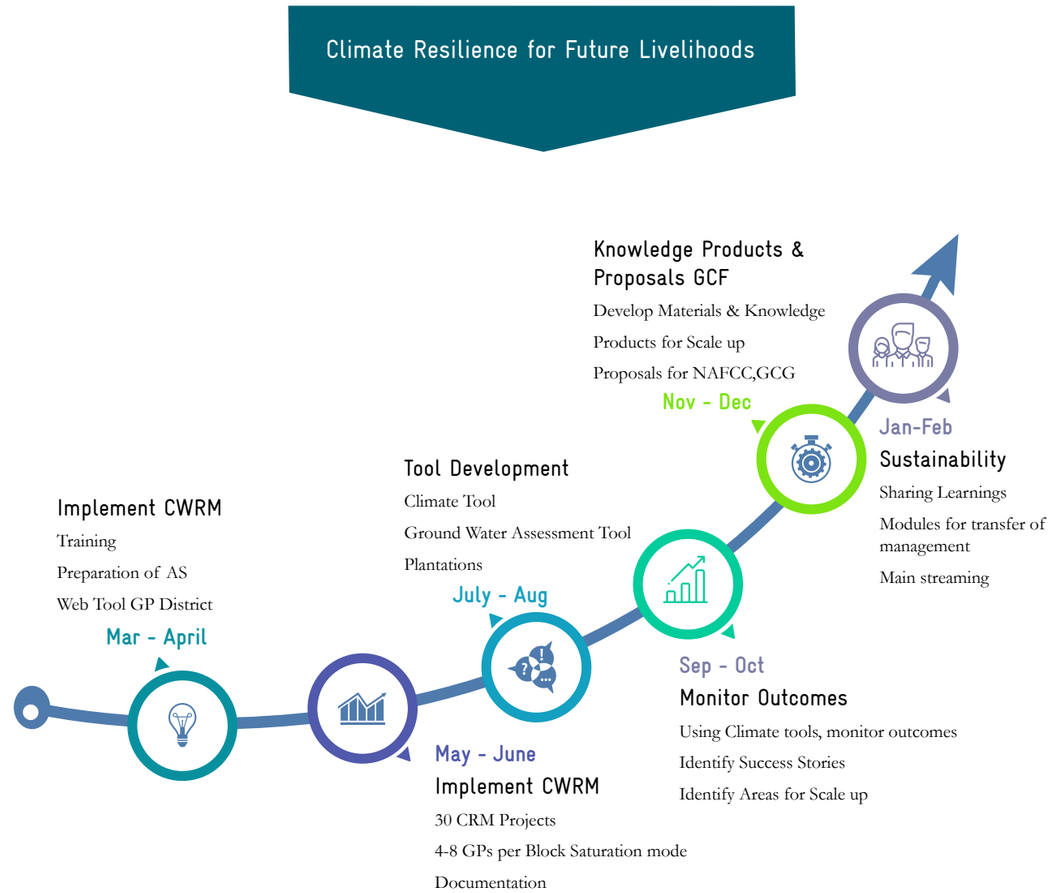


Fig 5.6: Framework for implementation

5.4.2 CDC STRATEGY 2: MAINSTREAMING

The main streaming should lead to:

- Reduce supply and demand gap and develop synergetic towards adaptation
- Evidence-based water use with scientific data (WASCA - CWRM approach) across all schemes and programmes
- Mapping water availability in major and minor water bodies in time and space
- Periodical monitoring the state of system and non-system tanks
  Ensuring the free flow in water ways that carry excess water
- Proper water quality monitoring
- Agricultural best practices at the local level
- Efficient irrigation practices

Capacity Development and Cooperation Strategy for main streaming is to focus on consolidating the learning from two districts and have a framework for implementing it across the state. The focus of mainstreaming is therefore the ability of people associated with Gram Panchayat and community in two districts on the learnings and feedback, leading to formation of road map for the scale up.

The District Collector and administration becomes champion campaigners for the improvised CWRM plan, implementation strategies and WASCA framework based on Climate Vulnerabilities for other districts to follow up. The CDC approach in mainstreaming focus on how line departments, Private Sector partners, Technical Partners, Academic, Research Institutions, NGOs, Community Based Organization working under WASCA collectively develop a policy framework for WASCA in Tamil Nadu to cover coastal eco systems and land locked eco systems.

For Mainstreaming WASCA approach GIZ, Department of Rural Development shall take up the following steps in 2021-22

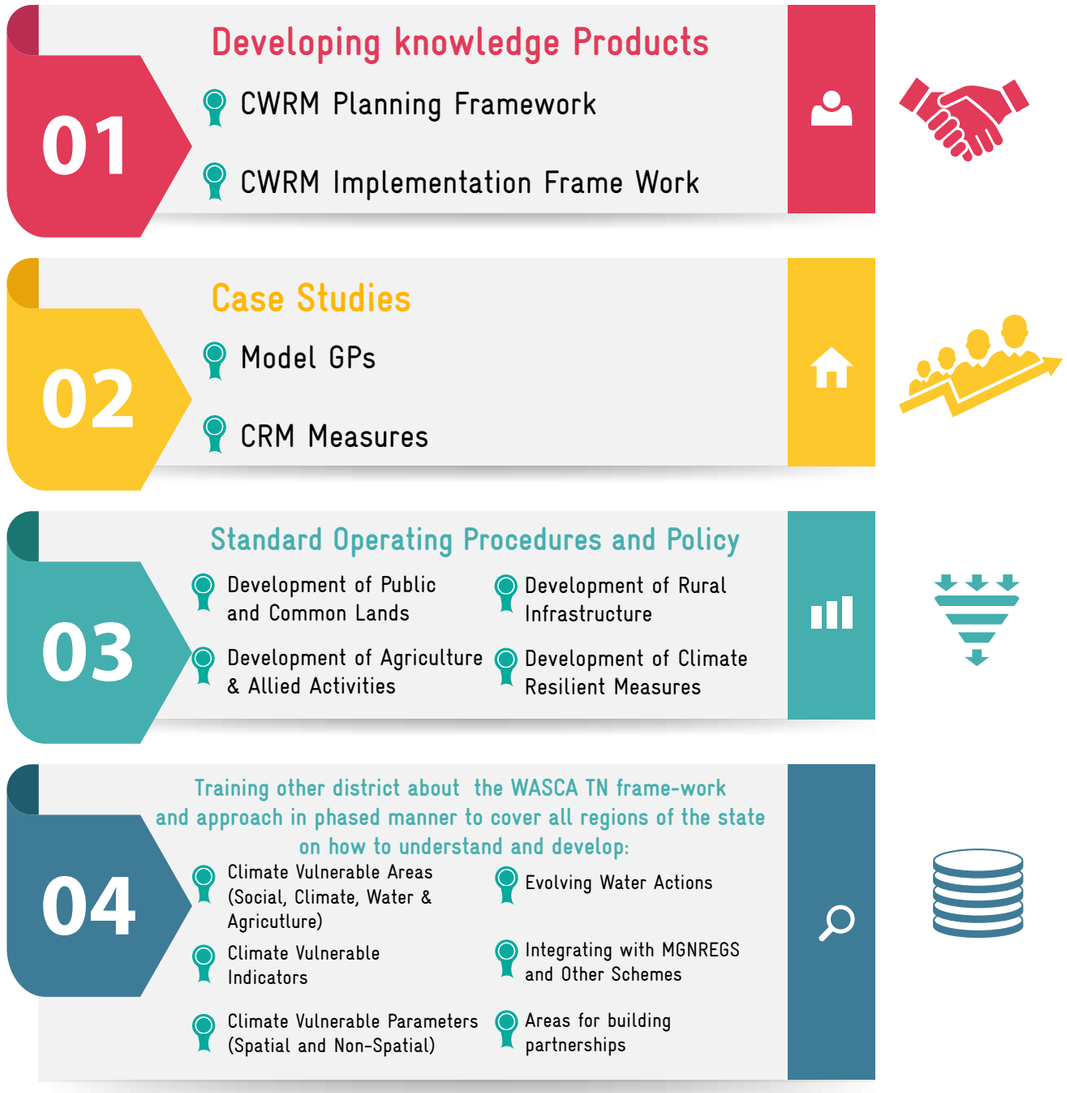


Fig 5.7: Steps in mainstreaming WASCA approach

CDC Strategy 2: Mainstreaming - District GIS Resource Centres

Mahatma Gandhi NREGA is world's largest outreach program. Planning is the key for success of implementation of Mahatma Gandhi NREGA. Scientific planning using GIS is now established and appreciated. To undertake planning, it is essential to have a knowledge centre close to GP or Block to enable planners use scientific data, information and prepare plans useful to their villages. The experience under WASCA implementation in two district shows that having a district level GIS resource centre helped in preparing plans in more scientific way with participation of all stakeholders.

Hence, if District GIS Resource Centres is established at every District or Division level, depending on number of Blocks and GPs it will go long ways in evidence based scientific planning and monitoring of works. These centres also helps in providing technical guidance, training to all functionaries up to village level and help community in undertaking works under Mahatma Gandhi NREGS and convergence.

1. Functions of District GIS Resource Centres:

1 **Data Repository:**

Collect, update and maintain data ((Spatial and Non-spatial information) related to natural resources, socio-economic, climate and district statistics useful for village level planning. The data will be maintained in digital form.

2 **Data Analysis:**

The centre analysis the various data in simple forms useful village level planning

3 Capacity Building: Conduct training and capacity building on data use, data collection, data analysis (Spatial and Non-Spatial) to functionaries and engineers involved in village level planning

4 **Plan Preparation:**

- Assist the village, block level planning teams in preparing draft plans using GIS and statistical data
- Assist the village, block level teams in analysis, finding the gaps and key action areas for resource allocation (prioritization)
- Assist the village teams in preparing drat plans in GIS environment
- Prepare simple plans for discussion, display at Gramsahba and GP meetings for necessary approvals

5 **Information dissemination:**

- Prepare progress reports on plans implemented
- Provide information, data to quality control teams for assessment
- Provide information to social audit teams necessary spatial data for necessary validation of findings
- Provide information for preparing block, district level reports for state and national level requirements
- Provide information for convergence planning to all concerned line departments

2. District GIS Resources Centres – Human Resource Plan

The District GIS Resource centre to be headed by a Nodal Officer not below the rank of Additional Project Director or Assistant Executive Engineer. She / He will be head of the District GIS Resource Centre and report to the Project Director (MGNREGS) / DRDA at the district level.

Each Grameen GIS Centre shall have following experts:

A) Staffing at the Centre

- 2 GIS experts
- One Watershed expert
- One Junior Statistical Officer cum data analyst
- 2 Computer Operators (Full Time) (Data Entry Operators)

B) Experts / Advisors from Line Department / Universities /Colleges

- 2 Engineers (One in field of Watershed and another Civil Engineer expert in rural engineering works
- Horticulture expert
- Agriculture expert
- Forestry and plantation expert
- Tanks expert
- Ground Water expert

3. District GIS Lab Setting

1 Two Rooms
2 One GIS Training cum plan preparation lab with LAN, high speed internet facility
3 Computers: 4 Systems for Staff and Experts
4 6 Systems at Lab (all connected by LAN) and training, planning facility for block or GP level officers
5 Two Projectors (One at Training Centre) and one for field level use during GP level meetings
6 One large TV at Training Centre to conduct online trainings or review meetings
7 Fixtures and furniture
8 GPS device for the lab.

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