SUB-NATIONAL CLIMATE ACTION ON ADAPTATION

Monitoring, Evaluation, and Learning Framework for Puducherry

India Phase II

Supported by / Prepared for
ICAT (UNOPS)

Initiative for Climate Action Transparency - ICAT

Subnational Report and MEL Framework for Puducherry

AUTHORS

Name: TERI Project Team

Affiliation: The Energy and Resources Institute

30th January, 2023

PREPARED UNDER

The Initiative for Climate Action Transparency (ICAT), supported by Austria, Germany, Italy, the Children's Investment Fund Foundation and the ClimateWorks Foundation.

The ICAT project is managed by the United Nations Office for Project Services (UNOPS).

Table of Contents

List of Figures

List of Tables

1. Introduction

The changing climate and the risks associated with the phenomenon make adaptation imperative for all countries. India, being a large country in the tropics with diverse agro-climatic regions and a long coastline, is extremely vulnerable to the consequences of the changing climate. According to the studies cited by the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report, climate change and rising demand would force at least 40% of the Indian population to live with water scarcity by 2050. The dual impacts, arising from rising sea levels and groundwater scarcity, will have a direct profound effect on the agriculture sector in India. The IPCC report estimates that yields of wheat, pulses, coarse crops, and cereals in India could fall almost 9% by 2050, this is likely to cause price spikes. In turn, these price spikes would threaten the food affordability, food security, and economic growth of the country. These risks have necessitated the need for extensive resources that are being targeted at not only designing activities and projects specifically addressing adaptation but also at ensuring that adaptation is integrated into the development planning to help reduce risks associated with climate change.

In India adaptation action was initiated under the National Adaptation Fund for Climate Change (NAFCC) in 2015 to extend financial support to all states and union territories (UTs). The priority areas for climate resilience under the NAFCC have been outlined along the lines of the Nation Action Plan on Climate Change (NAPCC) and the State Action Plan on Climate Change (SAPCC). The National Bank for Agriculture and Rural Development (NABARD) is the implementing agency for NAFCC projects, which is tasked with identification of projects, appraisal, sanction, release of funds, monitoring, and evaluation as well as capacity building of relevant stakeholders. Furthermore, there are various other central- and state-level initiatives which aim to enhance climate adaptation. Some prominent programmes include the National Innovations on Climate Resilient Agriculture (NICRA), State Action Plans on Climate Change (SAPCCs) and Programme on Climate Resilient Agriculture (PoCRA).

While the above-mentioned projects have been established, monitoring and evaluation frameworks that indicate the progress in work related to the projects are needed. The ICAT-A project seeks to identify some of these projects that are being implemented in the country to monitor, evaluate, and learn from the processes of implementation that are underway.

The Initiative on Climate Action Transparency (ICAT) aims to support countries with custom- made tools and methodologies to create frameworks for effective reporting on climate action while adhering to the country's development priorities. Globally, monitoring and evaluation frameworks are being developed to track the progress of the development programmes. These frameworks are considered as standardized tools which assist in reporting outputs, outcomes, and impacts of a project and help in establishing accountability. Monitoring and evaluation in adaptation projects not only support in tracking the progress of interventions but also help in evaluating needs for adjustments. They enable countries to comprehend whether they are doing the right things, doing them correctly, and what could have been done differently to arrive at the desired results. The following are the chief areas that the suitably developed frameworks can help facilitate understanding of the governments:[1]

- Successful adaptation actions which reduce vulnerability

[1] Details available at <https://www.adaptationcommunity.net/wp-content/uploads/2020/05/Adaptation-Briefings-2-Monitoring-and-Evaluation-of-Adaptation-An-Introduction.pdf>

- Addressing urgent adaptation needs
- Results of climate policies
- Increase in resilience of communities

As adaptation measures and development initiatives are implemented at the state level in India, there is a need to explore the implementation framework as well as identify the key stakeholders at this level. The present document entails details of the Puducherry adaptation initiatives, which focus on the water sector and the increasing threat of saltwater ingress in the groundwater table. Along with these adaptation initiatives, we also look at the mapping of the financial and implementing stakeholders in the state; as well as the needs and capacity of the line departments for the implementation of a monitoring, evaluation, and learning (MEL) framework.

1.1 ICAT-A Approach for Stakeholder Engagement

1.1.1 Scales of Engagement

Since adaptation is locally oriented and has to be context specific, there is a need to engage stakeholders at all possible levels of the implementation process. An effective implementation of any climate change adaptation intervention requires engagement at various scales, starting from individuals to institutions, both horizontally and vertically oriented. The application of various scales as indicated below is primarily based on the kind of adaptation intervention being planned/ implemented.

- National: Central government, other relevant entity/es in the implementation of the projects, private sector, research institutions, academia, and non-governmental organizations (NGOs), financial institutions, and others.
- Subnational: State relevant departments, state research institutions, private sector, academia and NGOs, financial Institutions, and others.
- Local: Community Based Organizations , Gram panchayats, and village-level committees
- Beneficiaries: Can be divided on basis of three social strata, namely, type, class, and caste.
  - » **Type**: Households/ individuals groups [farmers, fisher-folk, forest-dependent communities, coastal communities (any other if applicable)]
  - » **Class**: High, mid, low-income groups
  - » **Caste**: General category, schedule casts (SCs)/ schedule tribes (STs)

The objective of interactions being to understand, co-produce information that then assists in the learning process of how the implementation is being carried out.

1.1.2 Mode of Engagement

The mode of engagement primarily varies according to the type of stakeholder being taken into consideration and the kind of information that needs to be extracted. For instance, key person interviews and one-to-one interactions are generally carried out for establishing interactions with various institutions to garner information on the nature of the intervention, roles, and responsibilities in implementation and understanding the barriers and bridges for implementation. Community interactions are also conducted to understand their perspectives on the nature of impact and the interventions being carried out or proposed. Group discussions, Focus Group Discussions , surveys are the common modes of engagement and collation of information from the beneficiaries.

2. Description of the Sub-national Action on Adaptation in Puducherry, India

2.1 Geography and Climate

Puducherry is the capital of the Union Territory of Puducherry, located on the southeast coast of India at latitude 11.916064, and longitude 79.812325. Puducherry, a UT of India, is bounded on the East by the Bay of Bengal and on the remaining three sides by Tamil Nadu. The UT comprises Puducherry, Karaikal, Mahe, and Yanam, wherein Karaikal lies about 130 km south of Puducherry on the East Coast and Mahe is situated on the Malabar Coast on the Western Ghats surrounded by Kerala. Yanam is situated adjoining the East Godavari district of Andhra Pradesh. The coastline is 45 km, with 26 landing centres and 1,000 km2 of continental shelves (with potential marine fisheries).

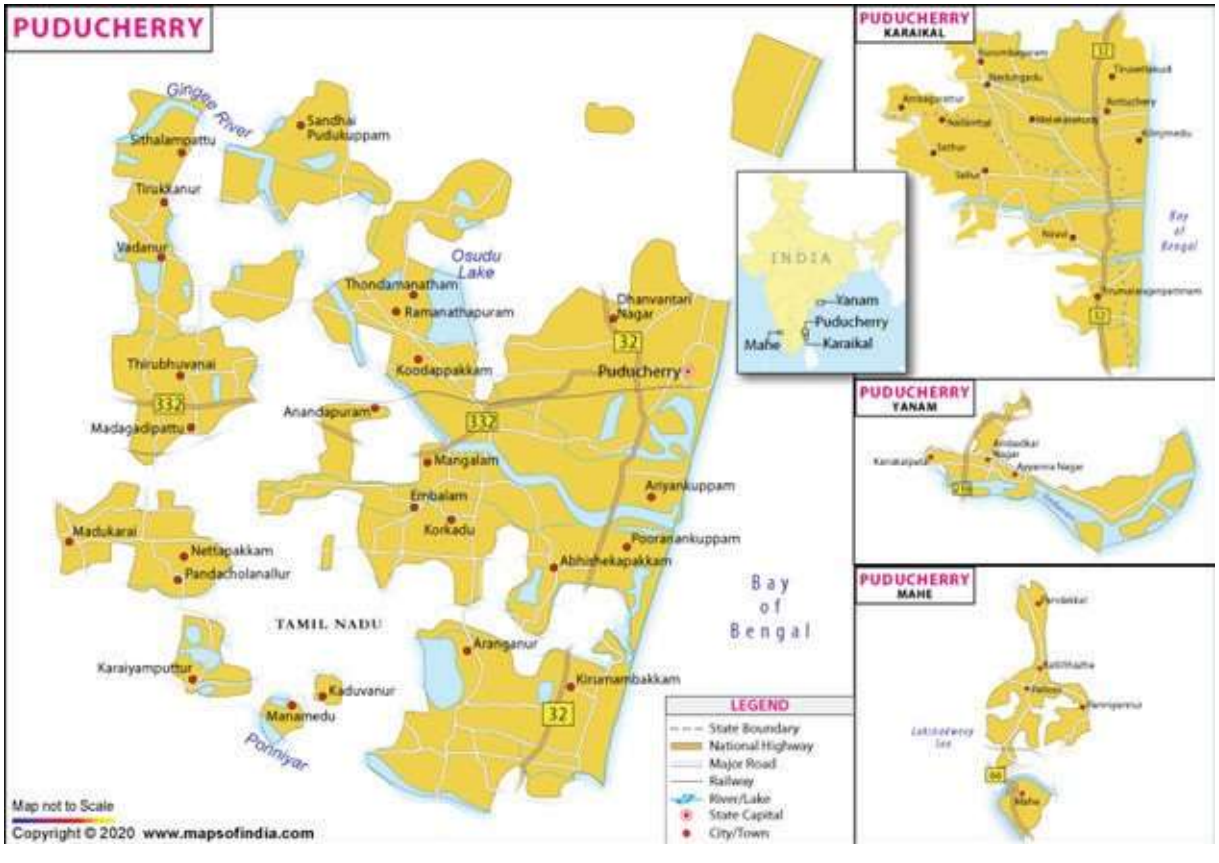

FIGURE 1 Map of Puducherry
Source Maps of India (2020)

The Puducherry region is intersected by the deltaic channels of Gingee and Ponnaiyar Rivers. It is also interspersed with lakes and tanks. Karaikal is part of the fertile Cauvery delta. Yanam region is skirted on the east and south by the Godavari River. The region is divided into two parts by the separation of the Godavari and Coringa Rivers. The Mahe region is divided into two parts by the west flowing Mahe River. It is bounded in the south-west by the Arabian Sea and in the north by the Ponniyam River. While Puducherry and Karaikal regions receive rain mainly from the north-east monsoon, Mahe and Yanam regions receive theirs chiefly from the south-west monsoon.

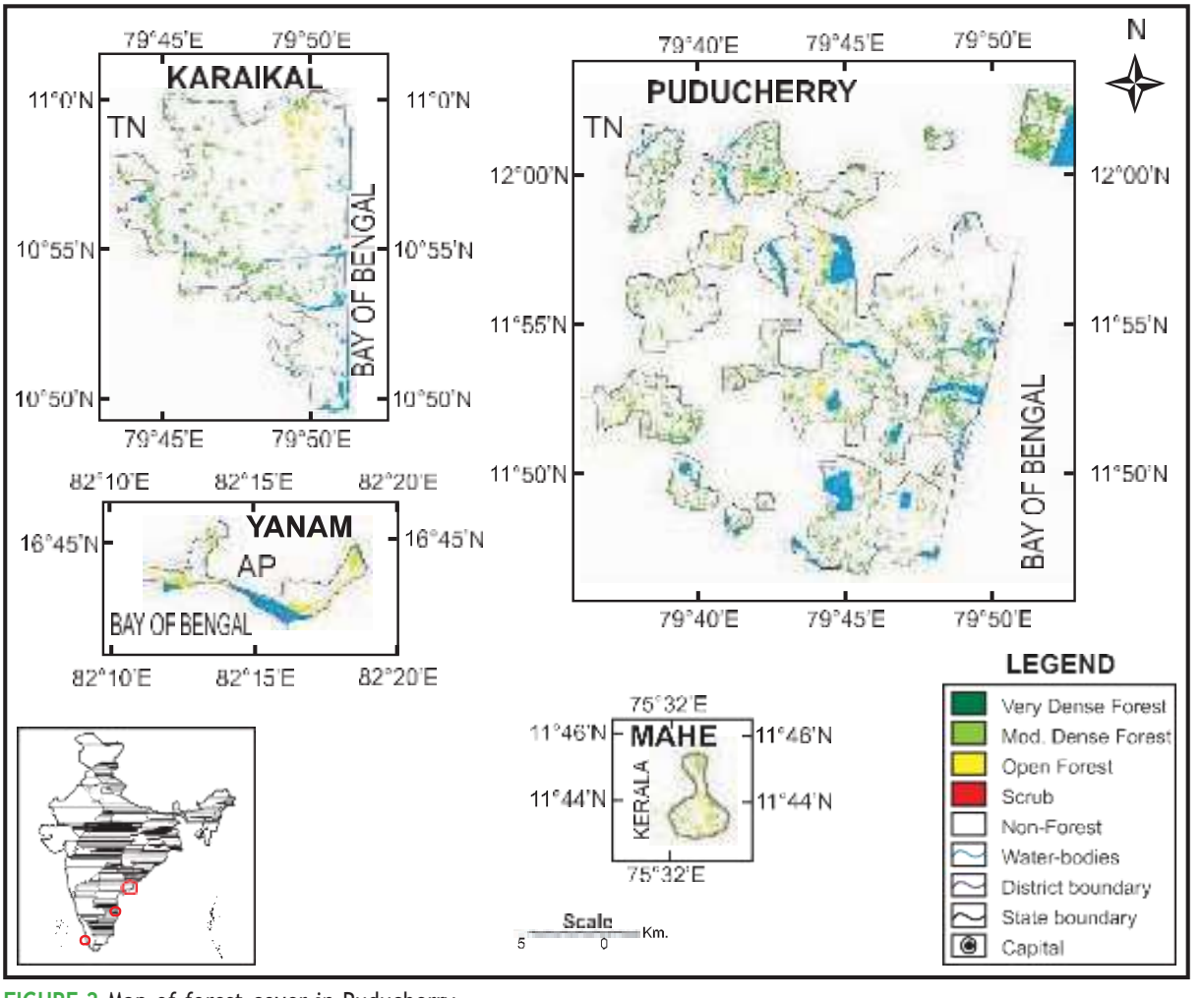

FIGURE 2 Map of forest cover in Puducherry
Source FSI (2011)

All the four regions of the Puducherry are coastal flat plains. Mahe is bounded by a stretch of calcareous hills on the east while there are no hills in the other regions. As per the Forest Survey of India (2019) the forest cover in Puducherry is 52.41 km2 which is about 10.70% of the total geographical area of the UT. Low forest cover and rapid land use change is a major factor that contributes to the climate vulnerability of the region. Mangrove

vegetation is seen to some extent in the estuaries and along the sides of Ariyankuppam river (in Puducherry region), Gouthami River near Guirempeta (in Yanam region).

TABLE 1 Land-use classification of Puducherry

Land-use classification (area in hectare)	Puducherry	Karaikal	Yanam	Mahe
Forest	0	0	0	0
Land put to non-agricultural use	7107.93	3590.24	1189	237
Barren and uncultivable land	11.35	0	0	1
Permanent pastures and other grazing land	0	0	0	0
Land under miscellaneous tree crops, etc.	339.27	184.46	480	2
Culturable waste	755.27	1,638.46	17	25
Other fallow land	987.01	874.65	84	4
Current fallow	2,032.54	533.73	27	8
Net area sown	10,425.4	5,343.51	594	593

Source Census (2011)

The Union Territory Puducherry experiences a hot and tropical maritime type of climate, characterized by small differences in the daily range of temperatures, humid weather, and moderate rainfall due to its geographical location closer to the sea. Puducherry and Karaikal regions experience similar climate. Summer lasts from April to early June, when maximum temperatures may reach 41°C. The average maximum temperature is 36°C. Range of minimum temperatures is 28–32°C. This is followed by a period of high humidity and occasional thunder showers from June till September. The north-east monsoon sets in during the middle of October, and the regions get the bulk of its annual rainfall during the period of October to December.

2.2 Demography

The population of the UT as per Census 2011 is 1,247,953 with 612,511 males and 635,442 females. The UT ranks 29th among all states and UTs in the size of population and second among UTs. The rural population is 395,200 (31.7%) whereas the urban population is 852,753 which constitutes 68.3% of the total population. As against the national pattern, the percentage of population in urban areas is much higher than the population in rural areas. The entire Mahe and Yanam regions have been classified as urban.

Scheduled caste (SC) constitutes about 16% of the total population of the UT and occupies 23rd position in SC population among the all states and UTs in India. There is no notified ST population in the UT. About 44% of the SC population are living in the urban areas of the UT while nearly 22% of the population belongs to below poverty line.

TABLE 2 Key demographic indicators of Puducherry

Item	Puducherry
Area	490 km^2
Population	1,247,953 (Census 2011)
Decadal growth	28.1% (Census 2011)
Crude birth rate	16.1 (2013-14)
Crude death rate	7.2 (2013-14)
Infant mortality rate	19 (2013-14)
Sex ratio	1037 (Census 2011)
Population density	2547 (Census 2011)
Population below poverty	21.67%
Literacy rate	85.85%
Human development index (HDI)	6th rank at international level

Source Puducherry State Disaster Management Plan (2021)

2.3 Socio-economic Profile

The Gross State Domestic Product (GSDP) of the UT is INR38,285 crore (2021-22) while the per capita income is INR216,495.

Agriculture, fishing, manufacturing, and service industries all have important roles in the totality of economic activities in Puducherry. However, over the past few years, the proportion of sectoral contribution to the GSDP of the primary sector contribution had declined considerably. In the primary sector, contribution of fisheries tends to be higher than the agriculture.

The UT has a strong presence in the tourism, agriculture, and marine product sectors. Agriculture and fisheries play an important role in Puducherry's economy, which provides livelihood for majority of the population. Principal crops in the UT are paddy, sugar cane, and groundnut. Agriculture is one of the most important occupations for the people of Puducherry. About 45% of the total population depends directly or indirectly on farming. However, the agriculture sector contributes <2% of the GSDP of the Government of Puducherry. The UT is one of the largest producers of bananas, flowers, tapioca, coconut, groundnut, and sugar cane in the country.

The UT is characterized with large chunk of small landholdings of less than 1 hectare (ha). The net area under various sources of irrigation during the year 2013-14 was recorded as 13,830 ha, 88.6% of the net area sown was irrigated in Puducherry district, whereas the corresponding figures for Karaikal, Mahe, and Yanam are 93.71%, 6.41% and 50.00%, respectively. Groundwater serves the irrigation, drinking, and industrial needs in Puducherry. Puducherry and Karaikal also have many ponds/tanks, which are also a source of irrigation. However, recently, there has been a reduction in cultivable land in Puducherry due to increased non-agri activities, especially animal husbandry and dairy.

Owing to its long coastline, Puducherry has an extensive fishing economy with fishermen population of about 95,467. The UT is also endowed with freshwater area in the form of ponds and tanks that are suitable for both capture and culture fishery.

In 2020, Puducherry witnessed arrivals of 1,114,942 domestic tourists and 92,080 foreign tourists. As per the government, the tourism sector has vast economic potential, as it can bring in foreign exchange and revenue to the UT. Therefore, due to concerted efforts to grow the tourism industry, the proportion of population depending on the tourism for revenue has been growing considerably.

All the major sectors of economy in Puducherry are highly vulnerable to climate change, especially through rising sea levels and the potential of climate hazards. Due to the influence of the monsoon season in all the regions of Puducherry, the UT is highly vulnerable to cyclones; which often develop in the Bay of Bengal. The regions are also affected by increasing variability of rainfall as well as saltwater ingress into the groundwater table; leading to further risks to the agricultural and irrigation activities in the region.

3.0 Three Climate Change Risks and Impacts in Puducherry

Climate projections for India suggest that impacts are likely to be varied and heterogeneous, with some regions experiencing more intense rainfall and flood risks, while others encountering sparser rainfall and prolonged droughts including spatial shift in the pattern of rainfall. The coastal areas are likely to suffer from higher tides, more intense storm rising from warmer oceans and further erosion of coastline due to sea-level rise. In lieu of the disproportionate climate change, the coastal areas constitute some of the most vulnerable ecosystems of the world. These coastal belts often prove to be the hot spots of severe impacts associated with permanent inundation of low-lying areas, increased flooding due to extreme weather events such as storm surges, tsunami, and greater erosion rates affecting beaches and cliffs and devastation due to calamities like cyclone.[2]

Climate change can also lead to an accelerated sea-level rise and possible increase in the intensity and frequency of cyclones.[3] The increase in sea surface temperature will lead to an increased risk of hazards such as flooding, coastal erosion, and shoreline retreat.[4] Such projections require the development of a robust sustainable coastal management plan which can anticipate the potential geomorphic changes along the coastline as well as mitigating the damage to coastal ecosystems and resources.

There are two rivers draining into the region of Puducherry: (1) the Gingee River, which traverses the region diagonally from north-west to south-east and (2) the Ponnaiyar (Penniyar) River, which forms the southern border of the region.

Karaikal falls in the deltaic region of Cauvery, and therefore the dominant soil of the district is sandy alluvium. There are eight rivers in Karaikal region: (1) Arasalar, (2) Mullaiyar, (3) Nandalar, (4) Nattar, (5) Noolar, (6) Piravidaiyanar,

---

[2] Nicholls and Cazenave. 2010; EC, 2005; EEA, 2006; Klein, et al. 2003

[3] Alakkat, Unnikrishnan, Kumar K, Fernandes, S E, Michael, G Selvan, and Patwardhan, SK. 2006. Sea level changes along the Indian coast: observations and projections. *Current Science* 90

[4] Pye, Kenneth and Blott, Simon. 2006. Coastal Processes and Morphological Change in the Dunwich-Sizewell Area, Suffolk, UK. Journal of Coastal Research. 22. 10.2112/05-0603.1

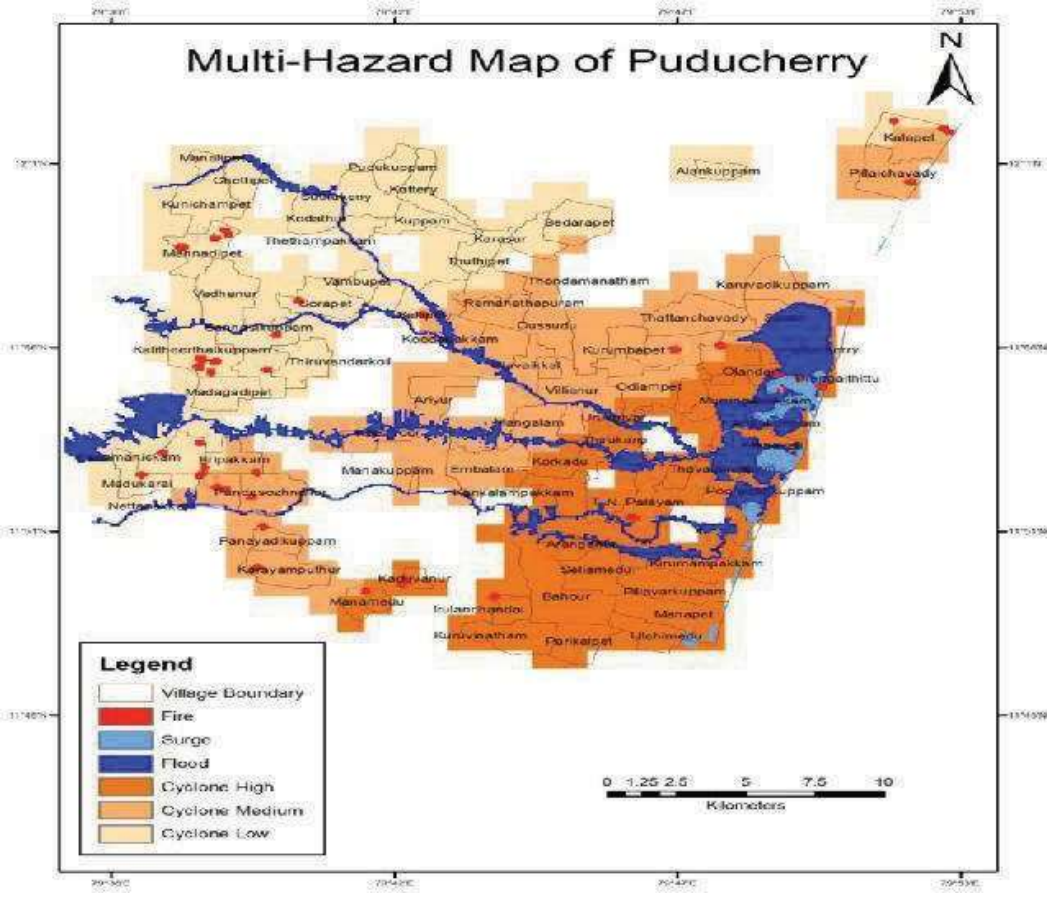

FIGURE 3 Multi-hazard-prone area in Puducherry district

Note Map based on grid-based analysis in GIS

(7) Thirumalairayanar and (8) Vanjiyar. These rivers are distributaries of the Cauvery River, and a major portion of the flow of water from Tamil Nadu is drained into the sea through these waterbodies.

The low-lying nature of the regions makes them highly vulnerable to inundation, as well as to the effects of imbalances in coastal erosion. The problem of soil erosion in the coastal regions and possibility of saltwater ingression into coastal aquifers has emerged as a pressing issue. Projections indicate increase in summer temperatures by 3–4°C in moderate emission A1B scenario.[5] Long-term climatic observations also indicate shift in rainfall period, deviation in amount of rainfall, and variation in water levels.[6]

[5] Details available at <https://dste.py.gov.in/Envispdy/assets/pdf/Action%20Plan/SAPCC_UT_of_puducherry.pdf>

[6] Thilagavathi, R., Chidambaram, S., Panda, B R, Tirumalesh, K., Devaraj, N., and Kurmana, A. 2017. Understanding the decadal variation of the groundwater resources along the coastal aquifers of Pondicherry-a climate change perspective. Journal of Climate Change 3(2): 25-42. Details available at <https://content.iospress.com/articles/journal-of-climate-change/jcc170012>

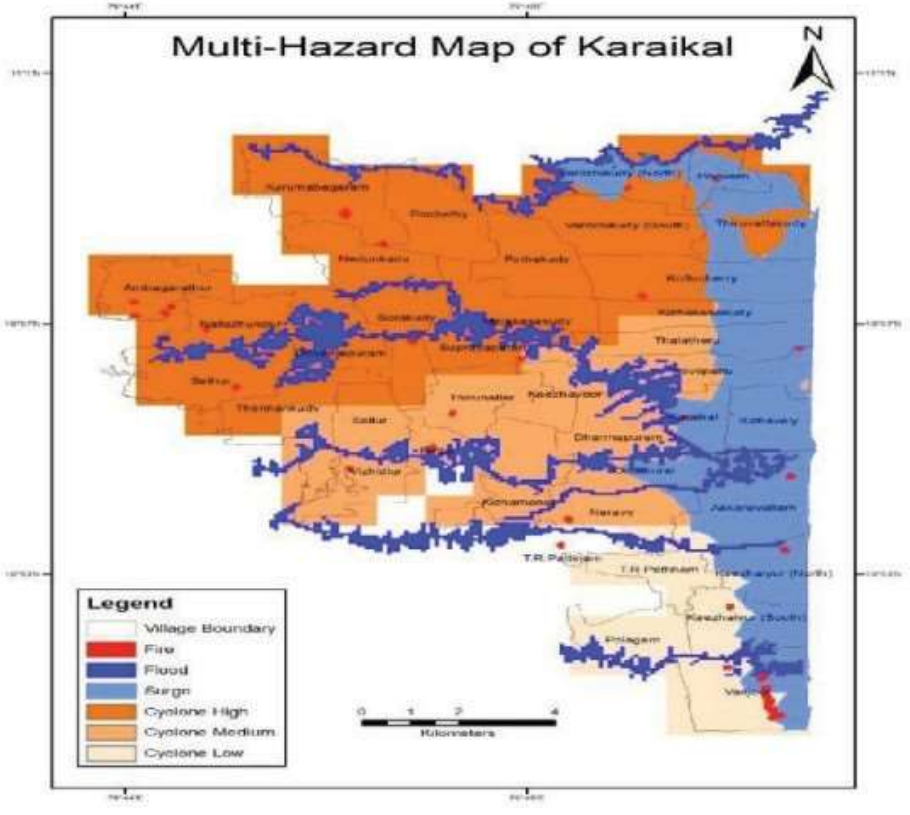

FIGURE 4 Multi-hazard-prone area in Karaikal district

Note Map based on grid-based analysis in GIS

The Bay of Bengal is one of the six regions in the world where severe tropical cyclones originate, and the UT of Puducherry, especially the Puducherry and Karaikal regions, witnessed the increased incidence of natural hazards such as storm surge, tsunami, and cyclone. The tsunami in December 2004 along the coastline of Puducherry and the Thane cyclone in 2011 had resulted in extensive economic and losses of life.

These changes have a particular bearing on water resources and sensitive sectors such as agriculture with issues such as drying up of surface water sources, decrease in groundwater table, salinization of groundwater, reduced soil fertility, and consequently decrease in crop output. The projection of the hydro-meteorological and geophysical hazards would jeopardize the current growth strategy and deepen poverty amongst the vulnerable coastal communities through discouraging engagement of communities in farm and non-farm sector. The impacts of extreme climate-induced events resulting in loss of life, livelihoods, assets, and infrastructure could affect Puducherry's economic growth and nullify the effectiveness of macroeconomic policies and economic development initiatives. Given its profile, climate change is an important concern for Puducherry as it is presently on a carbon-oriented development path and at the same time, it is vulnerable to climate variations.

3.1Heavy Rain/Flood

Heavy rain and flood occur frequently in Puducherry district. Heavy rains and floods often cause widespread damage to houses, infrastructure, road, communication networks, and agricultural crops. Some of the flood events have caused season long impacts on livelihoods for those who rely primarily on fishing and agriculture. The flood inundation affects mostly low-lying areas along major rivers/drains, as well as localities within 2–3 km from the shoreline. Both Ozhukarai and Puducherry municipalities are prone to flood hazard while the southern part of the district are relatively less affected by flood. Historical flood hazard data shows damaging floods occurred in 2007, 2006, 2005, 1998, and 1996.

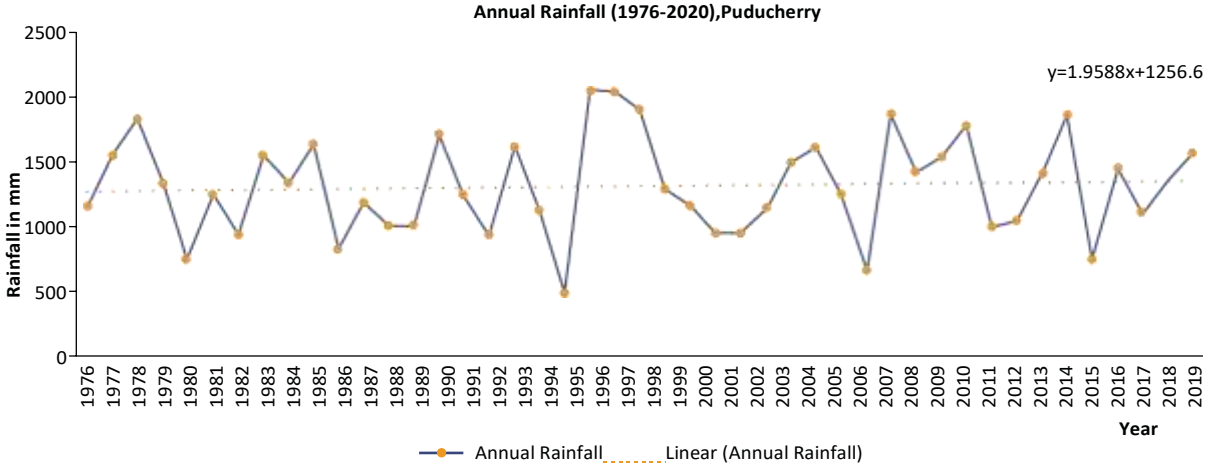

FIGURE 5 Annual and linear rainfall in Puducherry in 1976-2020

Among all the four regions of the UT, impact of flood is severe in Karaikal district. Catastrophic flood events were recorded in 2008, 2006, 2005, 1997, and 1993 causing heavy damage to agriculture and infrastructure. The district is categorized as a high-risk area due to exposure to flood, as per the BMTPC Vulnerability Atlas of India.

The monsoon rainfall has also been increasing in the Puducherry region. Owing to the rise in temperature along with rainfall increase, the climate is projected to be hot and humid in the near future. This would necessitate the need for temperature-adaptive agronomic practice and even varieties to withstand water logging and salinity in the low-lying areas to reduce climatic risks to agriculture.

3.2 Cyclones

The east coast of India is vulnerable to cyclones originating in the Bay of Bengal mostly during November, December, and January months. As per the BMTPC Vulnerability Atlas of India, the maximum probable wind speed in the Puducherry district is 64 miles/second and is categorized in the high damage risk zone (47 miles/second). The cyclone Thane (2011), Nisha (2008), the cyclones of 2000 and 1993 caused wide spread damage in Puducherry.

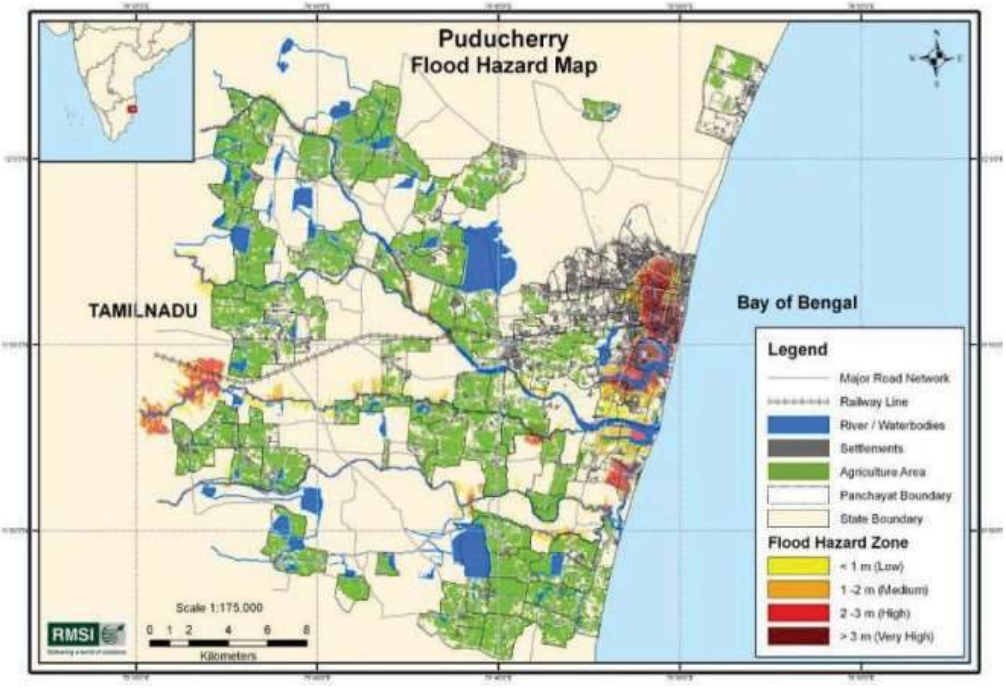

FIGURE 6 Flood hazard map for Puducherry district

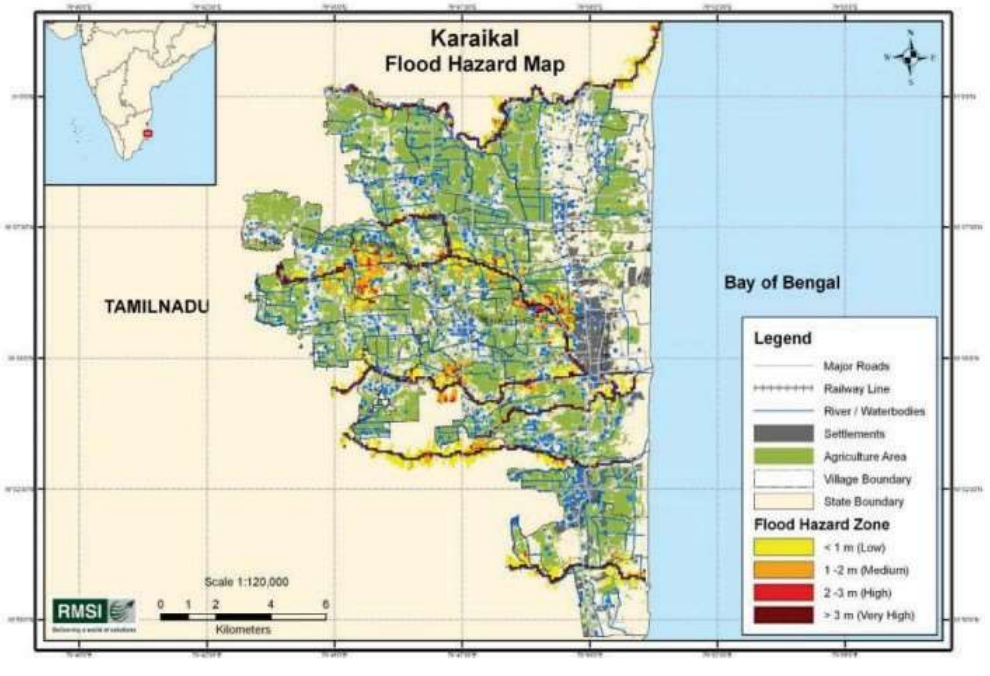

FIGURE 7 Flood hazard map for Karaikal district

The cyclonic situation can lead to wave surges, leading to water inundation in the coastal areas. However, in the case of Puducherry district, the damage is often caused by high wind velocity than due to wave surge and water inundation. Puducherry is also under the influence of strong winds mainly during May, June, and July months due to the monsoon in the subcontinent. During May, the peak summer period, unbalanced tropospheric temperature occasionally cause downbursts (strong wind normally sustained for not more than 3 to 5 minutes) along with heavy thunderstorms in the district. However, there is no record of damage and life loss due to strong winds in Puducherry.

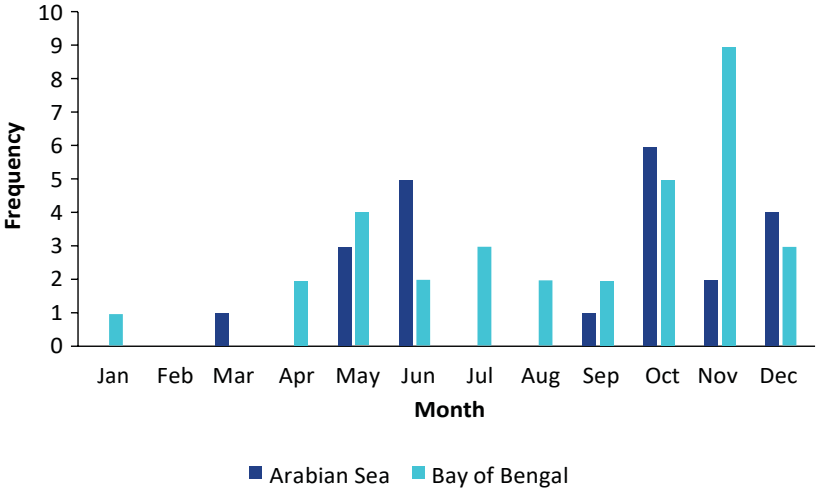

FIGURE 8 Monthly frequency of cyclones in India (1971-2022)

A major cyclone of maximum wind speed of 189 km/h was recorded in the Karaikal district in the year 1966. As per the BMTPC Vulnerability Atlas of India, the district has high risk factor with maximum probable wind speed of 64 miles/second. The historical tracks of cyclone in the region show that the district has higher incidence of cyclone events than the other three districts of Puducherry, Mahe, and Yanam. The maximum probable wave surge is also highest in Karaikal among other districts, which is 4.5 m. Karaikal is also under the influence of strong winds during the months of May, June and July, during the onset of the south-west monsoon. There are no recorded damages and life loss in the districts due to strong winds.

3.3 Droughts

Drought is not a common hazard in the Puducherry district. However, historical data shows that there was a prolonged dry spell in the summer months in 2002 in the Karaikal district. This impacted the agricultural productivity in the district, causing an economic loss of INR32.4 crore. The year was declared as a drought year in the district.

3.4 Water Sector in Puducherry and Seawater-induced Salinity

The health of water resources is essential for the economic prosperity of Puducherry, since the major livelihood forms in the UT, like fishery and agriculture, depend largely on water resources. Irrigation alone accounts for 83% of the water consumption in Puducherry, with tank irrigation, fed by the Gingee and Penniyar Rivers, popular in most places in the UT. However, most of the industrial demands for water are met by the groundwater resources of Puducherry.

TABLE 3 Sources of surface water in Puducherry

Region	Source of surface water
Puducherry	Tanks (86 small and medium tanks in Puducherry region of total capacity 46.36 MCM, which serve about 6764.6 hectares), ponds and small rivers like Sankaraparani, Pambayar, Malattar, Penniar
Karaikal	Arasalar and distributaries of Cauvery
Yanam	Gouthami
Mahe	Mahe

Source State Vulnerability Assessment (2019)

Puducherry is also endowed with substantial groundwater resources. The utilizable groundwater resources (at 85% of the gross recharge potential) are assessed at 151 MCM. Since alluvial aquifers cover about 90% of the Puducherry region, water level in the wells is shallow, ranging between 12 and 14 m below ground level. In the tank command areas alone, there are 70–80 shallow wells and around 1000 tube wells. Overall, there are some 8000 tube wells in the Puducherry region which extract water for agriculture, industry, and domestic purposes.

TABLE 4 Groundwater profile of Puducherry

Total replenishable groundwater resources (in MCM)	**174.60**
Provision for domestic, industrial and other sources (in MCM)	26.20
Available for irrigation (in MCM)	148.40
Projected net draft (in MCM)	115.50
Balance for future use (in MCM)	32.90
Level of groundwater development (in %)	77.85%

Source State Vulnerability Assessment (2019)

The impact of climate change on freshwater system and their management are mainly due to the projected rise in temperature, increased level of precipitation and evapotranspiration, lower water yield, land-use pattern. Adequate availability of water is the prerequisite for sustainable socio-economic development. The anticipated impacts of climate change would exacerbate the challenges and further imperil poverty reduction efforts. Seawater-induced salinity is amongst the major threats to the coastal aquifer system in the region. Seawater

and groundwater are connected naturally by an interface in coastal aquifers; the freshwater being lighter floats on the denser seawater. The over drafting of freshwater from coastal aquifers leads to inland movement of seawater.[7] Since dependence on groundwater for agriculture, domestic and industrial purposes is high in the region, salinity intrusion is a major concern.

The intrusion of seawater into the aquifer network causes the groundwater to be unsuitable for domestic usage as the salt content with respect to the drinking water standards becomes too high for use. Excessive extraction

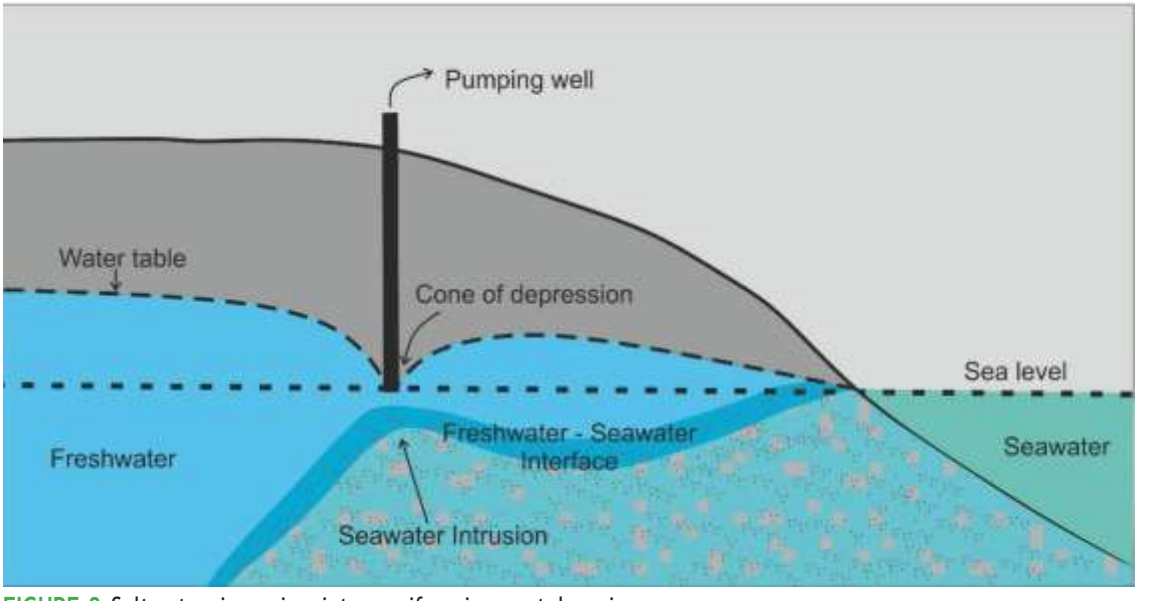

FIGURE 8 Saltwater incursion into aquifers in coastal regions

of groundwater in coastal areas also creates pressure in the form of saltwater intrusion, as the groundwater is vulnerable to seawater ingression. The shallow aquifers along the coast show signs of salinity. Owing to over pumping, there has been a reversal of gradient in certain areas like Kalapet, Muthialpet, Mudaliarpet, Kirumambakkam, and Panithittu. Saltwater has already intruded up to 5–7 km from the coast, creating a situation where any further extraction of groundwater must be done only beyond this distance.

[7] Khan, F., Krishnaraj, S., Raja, P., Selvaraj, G., and Cheelil, R. 2021. Impact of hydrogeochemical processes and its evolution in controlling groundwater chemistry along the east coast of Tamil Nadu and Puducherry, India. Environmental Science and Pollution Research 28 (15): 18567–588. Details available at <https://link.springer.com/article/10.1007/s11356-020-10912-y>

4.0 Adaptation Intervention in Puducherry under the National Adaptation Fund for Climate Change

The Integrated Surface Water Management for Climate Change Adaptation initiative is a National Adaptation Fund for Climate Change (NAFCC)-funded project. While the funding is routed through a central agency, but the interventions, implemented by the state are specific to the needs and the requirements of the state. The initiative promotes traditional system of water conservation, as stated in India's National Water Mission.

The Union Territory of Puducherry under the NAFCC project introduced the Integrated Surface Water Management for Climate Change Adaptation in UT of Puducherry. Climatic changes in the state include seal-level rise, coastal erosion, rise in temperature and precipitation during the summer months and increasing intensity of extreme events. These alterations in the environment have adversely impacted sectors based on natural resources such as agriculture and tourism.

The agriculture sector of the state is highly dependent on groundwater sources, leading to a depletion in groundwater levels. Water availability is further aggravated by increasing pressure of population, intensification of agriculture and industrial activities. As a result of this, the region is reporting issues of salinization of groundwater, drying up of waterbodies, declining soil fertility and reduced crop production. Through the NAFCC project, the aim is to embrace an integrated approach to revive surface waterbodies and increasing groundwater recharge, reducing groundwater salinization, and restricting the use of saline water.

The case study has been identified in consultation with experts in the UT of Puducherry and has been discussed in the sections to follow.

Puducherry Union Territory is a part of the eastern coast of India, with an average elevation of about 15 metres above sea level. The UT comprises four regions, namely, Puducherry, Karaikal, Yanam, and Mahe. All these regions, while being parts of different states are coastal. Puducherry, Karaikal and Yanam lie on the eastern coast while Mahe is located on the western coast of India.

The eastern coast of India is different from the western coast in many ways. While the western coast (Mahe) receives a good amount of rainfall annually, the rainfall in the eastern coast is highly variable and is contingent largely on the depressions of the Bay of Bengal. Over the years, it has witnessed the lack of a particular pattern and an erratic nature of rainfall (Gopalakrishnan 2016).

This has formed the rationale behind the construction of tanks in the region for water conservation and storage purposes. The UT has about 84 tanks and almost 600 ponds for water conservation and rainwater harvesting.

The dependence in the UT for water is however very strongly skewed towards the use of groundwater for all purposes such as irrigation, industrial, and domestic since in the middle of the 1980s. And this has led to a fall in the groundwater levels of the Puducherry region. The rise in population, coupled with intensified agricultural practices and increased industrial activities have been the reason behind the depleting groundwater levels, and deterioration of water quality due to upward movement of chemical constituents present in deep seated aquifer.

Government records also note that there has been significant intrusion of saltwater into groundwater aquifers to a distance of up to 4 km in some places.

A change from community-based approaches such as traditional tank system of irrigation to borewells have not just meant a disuse and lack of maintenance of rainwater water harvesting structures which suffer from sedimentation but have inevitably further exacerbated the depletion and salination of groundwater resources, along with the vulnerability of the dependent communities.

The NAFCC-funded project, is aimed to be undertaken in a phased manner, envisages increasing the recharge capacities of tanks and ponds in the villages. The project, focussing on the Puducherry and Karaikal regions of the UT, will lead to the renovation of 186 village ponds and 39 irrigation tanks, and will also build the capacities of tank water users association in the north-western parts of Puducherry. The rationale behind the project is to encourage a shift towards conjunctive use of water. A harmonious and coordinated use of surface water and groundwater resources through the use of tanks and village ponds that get filled up during monsoon period, will augment groundwater recharge and hence ensuring enhanced water storage of the aquifers of this region. This will reduce saline water intrusion and also ensure better availability of water during dry periods.

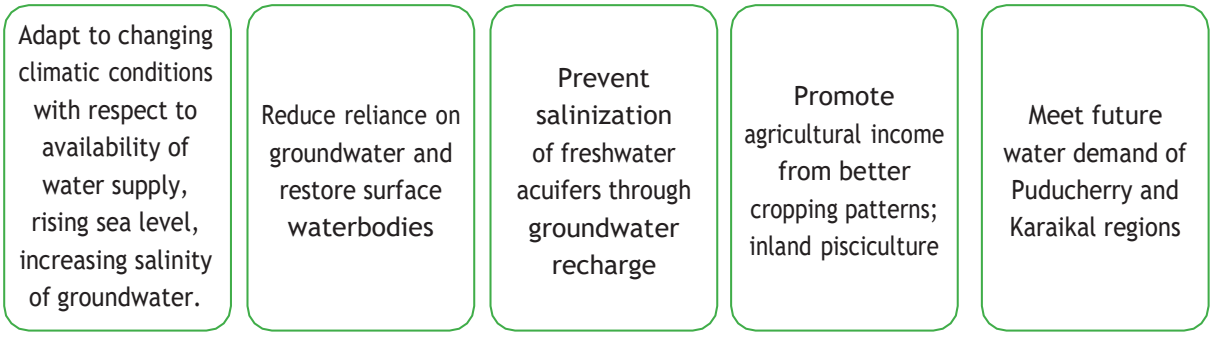

FIGURE 9 Objectives of the project

The project aims to rejuvenate surface water resources such as ponds and tanks to improve storage capacity, increase groundwater recharge, curb salinization of groundwater, and minimize the risk of usage of saline water. Channelizing storm water to village ponds is one of the preferred options for groundwater recharge, by minimizing groundwater depletion and seawater intrusion. The village ponds can be used as receiving and settling units for the storm water which can be utilized for agricultural activities. This would reduce the water consumption and help to adapt to extreme climatic conditions like drought, as well as combatting the effects of the incursion of saltwater into the groundwater network.

4.1 Governance Structure

The project is governed by a multi-tier structure of entities at national, state, and local levels, largely responsible for conception, funding, execution, and monitoring of the project.

TABLE 5 Governance structure

S. No.	Governance structure	Entities
1	Funding agency	Climate Ministry of Environment, Forests and Change (MoEF&CC), Government of India, under the National Adaptation Fund for Climate Change (NAFCC)
2	National executing entity	National Bank for Agriculture and Rural Development (NABARD)
3	State-level Steering Committee (SLSC)	**Chair:** Chief Secretary, Government of Puducherry **Members:** 1. Secretary to Government (Animal Husbandry) 2. Secretary to Government (Agriculture) 3. Secretary to Government (Power) 4. Secretary to Government (Fisheries) 5. Secretary to Government (Forest and Wildlife) 6. Secretary to Government (Health) 7. Secretary to Government (Local Administration) 8. Secretary to Government (Planning and Research) 9. Secretary to Government (Public Works) 10. Secretary to Government (Revenue and Disaster Management) 11. Secretary to Government (School Education) 12. Special Secretary to Government (Industries and Commerce) 13. Special Secretary to Government (Transport) 14. Special Secretary to Government (Science, Technology and Environment) 15. Chief General Manager, NABARD, Chennai **Convener:** 16. Director, Department of Science, Technology and Environment
4	Project executing entities	1. Department of Science, Technology and Environment (DST&E), Government of Puducherry 2. Public Works Department, Government of Puducherry 3. Department of Local Administration, Government of Puducherry, through the local bodies (Commune Panchayats) of Puducherry and Karaikal regions
5	Nodal agency	Department of Science and Technology and Environment (DST&E), Government of Puducherry
6	Beneficiaries	General public, farming community, and industries

Source DST&E, Revised Detailed Project Report (2020), and in-person consultations with DST&E

4.2 Description of the Project Components of the Adaptation Intervention

The project has five major components involving rejuvenation of irrigation tanks in Puducherry, rejuvenation of village ponds in Puducherry, formation of a mini lake in Karaikal, rejuvenation of ponds in Karaikal, and capacity building of tank user associations (TUAs). The expected outputs and outcomes for each of the components are described in Table 6.

TABLE 6 Components: activity-output-outcome-impact

S. No.	Project/programme components	Expected concrete outputs	Expected outcomes
1	Rejuvenation of 39 irrigation tanks in Puducherry	1. Replenishment of groundwater level 2. Increase in storage capacity of tank 3. Creation of livelihood and assets	1. Maintenance of ecological balance 2. Prevention of salinity ingress 3. Increase in water availability 4. Higher crop yields and farmers' income
2	Rejuvenation of 39 village ponds in Puducherry	1. Replenishment of groundwater level 2. Increase in storage capacity of tank 3. Creation of livelihood and assets	1. Maintenance of ecological balance 2. Prevention of salinity ingress 3. Increase in water availability 4. Higher crop yields and farmers' income
3	Formation of a mini lake Padutharkollai village in Karaikal	1. Replenishment of groundwater level 2. Increase in storage capacity of tank 3. Creation of livelihood and assets	1. Maintenance of ecological balance 2. Prevention of salinity ingress 3. Increase in water availability 4. Higher crop yields and farmers' income
4	Rejuvenation of 147 ponds in Karaikal	1. Replenishment of groundwater level 2. Increase in storage capacity of tank 3. Creation of livelihood and assets	1. Maintenance of ecological balance 2. Prevention of salinity ingress 3. Increase in water availability 4. Higher crop yields and farmers' income
5	Capacity building of TUAs	Participatory micro-vulnerability assessment Participatory micro-planning	Equitable benefit sharing Community involvement and ownership Local institutions development

Source DST&E; Revised Detailed Project Report (2020)

4.3 Rejuvenation of 39 Irrigation Tanks in Puducherry

This component involves climate-proofing of 39 tanks that have been identified as priorities. The work primarily entails de-siltation and catchment treatment to enhance the water-holding capacity of the tanks and recharge groundwater. The subcomponents include deepening of the 'arangani' of the tanks, strengthening of bunds with excavated earth, constructing recharge wells, repairing sluice shutters, planting tree along tank bunds, reconstructing inlet structures. The executing agency is the Public Works Department of Puducherry.

4.4 Rejuvenation of Thirty-nine Village Ponds in Puducherry

Ponds have been identified for restoring to their original storage capacity through de-siltation bund strengthening, construction of retaining walls, and recharge shafts. The enhanced water- holding capacity of the ponds will cater to needs of the local villagers for bathing, water for livestock, fish breeding, etc. Harvesting the rainwater will promote groundwater recharge which will help in the prevention of salinity intrusion. This component is being executed by five Commune Panchayats under the Local Administration Department.

4.5 Formation of a Mini Lake in Padutharkollai Village in Karaikal

Agriculture in Karaikal region is entirely dependent on Cauvery River and its branches. The rainfall in the region is spread across 3–4 months, however, the cultivation of Kuruvai (short- term crop) largely relies on the waters of Cauvery. Since Karaikal is at the tail end of Cauvery River system, water is not available in sufficient quantities and in the absence of adequate storage system, the monsoon water is not utilized and instead is discharged into the Bay of Bengal. The irrigation modernization schemes planned by the government largely depend on the release of water from the Mettur Dam into the Cauvery. In this light, creation of storage systems has garnered attention and mini lakes have been created in the region to enhance surface storage and recharge of groundwater. The lake in Padutharkollai is in continuation of this objective. The lake is spread over 14.34 hectares (35.43 acres) of land with a storage capacity of 400.86 million litres and a depth of 2.40 m to support agriculture of 141.6 hectares (350 acres). The subcomponents include construction of earthen bund, inlet and outlet sluice and an approach road to the lake. Public Works Department, Karaikal is the executing entity.

4.6 Rejuvenation of 147 Ponds in Karaikal

Ponds, 147 in number, have been identified across Karaikal for restoration through activities like de-silting, catchment treatment, and bund strengthening for enhancing the water-holding capacity. The Karaikal Municipality and five other Commune Panchayats under the Local Administration Department are the executing entities.

4.7 Capacity Building of Tank User Associations

This component entails formation of 39 TUAs and preparation of micro plans at the tank level to strengthen institutions and deliver on principles of equity and benefit sharing. The primary executing entity in this case is the Public Works Department.

FIGURE 10 A rejuvenated village pond in Puducherry region

FIGURE 11 Rejuvenated irrigation tank and adjoining paddy fields in Puducherry region

FIGURE 12 Two irrigation tanks separated by a bund in Puducherry region. The silt excavated from the tanks is used for the repair and strengthening of the bunds and also transported to external sites that require silt for construction purposes.

FIGURE 13 In conversation with local farmers and Junior Engineer of the Irrigation Division of Public Works Department, Puducherry. Site of sluice construction for diverting tank water to field channels in Manalipet.

4.8 Quantitative and Qualitative Estimate of the Expected Impact of the Adaptation Intervention

The primary objective of the project activities is to replenish the groundwater aquifers in the region which will augment water resources and cater to the agriculture and allied sectors and lead to enhanced lives and livelihoods. Table 7 elucidates quantitative and the qualitative impacts of the project.

TABLE 7 Quantitative and qualitative impacts of the project

Quantitative impact	Qualitative impact
Rejuvenation of 39 irrigation tanks in Puducherry region	» Recharge of groundwater aquifers » Livelihood generation » Capacity development and knowledge generation
Rejuvenation of 186 village ponds; 39 in Puducherry and 147 in Karaikal	» Improved ecological balance in the project area » Improved groundwater quality (reduced salinity)
Formation of Mini Lake at Padutharkollai village in Karaikal	» Improved farmer yield and therefore better farmer income » Promotion of community ownership of common pool resources
Capacity Building of TUAs	» Strengthening of local institutions (like Panchayats)

Source DST&E, Revised Detailed Project Report (2020)

An estimated number of 8.5 lakh residents of the north-western part of the UT, are expected to benefit from the project.

5.0 Stakeholder Identification: roles and responsibilities for integrated surface water management

TABLE 8 Stakeholder identification

Stakeholder	Role of the stakeholder
MoEF&CC	» The Ministry of Environment, Forest and Climate Change is responsible for the promotion, planning, coordination, and implementation of environmental and forestry programmes and policy. » The Technical Scrutiny Committee (TSC) provides the recommendations on the NAFCC Project Concept Note submitted by states/UTs. » It is responsible for the sanction and release of funds to NIE (NABARD) for the implementation of the adaptation project.
NABARD	» National Bank for Agriculture and Rural Development works to promote rural development through participative financial and non-financial interventions, innovations, technology and institutional development. » NABARD acts as the National Implementing Entity (NIE) for the NAFCC project and is responsible for its overall implementation through its regional offices located in 31 states and UTs. » It facilitates the identification of projects/concepts from State Action Plan for Climate Change, formulation of project, appraisal, sanction, disbursement of fund, capacity building of stakeholders and monitoring and evaluation.

TABLE 8 Stakeholder identification

Stakeholder	Role of the stakeholder
DST&E, Government of Puducherry	» The DST&E acts as the nodal implementing agency and through the Puducherry Climate Change Cell facilitates the implementation of the project » It is responsible for holding the project inception workshop with all stakeholders » Knowledge management through documentation of the best practices and dissemination of information » It operates the Management of Information System (MIS) developed by NABARD for reporting of progress
PWD, Government of Puducherry	» PWD is one of the project executing entities which is responsible for the following project components: ◊ Rejuvenation of 39 irrigation tanks in Puducherry ◊ Formation of mini lake at Padutharkollai Village in Karaikal ◊ Capacity building of TUAs
LAD and Commune Panchayats under LAD	» Local Administration Department (LAD) is one of the project executing entities, responsible for the following project components: » Rejuvenation of 39 village ponds in Puducherry » Rejuvenation of 147 ponds in Karaikal
TUA	» The TUAs play an important role in the uptake and ensuring the sustainability of the project interventions in the long term
Farmers and society at large	» Beneficiaries

6.0 Stakeholder Analysis: relevance and impact

TERI team carried out in-person consultations with officials and representatives from various departments in the UT of Puducherry such as DST&E, the PWD, the Irrigation Department associated with PWD, LAD and representatives from the Commune Panchayats. The tank, lake, and pond sites under the project in Puducherry and Karaikal were visited by the team and consultations were also held with farmers who are the direct beneficiaries of the project.

The nodal implementing agency of the project is the DST&E, under which the Puducherry Climate Change Cell (PCCC) executes the role of the project management unit entrusted with developing the project proposal, providing technical inputs, coordinating with executing agencies, managing the funds, documenting and disseminating information, and reporting the progress. The DST&E also assists the regional officer of the NABARD in carrying out routine inspections of the project sites and recording the output-based physical and financial progress of the project. A quarterly progress report and fund release request are presented by DST&E to the NABARD. It is worth mentioning, the NABARD has a strong district-/local-level presence which greatly contributes to its ability to verify progress on ground aiding in its objective to monitor, recommend and report progress that is routed through the regional to the head office which in turn reports to the MoEF&CC on a bi-annual basis.

The major project-executing entities are the PWD and LAD which further coordinates and supports the Commune Panchayats in the designated project regions for implementation work. The PWD engineers oversee the desiltation of irrigation tanks and the mini lake, construction of sluice gates and construction of bunds around the tanks. The PWD engineers are also accountable for measuring and reporting groundwater levels. Further, PWD is also responsible for undertaking capacity building of TUAs. The LAD and the Commune Panchayats are predominantly responsible for the rejuvenation and desiltation of village ponds. The LAD also takes complementary efforts in line with the objectives of this project to strengthen infrastructure, increase awareness to promote water conservation by aligning with various other relevant government schemes and policies. Table 9 elucidates and maps the roles, influence, and impact of the key stakeholders.

TABLE 9 Stakeholders' analysis

Stakeholder	Stakeholder influence (low, or medium, or high)	Stakeholder influence (low, or medium, or high)
MoEF&CC	Low (Central agency that sanctions funds)	High (Disbursement of funds for project implementation)
NABARD	Low (Objective of the entity is to increase channelization of NAFCC funds towards adaptation-oriented projects; acts as a monitoring and recommendatory authority)	High (Regulates fund disbursement for project implementation, monitoring physical and financial progress of the project)
DST&E, Government of Puducherry (through Puducherry Climate Change Cell)	Low (Planning and implementation through assisting NABARD with routine inspections, reporting progress)	High (Oversees both fund management and technical execution under the project in consultation with other stakeholders)
PWD, Government of Puducherry	High (Tanks and mini lake under the authority of the PWD)	High (Project implementation: irrigation tanks in Puducherry, Mini Lake in Karaikal, Capacity building of TUAs)
LAD and Commune Panchayats under LAD	High (Village ponds under the authority of LAD and Commune Panchayats)	High (Project implementation: village ponds in Puducherry and Karaikal; supporting Commune Panchayats)
TUA	Medium (Receive benefits of enhanced storage)	Medium (expected) (The uptake and sustainability of the project depends on the effective involvement of the TUAs)
Farmers and society at large	High (Receive benefits of enhanced storage of surface and groundwater and enhanced climate resilience)	High (Through conjunctive use of surface water and groundwater for irrigation and reducing the dependency on the latter for irrigation)

Other crucial stakeholders identified in this project are the TUAs which are expected to ensure the sustainability of the project at the local level. However, these associations have largely become defunct over time and the efforts are being made towards reviving them. The DST&E has enlisted the help of development organizations like DHAN Foundation to carry out capacity building of the TUAs.

The primary beneficiaries of this project are the farmers. Irrigation tanks have substantially enhanced groundwater recharge and storage and as a result the practice of digging deeper bore wells has significantly reduced. Further, there is an expressed interest among farmers to increase the depth of the irrigation tanks and ponds so that greater quantum of water is harvested for availability in the non-monsoon months.

The influence-impact matrix helps understand which stakeholders have the maximum influence and the impact that they can make towards the success of the project. Influence indicates the stakeholders' level of involvement in the project and impact indicates their ability to bring about the desired change. If a stakeholder in the high influence and high impact quadrant does not perform optimally, it will affect the overall implementation and progress of the project. Whereas the performance of the stakeholders with low influence and low impact does not have a significant effect on the implementation and progress of the project. In this regard, the performance

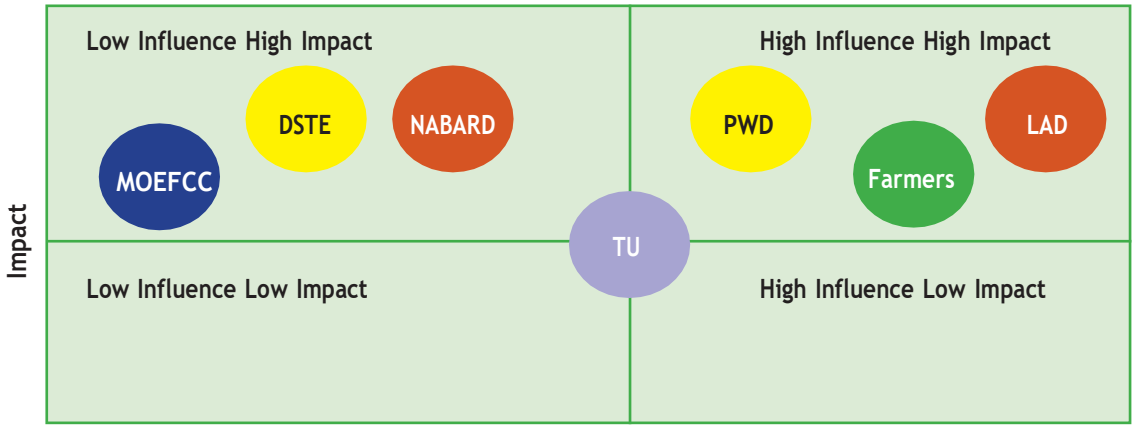

FIGURE 14 Stakeholders' influence and impact

of the project-executing entities such as PWD and LAD is crucial to the success of the project in the region.

7.0 Framework for Monitoring, Evaluation, and Learning

To prepare for and adapt to the long-term consequences of climate change, there is a growing emphasis on the use of Monitoring &Evaluation . The M&E processes are principally designed to cater to the two overarching functions of accountability and learning and support strategic and effective investment of finances and resources to maximize impact of activities and interventions in the context of climate change action (STAP 2017). As funding towards climate change action is picking up pace and is expected to scale up in the near future, ensuring the effectiveness, efficiency and equity of interventions/projects/programmes becomes important.

In the context of climate change action, particular emphasis is being given to using M&E for learning and improving throughout the duration of the implementation of the intervention. Monitoring, evaluation, and learning have gained traction as these cater to the objective of managing the uncertainty, context-specificity and complexities of adaptation interventions.

The implementation guidelines of the NAFCC lay out the mechanism for reporting, monitoring, and review. The state government and the executing entities are required to periodically report the progress to the National Implementing Entity, that is, NABARD. NABARD in turn is responsible to apprise the National/State Level Steering Committee of the status and progress of the project. During the implementation of the project, NABARD is responsible for carrying out field monitoring visits at regular intervals and maintain digital data of the progress of the projects. This data has to be maintained for a period of at least 10 years from the date of completion.

The outcome parameters as described in the NAFCC Framework comprise the following entities:

a) Reduced risks and adverse impacts of climate change in water and agriculture sectors.
b) Human development, poverty alleviation, livelihood security, and enhanced awareness.
c) Cross-sectoral benefits and co-benefits addressing challenges of food and water security.
d) Strengthened individual and institutional capacity to minimize risks linked with climate induced socio-economic and environmental losses.
e) Improved awareness and ownership of processes at local level aimed at adaptation and climate risk reduction.
f) Enhanced adaptive capacity within relevant development and natural resources sectors
g) Enhanced ecosystem resilience.
h) Diversified livelihoods and income sources for vulnerable people in target areas.
i) Improved regulatory and policy landscape promoting and enforcing resilience measures.

8.0 Proposed Framework for Monitoring, Evaluation and Learning

The results framework of the project has three primary components. The first component is the rejuvenation of irrigation tanks and village ponds. This component includes rejuvenation of 39 irrigation tanks and 39 village ponds in Puducherry and 147 ponds in Karaikal region and formation of a mini lake in Padutharkollai village in Karaikal. The second component is capacity building of TUAs, and the third component is project management (M&E and knowledge management). The nodal implementing agency, DST&E proposed the following framework during the inception of the project.

At present an outcome-based reporting is followed by the DST&E and regional NABARD office which report the physical and financial progress and disseminate information through the website maintained by DST&E. The reporting is also supplemented with site pictures across a timeline. There are, however, data gaps in reporting.

The MEL framework builds on the existing results framework of the project, the primary expected outcomes of which are replenishment of groundwater level, increase in storage capacity of tanks and creation of livelihoods and assets.

The rejuvenation of the irrigation tanks and ponds through adaptation activities like desiltation, bund strengthening, catchment treatment, repair of sluice shutters, and tree plantation, contribute towards building climate resilience through enhancing the water- holding capacities of the tanks, replenishing groundwater, preventing salinity ingress, improving farmers' incomes through potentially higher crop yields, and maintaining ecological balance.

1. Rejuvenation of irrigation tanks and ponds in Puducherry and Karaikal regions

Water scarcity for irrigation and agricultural activities due to salinization of groundwater		
Outcome	**Outcome indicator**	**Unit of measurement**
Outcome 1 Increase in water availability due to rejuvenation of irrigation tanks and ponds	» Change in water spread area after rejuvenation of irrigation tanks	Acre-foot
	» Change in water storage capacity due to rejuvenation of irrigation tanks and ponds	Acre-foot
Outcome 2 Recharge of aquifers from increased channelization from rejuvenated irrigation tanks and ponds	» Change in groundwater level due to increased channelization from the rejuvenated irrigation tanks and ponds	Metres below ground level (Mbgl)
	» Stage of groundwater development due to change in groundwater levels	%
Outcome 3 Prevention of salinity ingress from increased channelization from rejuvenated irrigation tanks and ponds	Change in total dissolved solids (TDS) levels due to change in channelization of water from the rejuvenated irrigation tanks and ponds	Parts per million (ppm)
	Change in salinity levels due to change in channelization of water from the rejuvenated irrigation tanks and ponds	Parts per thousand (ppt)
Outcome 4 Increase in Crop yield due to increased availability of water	Change in harvested crop yield per hectare due to change in availability of water	kg/ha
Outcome 5 Increased scope for agriculture and allied activities from increased water availability	Change in incomes due to change in crop yields	Rupee
	Increased crop diversity from increased availability of water	Nos
	Number of new assets created in allied activities from livelihood diversification	Nos
Output	**Output indicator**	**Unit of measurement**
Output 1.1 Rejuvenation of 39 irrigation tanks in Puducherry	Number of irrigation tanks rejuvenated in Puducherry	Nos
Output 1.2 Rejuvenation of 39 village ponds in Puducherry	Number of village ponds rejuvenated in Puducherry	Nos

Output 1.3 Formation of a mini lake in Padutharkollai village in Karaikal	Formation of mini lake in Padutharkollai	Y/N
Output 1.4 Rejuvenation of 147 ponds in Karaikal region	Number of ponds rejuvenated in Karaikal	Nos
Impact	**Impact indicator**	**Unit of measurement**
Maintenance of ecological balance through sustainable and conjunctive use of surface and groundwater resources	Change in balance of water budget from the impact of rejuvenation of irrigation tanks and ponds	%

2. Capacity building of TUAs

Water shortage due to increased risks and disaster events from climate change		
Outcome	**Outcome indicator**	**Unit of measurement**
Outcome 1 Community involvement and ownership, and development of local institutions to adapt to risks of water shortage from climate change	Number of active TUAs formed under the initiative	NNos
Outcome 2 Equitable Benefit sharing of new resources and infrastructure created through the adoption of TUA projects	Number of farmers linked with TUAs as a part of the initiative	N
	Number of women members in TUAs	N
Output	**Output indicator**	**Unit of measurement**
Training and capacity building of local TUAs for efficient and equitable use, as well as sustainable management of water resources	Number of training programmes conducted for skill development and capacity building of local TUAs	Nos
	Number of farmers trained in water management practices	Nos
Impact	**Impact Indicator**	**Unit of measurement**
Increased outreach and equitable decision-making through the involvement of TUAs in implementation of interventions.	Number of new farmers linked with TUA	Nos
	New interventions initiated by TUAs	Nos
Long-term sustainability of TUAs through adoption of TUA programmes (state-wide)	New TUA programmes started in the state	Nos

3. Capacity building of stakeholders and institutions (M&E and knowledge management)

Preparation of institutions and stakeholders for enhanced research and implementation of climate change projects and activities		
Outcome	**Outcome indicator**	**Unit of measurement**
Outcome 1 Project completion in time bound manner, to ensure transparency and credibility as well enhancing knowledge and learning for identification of gaps and strengths	Progress reports of ongoing and completed projects	Monthly/Quarterly
	No. of capacity building workshops conducted as part of climate action projects	Nos
	No. of staff involved in training/capacity building workshops	Nos
Outcome 2 Convergence of strategies, practices and policies undertaken by line departments regarding climate action and adaptation implementation	Change in policies and regulations to promote sustainable practices in water and agriculture sector	Descriptive
Output 1.1 Knowledge sharing and dissemination between institutions and stakeholders for enhanced learning and knowledge management	Number of case studies and success stories documented in climate change projects	Nos
	Quarterly and Annual Progress reporting of climate change projects, disseminated through Management Information System (MIS)	Nos
Output 1.2 Training and Capacity building of officials for research and implementation of climate-related projects	Number of training programmes and workshops conducted	Nos
	Number of staff trained in implementation and knowledge management of climate change projects	Nos
Impact	**Impact indicator**	**Unit of measurement**
Achievement of project objectives through development of active, coordinated, and transparent systems in line departments	Number of attained objectives in climate change projects	Nos
	Identification and piloting of adaptation measures undertaken as part of climate change projects	Nos
Government line departments and project staff capacitated to implement adaptation measures	Regular capacity building of local stakeholders by government departments in climate resilience and adaptation practices	N/year

The framework aims to capture both the quantitative and qualitative impacts of the project. Indicators are developed so as to reflect the measurable impact and capture the progress and achievements of the project over a long time period.

An effective project management approach is one which requires the participation of all stakeholders, establishes partnerships, and prevents the marginalization of groups and water resource users. Water management itself involves various complexities, given the changing climate, growing conflicts and governance issues. For better assessment and improving the contribution of stakeholders, indicators have to be designed to integrate environmental, economic, and social aspects. With particular reference to water, data that captures the social dimension will aid in the promotion of equity in water access. Environmental data will aid in ensuring the sustainability of water resources and the economic dimension data will contribute to the goal of improving water use efficiency.

The relevance of indicators depends on its ability to provide a representative image and its utility to the decision makers and managers. Further, a shared vision of the future of water resources among the stakeholders, adequate finance, consensus among stakeholders on integration of various water-related issues, strengthening institutional capacity for improved water management and promotion of decision making at the local level are fundamental to achieving the desired impact of project interventions.

9.0 Evaluation of the Adaptation Intervention

Evaluation of climate adaptation projects and programmes has been recognized critical for assessing the overall relevance, coherence, efficiency, effectiveness, sustainability, and impact. The Organization for Economic Cooperation and Development (OECD) defines evaluation as "The systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation, and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact, and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipients and donors."[8]

Likewise, in a paper by Gregorowski and Bours, the authors build on the OECD definition (Development Assistance Committee Working Party on Aid Evaluation 2002), and define evaluation as the process which can be used to determine the exact worth or contribution of a policy programme or institution—adopting a systematic and objective analysis of development interventions.

Evaluation is conducted to measure the overall progress of the interventions through outcome/result indicators.

Indicators that identify the continuous progress achieved in terms of the goals and objectives of the adaptation intervention are evaluated through Ladder based approach. These can be qualitative or quantitative. These indicators tend to be iterative in nature, and periodic evaluation processes seek to understand if these indicators show positive progress over time. They also help us identify challenges and shocks to the project, by assessing if certain indicators are not progressing as anticipated, and enable us to carry out course correction actions to ensure the success of the project.

[8] OECD (2021)

Evaluation of more permanent changes from the impacts of the project, such as behavioural or landscape changes, may be qualitative or quantitative. For instance, a quantitative method may involve the number of people adopting a certain type of behaviour. This may also be measured using a scorecard which helps in mapping the result as 'Yes,' 'No' or 'Partial' and may be represented using '2', '1' or '0' for evaluation purpose and may be analysed using a weightage. On the contrary, qualitative techniques for mapping behavioural change would involve use of expert judgement/narratives or use of pre and post surveys. In case of narratives, scoring for each sub-indicator is aggregated to produce an overall score for each outcome indicator. This method then provides a quantitative interpretation of the score. Such a scorecard approach enables us to understand the impact of the project, and whether the outcomes envisaged by the theory of change have been achieved by the project. Scorecard approaches can also help in course-corrections or for expanding the scope of the project, by identifying barriers, co-benefits, and opportunities during the project.

Other tools and techniques of evaluation would include economic assessments such as a cost benefit analysis, social evaluation methods like surveys as well as other technical methods such as geo-tagging or photo verifications of achieved targets. Economic assessments would also help in prioritization of adaptation options, whereas other methods help drive accountability and course correction regarding the achieved targets of the projects. Social evaluation methods can similarly assess the impact of the project on local stakeholders, establishing if positive impacts have been felt by the local communities and helping drive tangible change at the grassroots level.

1. Rejuvenation of irrigation tanks and ponds in Puducherry and Karaikal regions

Water scarcity for irrigation and agricultural activities due to salinization of groundwater		
Outcome	**Outcome indicator**	**Evaluation method**
Outcome 1 Increase in water availability due to rejuvenation of irrigation tanks and ponds	Change in water spread area after rejuvenation of irrigation tanks	Ladder method
	Change in water storage capacity due to rejuvenation of irrigation tanks and ponds	Ladder method
Outcome 2 Recharge of aquifers from increased channelization from rejuvenated irrigation tanks and ponds	Change in groundwater level due to increased channelization from the rejuvenated irrigation tanks and ponds	Ladder method
	Stage of groundwater development due to change in groundwater levels	Ladder method
Outcome 3 Prevention of salinity ingress from increased channelization from rejuvenated irrigation tanks and ponds	Change in total dissolved solids (TDS) levels due to change in channelization of water from the rejuvenated irrigation tanks and ponds	Ladder method
	Change in salinity levels due to change in channelization of water from the rejuvenated irrigation tanks and ponds	Ladder method

Outcome 4 Increase in crop yield due to increased availability of water	Change in harvested crop yield per hectare due to change in availability of water	Ladder method
Outcome 5 Increased scope for agriculture and allied activities from increased water availability	Change in incomes due to change in crop yields	Ladder method
	Increased crop diversity from increased availability of water	Ladder method
	Number of new assets created in allied activities from livelihood diversification	Ladder method
Output	**Output indicator**	**Evaluation method**
Output 1.1 Rejuvenation of 39 irrigation tanks in Puducherry	Number of irrigation tanks rejuvenated in Puducherry	Ladder method
Output 1.2 Rejuvenation of 39 village ponds in Puducherry	Number of village ponds rejuvenated in Puducherry	Ladder method
Output 1.3 Formation of a mini lake in Padutharkollai village in Karaikal	Formation of mini lake in Padutharkollai	Scorecard/ narratives
Output 1.4 Rejuvenation of 147 ponds in Karaikal	Number of ponds rejuvenated in Karaikal	Ladder method
Impact	**Impact indicator**	**Evaluation method**
Maintenance of ecological balance through sustainable and conjunctive use of surface and groundwater resources	Change in balance of water budget from the impact of rejuvenation of irrigation tanks and ponds	Ladder method

2. Capacity building of TUAs

Water shortage due to increased risks and disaster events from climate change		
Outcome	**Outcome indicator**	**Evaluation method**
Outcome 1 Community involvement and ownership, and development of local institutions to adapt to risks of water shortage from climate change	Number of active TUAs formed under the initiative	Ladder method
Outcome 2 Equitable benefit sharing of new resources and infrastructure created through the adoption of TUA projects	Number of farmers linked with TUAs as a part of the initiative	Ladder method
	No. of women members in TUAs	Ladder method
Output	**Output indicator**	**Evaluation method**
Training and capacity building of local TUAs for efficient and equitable use, as well as sustainable management of water resources	Number of training programmes conducted for skill development and capacity building of local TUAs	Ladder method
	Number of farmers trained in water management practices	Ladder method
Impact	**Impact indicator**	**Evaluation method**
Increased outreach and equitable decision-making through the involvement of TUAs in implementation of interventions.	Number of new farmers linked with TUAs	Ladder method
	New interventions initiated by TUAs	Ladder method
Long-term sustainability of TUAs through adoption of TUA programmes state-wide	New TUA programmes started in the state	Ladder method

3. Capacity building of stakeholders and institutions (M&E and knowledge management)

Preparation of institutions and stakeholders for enhanced research and implementation of climate change projects and activities		
Outcome	**Outcome indicator**	**Evaluation method**
Outcome 1 Project completion in time bound manner, to ensure transparency and credibility as well enhancing knowledge and learning for identification of gaps and strengths	Progress reports of ongoing and completed projects	Narratives
	Number of capacity building workshops conducted as part of climate action projects	Ladder method
	Number of staff involved in training/ capacity building workshops	Ladder method
Outcome 2 Convergence of strategies, practices and policies undertaken by line departments regarding climate action and adaptation implementation	Change in policies and regulations to promote sustainable practices in water and agriculture sector	Narratives
Output	**Output indicator**	**Evaluation method**
Output 1.1 Knowledge sharing and dissemination between institutions and stakeholders for enhanced learning and knowledge management	Number of case studies and success stories documented in climate change projects	Ladder method
	Quarterly and annual progress reporting of climate change projects, disseminated through management information system (MIS)	Narratives
Output 1.2 Training and capacity building of officials for research and implementation of climate-related projects	Number of training programmes and workshops conducted	Ladder method
	Number of staff trained in implementation and knowledge management of climate change projects	Ladder method
Impact	**Impact indicator**	**Unit of measurement**
Achievement of project objectives through development of active, coordinated, and transparent systems in line departments	Number of attained objectives in climate change projects	Scorecard
	Identification and piloting of adaptation measures undertaken as part of climate change projects	Ladder method
Government line departments and project staff capacitated to implement adaptation measures	Regular capacity building of local stakeholders by government departments in climate resilience and adaptation practices	Scorecard

10.0 Conclusion and Way Forward

Heavy dependence on groundwater continues to be a major feature in UT of Puducherry. Factors such as intensive farming patterns and provision of free electricity that enable unregulated operation of motor pumps for extraction of water from the ground ensure the continued prevalence of groundwater dependence. This issue becomes even more problematic with increasing salinity ingression and groundwater contamination which in the light of a changing climate will only exaggerate the vulnerabilities in the region. The integrated surface water management project, therefore, has tremendous potential towards addressing the issues specific to the region. Realizing the true potential of this project would involve addressing challenges pertaining to limited availability of funds. Further, behavioural and policy changes are required that would look into incentivizing surface water use/de-incentivizing surface water, and greater involvement of the local communities. Specific measures are also required to address unregulated growth of vegetation and eutrophication in the waterbodies. Another important aspect with regard to project implementation and monitoring is the need for a standardized set of terminologies and parameters to identify lakes, tanks, and ponds to establish a shared and coherent understanding of the nature of the waterbodies among the stakeholders in the different regions. To bring about transformation in sustainable use of water, scaling up of measures such as promotion of less water-intensive crops, micro and precision irrigation technology, water quality testing is required in addition to incentivizing surface water use and discouraging overexploitation of groundwater through regulatory interventions such monitoring of groundwater use and levying tariffs for extraction of groundwater for commercial purposes. These measures are increasingly being adopted by the union territory and as part of their action plan for climate change.

There is a need for continuous stakeholder engagement for developing an effective MEL framework and conducting capacity building and training programmes for key stakeholders. Such stakeholder engagement will be continued as part of the ICAT process for knowledge sharing and documentation and for receiving feedback for developing the MEL framework, and TERI will be conducting capacity building and training programmes for the key stakeholders in the Government of Puducherry as per the capacity needs assessment. In the future, the learnings from such stakeholder consultations and capacity-building workshops can be implemented at departmental levels of the nodal agencies of the state to be incorporated into all projects and activities in the state. By having a robust and inclusive MEL framework in place, that can be tailored to fit all requisite projects and activities, the state can ensure that the impacts of various interventions and policies are properly monitored; along with providing key learnings about any further requirements to ensure inclusive and complete development across the agricultural sector in Puducherry

The proposed M&E framework is grounded in the local context, it recognizes the heterogeneity of needs and maintains the local relevance. Lessons will be drawn from this exercise form the foundation for the development of the sector-level M&E at the national scale, with the framing of a more generalized framework that is flexible enough to take into account the contextual needs of individual states.

References

Gopalakrishnan, S. 2016. Saved by Tanks: The story of Puducherry's Bahour Commune. India Water Portal

Department of Science, Technology and Environment. 2020. Revised Detailed Project Report: Integrated Surface Water Management through Rejuvenation of 20 Tanks and 32 Village Ponds for Climate Change Adaptation in Puducherry. Government of Puducherry

STAP. 2017. Strengthening Monitoring and Evaluation of Climate Change Adaptation: A STAP Advisory Document. Global Environment Facility, Washington, DC

Climate Ministry of Environment, Forests and Change (MoEF&CC). 2008. Implementation Guidelines for National Adaptation Fund for Climate Change (NAFCC). New Delhi

Nobi, E. P., et al. 2009. Land Use and Land Cover Assessment along Pondicherry and its Surroundings Using Indian Remote Sensing Satellite and GIS. American-Eurasian Journal of Sustainable Agriculture 4: 54-58

Government of Puducherry, Department of Science, Technology and Environment Puducherry. 2013. Vulnerability Analysis on Climate Change for UT of Puducherry, Union Territory of Puducherry Action Plan on Climate Change, October

Government of Puducherry, Department of Science, Technology and Enviornment Puducherry Climate Change Cell. 2021. Regional Level Climate Change Vulnerability Assessment for UT of Puducherry, March

Government of Puducherry, Department of Revenue and Disaster Management, State Disaster Management Plan, Volume I

Annexure

No Objection Certificate from the Government of Puducherry

Smt. SMITHA. R, IAS
DIRECTOR
Department of Science, Technology
& Environment
Government of Puducherry

3rd Floor, PHB Building,
Anna Nagar,
Puducherry – 5
Phone: 0413 – 2201256
e mail: dste.pon@nic.in

No. 7529/DSTE/TERI – ICAT / FF/ 2021

Madam,

Sub: Acceptance on the collaboration with the ICAT initiative headed by TERI for the NAFCC Project "Integrated Surface Water Management for Climate Change Adaptation in U.T. of Puducherry" executed by DSTE, Puducherry.

Ref: Email received from TERI dated 07.10.2021.

The Department of Science, Technology and Environment (DSTE), Government of Puducherry appreciates the initiative taken by TERI towards the development of Monitoring and Evaluation Framework to assist the State Governments. This department has been making dedicated efforts on Climate Adaptation in the U.T. of Puducherry and the "Integrated Surface Water Management for Climate Change Adaptation in U.T. of Puducherry" under the National Adaptation Fund for Climate Change (NAFCC) since 2016 is one such initiative to replenish surface water and the ground water of Puducherry and conserve the Tanks and Ponds in the U.T. of Puducherry for the future.

In this regard, DSTE, Puducherry is pleased to make a collaboration with TERI on developing monitoring and evaluation framework for the NAFCC project which will give a new dimension to the works already being carried out under the project, in taking it forward as a research-oriented activity on climate adaptation. I hope that such a collaboration will assist DSTE in framing adaptation policies and actions and in developing ideas and tools for monitoring, reporting and evaluating the implementation of the said project with technical inputs from national and regional level experts associated with ICAT. Looking forward for a valuable collaboration with TERI and ICAT for the wellness of the Union Territory of Puducherry.

Yours sincerely,

Smitha. R, I.A.S.
Director - DSTE

To,
Ms. Suruchi Bhadwal
Senior Fellow and Director,
Earth Science and Climate Change Division,
The Energy and Resources Institute (TERI),
Lodhi Road,
New Delhi -110003.