सत्यमेव जयते

Government of Puducherry

**DEPARTMENT OF SCIENCE, TECHNOLOGY & ENVIRONMENT**

**PUDUCHERRY CLIMATE CHANGE CELL**

# REGIONAL LEVEL CLIMATE CHANGE VULNERABILITY ASSESSMENT FOR U.T. OF PUDUCHERRY


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Department of Science & Technology
Govt. of India

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# 1. Characteristics of U.T. of Puducherry

## 1.1 Overview

Coastal regions like Union Territory of Puducherry are highly susceptible to the impacts of climate change. Given the uncertainties in the magnitude and impacts of climate change, understanding the vulnerability of the region is crucial for adaptation planning and building resilience to climate risks.

Puducherry, formerly known as Pondicherry, is a Union Territory of India. It was formed out of four enclaves of former French India, namely Puducherry, Karaikal, Yanam and Mahe. The four regions are geographically separated from each other and are located in three different states with totally different agro-climatic zones and cultural practices. Karaikal region is nearly 135 kms. in the southern direction from the headquarters of Puducherry, Mahe is nearly 650 kms. in the south west direction and Yanam is nearly 800 kms. in the north eastern direction. *Figure 1* shows the geographic location and position of these four regions. Although not a contiguous stretch of land, the topography of these four separately located regions are all coastal plains with semi-arid climate.


*Figure 1: Map showing location of four regions of U.T. of Puducherry*

For administrative purpose Puducherry is divided into two districts namely Puducherry and Karaikal. Puducherry district comprises of Puducherry, Yanam and Mahe regions while, Karaikal region is a separate district. For the purpose of Census Operations all the four regions are treated as separate districts keeping in view of their proximity to disjoint locations. Accordingly, Climate Change Vulnerability has been assessed at the regional levels for all the four regions of the U.T.

## 1.2 Physical features and land use pattern

All the four regions of the Puducherry Union Territory 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. Puducherry Union Territory has a total area of 490 sq.km. Among its four regions, Puducherry region is the largest with a geographical area of 294 sq.km., followed by Karaikal with 157 sq.km., Yanam with 30 sq.km. and Mahe having small land area of 9 sq.km.

There are 5 Municipalities, 10 Commune Panchayats, 8 Taluks and 3 Community Development Blocks in the U.T. of Puducherry. As per 2011 Census, total population of the U.T is 12,47,953. There are 129 Revenue villages (Puducherry - 81, Karaikal - 37, Mahe - 5 and Yanam - 6). Puducherry and Karaikal regions are classified as urban and rural areas whereas, entire Mahe and Yanam regions are classified as urban area. Puducherry is the 29$^{th}$ most populous and the third most densely populated state/UT in India (Puducherry at a Glance, 2020).

The four regions of the Union Territory have a coastline of 45 km. with 39 marine fishing villages and 11 inland fishing villages. The land use classification of rural areas in the U.T. of Puducherry is given in *Table 1*.

*Table 1: Land use classification in rural areas of U.T. of Puducherry (Census, 2011)*

| Land Use Classification (Area is Hectares) | 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 | 1638.46 | 17 | 25 |
| Other fallow land | 987.01 | 874.65 | 84 | 4 |
| Current fallow | 2032.54 | 533.73 | 27 | 8 |
| Net area sown | 10425.4 | 5343.51 | 594 | 593 |

## 1.3 Biological features

As per the Forest Survey of India (2019) the forest cover in Puducherry is 52.41 sq. km which is about 10.70% of the geographical area of the UT (*Table 2)*. Low forest cover and rapid land use change is a major factor that contributes to the vulnerability in this region.

*Table 2: Forest area of Puducherry U.T. (Source – India State of Forest Report, 2019)*

| District | Geographical Area | 2019 Assessment | | | | Percent of GA | Change wrt 2017 assessment | Scrub |
|---|---|---|---|---|---|---|---|---|
| | | Very Dense Forest | Mod. Dense Forest | Open Forest | Total | | | |
| Karaikal | 157 | 0 | 6.83 | 8.34 | 15.17 | 9.66 | -0.23 | 0.00 |
| Mahe | 9 | 0 | 1.06 | 4.61 | 5.67 | 63.00 | 0.00 | 0.00 |
| Puducherry | 294 | 0 | 9.77 | 15.35 | 25.12 | 8.55 | -0.98 | 0.00 |
| Yanam | 30 | 0 | 0.00 | 6.45 | 6.45 | 21.50 | -0.05 | 0.00 |
| Grand Total | 490 | 0 | 17.66 | 34.75 | 52.41 | 10.70 | -1.26 | 0.00 |

Mangrove vegetation is seen to some extent in the estuaries and along the sides of Ariyankuppam river (in Pondicherry region), Gouthami river near Guirempeta (in Yanam region). Some of the important mangrove species in Pondicherry are Rhizophora apiculata, Rhizophora mucronata, Avicennia marina, Bruguiera cylindrica, Bruguiera gymnorrhiza (Rhizophoraceae), Acanthus ebracteotus, Acanthus illicifolius (Acanthaceae) etc.

The tanks of Ousteri and Bahour are home for a number of migratory birds. Some of the migratory birds visiting the wetlands at Pondicherry are little Grebes, Great Cormorant, Pelican, Grey Heron, Egrets, Indian Pond Heron, White Storks, Painted Storks, White Spoonbills, Black Headed Ibises, Tufted Ducks, Common Coots, Jacanas, Whiskered Terns etc.

The coastline of Puducherry is frequented by Olive Ridley Turtle, Green Sea Turtle and Leather Backed Turtle during breeding season.

## 1.4 Socio-economic features

Agriculture, fishing, manufacturing and service industries all have important roles in the totality of economic activities in Pondicherry. However, over the years the shares of the

last two sectors have been increasing vis a vis the first two sectors in the net domestic product of the region. The proportion of sectoral contribution to the GSDP indicates that the primary sector contribution had declined considerably to the level of some of the developed countries. Even the secondary sector contribution began to decline in the nineties. Only tertiary sector has been growing phenomenally. In the primary sector, contribution of fisheries tends to be higher than the agriculture.

Changes in sectoral contribution reveal that the economy of Puducherry is gradually shifting from agriculture activities to non-agriculture activities. The employment pattern in Puducherry indicates that there is a perceptible decline in the proportion of agricultural workers whereas, the manufacturing and tertiary sectors have registered a noticeable increase.

Puducherry has witnessed development in most of the sectors. The global public goods like health and education sectors have displayed remarkable strides. Though agriculture has not shown much development in consonance with other sectors, the industries sector and service sectors have been growing exponentially. Infrastructure has been perceptibly well developed to the growing needs of the economy.

In the social sector, all the components have been making exceedingly good progress. Tourism has vast potential to bring in more foreign exchange and revenue to the state, therefore concerted efforts are being made to attract tourists, and make significant impact in bringing revenues. However, the population depending on the tourism industry has been growing considerably.

## 1.5 Climate

Puducherry Union Territory experiences a hot and tropical maritime type of climate characterized by small daily range of temperature, 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. Minimum temperatures are in the order of 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 gets the bulk of its annual rainfall during the period from October to December.

Yanam region enjoys the benefit of both South-West and North-East monsoon season. Mahe is comparatively cooler than the other regions of the Union Territory due to its geographical location. Around 77 per cent of the rainfall is received during the south-west monsoon because of its location in the windward side of the Western Ghats.

# 2. Vulnerability Assessment Methodology

The Department of Science and Technology (DST) under the Union Ministry of Science and Technology and Swiss Agency for Development and Cooperation (SDC) is jointly developing the Climate Vulnerability Map of India for preparing communities and people to meet the challenge arising out of climate change. This research programme of DST is being implemented as part of the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). Under this project, a Common Methodology and Framework for Climate Vulnerability and Risk Assessment has been developed by IISc Bangalore, IIT Guwahati and IIT Mandi.

The methodology was developed based on Intergovernmental Panel on Climate Change (IPCC) 5$^{th}$ Assessment Report (2014) definition of Vulnerability, wherein, Vulnerability is defined as the propensity or predisposition of a system to be adversely affected. It includes sensitivity or susceptibility to harm and lack of capacity to cope and adapt. It is an internal property of a system and dynamic in nature. IPCC 4$^{th}$ Assessment Report (2007) considered 'exposure' as one of the three elements of 'vulnerability' other two being sensitivity and adaptive capacity. However, in AR5, this conceptualization of vulnerability has been modified and 'exposure' is no longer considered to be a component of 'vulnerability'.

In this report, regional climate change vulnerability assessment has been carried out for the four regions of U.T. of Puducherry following the aforementioned Common Methodology and Framework developed by IISc. The methodology is constructed on an indicator-based approach and use of secondary sources of information to quantify the indicators selected.

The following steps are involved while conducting the Vulnerability Assessment:

1. **Identification of Indicators:** In any Vulnerability Assessment we have indicators of different types (i.e., Bio-Physical, Socio-economic, Institutional, etc.). Considering the objectives and scale of the study, adopted tier method, availability of necessary data, indicators are carefully chosen. One has to be absolutely clear about the rationale behind selecting a particular indicator. Selection of appropriate indicators is the art of and central to a Vulnerability Assessment study. Indicators may capture 'sensitivity' or lack of 'adaptive

capacity' of a system. Higher the sensitivity, higher will be vulnerability (positive relationship) and lower the adaptive capacity higher will be the vulnerability (negative relationship).

2. **Quantification of Indicators -** We must express all indicators in terms of numbers so that we can apply mathematical operations to these. The values of the Indicators are obtained from secondary data sources like Census data or official website of various government agencies (e.g., the value of % BPL household which is a socio-economic indicator is taken from the Census 2011 data for each district / region).

3. **Normalization of Indicators -** Vulnerability Assessment indicators are expressed in different units (e.g., per capita income is measured in Rupees; BPL Household is expressed in %; employment under MGNREGA is measured in terms of days/year), thus we cannot simply add them up. As the indicators selected are quantified in different scale and units, they need to be normalised for aggregation.

Normalization yields two advantages. Firstly, normalized values are unit free, which can be readily combined to arrive at the Vulnerability Index value. Secondly, they all lie between 0 and 1 (0 implies least vulnerability and 1 implies the highest vulnerability) and can be related to ranking thus enabling comparison and prioritization.

The formula used for normalization depends on whether the indicator has positive or negative relationship with vulnerability.

Case I: The indicator has positive relationship with vulnerability

$$Normalized\ value = \frac{(Actual\ indicator\ value - Min\ indicator\ value)}{(Max\ indicator\ value - Min\ indicator\ value}$$

Case II: The indicator has negative relationship with vulnerability

$$Normalized\ value = \frac{(Max\ indicator\ value - Actual\ indicator\ value)}{(Max\ indicator\ value - Min\ indicator\ value)}$$

4. **Assigning Weights to Indicators -** Weights are assigned to each indicator according to their importance in determining vulnerability of a system. The total weight always should add

up to 1. Assigning proper weights is very crucial for obtaining reliable (reflecting the reality most) results. We often consult experts or survey the stakeholders to judge the actual importance of different indicators. However, here we are assigning equal weight to each indicator to make the case simple.

5. **Aggregation of Indicators and Developing Vulnerability Index** - The normalized indicators can be aggregated to come up with a Vulnerability Index. If different weights are attached to different indicators then a weighted average will be taken to calculate the Vulnerability Index (i.e. normalized values are to be multiplied by their respective weights and then added up). However, in the present study, equal weights are given, hence a simple arithmetic mean will do.

6. **Vulnerability Ranking -** Once Vulnerability Index are calculated for all the regions, a comparative ranking is carried out based on the index value. Higher the value of Vulnerability Index of a particular region, higher will be the vulnerability. This vulnerability rankings are usually presented in tabular form. Here, we have ranked the 4 regions according to their Vulnerability Index based on the eighteen indicators that has been considered.

7. **Representation of Vulnerability -** The basic idea behind representation of vulnerability is to convey the information about the state of vulnerability and the associated risks to the policy making bodies and other stakeholders. The most common way is to use spatial map with a gradient of colours indicating the level of vulnerability. Graphs, charts or tables too are widely used.

8. **Identification of Drivers of Vulnerability** - Most vulnerability studies are conducted as a prerequisite of making policies to prevent further degradation of environmental assets. To develop efficient adaptation planning technique, identifying the main drivers behind vulnerability is crucial. Vulnerability Assessment helps in selecting adaptation measures based on the assessment of the drivers of vulnerability.

# 3. Regional Level Climate Change Vulnerability Assessment for U.T. of Puducherry

## 3.1 Indicators selected, rationale for selection and source of data

The Department of Science and Technology, Government of India organised a National Workshop for all the States and Union Territories during 12th – 15th February 2020 in New Delhi for capacity building of the State / U.T. Climate Change Cells in preparing the State and District Level Vulnerability Maps, using the common framework developed by IISc Bangalore, IIT Guwahati and IIT Mandi. During this workshop eighteen common indicators were suggested for conducting District Level Vulnerability Assessment throughout the country, under the following four broad categories:

i) Socio-economic indicators
ii) Bio-physical indicators
iii) Institutional + Infrastructure indicators
iv) Health indicators.

The list of 18 common indicators is given in *Annexure I*. From the suggested list, sixteen indicators were selected. Also, two new indicators specific to U.T. of Puducherry viz. Rural population % and Tourist footfall /1000 persons were also selected.

**Socio-economic indicator** is composed of seven sub-indicators that aim to comprehensively represent the socio-economic status of the 4 regions of U.T of Puducherry. The seven indicators are: % BPL households, % Rural Population, Primary sector production (Agriculture, Fisheries & Animal Husbandry) per 1000 population, Total Number of Livestock per 1000 population, % of marginal and small farmers (land <5 acre), Tourist Footfall per 1000 population and Women participation in labour (employment) force

**Bio-physical indicator** is composed of four sub-indicators that captures dependency on forest resources as alternate livelihood, sensitivity to agriculture production like % of net irrigated area to net sown area and variability in food grain crop yield and water security in terms of status of ground water development.

**Institution and infrastructure indicator** is composed of three sub-indicators viz. Road density, No. of Banks / 1000 Population and average person days / household employed under MGNREGA which best indicates the adaptive capacity of the region to climate change impacts.

**Health Indicator** is composed of four sub-indicators that represents the health status of the regions viz. Cases of vector borne diseases/1000 Population (Dengue & Malaria), cases of Water Borne Diseases/1000 of population (Hepatitis & Diarrhea), number of doctors, specialists, health assistants & health workers per 1000 population, and infant Mortality Rate.

The list of indicators, rationale behind their selection, functional relationship with vulnerability (positive or negative) and data source is given in *Table 3*.

*Table 3: List of indicators for Regional Level Vulnerability Assessment, Rationale, Functional Relationship with Vulnerability and sources of data*

| Sl. No. | Main indicator | Sub-indicator | Rationale for selection | Functional relationship | Data Source |
|---|---|---|---|---|---|
| 1 | Socio-economic | % BPL households (as per BPL card) | Higher % BPL increases the sensitivity to adversity of climate change | Sensitivity (Positive) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |
| 2 | | % Rural Population | Higher proportion of rural population indicates higher dependence on natural resource-based livelihood | Sensitivity (Positive) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |
| 3 | | Primary sector production (Agriculture, Fisheries & Animal Husbandry) per 1000 population | Primary sector is more sensitive to climate variability as opposed to industry and service sector. | Sensitivity (Positive) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |
| 4 | | Total Number of Livestock per 1000 population | Potential source of income diversity | Adaptive Capacity (Negative) | http://dahd.nic.in/documents/statistics/livestock-census |
| 5 | | % of marginal and small farmers (land <5 acre) | Marginal farmers are known to have low social and economic capital and thus are inherently more sensitive and have lower adaptive capacities. | Sensitivity (Positive) | 2017 data- http://inputsurvey.dacnet.nic.in/ |
| 6 | | Women participation in labour (employment) force | Implies access to information, empowerment at household level, knowledge and financial resources contributing to adaptive capacity. | Adaptive Capacity (Negative) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |
| 7 | | Tourist Footfall /1000 population | Tourism is a potential source of income to the U.T. | Sensitivity (Positive) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Bio-physical | Forest area (in sq.km.)/1000 rural population | This is an important source of alternative livelihood and source of food, in case of crop failure. Also, for its provisioning and regulatory services. | Adaptive Capacity (Negative) | India State Forest Report, 2019 |
| 9 | | % of net irrigated area to net sown area | If % rainfed agricultural is higher, the sector becomes more vulnerable to rain fall variability | Adaptive Capacity (Negative) | District census hand books 2011. |
| 10 | | Variability in food grain crop yield (3 years - 2016-17 to 2018-19) | This is the coefficient of variation of the yield of food grains. This is a direct reflection of climate variability, especially the variability in rainfall. Could also capture impact of floods and cyclones. | Sensitivity (Positive) | Statistics Handbook 2017 - 2018 & 2018-19, Directorate of Economics & Statistics, Puducherry |
| 11 | | Stage of Ground Water Development (Draft of groundwater in relation to availability) % | Indication of further scope to harness ground water resources for irrigation and domestic use. A higher relative draft means less scope for development and hence higher sensitivity. | Sensitivity (Positive) | District Ground Water Brochure, CGWB, 2013 & 2014 |
| 12 | Institution + Infrastructure | Road density (road length/geographical area) | Road density indicates high adaptive capacity. | Adaptive Capacity (Negative) | Statistics Handbook 2017 - 2018, Govt. of Puducherry |
| 13 | | No. of Banks / 1000 Population | Financial institutions enhance adaptation response. | Adaptive Capacity (Negative) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |
| 14 | | Average person days / household employed under MGNREGA over last 5 years (2015-16 -2019-20) | MGNREGA forms an important alternative source of income for rural households. | Adaptive Capacity (Negative) | MNREGA Website |

| | | | | | |
|---|---|---|---|---|---|
| 15 | Health | Cases of vector borne diseases/1000 Population (Dengue & Malaria) | High number of vector borne disease implies poor quality of living and health infrastructure; can be fostered by temperature and rainfall variations. | Sensitivity (Positive) | NVBDCP, Health Department, Puducherry, Avg of 2015-19 |
| 16 | | Cases of Water Borne Diseases /1000 of population (Hepatitis & Diarrhea) | High number of water borne disease implies poor quality of living and health infrastructure; can be fostered by temperature and rainfall variations. | Sensitivity (Positive) | IDSP, Health Department, Puducherry (April 2019 to March 2020) |
| 17 | | No of doctors, specialists, health assistants & health Workers per 1000 population | Availability of doctors and health specialist reduces vulnerability of people's health. | Adaptive Capacity (Negative) | District census hand books 2011. |
| 18 | | Infant Mortality Rate | Infant mortality rate is an important marker of the overall state of public health, access to clean water, sanitation and medical infrastructure. | Sensitivity (Positive) | Puducherry at Glance 2020, Directorate of Economics & Statistics, Puducherry |

## 3.2 Indicator values and Normalised values

The sub-indicators selected are quantified with their actual values obtained from different secondary data sources. As the indicators selected are quantified in different scale and units, they need to be normalised for aggregation. The actual sub-indicator values used and their normalised scores for all the four regions are presented in *Table 4*. Normalisation is done using the formula given in chapter 2 depending on the sub-indicator's functional relationship with vulnerability (positive or negative relationship).

*Table 4: Actual values of sub indicators and their normalised scores*

| Sl. No. | Sub-indicators | Puducherry | | Karaikal | | Yanam | | Mahe | |
|---|---|---|---|---|---|---|---|---|---|
| | | AV | NV | AV | NV | AV | NV | AV | NV |
| 1 | % BPL households (as per BPL card) | 58.76 | 0.66 | 60.02 | 0.67 | 87.66 | 1.00 | 2.89 | 0.00 |
| 2 | % Rural Population | 30.80 | 0.60 | 51.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | Primary sector production (Agriculture, Fisheries & Animal Husbandry) per 1000 population | 735.10 | 0.45 | 1161.14 | 1.00 | 389.40 | 0.00 | 429.74 | 0.05 |
| 4 | Total Number of Livestock per 1000 population | 0.0029 | 0.18 | 0.0154 | 1.00 | 0.0011 | 0.06 | 0.0002 | 0.00 |
| 5 | % of marginal and small farmers (land <5 acre) | 94.44 | 0.63 | 86.22 | 0.09 | 100.00 | 1.00 | 84.81 | 0.00 |
| 6 | Women participation in labour (employment) force | 24.60 | 0.00 | 19.56 | 0.47 | 13.92 | 1.00 | 20.27 | 0.41 |
| 7 | Tourist Footfall per 1000 population | 1612.53 | 1.00 | 1385.08 | 0.81 | 759.28 | 0.30 | 391.02 | 0.00 |
| 8 | Forest area (in ha) per1000 rural population | 0.0891 | 0.41 | 0.1508 | 0.00 | 0.0000 | 1.00 | 0.0000 | 1.00 |
| 9 | % net area irrigated to net sown area | 92.40 | 0.00 | 81.25 | 0.13 | 46.80 | 0.52 | 7.42 | 0.97 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Variability in food grain crop yield (3 years - 2016-17 to 2018-19) | 9.94 | 0.47 | 20.03 | 0.94 | 0.00 | 0.00 | 21.29 | 1.00 |
| 11 | Stage of Ground Water Development (Draft of ground water in relation to availability) % | 139.00 | 1.00 | 15.00 | 0.00 | 54.61 | 0.32 | 36.00 | 0.17 |
| 12 | Road density (road length/geographical area) | 482.84 | 0.00 | 194.28 | 0.63 | 27.07 | 1.00 | 37.60 | 0.98 |
| 13 | No. of Banks per 1000 Population | 0.21 | 0.93 | 0.25 | 0.65 | 0.36 | 0.00 | 0.20 | 1.00 |
| 14 | Average person days/household employed under MGNREGA over last 5 years (2015-16 -2019-20) | 16.29 | 0.29 | 22.86 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 |
| 15 | Cases of vector borne diseases per 1000 Population (Dengue & Malaria) | 1.54 | 1.00 | 1.39 | 0.90 | 0.05 | 0.00 | 0.05 | 0.00 |
| 16 | Cases of Water Borne Diseases per 1000 of population (Hepatitis & Diarrhoea) | 74.00 | 0.58 | 84.00 | 0.83 | 51.00 | 0.00 | 91.00 | 1.00 |
| 17 | No of doctors, specialists, health assistants & health Workers per 1000 population | 4.88 | 0.00 | 2.56 | 0.48 | 2.30 | 0.54 | 0.09 | 1.00 |
| 18 | Infant Mortality Rate | 11.27 | 1.00 | 3.21 | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 |

Note: AV – Actual value; NV – Normalised value

## 3.3 Vulnerability profile and ranking of regions

Generally, Vulnerability Index is calculated by multiplying the normalised scores of each sub-indicator with the weights assigned to them through expert judgement of stakeholder consultation process and then taking the aggregated values. In this study equal weightage has been given to all the indicators. Accordingly, Vulnerability Index is calculated by taking simple average of the normalised scores of all the sub-indicators of the region and then the regions are ranked based on the calculated Vulnerability Index value. The Vulnerability Index value and corresponding rank of the four regions of U.T. of Puducherry are given in *Table 5*.

*Table 5: Vulnerability index values and corresponding ranks of the regions in U.T. of Puducherry*

| Regions | Vulnerability Index Value | Vulnerability Ranking |
|---|---|---|
| Puducherry | 0.51 | 2 |
| Karaikal | 0.55 | 1 |
| Yanam | 0.43 | 4 |
| Mahe | 0.48 | 3 |

## 3.4 Map of different regions of U.T. of Puducherry with vulnerability ranking

In order to have better visual representation and understanding of the vulnerabilities, and the drivers of vulnerability, so that decision makers can analyse where resources (e.g. funds allocated for adaptation planning) would require to be allocated for protection of these vulnerable areas, and to adapt to any probable future climate-induced disaster the vulnerability ranking of the four regions of U.T. of Puducherry is presented in *Figure 2* with a gradient of colours indicating the levels of vulnerability.

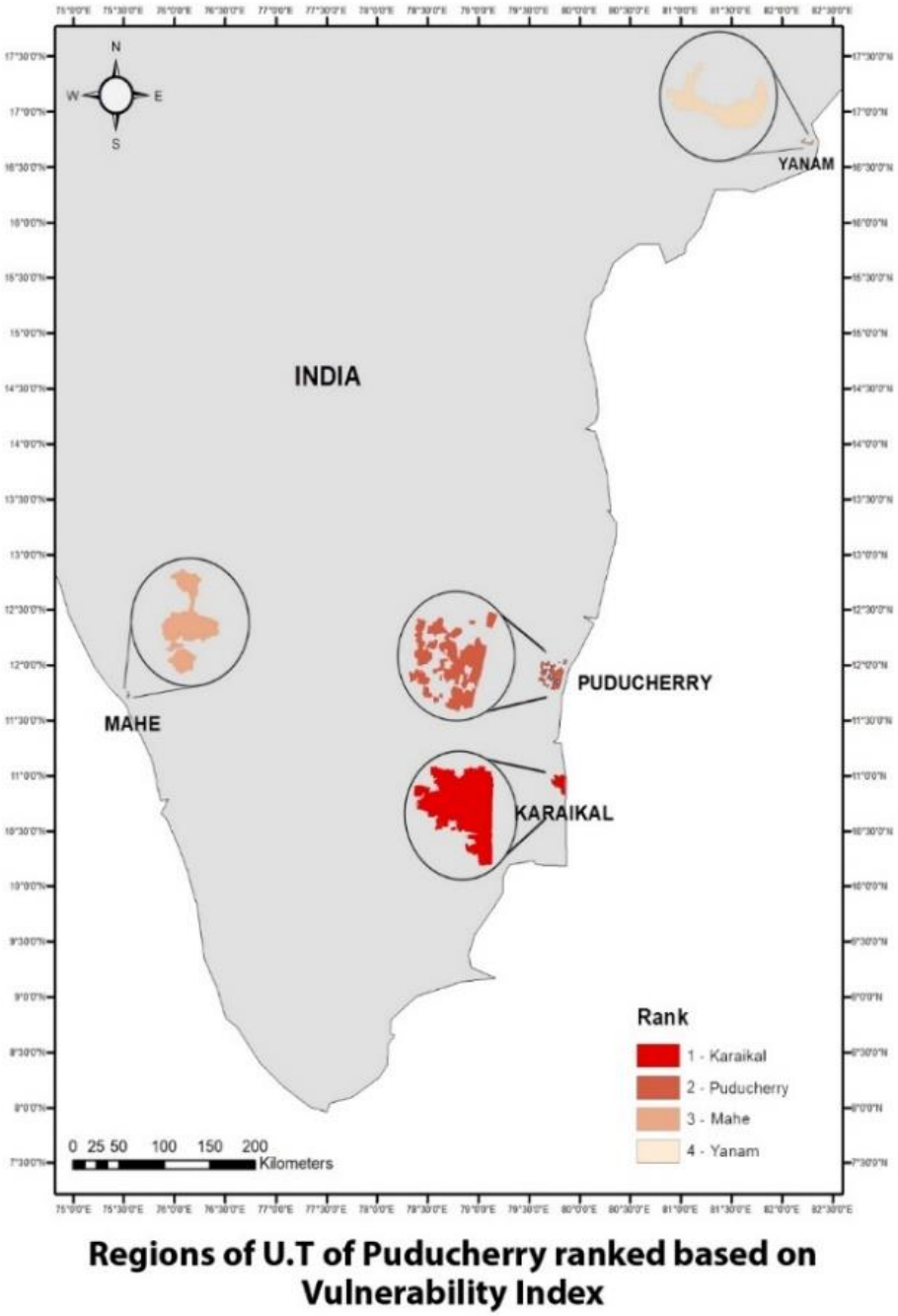


*Figure 2: Map showing regions ranked based on vulnerability assessment*

## 3.5 Major drivers of vulnerability

It is important to identify the drivers of vulnerability to prioritise adaptation strategies. Essentially, this means to identify the contribution of each indicator to vulnerability. *Figures 3 to 6* and *Table 6* provides detail explanation of the drivers of vulnerability across the four regions of U.T. of Puducherry.

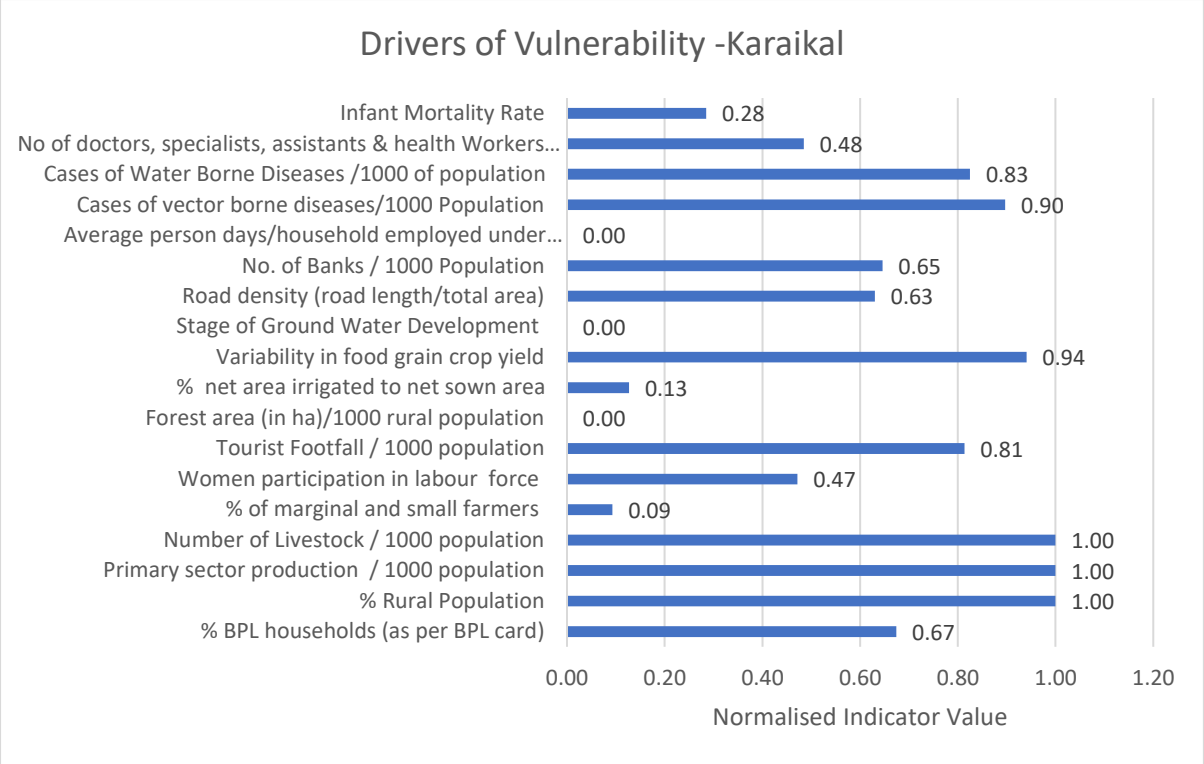


*Figure 3: Drivers of vulnerability for Karaikal region*

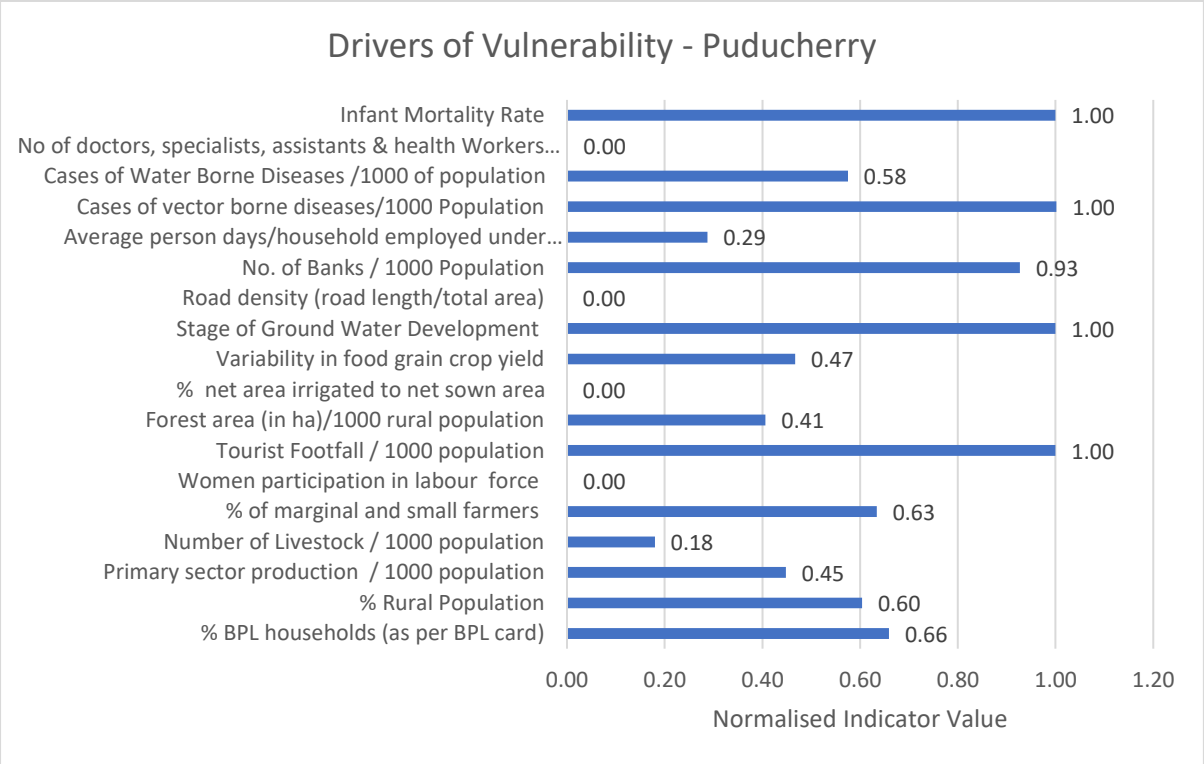


*Figure 4: Drivers of vulnerability for Puducherry region*

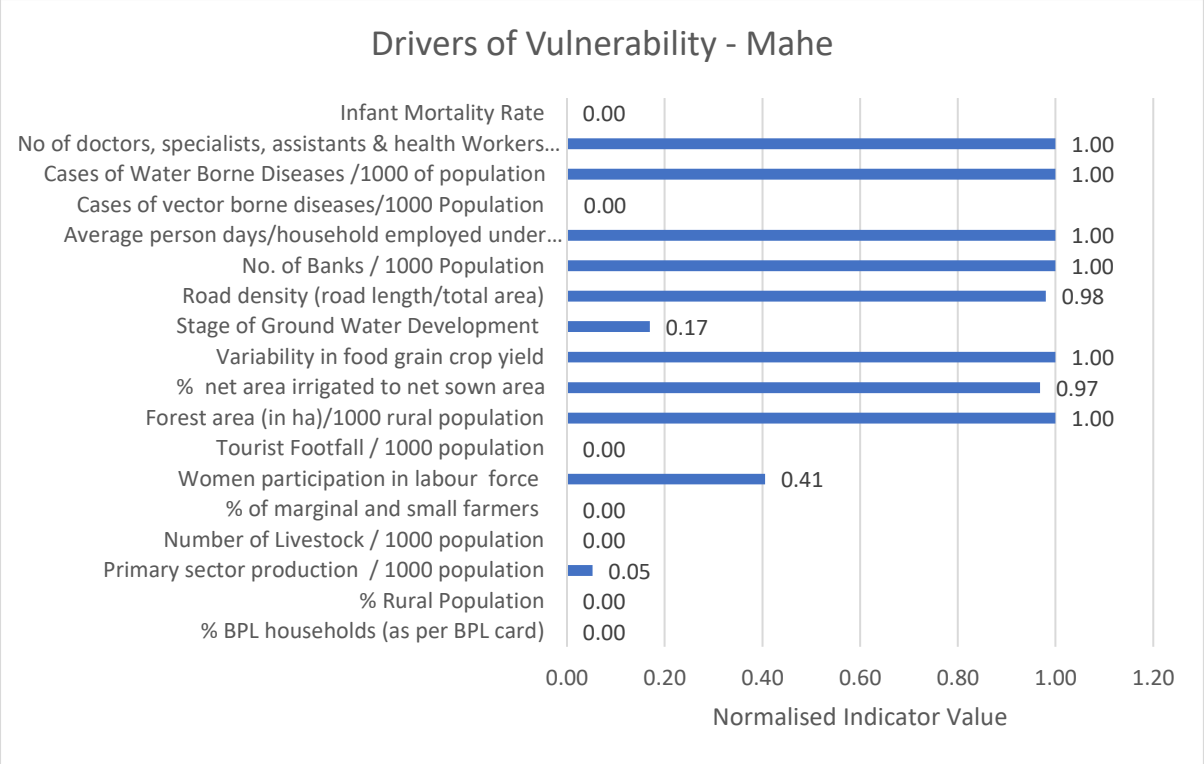


*Figure 5: Drivers of vulnerability for Mahe region*

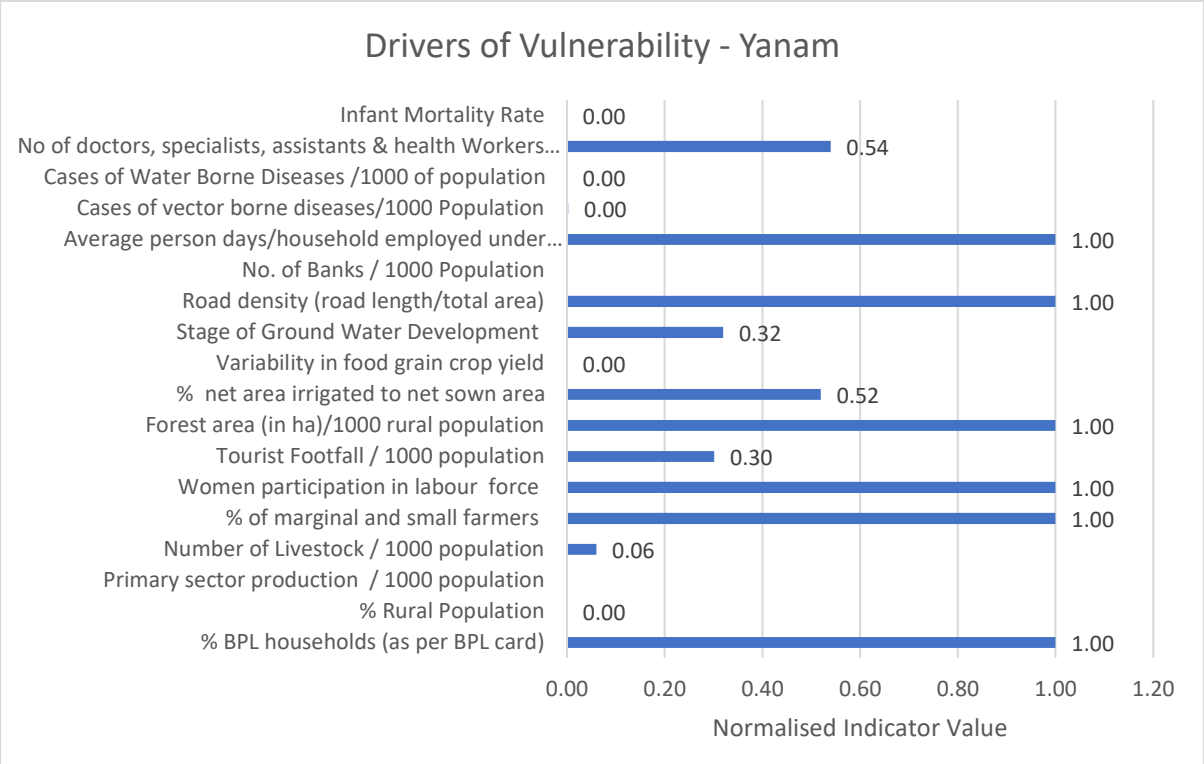


*Figure 6: Drivers of vulnerability for Yanam region*

*Table 6: Drivers of Vulnerability among four regions of U.T. of Puducherry*

| Region | Vulnerability Ranking | Drivers of Vulnerability |
|---|---|---|
| Karaikal | 1 | High rural population and high dependency on primary sector production are the major socio-economic drivers of vulnerability in Karaikal region. High variability in food grain yield and low livestock to population ratio (indicating lack of alternate livelihood and adaptation capacity) further adds to the climate change vulnerability of this region. |
| Puducherry | 2 | High tourist footfall prevailing in Puducherry region is a significant contributor to the socio-economic vulnerability of this region as tourism sector is highly sensitive to climate change. High ground water drawdown is a major threat to the water security of the region and enhances bio-physical vulnerability to climate change. Higher prevalence of Infant Mortality Rate and vector borne disease when compared to other regions indicates need to strengthen the sanitation and health facilities. |
| Mahe | 3 | Mahe region exhibits moderate vulnerability to climate change among the four regions mainly due to the lack of financial institutions – low ratio of banks to population, high prevalence of water borne diseases indicating lack of adequate sanitation facilities and low ratio of doctors / health workers available to total population indicating poor adaptive capacity.<br><br>Though ratio of forest area /1000 rural population and average person days / household employed under MGNREGA are very low it may not cause much impact as the region is predominantly urban in nature.<br><br>Low number of BPL persons, low rural population and low dependency on primary sector makes the region comparatively less vulnerable to climate change. |

| | | |
|---|---|---|
| Yanam | 4 | The major drivers of vulnerability in this region are high percent of BPL households, high percent of marginal farmers and low percent of women in labour force.<br><br>Low rural population and low dependency on primary sector makes the region comparatively less vulnerable to climate change.<br><br>Though ratio of forest area /1000 rural population and average person days / household employed under MGNREGA are very low it may not cause much impact as the region is predominantly urban in nature. |

## 3.6 Challenges, limitations and way forward

The location of the four regions of U.T of Puducherry in three culturally diverse states brings in perceptible heterogeneity among the population and the physical, biological, socio-economic and climatic features are unique for each region making the vulnerability assessment a challenging process. In this regional level vulnerability assessment exercise, equal weightage has been given for all the indicators which could act as a limitation. Also, for some indicators 2011 census data was used for the assessment as recent data was not available. These indicators need to be updated with latest data as and when available.

The vulnerability assessments discussed above would help in adaptation planning across the regions in U.T. of Puducherry. It would help in prioritising the drivers that are leading to vulnerability in each region. Decision makers can make necessary interventions across each region based on the findings of this study. Following this regional level vulnerability assessment, the next step would be to carry out such studies at the block level or village level. Also, conducting sector-specific vulnerability assessment for sectors such as agriculture, forest, water etc., will help in understanding vulnerability of such systems and the actions needed to provide necessary resilience to the sector.

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List of Indicators for District Level Climate Change Vulnerability Assessment

Vulnerability Assessment in India
Project funded by Swiss Agency for Development and Cooperation, Embassy of Switzerland (SDC)
and
Department of Science and Technology (DST), Government of India

## Indicators for Integrated Vulnerability Assessment (District level[1])

*States/UTs may use 3-4 additional indicators depending on their specific characteristics that may affect vulnerability*

| Main Indicator | Sub-Indicator |
|---|---|
| Socio-economic and livelihood | Per Capita Income (-) / % BPL households (+) |
| | % share of natural resource-based income (agriculture, livestock, forestry and fishing) in Gross Value Added by the district (+) |
| | Total Number of Livestock per 1000 rural households (use latest livestock census) (-) |
| | % of landless, marginal and small farmers (land <5 acre) (+) |
| | Female Workforce Participation[2] (-) |
| Bio-Physical | Forest area (in ha)/1000 rural population[3] (-) |
| | Value of Output of Total horticulture (only perennial) / Value of agricultural output (-) |
| | % of net irrigated area to net sown area (-) |
| | Variability in food grain crop yield (tonne/ha) (consider data for past 10 years)[4] (+) |
| | Groundwater availability (-) |
| Institutional + infrastructure[5] | Road density (road length/geographical area) (-) |
| | Rural bank / 1000 rural population (-) |
| | Average person days/household employed under MGNREGA over last 5 years (2015-16 -2019-20, no. of days) (-) |
| | % crop area covered under crop insurance (-) |
| Health[6] | Cases of vector borne diseases/1000 Population (Dengue & Malaria) (+) |
| | Cases of Water Borne Diseases /1000 of population (Hepatitis & Diarrhea) (+) |
| | No of doctors, specialists, health assistants & health Workers per 1000 population (-) |
| | Infant Mortality Rate (+) |

- +/- implies positive/negative relationship with vulnerability
- Highlighted variables were used in the demonstration by states during the Capacity Building Workshop

[1] Small states/UTs may use other suitable administrative/geographical boundary in consultation with IITs/IISc
[2] Additional indicator that were discussed with this regard are literacy rate and the gender gap in literacy. However, the definition of literacy is such that it may not reflect empowerment (of women). Also, migration is a relevant indicator, but data is not available.
[3] Additional indicator suggested: Income from forest, biological richness,
[4] Consider three main food crops that in produced in the district. Calculate the yield for each crop for each year. Calculate Coefficient of Variation.
[5] Additional indicators suggested: population covered under early warning system
[6] Additional indicator suggested: Number of anganwaris, livestock health