Department of Science, Technology & Environment
Government of Tripura

Department of Science & Technology
Ministry of Science & Technology
Government of India

NMSHE NATIONAL MISSION FOR SUSTAINING THE HIMALAYAN ECOSYSTEM

CLIMATE VULNERABILITY ASSESSMENT AT BLOCK LEVEL USING A COMMON FRAMEWORK, 2021-2022

Tripura Climate Change Cell, DSTE, Tripura.

Supported by :

Department of Science & Technology

Government of India.

ACKNOWLEDGEMENT

We would like to express our gratitude to Dr. Akhilesh Gupta, Senior Adviser, Department of Science and Technology (DST), Govt. of India and Dr. Nisha Mendiratta, Head of Scientific Division, Climate Change Programme, Department of Science and Technology (DST), Govt. of India for their continuous support for Tripura State Climate Change Cell (TCCC), DSTE, Tripura. This report would not have been possible if they haven't provided and arranged series of technical training and resources. We thank the Swiss Agency for Development and Co-operation (SDC), New Delhi, India for the Indian Himalayas Climate Adaptation programme (IHCAP) with which the development of Climate Vulnerability Assessment for the Indian Himalayan Region States has been facilitated and the capacity building training has been organized during, 2018.

We would also like to thank Prof. Rabindranath and his team from IISC Bangalore for developing framework for climate change vulnerability assessment which we can comprehend and follow it with ease upon training provided by team of IIT-Guwahati and IIT-Mandi. We sincerely thank all Block Development Officers (BDO), Nodal Persons of each Blocks, Government Departments and organizations from which the data were obtained for assessment of climate vulnerability at Block level.

Finally, we thank all the expert members from the State i.e. Mr. Anjan Sengupta, Sr. Scientific Officer, Directorate of Biotechnology, Tripura, Dr. Sabyasachi Dasgupta, Associate Professor, Tripura University and Dr. Ezekial Reang, Assistant Professor, College of Agriculture, Tripura for their unconditional assistance while developing this report.

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Chapter 1: INTRODUCTION

1.1 Introduction to Climate Change

Climate Change is undoubtedly one of the most critical challenges faced by humanity today and has witnessed increased momentum to coax a coherent global response. There is a consensus among the scientific community that the Earth is warming and the continued warming is likely to be severe more in the coming decades. In the last 130 years, the world has warmed by approximately 0.85°C. Each of the last 3 decades has been successively warmer than any preceding decade since 1850. Climate change modeling studies for India shows that the Indian sub-continent is likely to experience a warming of over 3–5°C and significant changes (increases and decreases) in flood, drought frequency and intensity by the late 21st century.

Climate Change is expected to destabilize the natural ecosystem, decrease the availability and quality of precious natural resources, decline in food productions, and scarcity of clean water and initiate extreme events that may claim millions of lives. IPCC report shows that in the poorer, low latitude countries Climate change could seriously challenge the capacity to adapt for a warming of more than 3° C.

Tripura being part of the Indian Himalayan Region is considered one of the most vulnerable state owing to its proximity to Bangladesh which has been declared to be one of the most vulnerable and climate sensitive countries by the world community (SAPCC - 1, Tripura).

Thus, there is need to address the implications of climate variability and projected climate change by developing adaptation and resilience building strategies in the short and long terms. Assessment of vulnerability is a pivotal step to develop adaptation policies, strategies and practices.

The objective of this assessment is to identify, rank and prioritise the most vulnerable Blocks in the State under current climate variability for developing programmes to enhance climate resilience to climate change. The assessment will be helpful for revision of SAPCC – 2, Tripura.

The target groups for this assessment would be stakeholders, government departments, policy makers, bureaucrats, academicians, researchers, development agencies etc.

1.2 What is vulnerability and why assess vulnerability?

Vulnerability is a dynamic and context-specific characteristic, determined by human behaviour and societal organizations. It influences the susceptibility and adaptive capacities of human or societal-ecological systems exposed to hazardous climatic or non-climatic events and stress.

In India, locations such as the Himalayas States, arid zones, coastal areas and mountainous regions are likely to be highly vulnerable to current climate variability and climate change. For example, the Indian Himalayan States have the most fragile biophysical environments and diverse socio-economic, ethnic and indigenous societies. These states are known to experience diverse weather or climatic conditions (due to varying altitudes), extreme weather events (floods, droughts, etc.) and high current rainfall variability. Preliminary modelling studies project higher levels of warming and climate change adversely impacting agriculture.

1.3 Rationale for vulnerability Assessment

Vulnerability assessment is required for multiple purposes, particularly for adaptation planning. Vulnerability assessment would assist in:

a) Adaptation planning of development programmes and projects.
b) Prioritisation of adaptation interventions and investment at National, State, District and Village levels.
c) Developing adaptation proposals from Green Climate Fund, World Bank, Asian Development Bank, Adaptation Fund, bilateral agencies, etc.
d) Meeting the requirements of Paris Agreement, Article 9 that requires assessment of the impact and vulnerability.
e) Designing and implementing the 'Nationally Determined Contributions' component which aims to better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.
f) Revision of the State Action Plan on Climate Change for assessing the vulnerability and prioritising adaptation programmes and projects.

CHAPTER –2: STATE PROFILE

2.1 Characteristics of Tripura

Tripura is the third smallest state of the country and second smallest state in North East India, spread over 10,491 sq. km, located precisely from 22°56'N to 24°32'N and 91°09'E to 92°20'E. The state is predominantly a hilly region, surrounded on all sides by deltaic basin of Bangladesh except for small part in North-East which adjoins Cachar Block of Assam and Mizoram. It is characterized by hill ranges, valleys, and plains and by tropical savannah climate. Lying within the Indo-Malaya eco-zone, Tripura hosts three different types of ecosystems: mountains, forests and freshwater.

Tripura is the 2nd most populous state in the North Eastern Region. According to 2011 census, the state's population is 36.74 lakh, with a density of 350 persons per sq. km. and literacy rate is 87.8%. The state is well endowed with surface water resources. As many as 10 (ten) major rivers in the state is reported to generate an annual flow of 793 million cubic meter of water. All major river originate from hill ranges are generally ephemeral in nature and their flow is directly related to the rainfall.

Majority of the population is dependent on agricultural and allied activities. Agriculture is the primary sector contributing to about 64 per cent of the total employment in the state and 48 per cent of the State Domestic Product. Industrial sector is also mostly agro based depending on rubber and tea. Various other horticultural crops like pineapple, orange, jackfruit, coconut, areca nut and cashew are also grown in Tripura.

Table-1 Districts of Tripura

District	Sub-Division	Blocks	Panchayats	Revenue Circles	Revenue Mouja	TTAADC	MC/NP
West	3	9	87	5	112	85	4
Sepahijala	3	7	111	6	118	58	3
Khowai	2	6	54	4	79	69	2
Gomati	3	8	70	7	130	103	2
South Tripura	3	8	99	6	138	70	3
Dhalai	4	8	41	7	154	110	2
Unakoti	2	4	59	3	78	32	2
North	3	8	70	7	88	60	2
Tripura	23	58	591	45	897	587	20

Source: Economic Review of Tripura, 2019 – 20.

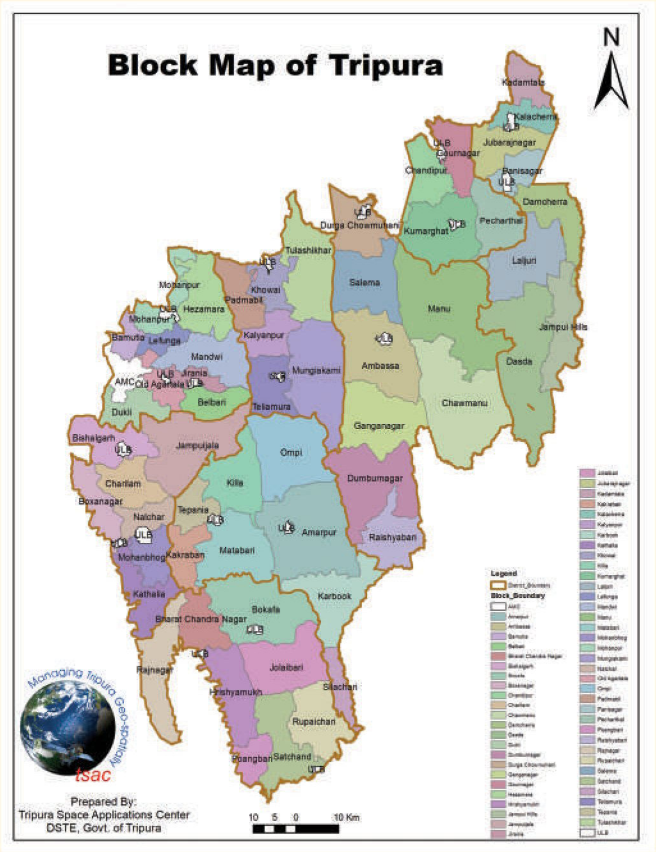


Figure: 1. *Blocks of Tripura*

2.2 Table-2 Demographic Profile of Tripura:

District	Area in Sq.km	Population	Literacy	Sex Ratio	Density (per sq.km)
West	942.55	918200	91.07	970	974
Sepahijala	1044.78	483687	84.68	952	463
Khowai	1005.67	327564	87.78	957	326
Gomati	1522.80	441538	84.53	959	290
South	1534.20	430751	84.68	956	281
Dhalai	2400	378230	85.72	944	158
Unakoti	591.93	276506	86.91	972	467
North	1444.50	417441	87.90	963	289
Tripura	10486.43	3673917	87.22	960	350

Sources: Economic Review of Tripura, 2019 – 20.

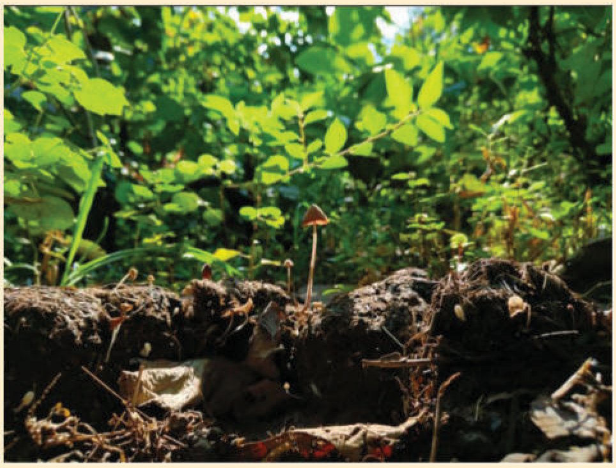


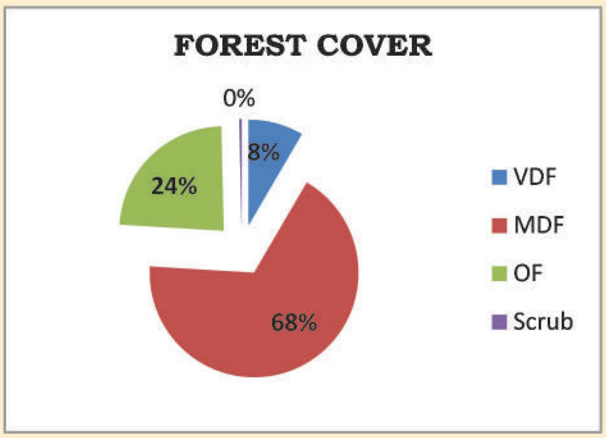
Fig: 2. *Forest Floor in Baramura RF.*

Fig: 3. *Scenic view of Haora River.*

2.3 Natural Resources in the State:

The State is divided in to 3 Physiographic Zones namely hill ranges, undulating plateau land and low-lying alluvial land. The State's geology is represented by sedimentary rocks ranging in age from Miocene to loosely consolidated sediments of recent age. Tripura has humid sub-tropical climate characterized by high rainfall. The terrain of the State includes parallel hills and ridges alternated with narrow valleys. The State has five major hill ranges which traverse in north-south direction. Tripura comes under one Agro climatic zones which is called as "Mild Tropical Plain Zone". Tripura is blessed with surface water resources. There are 10 major rivers in the state that originate from hill ranges and they are rain-fed and ephemeral in nature.

As per the Forest Survey of India Report 2019, the forest cover in Tripura is 7,725.59 Sq. km of which 653.51 Sq. km is very dense forest, 5,236.19 sq. km is moderately dense forest whereas 1,835.89 sq. km is open forest. The forest cover in the State constitutes 73.68% of the State's geographical area. The total Carbon stock of forest in the State is 76.06 million tonnes (278.89 million tonnes of CO_2 (equivalent) which is 1.07% of total forest carbon of the country.



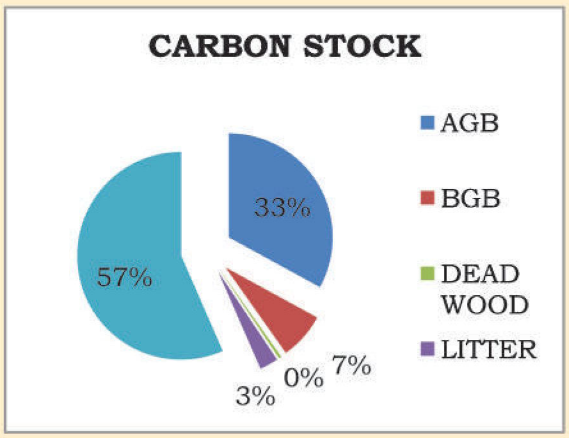


Figure: 4. *Forest Cover and Carbon Stock*

2.4 Table-3. Physical features and Land use Pattern :

Sl. No	Details	Area (in 000 Ha)	% with reference to geographical area
1	Forest Area	629	59.99
2	Land not available for agriculture use	148	14.10
3	Land under Misc. tree Crops, groves not including in net area sown	10	0.99
4	Permanent pasture & other grazing land	1	0.09
5	Cultivable Waste land	3	0.27
6	Current fallow	1	0.08
7	Fallow land other than current fallow	2	0.15
8	Net Cropped Area	255	24.31
	Total Geographical Area	**1049**	**100.00**

Sources: Economic Review of Tripura, 2019 – 20.

2.5 Biological features

The state is located in the Bio-geographic zone of 9B North East Hills and is extremely rich in biodiversity, which is getting increasingly threatened of late. The state has identified 379 species, 320 shrubs, 581 herbs, 165 climbers, 16 climbing shrubs, 35 ferns, 45 epiphytes and 4 parasites. The State has one of the oldest, richest and most diverse cultural traditions associated with use of medicinal plants. So far about 266 species of medicinal plants have been identified and documented. Maximum value of Plant-Diversity Index (Shannon-Weiner) reports is 5.23 indicating presence of a variety of species uniformity.

According to latest estimates, there are 90 mammal species in Tripura from 65 genera and 10 orders. These make up for about 19, 48 & 100% of the total species, genera and orders of the land-mammal record for India. Seven primates species have been documented in Tripura out of a total 15 found in India. Ornithofauna comprises 342 reported species in the State, of which 58 are migratory species. In the aquatic ecosystem 14 species of fish have been recorded, of 2 are endangered and 12 are vulnerable.

2.6 Socio-economic features

Table 4: Social profiles of the Blocks in the State (based on availability of data)

Blocks	Population (2011)*	Sex Ratio[1] (2011)*	% Population BPL (2018)**	Infant Mortality Rate per thousand (2018)***
Khowai	327564	957	62.51	8.1
Dhalai	378230	944	70.86	21.6
Unakoti	276506	972	64.95	21.6
North Tripura	417441	963	66.52	15
West Tripura	918200	970	59.78	14.4
Sepahijala	483687	952	66.33	5.6
Gomati	441538	959	67.64	8.1
South Tripura	430751	957	64.39	9.9

*Source: * DES-Tripura based on Census-2011 data.*

[1]Sex ratio: Females per '000 males

CHAPTER – 3: TRIPURA CLIMATE PROFILE

3.1 Climate Profile

Climate Change is generally defined as "a change in the state of the climate that can be identified (e.g., using statistical analysis) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer" (IPCC 2014). Anthropogenic climate change is defined as a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere (e.g., increase in greenhouse gases due to fossil fuel emissions) or surface characteristics e.g., deforestation) and which is in addition to natural climate variability observed over comparable time periods. It is reported that, in India, the mean annual temperature is increased by 0.6 degree Centigrade over the last century; the monsoon rainfall is declined over the last three decades of the 20th century in many parts of the country, while some parts have showed an increasing trend in the observed frequency of heavy precipitation events.[2]

3.2 Past and on-going climate trend

Tripura is in the north eastern region of India and lies between 22°56´ & 24°32´ north latitudes and 91°10´ & 92°20´ east longitudes. The State is part of the Himalayan Ecosystem and five major hill ranges- Hathaik'tor, Hachuk Beram, Longtharai, Shakhan and Jampui run through the state from north to south. It has a humid tropical climate. It observes moderately warm temperatures during summer and moderately cold temperatures during winter. Spring season starts from late mid-February and continues till mid-March. The State experiences high humidity in summer season because of the presence of Bay of Bengal to its south. It sometimes experiences early winter if there is early rain around mid-February. Summer season starts from middle of March and lasts up to May. Monsoon season through is from June-September, rainfall is seen across the seasons. Annual rainfall ranges from 1922 mm to 2855 mm. The State experiences four seasons:

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[2] IPCC (2014) 'Summary for Policymakers', in Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P.,Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T. and Minx, J.C.(Eds.): Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA

1. Winter-Winter starts from December itself. During winter, the state experiences moderate to dense fog and sometimes very dense fog. January remains the coldest month and average temperature remains around 10 degree Celsius.

2. Pre-Monsoon (summer)-Temperature starts increasing from March which results in thunderstorms. These thunderstorms in this season are called "*Kalbaisakhi*" in local language. The average maximum temperature remains around 31 to 32 degree Celsius and minimum temperature around 24 to 25 degree Celsius. April remains the warmest month of the year

3. Monsoon-South-west monsoon enters the State during first week of June. The State receives 60% of the annual rainfall during this period with average rainfall of more than 1300mm. June remains the rainiest season with more than 400mm of average rainfall.

4. Post-Monsoon-Rainfall and temperature starts decreasing in the State from October. The average maximum temperature remains around 26 degree Celsius and the average minimum temperature remains around 11 degree Celsius. The weather becomes dry from November, morning starts becoming foggy from December and winter season commences.

Based on the latest scientific understanding, this Chapter explains Tripura's Historical climate and climatic variability, based on IMD data for 1950-2013, observed trends and impacts within this period, as well as projected future climatic changes and related uncertainties.

3.3 Temperature

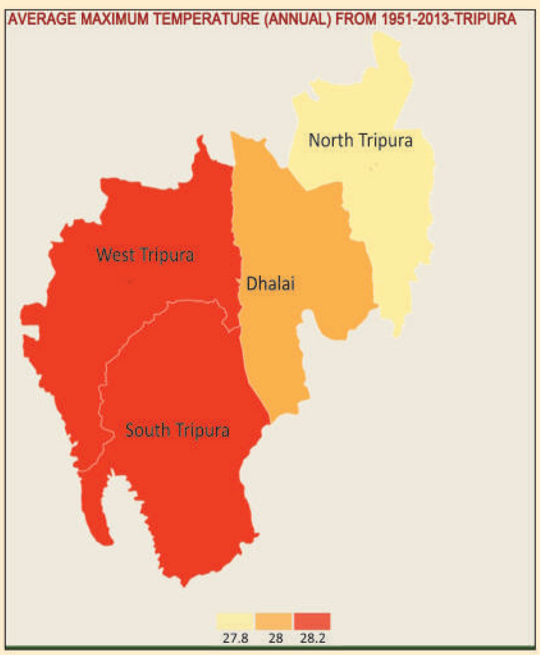
Based on the historical IMD Gridded data on daily temperature (maximum and minimum) from 1951 to 2013 for the state of Tripura has been analysed. This has been given in the table below.

Mean annual maximum temperature for Tripura is 28.1 degree Centigrade with a range varying from 27.9 degree Centigrade to 28.2 degree Centigrade. It is also observed that for annual maximum temperature, the highest value is attained for the districts- South Tripura, West Tripura, Gomati and Sepahijala. Mean annual minimum temperature is 17.9 degree Centigrade with a range varying from 17.8 degree Centigrade to 17.9 degree Centigrade.

Table 5: District-wise Temperature of Tripura (in degree C)

District	T_{max}	T_{min}
Dhalai	28.0	17.8
North Tripura	27.9	17.8
South Tripura	28.2	17.9
West Tripura	28.2	17.9
Khowai	28.0	17.8
Unakoti	27.9	17.8
Gomati	28.2	17.9
Sepahijala	28.2	17.9

The lowest average minimum temperature was 17.8^{0}C in Dhalai, North Tripura, Khowai and Unakoti. The past trend shows that both average annual maximum temperature and minimum temperature are showing an increasing trend. The following climate trends are available for the state of Tripura.



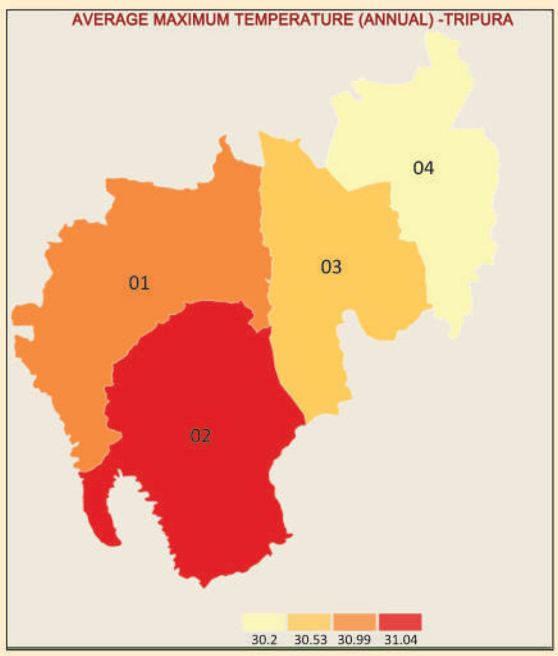


Figure 5: *Average Annual Maximum Temperature of Tripura- Historical (Left); Average Annual Maximum Temperature of Tripura projected for 2021-50 under RCP 4.5 (Right)*

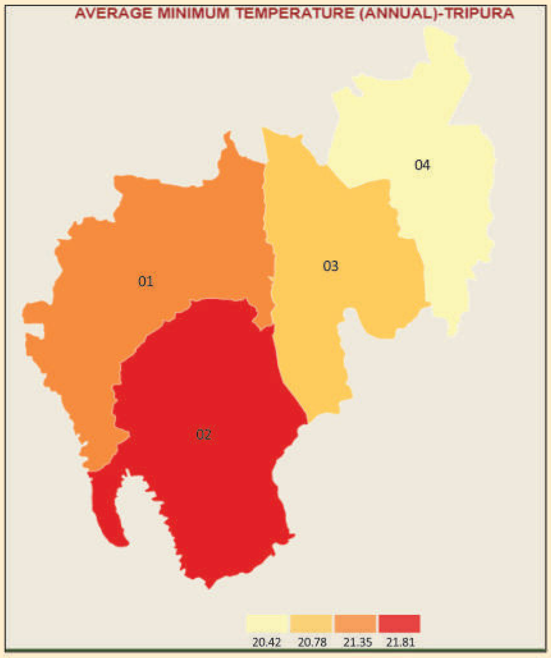


Figure 6: *Average Annual Minimum Temperature of Tripura - Historical (Left), Average Annual Minimum Temperature of Tripura projected for 2021-50 under RCP 4.5 (Right)*

The analysis[3] of the projected daily temperature under climate change scenario shows that:

- Mean annual maximum temperature for RCP 4.5 scenario is projected to increase by about 1.1 degree Celsius by mid-century. For RCP 8.5 scenario it is projected to increase by about 1.35 degree Celsius by mid-century for the state of Tripura.
- Mean annual minimum temperature for RCP 4.5 scenario is projected to increase by about 1.05 degree Celsius by mid-century. For RCP 8.5 scenario it is projected to increase by about 1.35 degree Celsius by mid-century.

3.4 **Precipitation**

Based on the IMD gridded data, the precipitation trends (1951-2013) have been given below. Average annual rainfall of Tripura varies with a range from 2338 mm to 2519 mm over the period 1951-2013

[3]Analysis from IMD gridded data and climate projection data source INRM

Table 6 : District-wise Rainfall of Tripura (in mm)

District	Average Annual Precipitation in mm
Dhalai	2472
North Tripura	2519
South Tripura	2415
West Tripura	2338
Khowai	2472
Unakoti	2519
Gomati	2415
Sepahijala	2338

From the above table is clear that North Tripura and Unakoti districts receive higher annual average rainfall than rest of the districts. The historical trend shows Dhalai, Khowai, North Tripura, Unakoti, South Tripura and Gomati, the precipitation is in a decreasing trend whereas West Tripura and Sepahijala is showing an increasing trend.

3.5 Representative Concentration Pathways (RCPs)

The IPCC scenarios provide a mechanism to assess the potential impacts on climate change. Global emission scenarios were first developed by the IPCC in 1992 and were used in global general circulation models (GCMs) to provide estimates for the full suite of greenhouse gases and their potential impacts on climate change. Since then, there has been greater understanding of possible future greenhouse gas emissions and climate change as well as considerable improvements in the general circulation models. The IPCC, therefore, developed a new set of emissions scenarios. The process by which these new scenarios are being produced differs from earlier scenario development.

The new process aims to both shorten the time required to develop and apply new scenarios, and to ensure better integration between socio-economic driving forces, changes in the climate system, and the vulnerability of natural and human systems. Rather than starting with socio-economic scenarios that give rise to alternative greenhouse gas emissions, the new scenarios take alternative futures in global greenhouse gas and aerosol concentrations as their starting point. These are called Representative Concentration Pathways (RCPs). The Representative Concentration Pathways (RCP) are based on selected scenarios from four modeling teams/models working on integrated assessment modeling, climate modeling, and analysis of impacts.

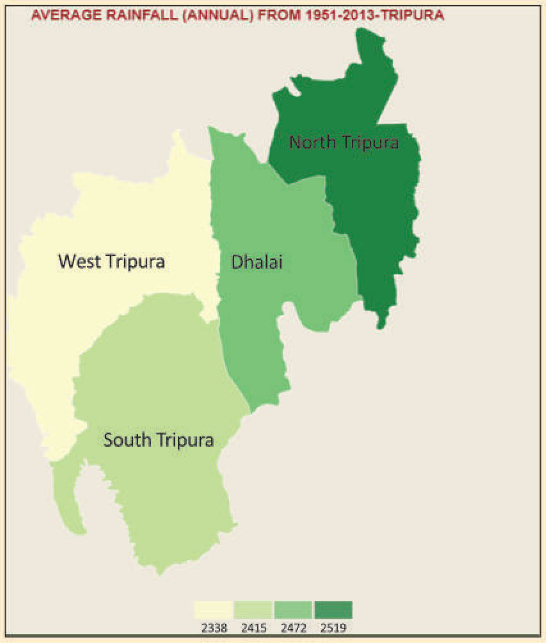
RCPs are four greenhouse gas trajectories adopted by the IPCC for its Fifth Assessment Report (AR5). The four RCPs; RCP 2.6, RCP 4.5, RCP 6, and RCP 8.5, are named after a possible range of radioactive forcing values in the year 2100.

Table- 7 .Overview of Representative Concentration Pathways (RCPs) adopted by IPCC AR5

RCP	Description	IA Model
RCP 8.5	Rising radioactive forcing pathway leading to 8.5 W/m2 in 2100.	MESSAGE
RCP 6	Stabilization without overshoot pathway to 6 W/m2 at stabilization after 2100	AIM
RCP 4.5	Stabilization without overshoot pathway to 4.5 W/m2 at stabilization after 2100	GCAM (Mini CAM)
RCP 2.6	Peak in radioactive forcing at ~ 3 W/m2 before 2100 and decline	IMAGE

Resolution of the projected climate data is at a grid-spacing of 0.5°x0.5° for IPCC AR5 scenarios, namely, RCP8.5 (a scenario of comparatively high greenhouse gas emissions and does not include climate policy interventions) and RCP 4.5 (moderate emission scenario and assumes climate policy intervention to transform associated reference scenarios). Ensemble mean of 3 regional climate models (RCM), namely, REMO (from MPI), RCA4 (from SMHI) and CCAM (from CSIRO) has been used for the analysis. Ensemble mean is chosen to reduce model related uncertainties and ensemble mean climate is closer to observed climate than any individual model. The analysis of annual rainfall reveals a negative trend indicating that, the total amount of rainfall received has been decreasing for some parts of the state in Mizoram.

- However, mean annual rainfall for RCP 4.5 mid-century scenario is projected to increase by about 4% from baseline. For RCP 8.5 scenario rainfall is projected to increase by about 13% towards both mid-centuries.



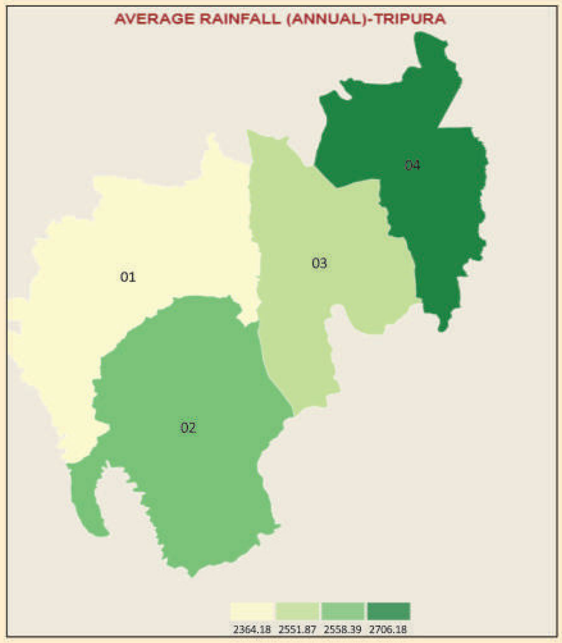


Figure 7: *Mean Annual Rainfall of Tripura-Historical (Left); Annual rainfall of Tripura - projected for 2021-50 under RCP 4.5 (Right).*

General implications of temperature increase may include heat stress related health impacts, increase in energy demand for cooling, additional evaporation and evapotranspiration losses resulting in increase in water required for irrigation of crops. Considering increase in intensity of rainfall events may lead to floods, urban storms, vector borne diseases, loss of work, transport disruption, additional cost for flood proofing factories and warehouses. However, it is likely that one day maximum precipitation event may decrease towards mid-century. The cold spell events may decrease about 2/3rd towards mid-century.

3.6 Climate Projections & Analysis

For Tripura State and districts, IPCC AR5 RCP 4.5 and RCP 8.5 scenarios has been analyzed for the annual maximum and minimum temperature and precipitation.

Table 8: Summary of Climate Analysis

<table>
<tr><td colspan="3">Observed Climate Data[4] (1951-2013): IMD Gridded Data</td></tr>
<tr><th>Temperature</th><th>Precipitation</th><th>Climate Extremes</th></tr>
<tr><td>Increasing trends observed for both maximum and minimum temperatures (high confidence (for the entire region it is 0.1 °C - 0.2 °C per year).</td><td>Annual average precipitation showed a decreasing trend for most districts except for West Tripura where it is showing an increasing trend</td><td>Frequency of one day maximum precipitation are increasing in both mid-century and end-century scenarios as compared to baseline, warm nights and hot days increased (Medium confidence in RCP 4.5 scenario)</td></tr>
<tr><td colspan="3">Projected Climate Data[5] (2021-50): RCP 4.5 and RCP 8.5</td></tr>
<tr><td>Projected change in Temperature
Under RCP 4.5
T_{max}: 1.10 °C
T_{min}: 1.05 °C</td><td>Projected annual precipitation changes
Under RCP 4.5
Increase by 4%</td><td rowspan="2">Projected extreme events: The one-day maximum precipitation events may decrease by 2% by mid-century under RCP 4.5. However, floods and warm spells are likely to increase in future and will become increasingly challenging for disaster management authorities.</td></tr>
<tr><td>Under RCP 8.5
T_{max}: 1.35 °C
T_{min}: 1.30 °C</td><td>Under RCP 8.5
Increase by 13%</td></tr>
</table>

[4]Based on IMD Gridded data for 63 years
[5]Based on 29 GCM CMIP simulated for Mid Century Scenario (near term to our NDC 2030) under RCP 4.5 and RCP 8.5 scenarios

CHAPTER – 4: VULNERABILITY ASSESSMENT

4.1 Vulnerability Framework Adopted

The IPCC 2014 report has adopted this construct of vulnerability and defined it as propensity of a system to be adversely affected, which is to be considered independent of the element exposure. According to IPCC 2014 report therefore, Vulnerability is a characteristic property of a system that shows its current internal state. The risk management framework adopted by the IPCC in the fifth assessment report (IPCC 2014) depicts that hazard; exposure and vulnerability interact and result in risk within the overall climatic and non-climatic physical and socio-political environment. Accordingly, in this report VA framework considers only sensitivity and adaptive capacity as the two co-factors determining Vulnerability.From the Fifth Assessment Report (AR5) of IPCC (2014)

Vulnerability - *The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.*

Adaptive capacity - *The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.*

Sensitivity – *Degree to which a system or species is affected, either adversely or beneficially by climate variability or change. The effect may be direct (e.g., change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damage caused by an increase in the frequency of coastal flooding due to sea level rise).*

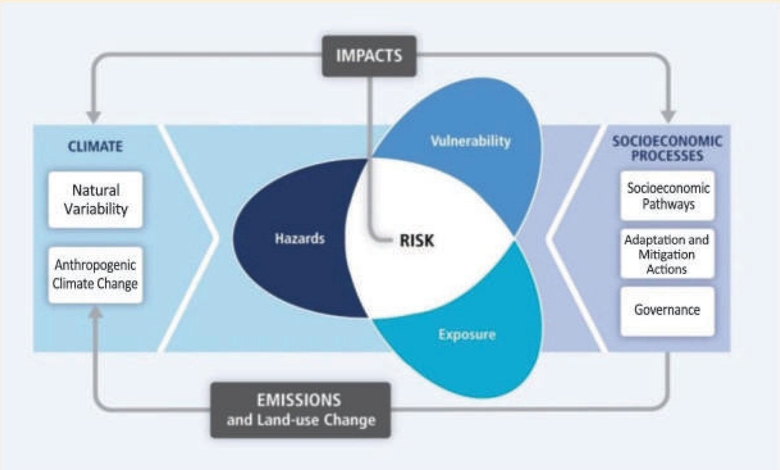


Figure 8: *Risk management and assessment framework (Source: IPCC, 2014).*

4.2 Methodology

Step 1
Scoping and objectives of vulnerability assessment

Step 2
Selection of type of vulnerability assessment

Step 3
Selection of Tier method

Step 4
Selection of sector, spatial scale, community/ system and period for assessment

Step 5
Identification, definition and selection of indicators for vulnerability assessment

Step 6
Quantification and measurement of indicators

Step 7
Normalisation of indicators

Step 8
Assigning weights to indicators

Step 9
Aggregation of indicators and development of vulnerability index

Step 10
Representation of vulnerability: spatial maps, charts and tables of vulnerability profiles and index

Step 11
Vulnerability ranking of sectors, regions, communities, cropping systems, river basins, watersheds, forest types, etc.

Step 12
Identification of drivers of vulnerability for adaptation planning

Figure 9: *Steps in vulnerability assessment.*

4.3 Steps Adopted:

Table 9: Approach and methodology adopted to assess vulnerability of Blocks in the State

SN	Steps in vulnerability assessment	Details of Vulnerability Assessment of Blocks in the State
1.	Scoping of vulnerability assessment.	To develop Block wise vulnerability profile of Tripura
2.	Selection of type of vulnerability assessment	Integrated assessment considering both biophysical, socio-economic, Institutional & Infrastructure indicators
3.	Selection of Tier methods	Tier 1
4.	Selection of Spatial scale and period for vulnerability assessment	Spatial scale: Block-level assessment Period: Data for different indicators pertained to 2018-2022.
5.	Identification, definition and selection of indicators for vulnerability assessment	Indicators were selected through experts and literature review. Nine indicators were selected: 1) % of Area without dense Forest Cover. 2) % of BPL & Antyodaya Families. 3) % of Cropping Intensity. 4) % of Yield variability. 5) Number of Marginal land holders. 6) Road Density 7) Number of Self Help Groups. 8) Number of ASHA workers.
6.	Quantification and measurement of indicators	All Indicators were quantified using secondary source data, Nodal Officers of Block, Tripura. The database used in the assessment along with its sources is provided in the report.
7.	Normalization of indicators	Normalization was done based on the indicators (i.e. Positive or Negative) functional relationship with

		vulnerability [$\frac{Actual\ indicator\ value - Minimum\ indicator\ value}{Maximum\ indicator\ value - Minimum\ Indicator\ value}$] for positive indicator & [$\frac{Maximum\ indicator\ value - Actual\ indicator\ value}{Maximum\ indicator\ value - Minimum\ indicator\ value}$] for negative indicators].
8.	Assigning weights to indicators	Weights were assigned to each Indicator in consultation with Nodal Officers, Block & State Expert Committee, TCCC, Tripura.
9.	Aggregation of indicators and development of vulnerability index	The normalised indicators have been aggregated to come up with Vulnerability Index [$\frac{1}{Total\ number\ of\ indicators}$ (Sum of all the indicators)]
10.	Representation of vulnerability; spatial maps, charts and tables of vulnerability profiles and index	Table, graphs and maps are used to represent vulnerability and its drivers. QGIS software has been used to construct the maps.
11.	Vulnerability ranking of the Blocks in the state	As per data availability from Nodal Officers, 58 blocks have been ranked according to VI based on 8 indicators.
12.	Identification of drivers of vulnerability for adaptation planning	Cropping Intensity, Road Density, BPL and Antyodaya families.

5.1 Indicators selected, rationale for selection and source of data

Table 10: List of indicators for Tier 1 vulnerability assessment relevant to Blocks, rationale for selection, functional relationship with vulnerability and sources of data.

Indicators	Rationale for selection	Adaptive Capacity or Sensitivity	Functional relationship with Vulnerability	Source of data
% Area without dense Forest Cover	Higher the area without dense forest cover more sensitive to the environment	Sensitivity	Positive	TSAC, DSTE, Govt. of Tripura
% of BPL & Antyodaya Families	Higher percentage of BPL indicates lesser adaptive capacity	Sensitivity	Positive	Nodal Officer, O/O the BDO, Tripura
Cropping Intensity	Cropping intensity is defined as a ratio between net sown area (NSA) and gross cropped area (GCA). Higher the index, greater is the efficiency of land use.	Adaptive Capacity	Negative	Nodal Officer, O/O the BDO, Tripura
Yield Variability	A high variability in crop yields indicates fluctuations in agro-climatic conditions. The agriculture sector is extremely sensitive to climate fluxes, particularly rainfall variability (delayed rainfall, dry spells, drought, extreme rainfall and floods) and this indicator captures this	Sensitivity	Positive	Department of Agriculture & Farmers Welfare, Tripura

	sensitivity (Davis, et al, 2019)			
Number of Marginal land holders	Marginal farmers (land holding <1 ha) are known to have low social and economic capital and thus are inherently more sensitive and have lower adaptive capacities	Sensitivity	Positive	Nodal Officer, O/O the BDO, Tripura
Road Density	Accessibility and connectivity are essential for overall development of a region since better connectivity comes with better access to market, essential services etc.	Adaptive Capacity	Negative	Nodal Officer, O/O the BDO, Tripura
Number of Self Help Group	Higher the number of SHGs betters the income source to livelihood.	Adaptive Capacity	Negative	Nodal Officer, O/O the BDO, Tripura
No. of ASHA workers	More Health Activists within the community will create better awareness on health and its social determinants and mobilize the community towards local health planning and increased utilization and accountability of the existing health services.	Adaptive Capacity	Negative	Nodal Officer, O/O the BDO, Tripura

5.2 Indicator and Actual Values and Normalised Indicator Values

This section presents the actual sub-indicator values used and their Actual and Normalized scores for each of the indicators, for all the Blocks in the states. Actual and Normalized values is done depending on the indicators' functional relationship with vulnerability (either positive or negative relationships) and corresponding formulae are used

Table 11: Normalized scores for the indicator Demographic characteristics

SN	Blocks	% of Area without dense Forest Cover	% of BPL + Antyodaya	Cropping Intensity	% of Yield variability	No. of Marginal land holders	Road Density	No. of Self Help Groups	No. of ASHA Workers
		NV	NV	NV	NV	NV	NV	NV	NV
1	Ambassa	0.65	0.50	0.90	0.28	0.22	0.94	0.48	0.82
2	Chawmanu	0.0	0.5	1.0	0.6	0.0	1.0	0.8	0.9
3	Dumburnagar	0.0	0.5	0.9	0.5	0.1	1.0	0.5	0.9
4	D. Chowmuhani	0.4	0.3	0.9	0.3	0.1	0.8	0.0	0.8
5	Ganganagar	0.9	0.1	0.8	0.2	0.1	0.9	0.9	1.0
6	Manu	0.3	0.8	0.9	0.1	0.6	1.0	0.3	0.9
7	Raishyabari	0.8	0.7	0.9	0.2	0.1	1.0	1.0	1.0
8	Salema	0.7	0.7	0.9	0.2	0.3	0.9	0.5	1.0

SN	Blocks	% of Area without dense Forest Cover	% of BPL + Antyodaya	Cropping Intensity	% of Yield variability	No. of Marginal land holders	Road Density	No. of Self Help Groups	No. of ASHA Workers
		NV	NV	NV	NV	NV	NV	NV	NV
9	Amarpur	0.7	0.5	0.8	0.3	0.3	0.9	0.4	0.8
10	Ompi	0.5	0.2	0.9	0.0	0.2	0.9	0.6	0.9
11	Kakraban	0.5	0.2	0.9	0.0	0.3	0.7	0.7	0.8
12	Karbook	0.2	0.7	0.9	0.1	0.2	0.9	0.6	0.9
13	Killa	0.0	0.5	0.9	0.2	0.3	0.8	0.6	0.9
14	Matabari	0.7	0.2	0.9	0.0	0.1	0.3	0.3	0.8
15	Silacharri	0.1	1.0	0.9	0.3	0.0	0.9	0.9	1.0
16	Tepania	0.3	0.3	0.0	0.1	0.1	0.8	0.4	0.9
17	Kalyanpur	0.3	0.3	0.9	0.3	0.2	0.8	0.8	0.9
18	Khowai	0.7	0.8	0.9	0.3	0.2	0.9	0.5	0.0
19	Mungiakami	0.4	0.5	0.9	0.7	0.1	0.8	0.9	0.9
20	Padmabil	0.4	0.5	0.9	0.8	0.1	0.8	0.8	0.8
21	Teliamura	0.0	0.6	1.0	0.2	0.3	0.8	0.6	0.8
22	Tulasikhar	0.6	0.6	0.9	0.4	0.2	0.9	0.8	0.8
23	Damcherra	0.9	0.6	1.0	0.7	0.2	0.9	0.9	0.9