Assam State Action Plan on Climate Change
Version 2.0
(2021-2030)

অসম চৰকাৰ

ACCMS

GOVERNMENT OF ASSAM

Assam Climate Change Management Society (ACCMS)
Government of Assam, India

Assam State Action Plan on Climate Change ASAPCC 2.0

(2021 – 2030)

Submitted by

Assam Climate Change Management Society (ACCMS)

Government of Assam

Acknowledgement

Chief Minister

Government of Assam

Message

I am happy to note that the Assam Climate Change Management Society (ACCMS), Assam has updated "Assam State Action Plan on Climate Change (2021-2030)". This report is of immense importance as it provides a comprehensive strategy to protect Assam which is among those states that are highly vulnerable to climate extreme events like floods, drought, and cyclones. The report also ensures sustainable economic growth of the State. The State Government is committed to a holistic approach to address climate change challenges. We strongly believe that there is a need to protect our environment, strengthen our energy security and spur economic growth through continued effortsand sustained actions.

The State Government is committed to taking affirmative actions at the grass-root level aimed at encouraging adaptation and mitigation innovations with an emphasis on all sectors including education by establishing a separate cell dedicated to climate change which will contribute towards global and local climate change issues. Assam State Action Plan on Climate Change (2021-2030) will create institutional linkages with the National Action Plan on Climate Change, and provide a framework of implementation for different stakeholder departments, organizations, and institutions functioning in the State.

I am given to understand that the Ministry of Environment, Forest & Climate Change, Government of India, has extended technical support towards this endeavor, and experts of the Assam Climate Change Management Society and Environment & Forest Department have worked tirelessly to complete this document. I am sure Assam State Action Plan on Climate Change (2021-2030) will facilitate tackling issues about climate change vulnerability, especially in sectors viz. agriculture, horticulture, fisheries, water resources, forests, energy, and disaster.

I extend my gratitude to the Ministry of Environment, Forest & Climate Change, Government of India, and the competent team of experts of Assam Climate Change Management Society for bringing out this updated Strategy and Action Plan on Climate Change for Assam.

(Dr. Himanta Biswa Sarma)

Minister of Environment and Forest

Government of Assam

Preface

Department of Environment and Forest, Government of Assam, has taken initiative to prepare 'State Action Plan on Climate Change (2021-2030)' for Assam, in coordination with the Ministry of Environment, Forests & Climate Change, Govt. of India and Assam Climate Change Management Society (ACCMS) and State government departments to meet the challenges posed by climate change, especially in the Himalayan context.

To tap Nation's natural resources with a need to maintain ecological balance keeping in mind India's economic need, the National Action Plan on Climate Change (NAPCC), a policy document was prepared in 2008 under Prime Minister's Council on Climate Change. The Government of Assam published its first State Action Plan on Climate Change (SAPCC) in 2015, recognizing and addressing the climate change concerns of water resources, forest and biodiversity, agriculture, urban habitat, and energy. Based on the rapid advancements in climate change, Assam also revised the document under the guidance of the Ministry of Environment, Forest and Climate Change (MoEFCC) which includes vulnerability assessment at the district level.

This study also contains formative suggestions which may help protect and enhance the vulnerable ecosystem of the state through a response matrix for anticipatory adaptation options, cost of implementation, and institutional arrangements for steering this strategy and action plan. As in all scientific endeavors; any estimate provided is necessarily contingent upon the availability of data and information, therefore, over time the strategies will be refined, and methodologies and data sources will be improved. Hence, it is anticipated that there will be adjustments in a future iteration, to keep pace with scientific convention and good practices.

I on behalf of the Department of Environment and Forest, Assam express our gratitude to the Ministry of Environment, Forest & Climate Change, Government of India for the financial assistance to undertake this revision besides experts from ACCMS who provided their wholehearted support in bringing out this scientific document.

I extend my appreciation and thanks to all the organizations, research institutions, and government departments which have provided valuable databases and guidance.

(Shri. Chandra Mohan Patowary)

Chief Secretary
Government of Assam

Key Message

The magnitudes of climate change on the social and financial systems are expected to vary in different regions of the world on account of several regional and other local factors. Therefore, different adaptation, mitigation strategies, and technology systems would be required in differing geographical and social contexts. Further, there are many uncertainties in disaggregating the effects of global warming on different Agro-climatic regions due to still inadequate scientific understanding of the processes involved in climate change. Hence, Agro-ecological zone-wise climate change study stands a major role in formulating a climate action plan for Assam.

Assam has six agro-ecological zones and hence has a reason to be concerned about Climate Change, as it has a large population dependent on agriculture and forests for livelihood. The state's economy is also dependent on natural resources and any adverse impact on these and allied sectors will negate all efforts to alleviate poverty and ensure sustainable livelihood for the population. This is an opportune time to integrate the concerns of Climate Change into Assam's policies and ensure the ultimate objective of sustainable development with inclusive growth.

While engaging with national policies and programs it is important to develop well-researched and formulated mitigation and adaptation strategies that are implementable and specific to the local issues formed due to the possible impacts of Climate Change. The revised State Action Plan on Climate Change has flagged important issues which require short-term, medium-term, and long-term attention. The action plan has highlighted key sectoral concerns and strategies for action to lead the way.

The issue of Climate Change is multidisciplinary and demands cross-sectoral convergence which requires inter-departmental coordination as well as constructive engagement with all the concerned stakeholders. Assam Climate Change Management Society (ACCMS) is a nodal organization to facilitate the implementation and overall monitoring & evaluation of the SAPCC 2.0.

I hope that this revised action plan will serve as a useful source of guidance to policymakers, planners, academicians, civil society groups, and those who are interested in the environment and climate change.

Lastly, I extend my gratitude to the Department of Environment and Forest, Assam, and a team of experts of Assam Climate Change Management Society (ACCMS) for their commendable work in bringing out this revised Strategy and Action Plan on Climate Change for Assam.

(Shri Paban Kumar Borthakur, IAS)

Additional Chief Secretary

Department of Environment and Forest Government of Assam

Key Message

One of the biggest threats to global security is climate change. Climate change knows no borders and poses us all with an existential threat. A significant security consequence of climate change is a rise in the frequency of severe weather events, especially floods and storms. This affects urban and rural facilities, access to drinking water, and other services to sustain everyday life. Since the phenomenon of climate change is ever-evolving and dynamic, the response to mitigate its adverse effects has also to be dynamic, evolutionary, and in line with emerging threats and national and international frameworks.

In this aspect, sub-national planning of action on climate change is a necessary extension of national-level planning, in federal countries like India. India's National Action Plan on Climate Change (NAPCC) outlines for addressing climate-related challenges through National Missions. State Action Plans on Climate Change (SAPCC) are required to effectively ensure that objectives are aligned with national and regional development priorities.

Assam prepared its first SAPCC in 2015. Since the formulation of the ASAPCC, important changes have impacted the realm of climate change policy planning. Not only have the science, knowledge, and understanding of climate change evolved at the global and regional level, but so has the policy context, with the ratification of important development and climate goals at the International level, such as the Sustainable Development Goals (SDGs) and the Paris Agreement temperature and adaptation goals and India's commitments such as Nationally Determined Contribution, pose the need for an evolving, appropriate climate change action planning process.

This adaptation and mitigation strategies document will certainly help the state machinery in orienting their endeavors in the relevant fields and sectors to cope and adapt to the ensuing and potential impacts of climate change. This document will also be useful in prioritizing and implementing various kinds of mitigation measures in the State under the overall guidance of the Ministry of Environment, Forest & Climate Change, Government of India.

The efforts put in by the Assam Climate Change Management Society (ACCMS) and the line departments of government are highly appreciable. The hard work of other experts and professionals - both external and from within the State Government Departments and civil society organizations, all those associated in finalizing this document are acknowledged thankfully.

I on behalf of the Department of Environment and Forest, Assam acknowledge the efforts of the Ministry of Environment, Forests & Climate Change, Government of India, for encouraging States to bring out such a guiding action plan.

(Shri Ravi Shankar Prasad, IAS)

Principal Chief Conservator of Forest & Head of Forest Force
Department of Environment and Forest, Assam

Key Message

Our planet is on the verge of a climate crisis due to our continued production of greenhouse gases, including carbon dioxide and methane. We are already seeing species decline due to global temperature increases. Every half a degree of warming has a huge knock-on effect on ecosystems, with migratory species running out of areas to migrate to and temperature-sensitive organisms like corals undergoing massive die-offs. When keystone species like reef-building corals disappear, the rich and complex ecosystems they support also collapse.

The State of Assam is concerned about Climate Change, as we have a large population dependent on agriculture and forests for livelihood. The State's economy relies on natural resources, and any adverse impact on these and allied sectors will negate our efforts to alleviate poverty and ensure sustainable livelihood for the population. While engaging with national policies and programs, we need to develop well-researched and formulated mitigation and adaptation strategies specific to the State to respond effectively to the possible impacts of Climate Change.

The SAPCC has been drafted to set up a common but shared agenda for climate change mitigation and adaptation. This State Action Plan is a document that aims to connect evolving climate science, policies, and practices. SAPCC is a dynamic document subjected to periodic review to revisit the suggested strategies and constantly refine them.

I am pleased to see that the various departments of the Government of Assam, with the help of the Assam Climate Change Management Society, have drafted the Assam Action Plan on Climate Change. The State Action Plan on Climate Change has flagged essential issues which require attention.

I extend my appreciation and thanks to everyone especially to Dr. Satyendra Singh, IFS, CEO ACCMS, Shri Rizwan Uz Zaman, Technical Consultant – ACCMS, and other experts of the ACCMS who gave their valuable input and time to revise the action plan. They have put in their best effort to develop this Strategy and Action Plan after putting together a massive database for formalizing recommendations for all sectors in the State.

I hope that the priorities identified under the Assam State Action Plan on Climate Change will lead to sound implementation of strategies that will help to address the challenge of climate change in the State and ensure a future of sustainable development.

(Shri M.K. Yadava, IFS)

Addl. PCCF (Climate Change),
Chief Executive Officer,
Assam Climate Change Management Society,
Government of Assam

Key Message

Assam Climate Change Management Society (ACCMS) has taken initiative to prepare State Action Plan on Climate Change (2021-2030) for Assam, under the guidance of the Ministry of Environment, Forests & Climate Change, Govt. of India to meet the challenges posed by climate change, especially in the flood-prone region of India.

Given this ever more urgent need for adaptation, and the fact that a comparison of planned ASAPCC strategies and a record of departmental activities during the ASAPCC period shows an at best partial implementation of the former, this document then identifies forward-looking strategies and actions that will enhance the fulfillment of the six adaptation-related ASAPCC State sectors, namely the Agriculture, Water Resources, Forest & Biodiversity, Disaster, Health, and Strategic Knowledge Management. Similarly, forward-looking mitigation strategies are defined that will contribute to the fulfillment of the Enhanced Energy Efficiency and State Solar Mission, as well as the State Mission on Sustainable Habitat. The elaboration of these strategies in a participatory process led by nodal and line departments – along with the identification of responsible line departments – ensures ownership of these strategies by the key actors.

I am pleased to see that the various departments of the Government of Assam, with the help of a team of experts from ACCMS, have drafted the Assam State Action Plan on Climate Change. The ASAPCC has been drafted to set up a common but shared agenda for climate change mitigation and adaptation. This State Action Plan is a document that aims to connect evolving climate science, policies, and practices. Even though this is the second version of SAPCC, it is subjected to periodical changes as it is a dynamic document. I acknowledge the efforts of the line departments, civil society organizations, and other prominent agencies for their valuable input to the documents. I highly appreciate the efforts made by Shri Rizwan Uz Zaman, Technical Consultant – ACCMS and the team of ACCMS and M/S IORA for the completion of the ASAPCC. I extend my gratitude to Shri Ravi Shankar Prasad, Additional Chief Secretary, Environment & Forest Department, Shri Mahendra Kumar Yadava, PCCF & HoFF, Government of Assam for their continuous guidance and advice.

I hope that the recommendations identified under the revised Climate Change Action Plan will lead to sound implementation of strategies that will help to address the challenge of climate change in the State and ensure a future of sustainable development

(Dr. Satyendra Singh, IFS)

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Abbreviations

ACCMS	Assam Climate Change Management Society
AEDA	Assam Energy Development Agency
AIWTDS	Assam Inland Water Transport Development Society
APFBC	Assam Project On Forest and Biodiversity Conservation Society
AR5	IPCC Fifth Assessment Report
AR6 WGI	IPCC Sixth Assessment Report (Working Group I)
AR6 WGII	IPCC Sixth Assessment Report (Working Group II)
AR6 WGIII	IPCC Sixth Assessment Report (Working Group III)
ASAPCC 1.0	Assam State Action Plan on Climate Change Version 1 (2015-2020)
ASAPCC 2.0	Assam State Action Plan on Climate Change Version 2 (2021-2030)
ASBB	Assam State Biodiversity Board
ASDMA	Assam State Disaster Management Authority
ASTEC	Assam Science Technology & Environment Council
AUWS&SB	Assam Urban Water Supply & Sewerage Board
AWRMIS	Assam Water Research and Management Institute Society
COP	Conference of Parties
DOHUA	Department of Housing & Urban Affairs
FREMAA	Flood And River Erosion Management Agency of Assam
GA	Government of Assam
GOI	Government of India
GP	Gram Panchayat
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
IEC	Chief Inspectorate of Electricity, Power Department, Assam
IMD	Indian Meteorological Department
IORA	IORA Ecological Solutions Pvt. Ltd.
IPCC	Intergovernmental Panel on Climate Change
IWT	Inland Water Transport Department, Assam
MOEF&CC	Ministry of Environment, Forest and Climate Change
MOES	Ministry Of Earth Sciences
NDC	Nationally Determined Contributions
NHM	National Health Mission Directorate
P&RD	Panchayat and Rural Development Department, Govt. of Assam
PA	Paris Agreement
PCBA	Pollution Control Board Assam
PHED	Public Health and Engineering Department, Govt. of Assam
PMCCC	Prime Minister's Council on Climate Change
PWD	Public Works Department
RCP	Representative Concentration Pathways
RLB	Rural Local Bodies (Gram Panchayats)
SDG	Sustainable Development Goals
ULB	Urban Local Bodies (such as Municipalities, Councils, Corporations etc.)
VA	Vulnerability Assessment

Key Notations:

Short Form	Full Form
Type of Action	
A	Adaptation
M	Mitigation
B	Both Mitigation and Adaptation
Nature of Action	
I	Implementation
P	Policy and Planning
R	Research
CB	Capacity Building
Action Priority	
VH	Very High
H	High
L	Low
Implementation Period	
ST	Short Term (2021-2023)
MT	Mid Term (2023-2026)
LT	Long Term (2026-2030)

EXECUTIVE SUMMARY

9 THEMATIC SECTORS

Agriculture   Water   Forest

Energy   Habitats   Transport

Health   Disaster   Knowledge

9 NATIONAL MISSIONS

NSM   NMEEE   NMSH

NWM   NMSHE   NMGI

NMSA   NMSKCC   NHM

ASAPCC 2.0

2021 - 2030

21 CORE GROUP SECTORAL DEPARTMENTS

NUMBER OF STRATEGIES ACROSS 9 SECTORS: 37

NUMBER OF ACTIONS/SUB-ACTIONS ACROSS 9 SECTORS: 198
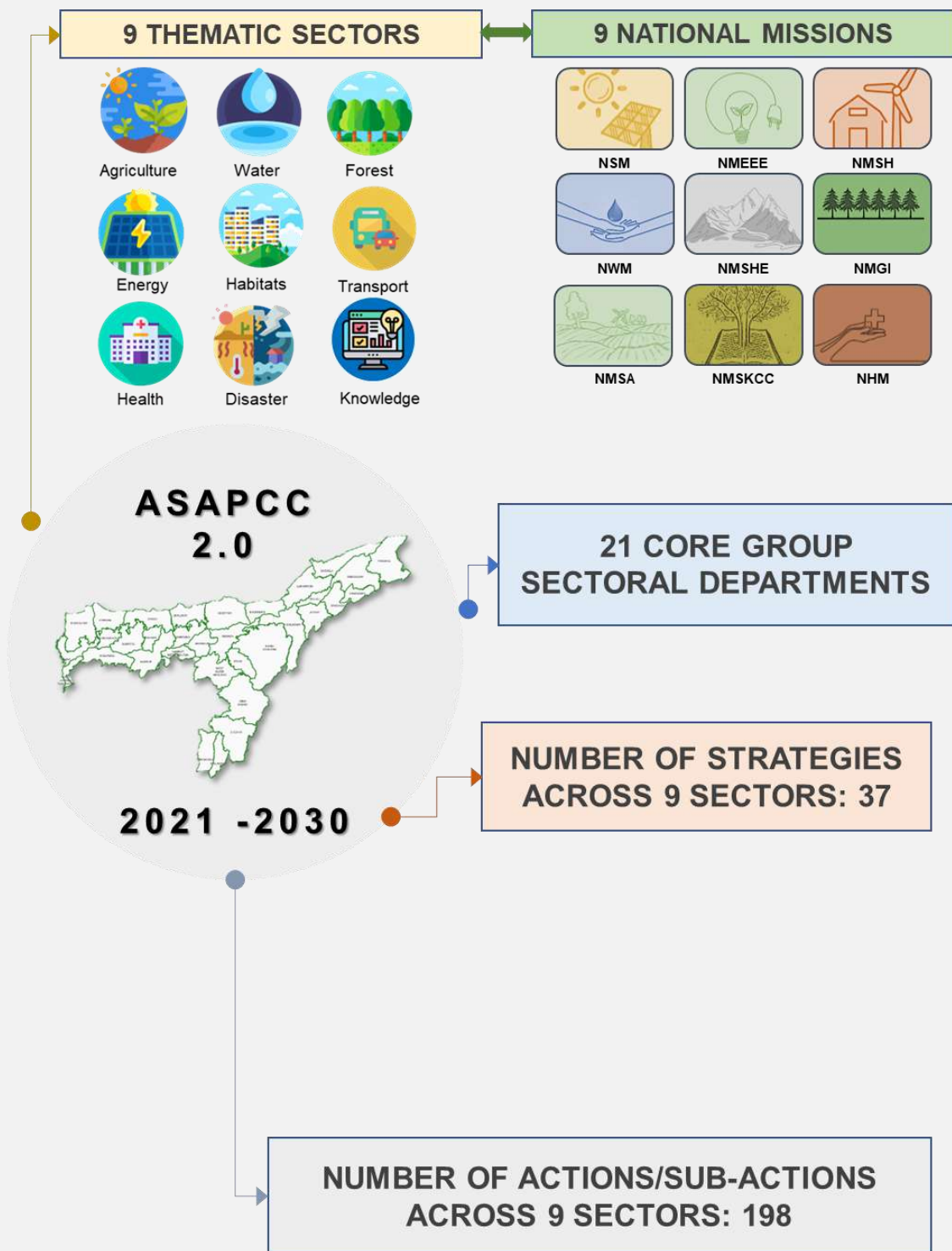
Executive Summary

Today Climate Change is an international emergency affecting lives, livelihoods, economy and our future sustenance. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since Intergovernmental Panel on Climate Change (IPCC's) AR5 report. Further, global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other Greenhouse Gas Emissions (GHG) occur in the coming decades (IPCC AR6 WG I, 2021).

In 2008, India launched the National Action Plan on Climate Change (NAPCC) under Prime Minister's Council on Climate Change (PMCCC). Subsequently, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, directed all Indian States & Union Territories (UTs) to prepare their respective State Action Plan on Climate Change (SAPCC), consistent with the strategies outlined in the NAPCC. The Government of Assam published its first SAPCC in 2015, recognizing and addressing the climate change concerns for key sectors - Agriculture & Allied, Water Resources, Forest and Biodiversity, Urban Habitat, and Energy.

The latest estimates suggest that the observed average temperature over India has warmed around 0.7˚C during 1901-2018 (MoES, 2020). Also, with the advancements in climate science and developments in global and national climate policy including Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs), all States & UTs were directed by MoEF&CC to revise their respective initial SAPCCs as per a common guiding framework. Based on this, Assam has prepared its revised SAPCC for the period of 2021-2030 (ASAPCC 2.0) in synergy with India's NDC goals (any updated targets thereof), Sustainable Development Goals (SDGs) and state development priorities. The Assam Climate Change Management Society (ACCMS), under the aegis of the Department of Environment and Forests, Government of Assam (formed as an outcome of the first SAPCC), is the nodal agency for matters concerning climate change issues in the state. The ACCMS led the process of revising Assam SAPCC with technical support from IORA Ecological Solutions Pvt. Ltd.

The overall objective of the revised SAPCC will be to enable Assam in:

1 Enhancing adaptation to climate induced risks that the state is susceptible to;

2 Mitigating the drivers of climate change at State level in line with the India's NDCs; and

3 Institutionalizing the updated SAPCC while building awareness and capacities to implement the same

Assam's Climate Profile

As per the historical climate analysis[1], it is observed that the mean maximum temperature has increased at the rate of **0.049°C/year** and the minimum temperature has increased at the rate of **0.013°C/year** over the period 1990-2019. While, analysis of seasonal and annual rainfall trends during the same period indicates that on an average, Assam received around **2576.49 mm** rainfall annually during this period. Between 1990 and 2019, the annual rainfall showed a decreasing trend by approximately **10.77 mm**.
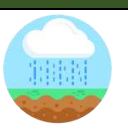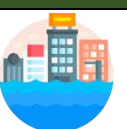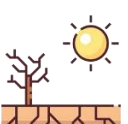
While the climate projections across three critical parameters i.e., annual mean maximum temperature, annual mean minimum temperature, and annual average rainfall till 2100 under low emission scenario (RCP 4.5) and high emission scenario (RCP 8.5) highlight the following. With respect to the baseline period (1981-2010), the annual average maximum temperature (Tmax) ranges across Assam likely to rise by **0.85°C** and **1°C** by 2011-2040 (near term) under RCP 4.5 and 8.5 scenarios respectively. While, annual average minimum temperature (Tmin) may increase up to **0.85°C** and **0.95°**C for RCP 4.5 and RCP 8.5 respectively by 2011-2040 (near term). Annual average rainfall in Assam is projected to increase over baseline (1981-2010) by **0.97** percent and **3.04** percent towards near-term (2011-2040) under RCP4.5 and 8.5 scenarios respectively consequently there may be shifts in patterns of the intensity and frequency of rainfall witness in the past and may lead to extreme events such as floods or may also induce drought-like situation with variability of rainfall.

Summary of Climate Impacts Drivers and Climate Vulnerability of Districts in Assam

Climate vulnerability is defined as 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 (IPCC AR5, 2015). District level climate vulnerability index[2] for the 9 key climate relevant sectors in Assam were developed using literature[3].

Owing to the importance of agriculture in the state, a two-fold analysis was done first for Food and Horticulture Crops (including Tea), second for Livestock, Dairy and Fishery Sub-Sectors at both district and agro-ecological levels.
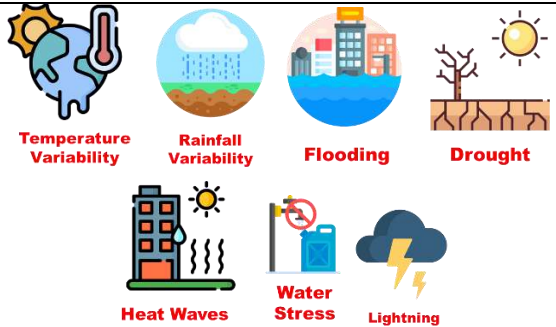
Summary key climate risks and potential impacts across sectors

Sector	Key Climate Risks	Potential Climate Impacts
Agriculture and Allied Sector	Temperature Variability, Rainfall Variability, Flooding, Pest and Diseases, Extreme Winds & Storms, Drought	• Reduced Crop Yield/Quality (cereals & pulses) • Reduced Tea Yield/Quality • Decreasing soil moisture/fertility • Rise in Pest and Crop Diseases • Decrease in fodder availability • Increase in livestock diseases and mortality • Fish Catch Decrease

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[1] Using IPCC AR5 methodologies, district level analysis of observed temperature and rainfall trends in Assam during 1990-2019 and projected climate change under two scenarios RCP 4.5 (mid-range emissions) and RCP 8.5 (high-end emissions) scenarios, in Near Term (2011-2040), Mid Term (2041-2070) and End Century (2071-2100) were carried out as part of the ASAPCC 2.0.

[3] Extensive literature review covering national (DST common Framework, IHCAP Vulnerability), regional, and international studies along with stakeholder consultations resulted in identification of sector wise vulnerability indicators.

Sector	Icons	Impacts
Water Sector	Temperature Variability, Rainfall Variability, Flooding, Drought, Water Stress	• Damage to Water Supply Source & Network • Wetland and Spring Area Variability • Increased water scarcity • Surface Water Quality Deterioration • Groundwater Quality Deterioration
Forest Sector	Temperature Variability, Rainfall Variability, Drought, Pest and Diseases, Extreme Winds & Storms, Forest Fires, Land & Forest Degradation, Biodiversity Loss, Flooding	• Rise in Pests & Disease Occurrence • Rise in area under Invasive Alien Species (IAS) • Vegetation and wildlife habitat shift • Increased sensitivity to forest fires • Wetland & Springs area variability
Energy Sector	Temperature Variability, Rainfall Variability, Flooding, Drought, Extreme Winds & Storms, Heat Waves	• Damage to Infrastructure • Decrease in Energy Efficiency & Power Output • Increase in the moisture content of Coal & Damage to mines • Decrease in availability of water for cooling • Increasing Cooling Demand
Habitat Sector	Temperature Variability, Rainfall Variability, Flooding, Drought, Extreme Winds & Storms, Heat Waves, Water Stress	• Damages to Housing Infrastructure • Destruction/ Disruption to Drinking Water Supply • Damages to wastewater infrastructure • Livelihood and Economy Loss • Loss of Urban Greens/ Biodiversity
Transport Sector	Flooding, Heat Waves	• Damages to road infrastructure & mobility due to flood inundation and extreme heat

Human Health	Temperature Variability, Rainfall Variability, Flooding, Drought, Heat Waves, Water Stress, Lightning	• Increased Human Mortality • Increased Communicable & Non-Communicable Disease Incidences • Increased Damage to Health Infrastructure • Increased pressure on healthcare services • Increased mental health issues • Increased nutritional deficiencies

Refer Chapter 4 for detailed sectoral vulnerability at district level

Summary of ASAPCC 2.0 Strategies and Action Plan 2021 – 2030

The assessments of observed climate trends and future scenarios for Assam, sectoral climate vulnerability assessments and literature review informed the development of targeted strategies and actions needed to build climate resilience and ensure carbon neutrality across sectors for the state. These climate strategies and actions along with their targets till 2030 were finalised through a series of consultations with various state government departments and other agencies. Each of the strategy is aligned the SDG goals and NDC goals along with state development priorities based on which the actions were prioritised by the departments and agencies. The strategies and action points of all nine sectors mentioned in ASAPCC 2.0 are in line with the 10 missions envisaged in NAPCC. Following table represents the linkages between national missions and thematic sectors:

Linkages between National Missions and Thematic Sectors

S. No.	National Missions under NAPCC	Thematic Sectors under Assam SAPCC 2.0
1	National Mission for Sustainable Agriculture	Agriculture and Allied Sector
2	National Water Mission	Water Sector; Disaster Management
3	National Mission for a Green India	Forests, Biodiversity Sector (including Tourism)
4	National Mission on Sustainable Habitat	Human Habitat Sector; Disaster Management Sector; Transport Sector (including inland waterways)
5	National Solar Mission	Energy Sector (renewable energy components)
6	National Mission for Enhanced Energy Efficiency	Energy Sector (energy efficiency components)
7	National Mission for Sustaining the Himalayan Eco-system	Forests, Biodiversity Sector (including Tourism); Disaster Management Sector; Strategic Knowledge Management
8	National Health Mission	Human Health Sector
9	National Mission on Strategic Knowledge for Climate Change	Strategic Knowledge Management Sector

*National Coastal Mission not included here as it is not relevant for Assam State.

Agriculture and Allied Sector
[In line with National Mission for Sustainable Agriculture]

Addressing the key climate risks and build holistic climate smart agriculture measures across value chains is crucial in the current climate change context in Assam. Considering about 4.75 lakh hectares of land is chronically flood prone and about 0.94 lakh hectares of land is drought prone in Assam and owing to increasing likelihood of impacts of floods, droughts in future on the food crops such as rice, wheat, bajra. The strategies under ASAPCC 2.0 focuses on the path to achieve the vision of creating 'sustainable agriculture for enough food, employment and wealth' of agriculture sector in the state. In

addition to food crops, horticulture crops support farmer in doubling their income, and build resilience. With growing extreme events informed decision making on the cropping pattern, climate smart practices need to be mainstreamed into the entire value chain to support all size holding farmers. Also, fisheries a part of staple diet in Assam. Increasing population pressure to sustain the production requires a special attention within the landscape of climate change pertinent to fisheries and its supply-chain in the state.

In addition, promoting affordable weather-based crop insurance and enhancing Agri advisories play a critical role in increasing overall adaptive capacities to avoid risks. Also, to double the farmer's income, actions focusing on diversification of risk through integrated farming systems, increasing cold-storage capacities, and awareness and building capacities of farmers, training of trainers and policy makers thereby improving access to risk sharing options and protect vulnerable farmers.

Assam being a top tea producing state, climate change impacts on the entire tea sector needs a special attention. Also, to meet the production targets in the extreme weather events and slow-onset conditions caused by climate change holistic adaptation and mitigation measure throughout the tea value chain necessitates the strategies and actions in the state.

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total three Strategies have been evolved to deal with impacts of climate change on agriculture and allied sector in Assam. Across the three strategies, a total of 23 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under agriculture and allied sector:

Strategies	Number of Proposed Actions/Sub-actions	Key Nodal Agencies and Implementing Agencies	SDG and NDC Linkages
Strategy 1: Addressing climate risk through climate smart agriculture practices	12	Directorate of Agriculture; Soil Conservation Dept., Animal Husbandry & Veterinary Department, Fisheries Dept.	SDG 01 SDG 02 SDG 13 NDC 06
Strategy 2: Improved access to risk sharing measures to increase farmer's income and livelihood security	7		
Strategy 3: Strengthening Tea Sector and build climate adaptation	4	Tea Board, Directorate of Tea (Industries Dept.)	

Water Sector (Including Irrigation and Flood Management)
[In line with National Water Mission]

Even though Assam is rich in water resources, it faces water shortage in the summer months from past few years and hence water budgeting is much necessary in coming years for its sustainability. Basin level water budgets may help at administrative level to take decisions of water allocations at sectoral level, but to take local adaptation specific decisions it is relevant to have water budgets at much lower spatial level i.e., micro basin. Hence, a proper network of water monitoring mechanism should be in place. Despite being supported by two major river systems; the state has rivers/ tributaries which are dying due to silting and encroachments. High rainfall intensities and resulting heavy runoff provides no opportunity to go water inside the soils and support base flow, resulting in poor groundwater recharge.

Further, Climate change not only affects water availability and accessibility, but also puts stress on the duration and timing of its availability and accessibility, and the distribution. Due to increased temperatures and population, the pressure is expected to rise further on the available resources. Hence conserving the water, recycling & reusing the water, minimizing the wastage and increasing water use efficiency in all sectors is necessary for water resource sustainability and management in Assam. With the increase of temperature, the evaporation will also be more and subsequently the precipitation/ rainfall activities will be more and ultimately flooding and river bank erosion will also be more. Therefore, there will be a great impact on the overall water resources management structures of Assam. In that case, the fortification of the existing embankment and strengthening of bank protection will be required. On the other hand, wetlands are one of the important sources of surface water in Assam, constituting 1.29 per cent of the total geographical area of the state. Numerous studies have been carried out in different regions of Assam in order to see any climate change impacts on wetlands and springs. The major risks faced by in the state includes vanishing wetlands and dying springs.

Finally, Assam with its vast network of rivers is prone to natural disasters like flood and erosion which has a negative impact on overall development of the state. The Brahmaputra and Barak River with more than 50 numbers of tributaries feeding them, causes the flood devastation in the monsoon period each year. The flood prone area of Assam is four times the national mark of the flood prone area of the country. Hence a strong resilient system should be in place to overcome and minimise the losses from this hazard.

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total Six Strategies have been evolved to deal with impacts of climate change on water sector in Assam. Across the six strategies, a total of 38 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under water sector:

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Enhanced monitoring and research to establish water budgets and manage water equitably	3	WRD, NHP, AWRMI, NERIWALM, PHED, DOHUA, P&RD	SDG 01 SDG 03 SDG 06 SDG 13 SDG 15 NDC 06
Strategy 2: Enhanced efforts towards ground water recharge in over draft areas	3	WRD, NHP, AWRMI, PHED, DOHUA, P&RD	
Strategy 3: Enhanced water use efficiency across sectors	10	WRD, Irrigation Department, and Soil Conservation	
Strategy 4: Strengthening water sector infrastructure to adapt to climate change	7	WRD, Irrigation Department, Agriculture and Horticulture Dept., NABARD	
Strategy 5: Conservation of wetlands and springs	6	Forest Department, P&RD, WRD, Soil Conservation, Irrigation, PHED	
Strategy 6: Enhancing resilience towards frequent and unprecedented floods	9	WRD; FREMAA, ASDMA	

Forests, Biodiversity Sector (including Tourism)

[In line with National Mission for Sustaining the Himalayan Eco-system, National Mission for a Green India]

Assam is well-known for its extensive forest resources. As compared to 2019, there has been a significantly low reduction of 0.05 per cent in the forest cover recorded (ISFR, 2019). If this continues, then the load on the existing forest may increase with respect to the increasing encroachment and population. The trees outside the forest can serve as source of food & feed, timber & wood, and fuelwood. Urban and rural ecosystems play a significant role in protection of the biodiversity and habitats. Creation of state-of-the-art tree nurseries at local levels, promotion of tree cover outside forests especially on institutional lands enhances the overall quality of life of urban and rural dwellers. Further they also act as local gene banks. Supportive policy and regulations also play a critical tole in managing the forests sustainably.

Special emphasis on the Non-Timber Forest produce (NTFP) play an important role in maintaining daily nutrition requirements of the villages rely on forests. Therefore, the strategies proposed under ASAPCC protects the needs and promotes livelihoods of the forest dependent indigenous and other communities by providing a climate sensitive measure for improving overall adaptation.

The projected climate scenarios given ISFR 2021 report indicates that the although current area in Assam is not directly impacted by climate change till 2030, rapid impacts can be witnessed with the high variation of global temperature and precipitation variability during 2050 and till 2085. Thus, there is crucial need to plan for strengthening overall forest and biodiversity system in Assam.

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total Five Strategies have been evolved to deal with impacts of climate change on Forest sector in Assam. Across the Five strategies, a total of 22 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under forests and biodiversity sector:

Strategies	No. of proposed Actions/ sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Enrich and restore forests and increase area under tree outside forests with co-benefits of improvement in ecosystem services and carbon sequestration	15	**Forest Department** (APFBC, CAMPA, Autonomous Councils (ACs), Finance Dept., Industries Dept., PCBA, Indian Railways (NER), APFBC (FIUs); CHD (BTC); LAZ; UAZ; Education Dept., ULBs, District Administration, Revenue Dept.	SDG 13 SDG 15 NDC 05 NDC 06
Strategy 2: Enhance tree cover in Urban and Peri-Urban areas (including institutional lands)	12	**Forest Department**, P&RD, DOHUA	
Strategy 3: Provide policy and regulatory support for improving forest and tree cover	3	**ACCMS, Forest Dept.,** Finance Dept., Industries Dept., PCBA, District Administration, Revenue Dept.	
Strategy 4: Improve incomes of forest dependent population through agroforestry in private and community lands	2	**Forest Department,** Agriculture and Horticulture Department	
Strategy 5: Conservation of biodiversity and protection of habitats	3	**Forest Department** (APFBC, ASBB, SF, Autonomous Councils), Tourism Department	

Energy Sector (Renewable Energy and Enhanced Energy Efficiency)
[In line with National Solar Mission, National Mission for Enhanced Energy Efficiency]

Assam is still predominantly dependent upon conventional sources of energy. While assessments of the functionality of Solar lighting systems and their impact on livelihoods in rural areas has been carried out, large sections of the urban populace still derive energy for their needs through coal and natural gas. There is an urgent need to increase the share of renewables in the energy consumption of the state through promotion and incentivizing use of renewable energy. Domestic, Municipal and Commercial consumers can leverage existing technologies to transition to cleaner fuels as well as improve the energy efficiency across energy infrastructure and systems. Upgrading to higher efficiency equipment, appliances and machinery improves not just the resource efficiency of the energy sector, but also provides avenues for better energy accounting and subsequent interventions to improve the health, education and livelihood opportunities.

Increasing frequency and intensity of the extreme and slow on-set events due to climate change will have a huge impact on the mining operations across Most of these mines are located in socially, politically and environmentally challenging locations makes the additional impacts of the climate change an added pressure for day-to-day operations and impact on the economic growth. Therefore, it is imperative for the industry to approach climate adaptation and mitigation measures to improve the resilience of the inputs to mining processes, employee health and safety and more.

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders and experts a total of three strategies[4] have evolved to deal with impacts of climate change on energy in Assam. Across the three strategies, a total of 14 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under energy sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Promoting renewable energy to ensure energy access for all	3	Power Department, AEDA, APGCL	SDG 07 SDG 09
Strategy 2: Enhancing Energy Efficiency across sectors	5	Power Department, IEC, DOHUA, Industries, SLDC	SDG 11 SDG 13
Strategy 3: Developing sustainable, resilient, and low carbon mining industry	6	Mines and Minerals Department, Science & Technology, District Mineral Foundation Trust	NDC 01 NDC 03 NDC 04

Human Habitat Sector (Urban and Rural)
[In line with National Mission on Sustainable Habitat]

In addition to the first SAPCC, ASAPCC 2.0 gave equal focus on both urban habitat and rural habitat considering devastating impacts on both due to extreme and slow-onset events. Studies show that as a result of complex causal chains, climate impact drivers have a disastrous influence on rural communities' settlement pattern, means of subsistence, and income. Extreme weather conditions like

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[4] Strategies evolved are in line with the National Solar Mission, and National Mission for Enhanced Energy Efficiency for the Promotion of Clean Energy, Enhancing Energy Efficiency, and Emission Standard and Energy Transition.

floods, wind hazards, and storms, which have an effect on rural infrastructure and directly result in fatalities. On the other hand, effect on ecosystems important to rural residents or on agriculture as a result of severe occurrences, altered extremes owing to climate change, or from changes in mean conditions (Dasgupta, et al., 2014).

While the impacts of the climate change in urban areas are manifold it affects not the just patterns of livelihoods, and economy. It also causes a huge health impact. Due to frequent extreme weather events the infrastructure is more exposed to damage. Cities source their water supply from far places outside the urban limits, with an event of flood or drought in the region the entire water supply and demand disturbance create water woes. With increasing temperature, the energy demands raise with the increasing cooling demand across India (WEF, 2021), while it also affects the already polluted cities and worsening the air quality (IPCC AR6 WGI, 2021) added to the impacts exaggerated by urban heat islands in cities. High year-to-year rainfall variability and increase in frequency and intensity of flooding events causes' damage to all critical infrastructure as well as housing. While the extreme weather events add additional pressure on cities due to distress migration from rural areas either temporarily or permanently. While the opposite of excess water i.e., creating drought causes water shortages, food demand, disruption of hydroelectricity add to the pressure on the vulnerable habitats. Thus, it is critical to understand the Habitat sector with both lenses of climate adaptation and mitigation in Assam to improve the habitat's resilience against any extreme or slow-onset events induced by climate change.

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders and experts a total of three strategies have evolved to deal with the impacts of climate change on urban habitats and three strategies have evolved to deal with the impacts of climate change on rural habitat. Across the three strategies in the urban habitat sector, a total of 16 actions/sub-actions are proposed to be implemented by 2030 with an estimated budget of ₹ 3,240.90 Cr. Similarly, across the three strategies in the rural habitat sector, a total of 15 actions/sub-actions are proposed to be implemented by 2030.

Summary of strategies and actions under habitat sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Urban Habitat			
Strategy 1: Mainstreaming Climate action into urban governance and policy	2	Department of Housing and Urban Affairs (DoHUA)	SDG 11 | SDG 13 | NDC 6
Strategy 2: Building Climate resilient urban housing infrastructure	6	Assam State Housing Board, DOHUA	SDG 9 | SDG 11 SDG 13 | NDC 6
Strategy 3: Developing climate smart and resilient urban waste management infrastructure	8	DOHUA, AUWS&SB, PWD	SDG 6 | SDG 11 SDG 13 | NDC 6
Rural Habitat			
Strategy 1: Mainstreaming Climate Action into Rural Governance and Policy	6	Panchayat & Rural Development Dept. (P&RD)	SDG 13 NDC 1 | NDC 6
Strategy 2: Building Climate Resilient Rural Housing Infrastructure	3	P&RD, PHED	SDG 6 | SDG 9 SDG 11 | SDG 13 | NDC 6
Strategy 3: Enhancing Climate Smart and Resilient Rural Waste Management Infrastructure	6	P&RD	SDG 9 | SDG 11 NDC 2 | NDC 6

Transport Sector
[In line with National Sustainable Habitat, National Policies related transportation]

Transportation under Human Habitat Sector play's a critical role for climate mitigation. With India's increasing focus on the transport resilience, low-carbon mobility and alternate sustainable modes. Assam SAPCC 2.0, provided a special emphasis on both urban and rural transportation in order to create pathways for enhanced urban and rural sustainability and resilience. Urban settlements are the central to the increasing proportion of GHG emissions across the world (IPCC AR6, 2022). From unmanaged solid waste (CH4), fossil fuel dependent transport and mobility systems (CO2, NOx, SOx etc.) and unsustainable lifestyle in cities contributes to the GHG emission. Moving away from traditional polluting modes, promoting use of electric vehicles, alternate modes such as inland water ways etc are key focus areas under Transport sector.

Based on the identified climate risks, vulnerability assessment under habitat sector and discussions with department stakeholders and experts, two strategies were evolved to deal with the impacts of climate change on urban and rural transport and mobility. Across the two strategies, a total of 13 actions/sub-actions are proposed to be implemented by 2030.

Summary of strategies and actions under transport sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agencies	SDG and NDC Linkage
Strategy 1: Building climate resilient and low carbon urban and rural road network and mobility	7	PWD, Transport Department, ULBs, P&RD	SDG 6 | SDG 9 SDG 11 | SDG 13 NDC 2 | NDC 6
Strategy 2: Ensuring holistic management of pollution and emission in cities and villages	6	PWD, Transport Department, AIWTDS, PCBA, ULBs, P&RD	SDG 7 | SDG 11 SDG 13 NDC 2 | NDC 5 NDC 6

Human Health Sector
[In line with National Health Mission]

Human Health is greatly affected by shifts in weather patterns and other aspects of climate change. These effects may occur directly, due to changes in temperature and precipitation and occurrence of heat waves, floods, droughts, and fires. Indirectly, health may be damaged by ecological disruptions brought on by climate change (crop failures, shifting patterns of disease vectors), or social responses to climate change (such as displacement of populations following prolonged drought).

In Assam, Health and Family Welfare Department (H&FWD) has important to play in mitigating and responding to climate change or variation in climate in any geographic location as such change may affect the pattern of morbidity and mortality among dwelling population. The commonly identified illnesses may be grouped as (i) Extreme events (heat related illness). (ii) Air pollution and health related issues. (iii) Vector borne disease. (iv) Water borne illnesses. (v) Malnutrition. (v) Various NCDS.

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders, experts and state objectives a total of two strategies have evolved to deal with impacts of climate change on Human health in Assam. Across the two strategies in the human health sector, a total of 8 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under human health sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Assess the health risks associated with current and future climate change in the state and provide action plans for response at a state level	3	Health and Family Welfare Department, and NHM Directorate	SDG 3 NDC 1 NDC 6
Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam	5	Health and Family Welfare Department and NHM	SDG 3 NDC 1 NDC 6

Disaster Management Sector

[In line with National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Eco-system]

Assam with its vast network of rivers is prone to natural disasters like flood and erosion has a negative impact on overall development of the state if not managed. Within the current context of climate change, high vulnerability of state towards hazards like flood, drought, storms and erosion, it is at most important to map the risks and hazards in order to reduce the physical, financial and social losses. Also, in order to locally adapt and build resilience towards any hazard a proper channel to execute the interventions is very important and hence strong convergence mechanism is required to set things in place within the state resulting into reduction of losses.

Further, flood is an annual event in the State of Assam. More than 40 percent of its land surface is susceptible to flood damage. In order to take necessary measures by local people, it is mandatory to provide location specific advance precautionary measures and flood alerts and hence enhanced early warning system is very significant for administrators and communities. Damages caused due to erosion runs into several hundred crores every year. Bank erosion by the rivers has been a serious issue since last six decades as more than 4.27 Lakh Hectares of land was already eroded away by the river Brahmaputra and its tributaries since 1950, which is 7.40 % of area of the state. Thus, to minimise the soil erosion, appropriate measures need to be taken.

With Barak Valley and Hill Regions of Assam prone to landslide, it is important to be prepared to minimise the incidences and impacts of landslides as it takes massive toll of human lives and lead to huge economical losses every year besides damages to environment, resources infrastructure and services. In addition, Southern districts of Assam are in very high and high wind zone (BMTPC, 2019). In this zone wind speed can reach up-to 55 m/s, can resultant into large scale damage such as damages of lives, infrastructures, and transmission and communication infrastructure. In order to minimise the losses, appropriate measures are required.

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total Six Strategies have been evolved to deal with impacts of climate change on Disaster Management in Assam. Across the Six strategies, a total of 25 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under disaster management sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Risk Assessment and mapping for holistic Disaster Management In state	2	Assam State Disaster Management Authority (ASDMA)	SDG 11 SDG 13 NDC 06
Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam	6	Assam State Disaster Management Authority (ASDMA)	
Strategy 3: Enhanced flood forecasting mechanism for minimum human and economic loss	4	Assam State Disaster Management Authority (ASDMA)	
Strategy 4: Enhanced mechanism for landslides preparedness and mitigation	5	ASDMA, PWD (Roads), CGWB, PHED	
Strategy 5: Minimizing the soil erosion due to floods through appropriate construction regulation and vegetation measures	3	ASDMA, Soil Conservation Dep't., WRD, Forest Dep't.	
Strategy 6: Ensuring minimum losses from wind and storms	5	ASDMA, Rev. & DM Dep't., GMDA, DOHUA & GDD, PWD Bldg.	

Strategic Knowledge Management Sector

[In line with National Mission on Strategic Knowledge for Climate Change]

Since climate change affects all aspects of the state including natural resources, livelihood and economy, it requires engagement from all stakeholders, cross-sectoral action and interdepartmental coordination. Keeping this in mind, it is essential to establish a strong knowledge base for identifying, formulating, planning and implementing climate policies. Having a robust and strategic knowledge system is crucial not only at the national level but also at the state level. The strategic knowledge system should access and integrate information and assessments originating from a large number of inter-connected sources.

Based on stakeholder consultations and literature review following national strategic knowledge mission, three strategies have been formulated to strengthen strategic knowledge mission in Assam. Across the three strategies in the sector, a total of 24 action/sub-actions are proposed to be implemented till 2030.

Summary of strategies and actions under strategic knowledge management

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Creation of Knowledge Management Portal for Climate Change	3	ACCMS, ASTEC	SDG 04 SDG 13 NDC 06 NDC 08
Strategy 2: Strengthening departmental and institutional capacities and generating awareness to understand climate change and impacts on sectors	7	ACCMS, ASTEC, Education, ULBs, District Administrations	
Strategy 3: Build climate change relevant policies, research, and outreach for strengthening adaptation and mitigation	14	ACCMS, Finance Dept., ASTEC	

ASAPCC 2.0 Action Plan and Implementation Mechanism

Overall, the 198 actions proposed as part of the ASAPCC 2.0 are distributed under two major heads:

- **Type of Climate Action** to understand the direct impact of the action which can be climate adaptation focused or climate mitigation-focused or both combined; and
- **Nature of Action** head which categorizes actions into implementation action (Hard Infrastructure/Physical), policy action, research action or capacity-building action (includes outreach, awareness and human resources).

The following figure shows that out of 198 proposed actions in ASAPCC 2.0 across all 9 sectors, 62% are adaptation focused, 20% address mitigation opportunities, rest 10% are both adaptation and mitigation focused. While, out of 198 actions, 50% are implementation centric, 24% are policy measures, 12% are research related, and 14% are capacity-building, awareness and outreach.

Type of Climate Action (out of 198 actions)
- 13% Both
- 87% Adaptation
- Adaptation | Mitigation | Both

Nature of Climate Action (out of 198 actions)
- 34% Policy
- 33% Research
- 33% Capacity Building
- Implementation | Policy
- Research | Capacity Building
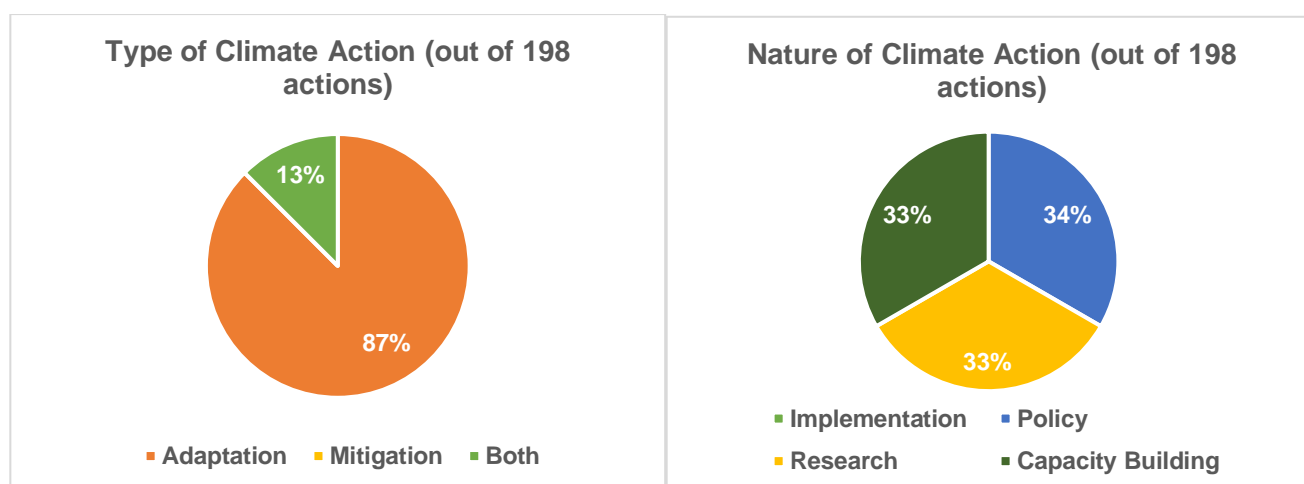
Type of Actions and Nature of Actions Breakup of 198 actions

In order to effectively enable the implementation of the strategies, actions and target by 2030, following the institutional mechanism depicted below involving 21 core departmental stakeholders play a crucial role for effective implementation, monitoring, evaluation, and learning across all nine sectors.
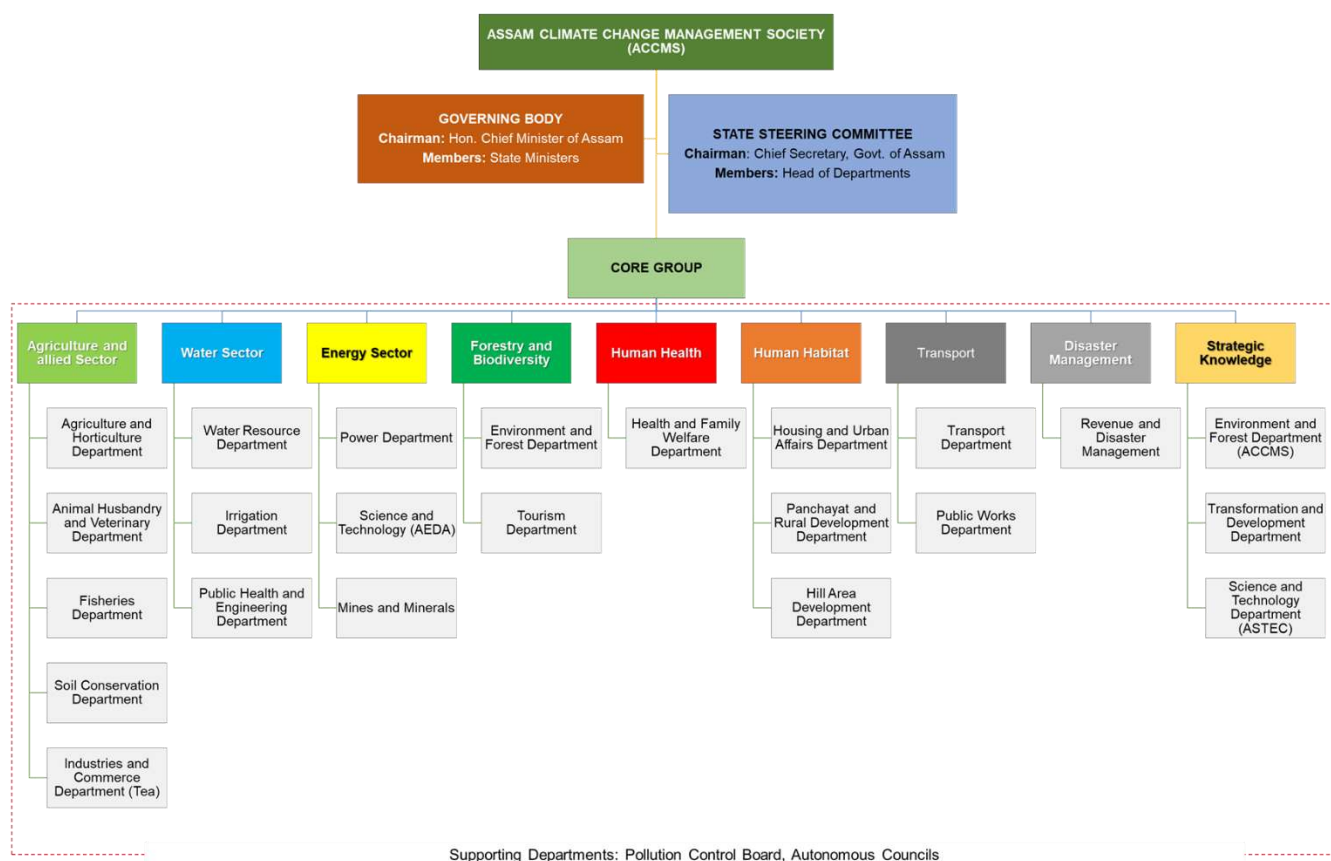
*Energy Sector (includes both Renewable Energy and Enhanced Energy Efficiency)

Monitoring and Evaluation Framework

Built on past experiences and learnings, a three tier Monitoring and Evaluation (M&E) framework for ASAPCC 2.0 has been drafted to determine States' overall progress toward climate adaptation and mitigation. The M&E will help to assess the SAPCCs' contribution to achieving national and international commitments such as NDCs and SDGs. Further, individual strategies proposed under the respective nine sectors in ASAPCC will have their respective result framework highlighting the output and impacts.

ASAPCC 2.0 M&E Framework

Strategy Level	Sector Level	State Level
Strategy/Action specific indicators	SDG and NDC indicators across 9 thematic sesctor.	Progress implementation of overall SAPCC Targets

At state level, each year all the core group departments will report to ACCMS about the progress of implementation, key challenges during implementation etc. While at sector and strategy level these core departments will support ACCMS in monitoring based on the following table depicting key performance indicators that are mentioned in Assam Vision document 2030, and State Indicator Framework which is relevant to climate change, along with the additional indicators for monitoring development as per 9 National Missions under NAPCC (Excluding National Coastal Mission) which are relevant for nine sectors mentioned in ASAPCC 2.0. For effective evaluation of the strategies mentioned in each sector, relevant implementing agencies should mandatorily submit annual report elucidating the progress of physical and financial targets. Further, a mid-term review post 5 yrs is suggested for evaluating the overall progress of strategies from the period of SAPCC implementation.

Key monitoring indicators under ASSAPCC 2.0

Sector	Key Indicators for Monitoring and Evaluation of SAPCC progress in Assam
Agriculture and allied	Increased coverage under climate resilient crop varieties (like millet) (lakh ha)
	Increased area under organic farming – Including Tea (lakh ha)
Water Resources (including irrigation, flood and erosion)	Proportion of households with access to functional tap connections (%)
	Development of area resilient to flooding & erosion (ha)
Forests and Biodiversity (including tourism)	Enhancement of area/density of forests in the state (ha or trees/ha)
	Enhancement of area under tree cover (ha)
Energy (Renewable energy and enhanced efficiency)	Proportion of renewable energy to total annual energy production by installed capacity (%) (for measuring renewable work)
	Proportion of Aggregate Technical & Commercial (AT& C) losses to total energy produced (%) (for measuring efficiency)
Human Habitat (Urban and Rural)	Inclusion of Climate Actions and their implementation into Gram Panchayat Development Plans (GPDP) [Refer proposed actions for climate actions]
	Number of ULBs with climate sensitive master plans - prepared/updated/notified
Transport	Enhanced coverage under all-weather roads (kms) and Share of EV to total vehicles (%)
Human Health	Adaptive preparedness of the PHCs/CHCs against diseases induced by climate change (vector borne, water borne, respiratory, zoonotic etc.)
Disaster Management	Vulnerability based disaster management preparedness at district level resulting in reduced loss to life and property
Strategic Knowledge Management	Number of knowledge products created and trainings/workshops conducted for awareness generation

01
INTRODUCTION

Chapter 1.   Introduction

1.1 Background

IPCC 6th Assessment Report (AR6) notes that every inhabited region globally is already affected by climate change and global surface temperature will continue to rise until at least mid-century. The report has warned that the global warming threshold of 1.5°C and 2°C will be exceeded during the 21st century unless deep Greenhouse Gas (GHG) emission reductions occur in the coming decades. Extreme events such as the number of hot days is projected to increase in most land regions along with increasing risk from droughts and precipitation deficits. The impacts of global warming have already been observed on natural and human systems, as many land and ocean ecosystems as well as the ecosystem services they provide have already changed due to the warming (IPCC AR6 WGI, 2021).

Globally, India ranks 121 out 181 countries globally assessed for adaptation index by ND-GAIN Country Index ranking, under the study it also highlights that India is the 51st most vulnerable country and the 79th least ready country to adapt climate crisis (ND-GAIN, 2020). Also, as per SwissRe study on climate economics, India could lose up to 35% of GDP by mid-century in a severe scenario if no further climate mitigation actions are taken (SwissRe Institute, 2021).

In 2008, India launched the National Action Plan on Climate Change (NAPCC) under Prime Minister's Council on Climate Change (PMCCC). Eight national missions were formulated i.e., National Solar Mission, National Mission for Enhanced Energy Efficiency, National Water Mission, National Mission on Sustainable Habitat, National Mission for Sustaining the Himalayan Ecosystem, Green India Mission, National Mission for Sustainable Agriculture, and National Mission on Strategic Knowledge for Climate Change. In 2015, the reconstituted PMCCC reviewed the progress of eight national missions and suggested formulation of four new missions on Climate Change, viz. National Health Mission as part of National Action Plan for Climate Change & Human Health, National Mission on Waste to Energy Generation, National Mission on India's Coastal areas, and National Wind Mission.

Further, a clear mandate was given to all Indian States & Union Territories (UTs) to prepare their respective State Action Plan on Climate Change (SAPCC) consistent with the strategies outlined in the NAPCC. States/UTs were encouraged to integrate State-level variations in ecosystems, geographic conditions, socio-economic scenario, and other factors within the framework of NAPCC and identify synergies with the existing policies and ongoing programmes and schemes under implementation. Between 2008 and 2015, SAPCC of 33 states and union territories have been notified by the Ministry of Environment Forests and Climate Change (MoEF&CC). The Government of Assam published its first State Action Plan on Climate Change (SAPCC) in 2015, recognising and addressing the climate change concerns of water resources, forest and biodiversity, agriculture, urban habitat, and energy.

In 2015, India, being a party to United Nations Framework Convention on Climate Change (UNFCCC), contributed to the development of the milestone Paris Agreement (PA)[5], a legally binding international treaty on climate change to limit the warming of the global atmosphere below 2°C by 2100 and preferably to 1.5°C compared to pre-industrial levels. As a part of this Agreement, India ratified its respective Nationally Determined Contributions (NDCs) in 2015 (Government of India) with the aim to mitigate national emissions and adapt to the impacts of climate change.

Further, India has update to its first NDC submitted earlier on October 2, 2015, for the period up to 2030, this will be a step forward towards India's long term goal of reaching net-zero by 2070 as under (Government of India, 2022):

Goal 1: To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for 'LIFE'– 'Lifestyle for Environment' as a key to combating climate change

Goal 2: To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.

Goal 3: To reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level.

Goal 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF)

Goal 5: To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.

Goal 6: To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.

Goal 7: To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.

Goal 8: To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

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[5] Paris Agreement (PA), a legally binding international treaty on climate change, has been adopted by 196 Parties at COP 21 in Paris in 2015. Till date, 191 Parties to the Agreement have submitted their Nationally Determined Contributions (NDCs).

In January 2018, owing to the rapid advancements in the climate science, and nuanced understanding of risk, impact, and vulnerability assessment methodologies, Ministry of Environment, Forests and Climate Change, GoI had directed all the States and Union Territories (UTs) of India to update their respective initial SAPCCs as per the common guiding framework. Subsequently, the Assam Government has initiated the process of updating its state climate action plan for the period of 2021-2030 following the common guiding principles and framework.
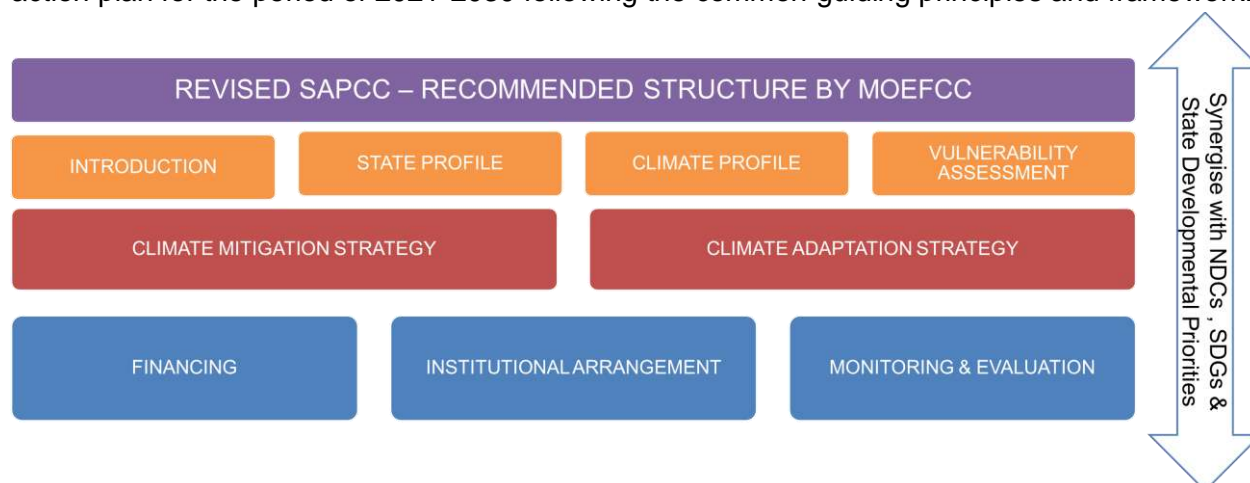
Figure 1: Framework for Revised SAPCC

The Assam Climate Change Management Society (ACCMS) under the aegis of the Department of Environment and Forests, Government of Assam, formed as an outcome of the first SAPCC is the nodal agency for all the matters related to climate change issues in the State, and it led the process of revising the SAPCC with the support of technical consultancy (IORA Ecological Solutions Pvt Ltd.).

1.2 Principles

Assam's first SAPCC focused on formulating mitigation and adaptation strategies specific to the state to respond effectively to the possible impacts of Climate Change in the areas of water resources, forest and biodiversity, agriculture, urban habitat, and energy. In addition to the above-mentioned thematic sectors, the revised version of Assam SAPCC will focus on rural habitat, human health, hills, and tribes owing to increased science and advancements of technology to better understand impact on developmental sectors.

Hence, the subsequent principles of adaptation and mitigation were followed while developing the Assam SAPCC 2.0:

1.   ***Ensuring sustainable and climate smart agriculture systems***: Sustainability of critical ecosystems primarily agro-ecosystems (agriculture, horticulture, tea, fishery, and livestock) is of paramount importance to ensure livelihood security in a changing climate scenario.

2.   ***Integrating climate adaptation in water resource development & management:*** Water being essential to all economic activities, the SAPCC looks at how water resource can be augmented and best utilized in a changing climate scenario and what necessary institutional changes will be required to make these strategies come to affect.

3. ***Protecting, restoring and enhancing forest & tree cover and biodiversity conservation***: Key focus areas are sustainable management of forest, wildlife and biodiversity along with developing resilience of eco-system services.

4. ***Developing climate resilient and low carbon human settlements:*** Major concern is the expanding and high-density urban settlements and rural settlements where proving sanitation, drinking water, transportation, health, waste management and other amenities will be a challenge in the future changing climate scenario.

5. ***Promoting adoption of renewable energy and energy efficiency solutions to support achievement of carbon neutrality***: Major concerns will be technological initiations and intervention with more focus on harnessing new and renewable energy, energy efficiency and conservation.

6. ***Strengthening health of Assamese people against climate sensitive illness, especially the vulnerable & marginalized population***: The goal is to reduce morbidity, mortality, injuries and health vulnerability to climate variability and extreme weathers

7. ***Building disaster preparedness and risk management towards climate change related extreme weather events***: Leaving no one behind by building disaster preparedness and response systems in anticipation of increased intensity and frequency of extreme weather events will be the underlying motto here.

1.3 Assam SAPCC Update Objectives and Methodology followed

The overall objective of the revised SAPCC will be to enable Assam in:

1 Enhancing adaptation to climate induced risks that the state is susceptible to;

2 Mitigating the drivers of climate change at State level in line with the India's NDCs; and

3 Institutionalizing the updated SAPCC while building awareness and capacities to implement the same

The revised Assam SAPCC has developed strategies and actions for mainstreaming climate adaptation and mitigation across all relevant sectors. It has set action wise targets till 2030, which are in synergy with India's NDC goals, SDGs and the state's development priorities. The plan has a well-developed implementation structure in place, comprising of a strong financing plan that identifies convergence opportunities with existing schemes and programmes, a robust institutional framework to ensure implementation and an effective monitoring and evaluation framework to provide feedback for continuous planning.

Figure 2 schematically captures the approach that was undertaken in revision of the Assam SAPCC.
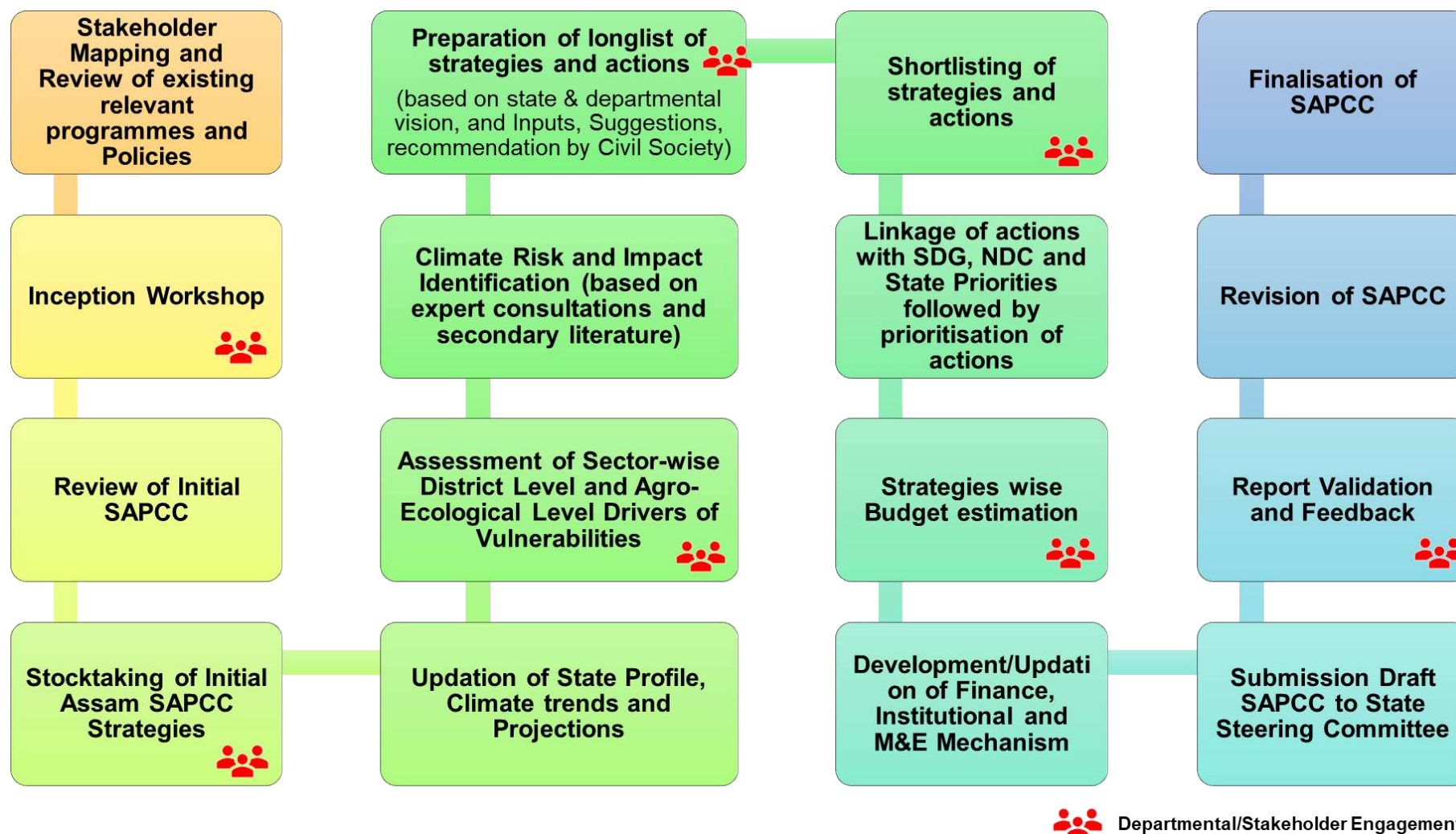
Figure 2: Process followed for the update of Assam SAPCC

02

State Profile

Chapter 2.   State Profile

2.1 Location, Demography, Economy

Demographic Profile:

The State of Assam is situated in the North-Eastern region of India extending over a geographical area of 78,438 sq. km. It is surrounded by the Indian states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal and shares its international borders with Bangladesh and Bhutan. The State is administratively divided into 34 districts, 219 Development Blocks and 2202 Gram Panchayats. Of these, three districts, namely, Dima Hasao, Karbi-Anglong and Bodo land are administered through their respective autonomous councils set up under the provisions of the VI Schedule of the Indian Constitution.

Assam shares about 2.4% of the country's total geographical area and provides shelter to 2.6% population of the Country as per 2011 census. Assam is a state of heterogeneous population with socio-cultural and ethnic diversity. According to the Census of India, 2011 the population of Assam was 312.05 lakhs of which 159.39 lakhs were male and 152.66 lakhs female. The decadal growth of the State's population during 2001-2011 was 17.07% against 17.68% growth for the country as a whole.

Out of the total population, 86% population lived in rural areas and 14% population in urban areas of the State, while the percentage of rural population of the State was higher than All-India average (69%). The urban population in the State had increased from 12.9% in 2001 to 14% in 2011. The density of the population of Assam in 2011 was 398 persons per sq. km as compared to 340 persons in 2001. The sex ratio (number of females per thousand male) of Assam had increased to 958 in 2011 from 935 in 2001. Compared to overall sex ratio of the State, the Child sex ratio (age-group 0-6 years) had gradually declined from 975 in 1991 to 967 in 2001 and further to 962 in 2011. On the other hand, sex ratio at birth in Assam as per 2011 Census was 957.
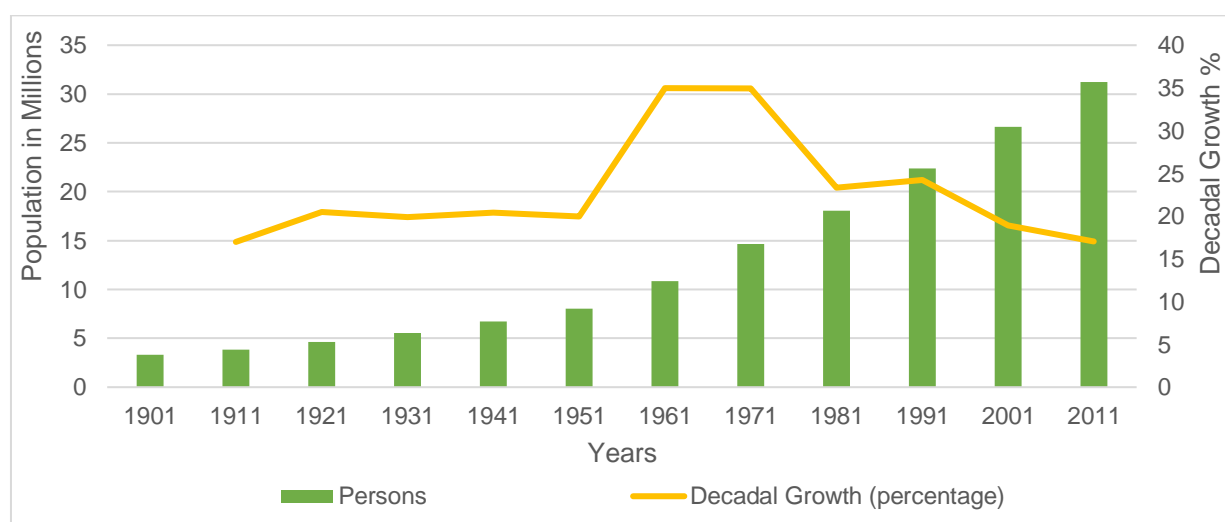
Figure 3: Decadal variation in population of Assam

Source: Census (2011)

Table 1 outlines a glimpse of Assam's performance across the key demographic indicators (Census, 2011).

Table 1: Assam's performance across the key demographic indicators

Particulars	2001	2011
Population	2,66,55,528	3,12,05,576
Male Population	13777037	15939443
Female Population	12878491	15266133
Percentage Decadal Rural Population Growth	16.51 -	15.47
Percentage Decadal Urban Population Growth	38.24	27.89
Population density (per sq. km)	340	398
Decadal Growth of Population (%)	18.92	17.07
Average Annual Exponential Growth Rate of Population	-	1.58
Sex Ratio (Females per thousand males)	935	958
Literacy Rate (%)		72.19
Infant Mortality Rate (IMR) (Per 1000 Live Births)	44(2017)	41(2018)
Birth Rate (%)	21.2 (2017-18)	21.1 (2018-19)
Death Rate (%)	6.5 (2017-18)	6.4 (2018-19)
Total Fertility Rate (TFR) (Birth/ Woman)	-	2.3(2017)
Rural Unemployment Rate – Usual Status (Adjusted) [Per Thousands]	45 (2011-12)	63 (2018-19)
Urban Unemployment Rate – Usual Status (Adjusted) [Per Thousands]	54 (2011-12)	99 (2018-19)
Average Inflation (CPI) – General	2.6 (2016-17)	8.5 (2020-21)

Source: Compiled using Census of India (2001), Census (2011), Assam Economic Survey (2020-21), Niti Aayog (2016), and (Golait, 2021)

In addition, there has been a decline in poverty head count ratio from 37.9% to 32% between 2009-10 and 2011-12 (Table 2).

Table 2: Poverty estimates for Assam (2009-10 and 2011-12)

Poverty estimates	2009-10		2011-12	
	Head count ratio (%)	Number below poverty line (in lakhs)	Head count ratio (%)	Number below poverty line (in lakhs)
Rural	39.9	105.3	33.9	92.1
Urban	26.1	11.2	20.5	9.2
Combined	37.9	116.4	32	101.3

Source: Niti Aayog, Tendulkar Poverty Estimates (2016)

Assam's Economic Profile:

Economy plays a critical role in achieving the aspirations of the state and its citizens. Gross State Domestic Product (GSDP) of Assam at current prices is estimated at Rs.381, 003.97 crores during 2020-21 while quick estimates during 2021-22 recorded at Rs. 433,925.44 crores indicating a growth of 13.89 percent. While Assam's GSDP at constant prices is estimated at Rs. 273,836.71 crores for 2021-22 as compared to Rs.250,922.83 crores for 2020-21 indicating a growth of 9.13 percent.

During the period of three years i.e., 2018-19 to 2021-22, the state achieved annual average growth rate of 6.17 percent in terms of GSDP at constant (2011-12) prices reflected a moderate growth of state economy despite COVID-19. During this period, the agriculture and allied sectors have achieved maximum growth rate of 13.04 percent as against industry sector (2.43 percent) and service sector (4.48 percent).
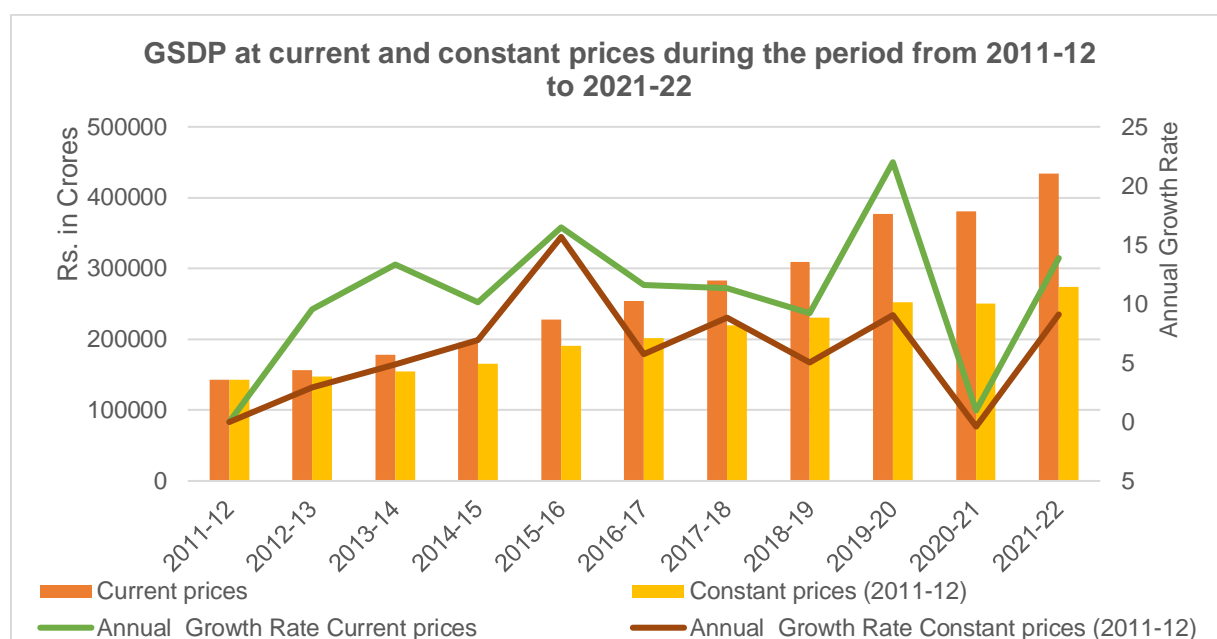
Figure 4 Assam's GSDP profile from 2011-12 to 2021-22

Source: Directorate of Economics and Statistics, Assam

Sectoral Composition of GSDP:

The sectoral composition of State Domestic Product (SDP) depicts percentage contribution of different sectors over a period of time. It is an indication of the real structural changes taking place in the economy which is critical in formulation of various policies (such as SAPCC) plans and programmes for overall economic development of the State.

As per Quick Estimates for 2021-22, the percentage contribution of agriculture & allied sector, industry, service and taxes & subsidies to GSDP of Assam at current prices have estimated at 22.07 percent, 26.90 percent, 40.00 percent and 11.03 percent as compared to 19.89 percent, 30.63 percent, 43.97 percent and 5.51 percent respectively in the year 2011-12. (Directorate of Economics and Statistics, 2021)
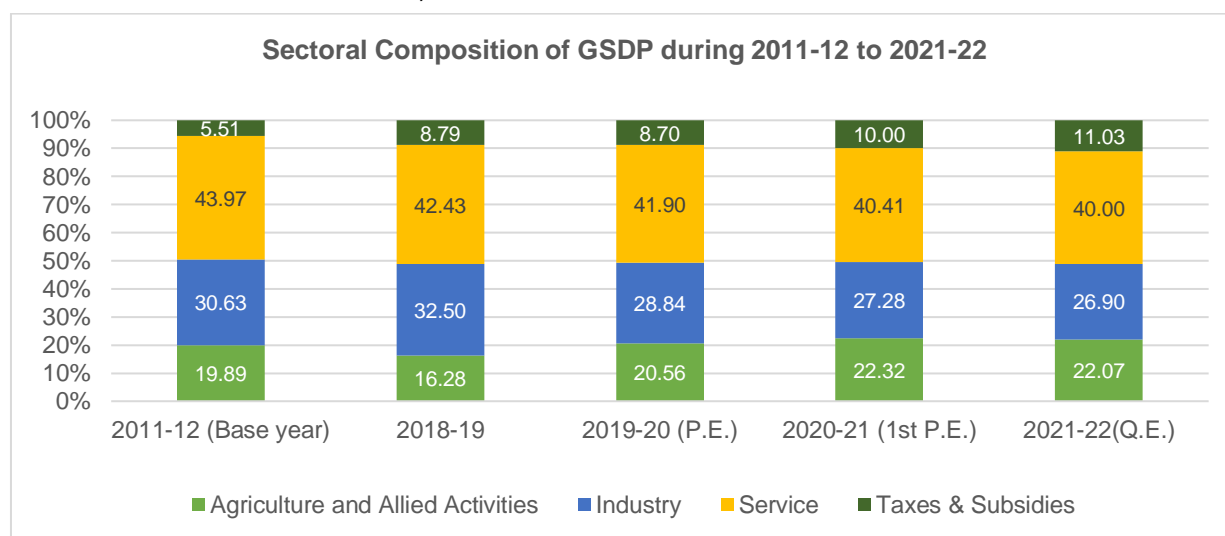
Figure 5: Sectoral Composition of GSDP at current prices in Assam

Example of economic loss and damage associated with climate extreme events (such as floods):

During post-independence period, Assam faced major floods in 1954, 1962, 1972, 1977, 1984, 1988, 1998, 2002, 2004, 2008, 2014.The flood damage to crops, cattle, houses and utilities in Assam alone between 1953 and 1995 is estimated at Rs 4400 crore with a peak of Rs 664 crore in a single bad year." (Shukla Commission, 1997). Average annual loss due to flood in Assam is to the tune of Rs. 200 Crores and particularly in 1998, the loss was about Rs. 500 Crores and during the year 2004 it was about Rs. 771 Crores (DES, 2021-22). (Wiebe, 2006) had estimated that due to floods the annually damage was at Rs.6,521 per Ha during the period 1999-2005. While in 2009, Government of Assam estimated the annual flood damage at Rs.14,590 per Ha in the Dhemaji district (DES, Assam Economic Survey, 2018). Also, during 2019, the government has estimated that due to flood total damage caused to livestock loss was worth Rs. 44.27 lakhs, agriculture crops worth Rs.15,754.6 lakhs and property damaged worth Rs.10,744.3 lakhs (DES, 2020)

2.2 Sectoral Overview

The following section provides brief outline key statistics, trends, development progress of the 9 thematic sectors[6] under study i.e., Agriculture and allied, Water Resources, Forests and Biodiversity, Energy, Human Habitats (urban and rural), Transport, Human Health, and Disaster Management in Assam. Figure below depicts the key components addressed under each of the 9 thematic sectors.
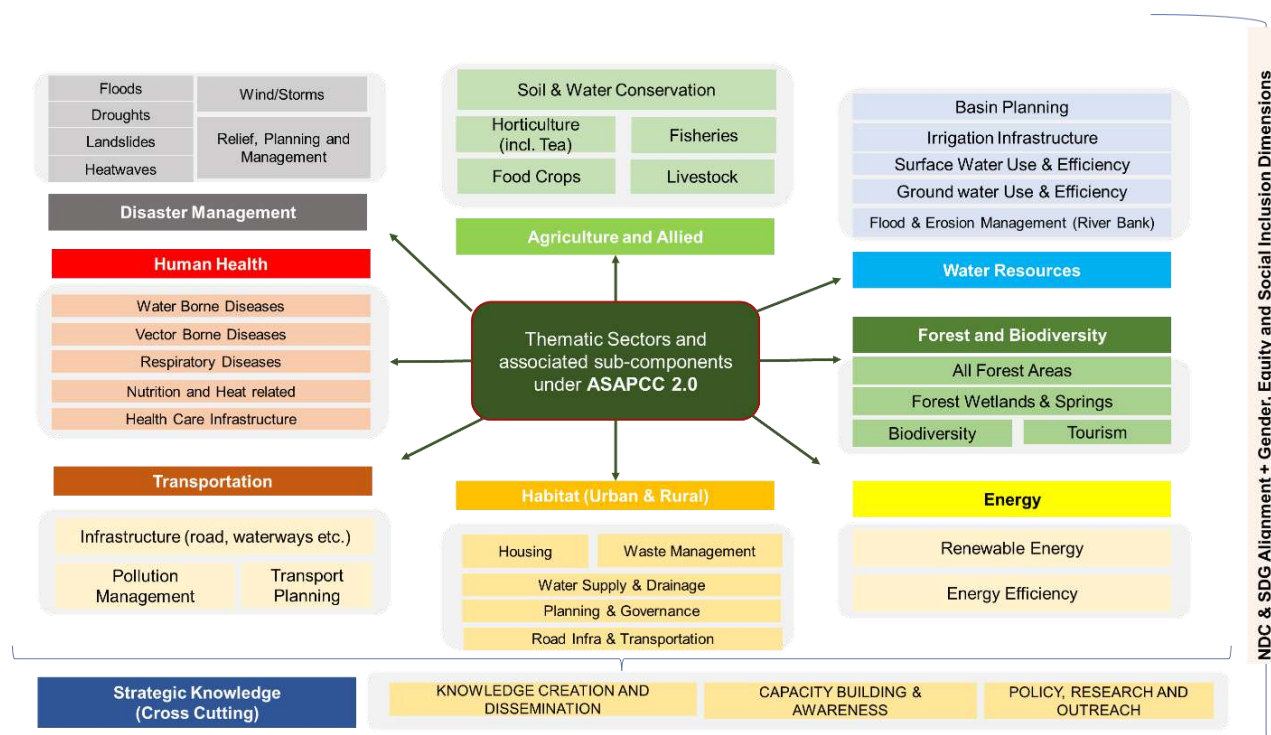
Figure 6: Thematic sectors and associated sub-components under ASAPCC 2.0

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[6] Excluding Strategic Knowledge Management Sector

2.2.1 Agriculture & Allied Sectors

Agriculture and allied sector play critical role in livelihood and economy in Assam, as almost 50 percent of the workers depend directly on the primary sector. Due the soil, topography, rainfall and climate Assam is classified into six agro-ecological zones i.e. Lower Brahmaputra Valley Zone, North Bank Plain Zone, Central Barak Valley Zone, Upper Brahmaputra Valley Zone, Barak Valley Zones, Hill Zones.

As per the Agriculture census 2015-20, approx. 27.42 lakh households are dependent on agriculture in Assam (DES, 2020). Out of the total geographical area of Assam i.e., 78.44 lakh hectares, the Gross Cropped Area of the state was 40.04 lakh hectares (2018-19) and Net Area Sown was 27.23 lakh hectares (DES, Statistical Handbook , 2020). While, the current irrigation potential of the state is 10.24 lakh hectares was created by the Government under the Department of Irrigation till 31st March, 2020 through ongoing Major, Medium and Minor irrigation schemes (DES, Statistical Handbook , 2020).

Agriculture Census 15-16 revealed that the average size of holdings stand at 1.09 hectares. It is important to note that there has been a significant fragmentation of land into marginal landholding sizes (i.e., below 1.0 Ha) from small, semi-medium and medium between 2000 to 2016. With increasing marginal land holding, the vulnerability towards any climatic disturbances increases significantly due to multiple drivers (as studied in Chapter 4) unless managed with adept adaptation measures. The following figure depicts the change in land holdings with respect to land holdings as per agriculture census 2000-01 and average landholdings.
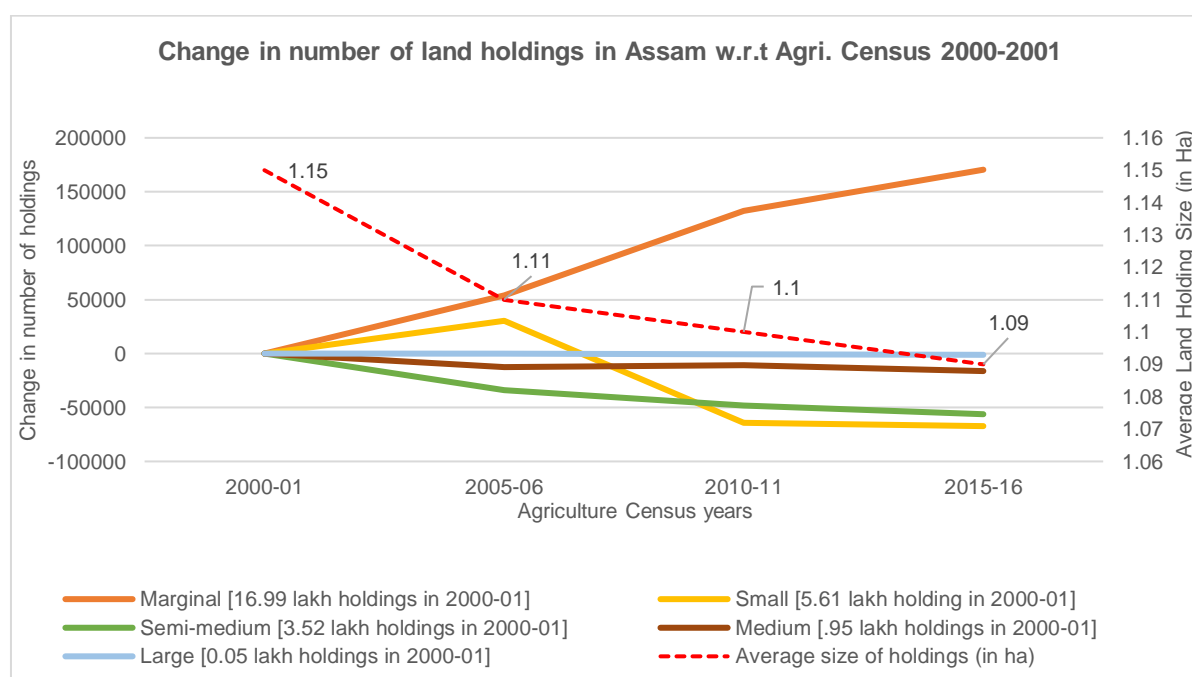
Figure 7: Change in the number of landholdings from 2000-2016

Source: (DES, Statistical Handbook , 2020)

Food Crops:

During 2019-20, the area covered under food grains was 25.98 lakh hectares in 2019-20. Area under Rice (Autumn, Winter and Summer) was 24.00 lakh hectares, Wheat - 0.11 lakh hectares, total pulses - 1.44 lakh hectares and total oil seeds (excluding coconut) covered 3.11 lakh hectares during the year 2019-20. The total food grain production was 5467 ('000 tonnes) which accounted for total average yield of 2129 Kg/hectare in the year 2019-20.

While during 2019-20, the total rice production was 5214804 (in tonnes) with average yield of 2199 (kg/hectare) as against production of 5437372 (in tonnes) and average yield of 2271 (kg/hectare) in the year 2018-19. Also, during the year 2019-20, rice production decreased by 4.09 percent and average yield came down to 3.17 percent as compared to the previous year 2018-19

Between 2011-12 to 2019-20, total area under paddy showed a steady decline mainly due to decline in area under autumn rice (ahu rice). While, the area under the winter rice (sali) and summer rice (boro) had remained stable with cultivated areas being 18.78 lakh Ha and 3.96 lakh Ha respectively in 2019-20. On the other hand, marginal changes were registered in area under wheat, pulses, and total oil seeds. (DES, 2020)
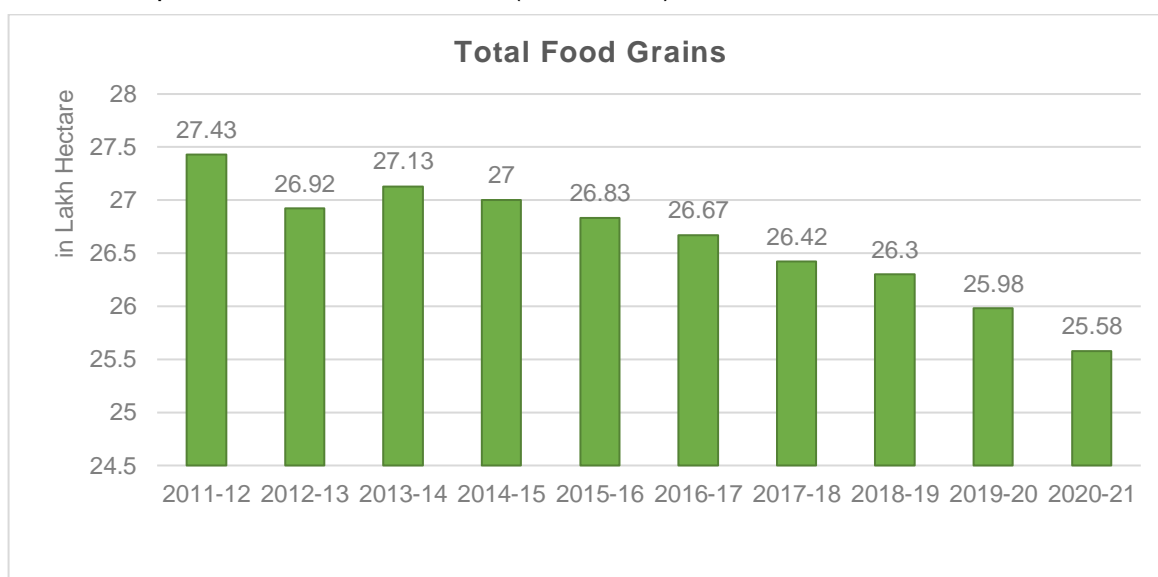
Figure 8: Trends in area under total food grain in Assam

Source: Directorate of Agriculture, (DES, 2021-22)

It is important to note that the state has been putting special efforts to promote cultivation of hybrid varieties of rice on experimental basis since 2009-10. During 2019-20, the area under these crops stands at the 290.430 thousand Ha.

Horticulture:

Assam is traditionally rich in horticultural production due to its diverse and unique agro-climatic condition which is conducive for growing wide range of horticultural crops like various fruits, vegetables, flowers, spices nuts tuber crops and medicinal and aromatic plants. The world citrus belt encompasses Assam within it. Horticultural crops occupy about 15 percent of the gross cultivated area of Assam with an annual production of more than 67 lakhs metric tonnes of various produce types. Interestingly, in all the agro climatic regions of the Assam, almost all type of horticulture crops can be taken up.

Also, the undulating physiography, subtropical climate with hot, humid summers, severe monsoons and mild winters, high soil fertility and preferential climatic conditions is conducive to production of tea in Assam. Tea gardens cover an area of 307.08 thousand ha for distribution of tea growing area in Assam). Assam is one of most important tea-producing regions in the world, manufacturing high-end graded tea which contributes to around 17% of world tea. Assam produces annually more than 50% of India's total tea production.

Livestock:

Although cereals dominate the cropping pattern, livestock and poultry are considered as one of the important homestead activities in the farm households of Assam. Livestock and poultry, as a source of milk, meat, egg, manure, draught and transportation form an integral part of rural farming system in Assam. Livestock and poultry sector have immense contribution toward rural household economy, employment, food and nutritional security. Assam contributes 3.83% and 3.73% to the total livestock and poultry population of the country. Assam has the largest pig population in the country accounting for 15.89% of the country's total pig population

The total Milk production of the State for the year 2019-20 was estimated at 975 million litres as against 946 million litres of the previous year 2018-19 revealing a growth of 3.16% in 2019-20 over the year 2018-19.

The total Meat production in 7019-20 was 52.96 (000' tonnes) and 50.00 million tonnes in the 2018-19 resulting in the increase of Meat production by 4.99 percent in the year 2019-20 over the previous year 2018-19.

The Egg production during the period 2019-20 for both (Fowl and Duck) was 514 (in million no.) and 501 (in million no.) in the previous year 2018-19 and the increase in Egg production was 2.7 percent in the current year over the previous year.

The total no. of dispensaries in the state was 311, Sub-Centre/FAC/SMC - 804 nos. and key village centres - 19 numbers as on Mar-2020. The number of livestock and poultry vaccinated was 1936886 and 510430 respectively during the year 2019-20.

Fisheries:

Fishery sector plays a significant role in the socio-economic development of the state providing rural employment, nutritional support and livelihood security thereby reducing poverty and encouraging promotion of health. Fishery sector has been identified as one of the Ratnas among the selected Navaratnas under the 'Chief Minister's Samagra Gramya Unnayan Yojana (CMSGUY)'.

Fish Production in the state has reached a level of 3.73 lakh MT during 2019-20 against the corresponding nutritional requirement of 3.87 lakh MT. The per capita consumption of fish is 11.12 Kg per annum which is now included as one of the SDG indicators for the State. Fish is the most important cuisine of the people of Assam and more than 90% of the people of the state prefer fish in their meal leading to ever increasing demand for fish. In rural areas of the state, fish farming has become one of the most common activities. Thus, the Fishery Sector is considered as an important economic activity in the socio-economic context of the state of Assam, providing scope for employment generation especially in the rural areas through fish production and its related activities, The contribution of Fishery Sector to the State's GSDP (at constant price 2011-12 prices) was Rs 5, 97,648.00 lakhs for the year 2019-20 with a growth rate of 1, 49 percent per annum over the previous year. An overview of agriculture sector in the state is highlighted in the following Table 3.

Table 3: An overview of agriculture and allied sectors in Assam

Component	Highlights
Primary Sector Workforce Engagement (census 2011)	59.06 lakh persons engaged in primary sector (Cultivator labourers, agriculture labourers -both main and marginal) i.e., 49.35 percent of total workers in the state
Landholdings	Number of operational landholdings: 27,41,000 (2015-16) Area of operational landholdings: 2,976 ('000 Ha)
Agro climatic zones	6: Upper Brahmaputra Valley Zone (UBV), Lower Brahmaputra Valley Zone (LBV), Central Brahmaputra Valley Zone (CBV), Barak Valley Zone (BV), North Bank Plain Zone (NBP), Hill Zone
Major Soils #	Alluvial soils, piedmont soils, hill soils and lateritic soils
Gross cropped area ('000 Ha)	4,004 (2018-19)
Net sown area ('000 Ha)	2,723 (2018-19)
Cropping intensity	147.51 (2019-20)
NSDP - Agriculture & Forestry and Fishing	During 2019-20: At current price: Rs. 49,509 Crores At constant price: Rs. 34,414 Crores
Major Food and Horticulture crop	Rice, Wheat, Maize, Rape, Mustard, Tea
Area under principal crops (in '000 Ha)	Food Grains: 2,598 Sugarcane: 30 Cotton: 1 Fruits & Vegetables: 209
Gross irrigated area to gross cropped area irrigation (%)	5.49 (2016-17); 11.94 (2017-18)
Chemical Fertiliser Consumption	66.84 Kg/Ha
Total Livestock (in '000)	18,077 (2019 census)
Food grains production (2019-20)	54.67 (lakh tonnes)
Storage Capacity of Food grains (in lakh metric tonnes)	4.2 (2021)
Milk production (2019-20)	975 million litres
Meat production (2019-20)	52.96 thousand tonnes
Egg production (2019-20)	514 million
Fish production (2019-20)	3,73,154.45 Tonnes (Raw Fish) 282.12 Tonnes (Dry Fish)
Inland fisheries resources	2.42 lakh Ha (water spread area except 5820 km stretch river)
Total Poultry Vaccinated	5,10,430
Total Livestock Vaccinated	19,36,886

Source: Compiled from Census of India 2011, Economic Survey 2020-21, Economic Survey 2021-22, Statistical handbook (2020 & 2021), (Golait, 2021), # - ASTEC ENVIS.

2.2.2 Forestry

As per India State Forest Report (ISFR) 2021 the total forest cover of Assam is 28,312 sq. km which is 36.09 percent of the total geographical area of the state. Assam has shown a marginal increase of 222 sq. km area of forest cover compared to the ISFR report, 2017. It is estimated that plantation mostly outside forest area is the main cause for this increase.

In terms of forest canopy density classes, the state has 3017 sq. km very dense forest, 9991 sq. km moderately dense forest and 15197 sq. km of open forest. Besides forest cover, the area under tree cover is 1408 sq. km in the state as per ISFR 2019 report. In respect of Bamboo resources of the state it was revealed that the area of bamboo bearing area in the state has significantly increased which is 1570 sq. km compared to ISFR, 2017 estimation.

Forestry and Logging is one of the main components of the Primary Sector of the state economy. As per quick estimation (QE) the total contribution of Forestry and logging to the state GSDP in 2019-20 (QE) at current prices was Rs 327099 lakhs as against Rs 306278 lakhs (Provisional Estimate) at current price with a growth rate of 6.78 percent.

Table 4: An overview of Forestry sectors in Assam

Component	Highlights
Total Forest Cover (in Sq. km) [ISFR 2021]	28,312
Percentage of state area under forest [ISFR 2021]	36.09
Area under VDF (Very Dense Forest) (in Sq. km) [ISFR 2021]	3,017
Area under MDF (Moderately Dense Forest) Area under OF (Open Forest) (in Sq. km) [ISFR 2021]	25295
Scrub Forest (in Sq. km) [ISFR 2021]	228
Total Protected area in the state (%)	4.87
Reserved Forests (in Sq. km)	17864
Total tree cover (in Sq. km)	1408
Total carbon stock in forests (in '000 tonnes)	270149
Extent of water bodies within forests (in Ha)	27,54,784
Altitudinal Strata of forest (in Sq. km)	28,327
Reserved Forest Areas (in Sq. km) [2019-20]	13,590.267
Encroached Area (in Sq. km) [2019-20]	3641.4502
Nos. of Encroachers (Household), 2019-20	205209.00
National Park (in Nos.)	7
Wildlife Sanctuaries (in Nos.), 2019-20	18
Forest Revenue (in Lakh), 2020	27644.04
Total No. of tourists visited different national parks (2019-20)	2,33,472.00

Source: Statistical Handbook 2020, ISFR 2019, ISFR 2021

2.2.3 Water Resources

The State of Assam is endowed with abundant water resources. The two major river systems - the Brahmaputra and the Barak along with numerous tributaries constitute the rich surface water resources of the State. The ground water availability in the State are falling under safe category. But in spite of the rich resources of water in the State, irrigation has become highly essential because of adverse and unpredictable weather condition including flood, erosion and drought like situation etc.

Owing to the two mighty rivers, the state can be classified into two valleys i.e., Brahmaputra and Barak Valley. Out of total state geographical area 56,194.00 Sq. Km and 22,244.00 Sq. Km fall under the Brahmaputra and Barak Valley including 3 (Three) hill districts.

The Brahmaputra Valley has an average width of about 80 Km. The main river of the valley, Brahmaputra is one of the largest rivers in the world and ran k fifth with respect to its average discharge. The river originates from the Kailash ranges of Himalayas at an elevation of 5300 M. After flowing through Tibet, it enters India through Arunachal Pradesh and flows through Assam and Bangladesh before it joins Bay of Bengal.

The catchments area of Brahmaputra in Tibet is 2, 93,000 Sq. Km; in India and Bhutan is 2, 40,000 Sq. Km and in Bangladesh is 47,000 sq. km. The Brahmaputra basin extends over an area of 5, 80,000 Sq. Km up to its confluence within Bangladesh. The average width of Brahmaputra is 5.46 Km. The maximum discharge of Brahmaputra at Pandu near Guwahati was recorded as 72,779 cumec on 23.08.62 and minimum discharge was recorded as 1757 cumec on 22.02.63. The average annual discharge is about 20,000 cumec and average dry season discharge is 4,420 cumec.

The Barak valley has a geographical area of 6922.00 Sq. Km excluding 3(three) hill districts. The local rainfall run off of the valley along with that of adjacent hilly areas flows through river Barak and its various tributaries and is drained out to Bangladesh. The Katakhal, Jiri, Chiri, Modhura, Longai, Sonai, Rukni and Singla are the main tributaries of the valley. The tributaries are mainly rain bed and cause flood problems when precipitation occurs.

Flood and Erosion are two main natural disasters being faced by the state. The flood prone area of the state is 31,500.00 sq. km. as assessed by the Rastriya Barh Ayog which is about 39.58 % of the total land area of Assam. This is about 9.40% of total flood prone area of the whole country. The flood prone area of the country as a whole stand at about 10.2 % of the total area of the country, but flood prone area of Assam is 39.58 °/a of the area of the state. It signifies that the flood prone area of Assam is four times the national mark of the flood prone area of the country. Records show that average annual area affected by flood is 9.3 1 Lakh Hectares. The flood protected area of the state is 16500.00 Sq. Km till date.

The severity of flood problem of the state has been further aggravated by the acuteness of erosion on both banks of river Brahmaputra and its tributaries. Study reveals that an area of 4.27 Lakh Hectare of the state has been eroded by the rivers since 1950, which is 7.40 % of area of the state. The average annual rate of erosion is 8000.00 Ha.

Hydro geologically the State can be divided into three units namely consolidated formation, semi consolidated formation and unconsolidated formation. More than 75% of the State is underlain by unconsolidated formation comprising of clay, silt, sand, gravel, pebble and boulders. The Bhabar belt is about 11 to 15 km wide; the tube wells yield 27 to 59 m3/hr in this zone. The Tarai zone follows immediately down slope of the Bhabar zone where the yield of the well's ranges between 80-240 m3/hr. The flood plains follow the Tarai in Brahmaputra valley where the shallow tube wells yield between 20-50 m3/hr and deep tube wells between 150-240 m3/hr.

In the semi consolidated formations of Cachar District, the yield of the tube well ranges between 50 to 100 m3/hr.

Comparison of March 2020 water level with mean water level data of the same period of preceding 10 years indicate rising trend in 51.5% (86) stations in the range of 0-2 m and in6.6% (11) stations in the range of 2-4 m. Falling trend was observed in39.5% (66) stations in the range of 0-2, in 1.8% (3) stations in the range of 2-4m and in 1 (0.6%) station above 4m. In total, rising trend was observed in 58.1% (97) of the monitored stations. The rising trend ranges from 0.01 to 3.9 m and the declining trend ranges from 0.03 to 7.39 m. The maximum rising trend and declining trend had been recorded in Hailakandi and East Karbi Anglong District respectively. Declining trend beyond 4m had been observed in one station at East Karbi Anglong district.

Table 5: An overview of Water Resources sectors in Assam

Components	Highlights
Physiography	• Brahmaputra Valley (56,194.00 Sq.km) • The Central Assam Ranges. • Barak Valley (22,244.00 Sq.km)
Drainage	• Brahmaputra Basin with sub basin of Subansiri, Jia Bharali, Badeng-Pubnoi, Dhansiri, Manas, Champamati Kalang. • Meghna Basin with sub basin of Barak River
Total Irrigation Potential (till March 2020)	10.24 Lakh Ha
Total Annual Ground Water Recharge (in bcm)	27.05
Total Natural Discharges (in bcm)	5.09
Annual Extractable Ground Water Resource (in bcm)	21.97
Net Ground Water Availability for future use (in bcm)	19.33
Current Annual Ground Water Extraction (in bcm)	2.58
• **Irrigation**	1.97
• **Industrial**	0.01
• **Domestic**	0.6
Stage of Ground Water Extraction (%)	11.73
Total Recharge Worthy Area if Assessed Units (in Sq. km)	68817.93
Ground Water Quality Problems	
Contaminants	**Districts affected (in part)**
Fluoride (>1.5 mg/l)	Dhubri, Goalpara, Golaghat, Jorhat, Kamprup Metro Rural, Kamprup Metro Urban, Kamrup, Karbi Anglong, Karimganj, Nagaon, Nalbari, Udalguri
Arsenic (above 0.05 mg/l)	Cachar, Darrang, Dhemaji, Dhubri, Goalpara, Golaghat, Hailakandi, Jorhat, Kamprup Metro Rural, Kamrup, Karimganj, Kokrajhar, Lakhimpur, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur

Sources: Statistical Handbook 2020, Economic Survey 2021, and CGWB 2020-2021.

2.2.4 Energy Sector (Clean, Renewable and Efficient Energy)

The development of power sector in Assam will help in achieving the larger objectives of poverty alleviation along with industrial and economic growth in the State. Currently, the installed capacity of APGCL in the state was 376.155 MW in 2019-20. Power generation in Assam is insufficient to meet the rising demand and this deficit is being met by purchasing of power from the Central Government Grids and neighbouring states. Gross power generation in the state was 1545.97 MU in 2019-2020, which were 1594.15 MU in 2O18-2019 and 1489.84 MU in 2017-2018 recorded a fluctuation in generation of power in the state. While, the installed

capacity of generating plants hydel and gas plants of the state was 376.155 MW as on March, 2019 compared to 375.355 MW in 2018-19 and 364.7 MW in 2017-18. Source-wise electricity generated in Assam, now also includes renewable energy sources like Solar and Wind Energy to meet the additional requirement of power in the state.

The energy requirements of the State has been worked out at 9413 Million Units (MU) for the year 2019-20 which was 9173 MU in 2018-19 and 8694 MU in 2017-18. The peak demand for electricity in the State has increased from 1745 MW in 2017-18 to 1809 MW in 2018-19 and further to 1956 MW in 2019-20. The aggregate transmission and commercial losses in the state was 15.71% in 2017-18, 20.05% in 2018-1 9 and 21.07% in 2019-2020. Wastage of power at the stages of transmission is a matter of concern in a state like Assam having serious shortage of power supply, though the state has put efforts to mitigate the losses. The Power Department has taken up a number of initiatives for electrification of the rural areas of the state under its programmes of Rajiv Gandhi Gramin Vaidyutikaran Yojana (RGGVY), Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Saubhagya and Gram Swaraj Yojana (GSA-I and GSA-II).

Initiatives have also been taken up for promoting renewable energy sources like Solar and Wind energy to complement the existing sources of power for lighting the remote villages, hill areas and char areas and cater to the additional power requirements of the state. While to bring down transmission and distribution losses: the state is also taking measures such as Energy accounting and electricity live ring fencing under capital R-APDRP, Repair and maintenance and re-conducting or 33KV, 1 1KV and LT lines, Changing and replacing of electro mechanical meters to electronic meters, Establishment of police stations in different circles for theft detection, Energy bill payments through net banking procedures.

A multi-pronged approach has been taken in India to improve energy efficiency. It has promoted innovative programmes such as PAT (Perform Achieve and Trade) scheme, Standard & Labelling, UJALA scheme, Energy Conservation Building Code, Electric Vehicle Mission, Smart Metering, etc. These target- industries, domestic sector, agriculture, transport, commercial sector and municipalities.

With more than 2 thousand crores revenue generated from the extraction of major minerals through colliers, oil refineries, lime extraction, natural gas, etc makes mining industry in Assam a key part in managing the energy demand across India.Hence needs a clear attention to manage the climate risk on this industry.

Table 6: Overall highlights of the Energy Sector in Assam

Components	Highlights (2019-20)
Installed Capacity (MW) [As on Jan 2022]	State Share – 434.37 Private – 74.67 Central – 1285.16 **Total 1794.20**
Mode wise break up of Installed Capacity in MW (% to total) [As on Jan 2022]	Thermal – 1167.44 (65.07) Nuclear – 0.00 (0) Renewable – 626.76 (34.93)
Gross Unit Generation (MU)	1545.980
Energy Requirement (MU) [Provisional]	9413
Energy Availability (MU) [Provisional]	10933
Peak Demand (MW)	1956
Peak Demand Met (MW)	1956

Components	Highlights (2019-20)
No. of Consumers	
• **Domestic**	5501547
• **Commercial**	282299
Energy Billed (MUs)	7257
T & D Losses (MUs)	1709
Amount Billed (Rs. in Crore)	5392
Amount Realised (Rs. in Crore)	5268
Collection Efficiency (in %)	97.70
Overall Efficiency (in %)	79.08
Aggregate Transmission and Commercial Losses (%)	20.92
Source wise electricity generated by APGCL	
• **Natural Gas (in MU)**	1119.068
• **Hydro (in MU)**	426.908
Sector Wise Electricity Consumption (in MU) [%] – 2019-20	
• **Industrial**	1586.00 [21.85]
• **Agriculture**	47.00 [0.65]
• **Domestic**	3818.00 [52.61]
• **Commercial**	1112.00 [15.32]
• **Public Services (Public Lighting Work)**	16.00 [0.22]
• **Other**	678.00 [9.34]
Renewable Energy Installed	
• **Solar PV Pump set (till 2019-20)**	9324
• **Smart street lighting project in identified urban areas during 2019-20**	372
• **Grid Connected Rooftop Solar Power Plant with battery backup at different Govt. buildings (2018-19)**	629 in Kilowatts peak
• **Nos. Of solar photovoltaic power plant (off grid) installed under JNNSM & other demonstration project/**	184 (1655 KWP)
Mining and Mineral Production	
• **Index of Mineral Production (all) (Base:2011-12 = 100)**	79.67 (2020-21)
• **Coal Production ('000 M.T.)**	596 (2019-20)
• **Natural Gas (Utilised) (MCM)**	2931 (2019-20)
• **Petroleum (Crude) ('000 M.T.)**	4093 (2019-20)
• **Total Revenue earned from major minerals extracted in state (Rs. in Cr)**	2,328.34 (2019-20)

Source: CEA 2022, Statistical Handbook of Assam 2020-21

2.2.5 Human Habitat (Urban and Rural Settlements)

Sustainable Habitat Mission follows the outline and components mentioned as per the initial ASAPCC as well as keeping the components mentioned in the National Mission on Sustainable Habitat (approved by the Prime Minister's Council for Climate Change in June 2010). As per the National Action Plan on Climate Change (NAPCC), the mission on Sustainable Habitat comprises three components, i.e., promoting energy efficiency in the residential and commercial sector, management of municipal solid waste, and promotion of urban public transport. Considering that the component of energy efficiency will be dealt in detail under the Assam Energy Sector.

As per Census 2011, 86% of Assam's population lives in 26395 villages as compared to only 14% that are spread across its 214towns. Other than Assam, Himachal Pradesh, Bihar and Odisha are the only other Indian States, who have less than 20% of their total population living in urban spaces. At all India level, 68.84% of the India's population lives in rural areas and 31.16% in cities. Like elsewhere, the decadal growth rate of rural population in Assam is declining. It has decreased from 17.29% in 2001 to 15.23% in 2011. Around 4.3 million of

Assam's population lives in cities57. The urban population growth rate has risen from 12.72% in 2001 to 14% in 2011.

Guwahati, Nagaon, Dibrugarh and Silchar spread across length and breadth of Assam are the most prominent cities. Guwahati is the largest Urban agglomerate with a population of 0.9 million.

Considering that 4.3 million people live in urban areas in Assam and they produce on an average 300 tons of solid waste per day38, the annual solid waste generated is around 471 Giga tons. Though door to door collection of MSW has been introduced in some cities in Assam but still scientific treatment and management of solid waste is not the norm anywhere. India's first integrated waste management is being implemented in Guwahati, where the facility would develop mechanisms for waste collection, segregation, recycling and improved solid waste collection, transportation, treatment, disposal and energy generation. However, as the pace of the population pressure increases in urban areas, development of MSW management infrastructure development has to be sped up, as unscientific management of MSW leads to many issues.

The re-structured erstwhile IAY programme PMAY-G is implemented for providing shelter to the shelter-less/homeless people living below the poverty line (BPL). It is funded by the Centre and the State at the ratio of 9: 1. A beneficiary gets Rs.1.30 lakhs under PMAY-G scheme from the year 2016-17. The fund is directly transferred to the beneficiary's Bank Account in three instalments. Plans for the implementation of a new scheme to provide financial assistance to the landless PMAY-G beneficiaries for procurement of a plot of land @ Rs.50000/-is under discussion.

For the financial year 2019-20 against the fund receipt of Rs. 146,109.44 lakhs, utilization was Rs. 204, 668.75. Likewise, for the financial year 2020-21, a target of 365,976 houses has been provided by Govt. of India against the estimated cost of Rs. 475,768.78 lakhs.

In Assam, the Deendayal Antodaya Yojana— NRLM (DAY-NRLM) is being implemented through Assam Rural Livelihood Mission, Assam (ARSLM) since 2012, working with a mission to reduce poverty by enabling the poor households to access gainful self-employment and skilled wage employment opportunities. This has resulted in appreciable improvement in their livelihood building strong grassroots institutions of the poor. Till 31*' / larch, 2020 Assam State Rural Livelihood Mission has promoted 283,790 Women SHGs across 33 districts covering 30, 29, 864 households.

In order to empower women SHGs financially, the Government of Assam launched Kanaklata Mahila Sabalikaran Asoni on 1st April 2018 for promotion of 1 lakh women SHGs in the state and subsidy linked loan upto Rs. 5 lakhs for development of Women SHGs. Till March 2020, a total of 134,000 SHGs D Rs. 15,000.00 each, have been provided Revolving Fund of Rs.176. 59 crores.

Table 7: Overall sectoral highlights of the urban and rural habitat in Assam

Components	Highlights
Urban Habitat	
Total Urban Population (persons)	43,98,542
Urban Population share (%)	14.10
Percentage Decadal Urban Population Growth (Census 2011)	27.89
Total No. of Towns	214
• Total No. of Statutory Towns	88
• Total No. of Census Towns	126
No. of AMRUT Cities	4
No. of Smart Cities	1 (Guwahati)

Components	Highlights
Slum Population (2011)	197,266
Rural Habitat	
Total Rural Population (persons)	26807034
Rural Population share (%)	85.9
Percentage Decadal Rural Population Growth (Census 2011)	15.47
Total No. of Villages	26395
No of Rurban Clusters	9

Source: Census of India 2011, Assam Statistical Handbook 2021

2.2.6   Transport

Transportation under Human Habitat Sector play's a critical role for climate mitigation. As per the Economic Survey of Assam 2021-22, the contribution of the transport sector was calculated at 5.00% of GSDP in 2019 – 20 at constant prices (at 2011-12 prices) as against the contribution of 5.29% in 2018-19. The road network in Assam comprised of total 58882 km of roads consisting of 3890 km of National Highways, 2530 km of State Highways, 4379 km of Major districts roads, 1739 km of Urban roads, 46344 km of Rural roads as on March 2019-20. Out of the total 54992 km road length maintained by the PWD, 31493 km is blacktopped; 650 km is cement concrete, 5566 km is inter-locking cement concrete block pavement (ICBP) and 17284 km is metalled and un-metalled roads.

The on-road vehicle population in the State was 4167346 as on March 2020. The density of motor vehicles in Assam was 53.1 per sq.km. during the year 2019-20 as against 47.5 vehicles per sq. km. during the year 2018-19. At present Assam has total railway route length 2518.99 km. which is 3.9% of the total Railway route of the country.

Table 8: Transport highlights of the State

Transport Statistics (2019-21)	
Total Road Length excluding N.H. (in Km)	54992
Surfaced (Black topped) (in Km)	31492
Cement Concrete (in Km)	652
National Highway (N.H.) (in Km)	3891.51
Road length per lakh of population (in Km)	188.69
Road Length per '00 sq.km. of Geographical Area (in Km)	75.07
State Highways (in Km)	2530
Major District Roads (in Km)	4379
No. of vehicles on the road	4167346
No. of vehicles registered	473668
Railway route length in Assam (in Km)	2518.99
N.F. Railway Route Length (in Km)	4239.32
No. of inland water transport ferry divisions	3
No. of passengers using inland water transport	1979198

Source: Assam Statistical Handbook 2021

2.2.7   Health

The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change. These effects occur directly, due to changes in temperature and precipitation and occurrence of heat waves, floods, droughts, and fires. Indirectly, health may be damaged by ecological disruptions brought on by climate change (crop failures, shifting patterns of disease vectors), or social responses to climate change (such as displacement of populations following

prolonged drought). Variability in temperatures is a risk factor in its own right, over and above the influence of average temperatures on heat-related deaths. Biological and social adaptation is more difficult in a highly variable climate than one that is more stable. Assam having an undulating physiography, moist tropical climate is endemic to malaria. Malaria incidences reported in the state go up to many other climate related diseases are being routinely reported despite control measures being taken. Some of the other diseases occurring at a large scale i.e., incidences reported in excess of 30,000 include Acute Respiratory Infection (ARI) and influenza, Pyrexia related to ticks, Japanese Encephalitis.

The status of health care performance in the state has gradually improved over the years. At present there are 6 Medical colleges, 24 Civil Hospitals, 14 Sub- Divisional Civil Hospitals, 12 First Referral Units, 841 Primary Health Centres, 192 Community Health Centres, 154 State Dispensaries, 4690 Sub-Centres, 21475 number of beds for patients in the Government Hospitals at the end of 2019. Till 31* March, 2020 there were 5609 doctors including ayurvedic and homeopathic doctor, 2089 pharmacist, 6395 G.N.M, 12251 A.N.M. 562 rural Health Practitioner and 1647 number of laboratory technicians who are rendering their level best services for better health of common people.

For sustainable health care facilities in the state, Government has concentrated an effort toward the establishment of an efficient system of health care and family welfare through effective planning. Department of Health and Family Welfare, Assam, along with National Health Mission have been implementing many health care schemes for improving Maternal health and reducing MMR, IMR and under 5 Mortality Rate. There is a downfall of MMR to 22% at the all-India level from 167 in 2011-13 to 130 in 2014-16. Likewise, at the state level downfall is 21% in the MMR from 300 to 237. During 2016-18 the MMR of the state is 215 from while it was 229 during 2015-17 against the all-India level; the rate is 113 in 2016-18 and 122 in 2015-17. As per report available, under 5 Mortality Rate (U5MR) of Assam per 1,000 live births is also higher for the state as compared to the all-India figure. It was 47 for Assam in 2019 against 34 at the all-India level.

Table 9: Health Care Profile and Disease Incidence in Assam

Health Statistics (2019-21)	
Birth Rate (%) [2018]	21.1
Death Rate (%) [2018]	6.4
Total Fertility Rate (number of births per woman) [2018]	2.3
Infant Mortality Rate (IMR) (per 1000 live births)	41
Civil/District Hospitals	24
Sub-divisional Hospitals	14
Functional Primary Health Care Centres	1002 (Rural -946, Urban -56)
PHCs functioning on 24X7 basis in Rural Areas (% of total functional)	31.6
Functional Community health care centres	192 (Rural – 190, Urban -2)
Functional Sub centres	4690 (Rural – 4659, Urban-21)
Functioning Health & Wellness Centres (RHS 2019-20)	1196
First Referral Units (FRUs)	69
Bed Strength, 2019	21475
Nutritional Status (as per NFHS 5) [2019-20]	
Children under 5 years who are underweight (weight-for-age) (%)	32.8
Women whose Body Mass Index (BMI) is below normal (BMI <18.5 kg/m^2) (%)	17.6
Men whose Body Mass Index (BMI) is below normal (BMI <18.5 kg/m^2) (%)	13.4
Children age 6-59 months who are anaemic (<11.0 g/dl)	68.4
All women age 15-49 years who are anaemic (%)	65.9

Health Statistics (2019-21)	
Disease Incidence Profile (2021-22)	
Vector borne (Malaria, Acute Encephalitic Syndrome, Chikungunya, Dengue)	7,604
Water borne (Jaundice, Diarrhoea, Acute Hepatitis, Dysentery, Typhoid)	20,086
Respiratory (ARI/Influenza Like Illness [ILI], and SARI)	59,512
Zoonotic (COVID 19 Cases) [Till 24th Feb 2022]	Total Cases: 7,24,038 Deaths: 6,637

Source: Statistical Handbook of Assam, 2020-21, Department of Health and Family Welfare - District Wise Disease summary report (P form) Assam 2021-2022, National Family Health Survey (NFHS)-5, Assam Factsheet, 2020, RHS 2019-20

2.2.8 Disaster Management

Due to its topographic and climatic conditions, Assam is vulnerable to numerous extreme climate events, which may lead to the disasters. The state faces flood, droughts, cyclones/extreme winds etc. The intensity and frequency of the extreme event is also increasing due to climate change. A detailed analysis of the existing hazards in Assam has been presented in the "Assam State Disaster Management Plan". The plan has categorised to address assessment, preparedness and responses related gaps for disaster management. The integration has been done from disaster perspectives and prom department perspectives.

Evidences show that there is high probability of increase in the frequency and intensity of climate related natural hazards due to climate change and hence increase in potential threat in India, and Assam is no exception to this. Being geographically, physiologically and ecologically diverse, scenario is expected to get further grieve in the future. Assam is highly vulnerable to floods being in middle of Brahmaputra and Barak river basins. The state is, addition also vulnerable to Droughts, Erosion and wind/cyclones related disasters. These have been described in reference to the state further in detail in Chapter 4.

A brief table below highlights the key statistics related to disaster profile and risk management in Assam.

Table 10: Hazard Profile and Overall Highlights of Disaster Management in Assam

Components	Highlights
Key Hazard Profile	
Total Geographical Area *(in Sq. km)*	78,438
Landslide prone Area *(% to geographical area)* • Moderate (Zone-III) • High (Zone – IV) • Severe (Zone – V)	• 17.18 • 7.58 • 0.01
Total Flood Prone Area in Sq. km *(% to geographical area)*	31,500 (39.58%)
Average Annual Flooding in Sq. Km *(% of geographical area)*	8,320 (10.61%)
Maximum Annual Flooding in Sq. Km *(% of geographical area)* – *'Year of max. flooding'*	38,200 (48.70%) – '1988'
Total No. of Flooding Events (1969-2019)	2640
Total Lightning Mortalities (between2001 - 2016)	392
Lightning Mortalities Average Annual (between2001 - 2016)	26.13
Total Annual Average Heatwave Days (1969-2019)	9.42
Disaster Management (DM)	
Year of preparation of State DM Plan	2015
Years of revision of State DM Plan	Under process
No. of districts prepared District DM Plans	33 districts
No. of Departments prepared Departmental DM Plans	16 key department

As per the latest BMTPC Vulnerability Atlas 2019, 14.7 percent of the total geographical area under flood risk. A spatial map representing the flood hazard, wind hazard and landslide incidence are depicted in the **Figure 9**.
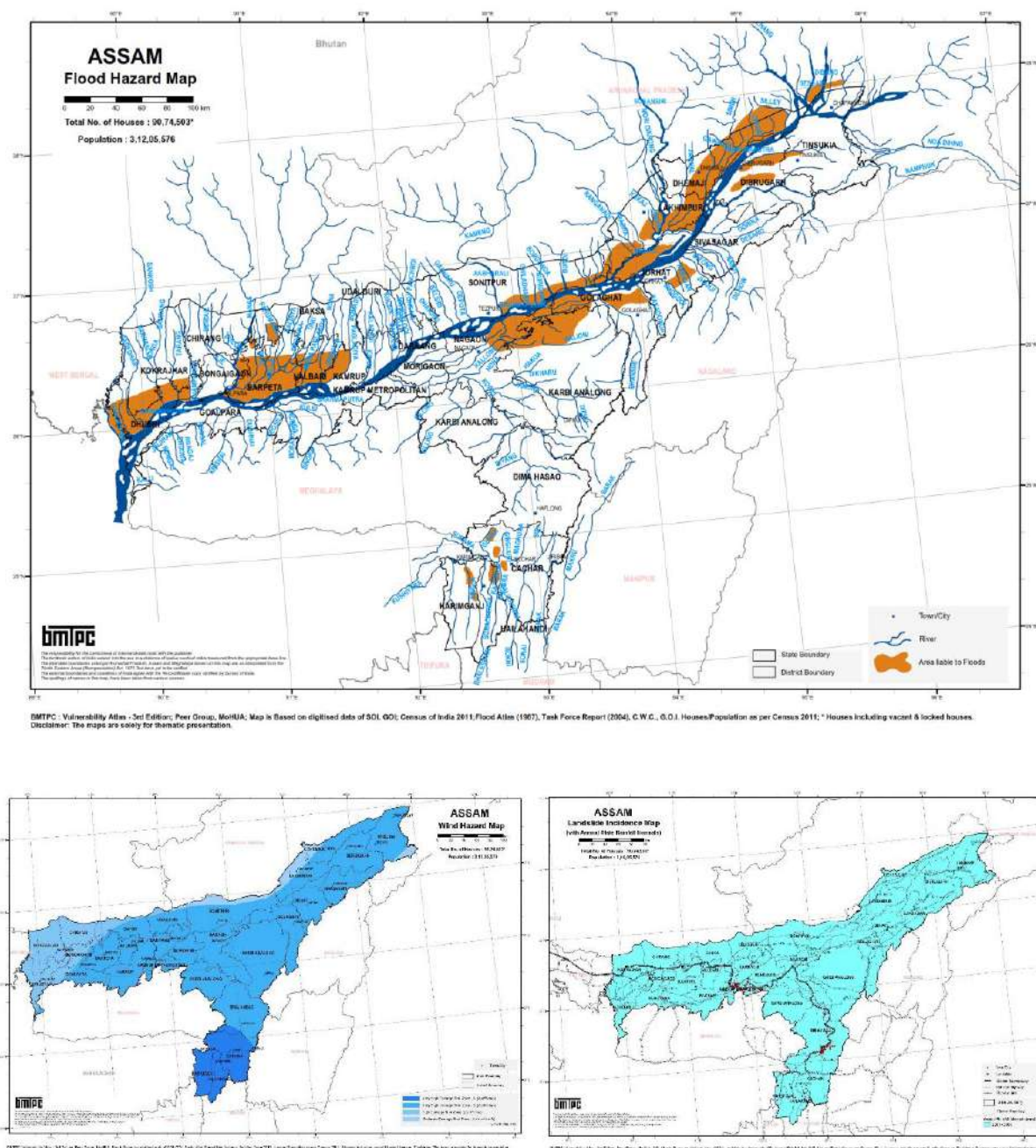
Figure 9: Assam Flood Hazard, Wind Hazard and Landslide Incidence Map

Source: BMTPC, 2019

2.3 State Development Performance and Priorities of Assam

According to SDG India Index 2020-21 of National Institution for Transforming India (NITI) Aayog, Assam stands at 26th rank out of 28 states in India with a composite score of 57 and

classified as performer state. Table 11 depicts SDG goal wise score and respective performance class.

Table 11: Performance of Assam under SDG Goals

	SDG Goal	Score	Performance Class
Goal 1	No Poverty	51	Performer
Goal 2	Zero Hunger	41	Aspirant
Goal 3	Good Health & Well Being	59	Performer
Goal 4	Quality Education	43	Aspirant
Goal 5	Gender Equality	25	Aspirant
Goal 6	Clean Water & Sanitation	64	Performer
Goal 7	Affordable & Clean Energy	98	Front Runner
Goal 8	Decent Work & Economic Growth	50	Performer
Goal 9	Industry Innovation & Infrastructure	39	Aspirant
Goal 10	Reduced Inequalities	65	Front Runner
Goal 11	Sustainable Cities & Communities	55	Performer
Goal 12	Ensure Sustainable consumption and Production pattern	66	Front Runner
Goal 13	Climate Action	53	Performer
Goal 15	Life on Land	78	Front Runner
Goal 16	Peace, Justice & Strong Institution	62	Performer
	Composite Score	**57**	**Performer**

Source: (NITI Aayog, 2021)

The sectoral key development priorities and targets set in the Assam Vision 2030 Document across are outlined in the Table 12 below.

Table 12: Key Development Priorities of Assam

Related State SDG Targets (Assam Agenda 2030)[7]				
Sector – Agriculture and Allied [SDG 2]				
Indicators	**Baseline 2016-17**	**Target 2019-20**	**Target 2023-24**	**Target 2030-31**
Average rice yield (kg/ha)	2119	3000	3500	4238
Cropping intensity (%)	149	166	189	223
Distribution of soil health cards (proportion%) of total requirement of 272,000	34.3	100	100	100
Production of Pulses (lakhs MT)	1.43	4.96	5.18	5.52
Production of oilseeds (Lakhs MT)	2.48	4.46	4.66	4.97
Per-capita fish consumption (kg/person/year)	9	11	15	20
Meat availability ('000 tonnes)/ (as %of requirement)	49 (13.5)	150(40)	300 (77.3)	405 (100)
Egg availability (million no.)/ (as % of requirement)	476 (8.0)	1500 (24.5)	4000 (63)	6624 (100)
Milk production (Million ltr)/ (as %of requirement)	908 (36.2)	1300 (50.3)	1632 (60.9)	2794 (100)

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[7] https://transdev.assam.gov.in/portlet-innerpage/assam-agenda-2030

Related State SDG Targets (Assam Agenda 2030)[7]				
Production of Silk Yarn (eri + Muga + Mulberry) (MT)	2712.0	2996	3786	7584
Requirement certified Paddy seeds (MT)	53696	55448	57848	61664
Production (MT)	55000	55448	57848	110000
Requirement certified pulse seeds (MT)	9816	10122	10571	11265
Production (MT)	200	10122	10571	11265
Requirement certified oil seeds (MT)	3600	3717	3883	4142
Production (MT)	3800	3717	3883	4300

Sector – Water Resources [SDG 6, SDG15]				
Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
Irrigation potential (all departments) created (lakh ha)	17.5	21	24	27
Home connection for drinking water supply (%)	1.9	70	80	100
Water quality affected habitation to be addressed (%)	10 (2016)	2.5	0	-

Sector – Forests and Biodiversity [SDG 12, 13, 14, 15]

- Creation of 120 MtCO2 sinks by planting more than 5 crore of Saplings till 2030 (support by create about 4% of carbon sinks declared by India)
- Expand growing stock from 143.7 million cum in 2016-17 to 300 million cum by 2030
- Afforestation/reforestation in degraded and attrition areas by 2030
- Controlling of erosion through suitable bio-engineering techniques by 2030
- By 2030, at least 75% of youth to be aware of values of biodiversity, and the steps they can take to conserve and use it sustainably
- Terrestrial, inland aquatic, wetland ecosystems, and associated species are conserved effectively and equitably by 2030
- By 2025, all wildlife corridors shall be restored to their original status

Sector – Energy [SDG 7]

Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
Proportion of HH using electricity as the primary source of lighting (%)	37 (2011)	100	100	100
Proportion of Renewable energy to total annual energy production by installed capacity (%)	2.08 (2016)	54.7*	27.3	31.01
Total power generating capacity (conventional+ renewable) in MW	609.9	865.4	2949.4	3104.9
Aggregate technical and commercial (AT&C losses to total energy produced (%))	23 (2016)	17	15	8
Street Lighting (gap)	155000 lights	32%	96%	100%

Sector – Human Habitat & Transport [SDG 1, 6, 7, 8, 9, 11, 13]				
Indicators	Baseline 2016-17 (Current and future gap)	Target (2017-2020 Achievement	Target Achieved 2020-24 (Cumulative)	Target Achieved 2030 (Cumulative)
No. of slum Households covered	5100	39%	89%	100%
No. of Tenable/untenable slums	70/233	42% / 43%	90% /91%	100% / 100%
No, of EWS HHs sanctioned	26,467	100%	-	-
Urban housing (gap)	5,44,000 nos	26%	59%	100%
Water Supply (gap)	429 MLD*	23%	46%	100%
Sewerage and Sanitation (gap)	600 MLD	35%	79%	100%
Solid Waste Management (gap)	1285 TPD**	12%	34%	100%
Storm Water Drainage (gap)	4578 km	22%	74%	100%
Urban Transport (gap)	1900 buses	16%	37%	100%
Street Lighting (gap)	155000 lights	32%	96%	100%

Related State SDG Targets (Assam Agenda 2030)[7]				
Mortality Ratio due to Accident(per 100000	34.4 (Baseline)	15	5	Negligible
Street Lighting (gap)	155000 lights	32%	96%	100%
Total length of surfaced rural roads ('000 KM)	18.3	24	31.9	43
Road network (km)	6384	23%	83%	100%
Total Length of Public Transport System (km)	1450	14%	41%	100%
Green Transport Corridors (km)	3500	40%	85%	100%
Dedicated cycle track (km)	1250	32%	81%	100%
Pedestrian friendly environments in towns and cities (km)	6000	42%	92%	100%
Traffic Management system (km)	6384	28%	98%	100%
Home connection for drinking water supply (%)	1.9	70	80	100
Water quality affected habitation to be addressed (%)	10 (2016)	2.5	0	-
Proportion of households covered with sanitary toilets (%)	52 (2016)	100	-	-
Sector – Human Health [SDG 3]				
Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
Maternal Mortality Ratio (00 per lakh)	300 (2011-13)	203	155	70
Infant Mortality Ratio (per 1000 live births)	44 (2016, SRS)	41	33	19
Immunization (%)	47.1 (NFHS-4, 2015-16)	85	92	100
Functional 24x7 PHCs out of 1014	563	676	800	1014
Sub centres out of 4621, equipped for handling deliveries	696	1201	1709	2310
Functional hospitals out of 758 surveyed tea gardens	428	538	652	758
Hepatitis B service coverage rate (child age 12-23 months received 3 doses of hepatitis B vaccine) (%)	52 (NFHS-4)	90	90	90
Malaria incidence rate (%)	0.23 (2016)	<1	<1	elimination
Dengue incidence (No of cases)	6157 (2016)	3079	1540	770
Japanese encephalitis incidence (no of cases)	427 (2016)	214	107	54
Cardiovascular disease among 30-70 years early detection rate (%)	-	20	50	75

Source: Assam Agenda 2030

03
Climate Profile

Chapter 3. Climate Profile

3.1 Global Climate Context:

IPCC AR6 WGI,2021 8 states that the each of the last four decades has been successively warmer than any decade that preceded it since 1850. Global surface temperature9 in the first two decades of the 21st century (2001-2020) was 0.99 [0.84-1.10] °C higher than 1850-1900. Global surface temperature was 1.09 [0.95 to 1.20] °C higher in 2011–2020 than 1850–1900, with larger increases over land (1.59 [1.34 to 1.83] °C) than over the ocean (0.88 [0.68 to 1.01] °C). Globally averaged precipitation over land has likely increased since 1950, with a faster rate of increase since the 1980s. In addition, global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. The number of hot days is projected to increase in most land regions along with increasing risk from droughts and precipitation deficits. The impacts of global warming have already been observed on natural and human systems, as many land and ocean ecosystems as well as the ecosystem services they provide have already changed due to the warming (IPCC, Special Report: Global Warming of 1.5 C, 2018).

Evidence of observed changes in extreme weather conditions such as heatwaves, heavy precipitation, droughts and their attribution to human influence, has strengthened since AR5 (IPCC AR6, 2021). From a physical science perspective, limiting human-induced global warming is essential and to do that to a specific level, it is essential to limit cumulative CO_2 emissions, along with reductions in other greenhouse gas emissions. Global surface temperature will continue to rise until at least the mid-century across all emissions scenarios considered. Unless deep reductions in CO_2 and other greenhouse gas emissions are made in the coming decades, global warming of 1.5°C and 2°C will be exceeded during the 21st century.

3.2 Assam Context

Generally, climate in Assam can be classified as 'Tropical Monsoon Rainforest Climate'. Significant geographical aspect of Assam is that it contains three of six physiographic divisions of India – The Northern Himalayas (Eastern Hills), The Northern Plains (Brahmaputra plain), and the Deccan Plateau (Karbi Anglong). Assam has mostly plain areas of low elevation, a large number of rivers and hills of low elevation in Karbi Anglong, North Cachar Hills and Cachar districts in the southern region. The peak height of hill in the state is about 1850 metres above mean sea level in North Cachar Hills district. All the rivers in Assam are liable to floods, mainly because they receive heavy rainfall within a short time in the state and its neighbourhood (Himalaya) where water runs very fast into Assam which has mostly low elevation. These rivers are in their early stage of maturity and are very active agents of erosion. The river water collects a tremendous amount of silt and other debris from the hilly terrains and raises the level of the riverbeds. (IMD, 2020)

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[8] https://www.ipcc.ch/report/ar6/wg1/#FullReport

[9] The term 'global surface temperature' is used in reference to both global mean surface temperature and global surface air temperature

3.3 Methodology

3.3.1 Observed Climate Variability and Trend Analysis

Daily gridded rainfall and temperature data sets available at a spatial resolution of 0.25°x0.25° and 1.0°x1.0° latitude and longitude respectively have been extracted from the IMD data base (http://cdsp.imdpune.gov.in/home_gridded_data.php) for the grids pertaining to each of the districts in Assam for the period of 1980-2019.Figure 10 shows the flow of analysis and \

Table 13 lists the data sets analysed.
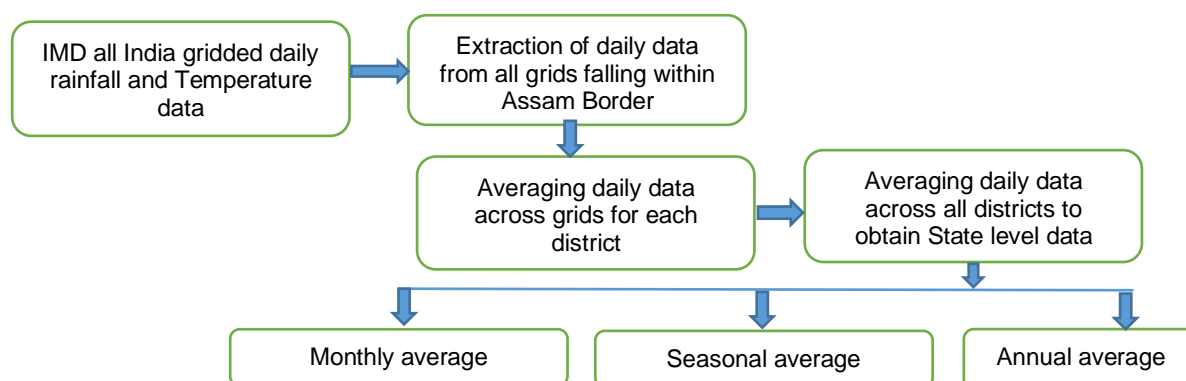
Figure 10: Flow of climate data analysis

Table 13: Parameters analysed at State and District level

	State level	District Level
Temperature (°C)	• Annual Average Maximum Temperature(°C) • Annual Average Minimum Temperature(°C) • Annual Average DTR (°C)	• Annual Average Maximum Temperature(°C) • Annual Average Minimum Temperature(°C)
Rainfall (mm)	• Total annual rainfall (mm) • Total seasonal rainfall (JF, MAM, JJAS, OND)10 (mm)	• Total annual rainfall (mm) • Total monsoon (JJAS) rainfall (mm) • Total seasonal rainfall (mm) • Number of rainy days (decadal, during JJAS months) • Number of dry days (decadal, during JJAS months) • Number of heavy rainfall days (decadal, during JJAS months) • Number of very heavy rainfall days (decadal, during JJAS months)
Extreme Weather Events*	• Floods • Heat Wave Days • Lightning	

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[10] JF – January, February; MAM-March, April, May; JJAS – June, July, August and September; OND- October, November, December

*-Extreme Events Data is based on the annual disaster weather report of IMD presented in form of Hazard Atlas on https://imdpune.gov.in/hazardatlas/index3.html

3.3.2 Climate Change Projections

The climate change projection data for the Indian region is publicly available at http://cccr.tropmet.res.in/home/esgf_data.jsp. The data sets have been generated by the Coordinated Regional Climate Downscaling Experiment (CORDEX) conducted for South Asia11. The CORDEX South Asia dataset includes dynamically downscaled climate change daily projections at 50 km x 50 km resolution using 3 RCMs with 17 ensemble members. For Assam, the climate change projections have been derived from ensemble average of 10 of these RCM outputs suitable for the Indian region which are available at http://climatevulnerability.in.

The future projections in this report are based on two standardised forcing scenarios called Representative Concentration Pathways (RCPs), namely RCP 4.5 (mid-range emissions) and RCP 8.5 (high-end emissions) scenarios. Each scenario is a time series of emissions and concentrations of the full suite of GHGs, aerosols, and chemically active gases, as well as Land Use changes through the twenty-first century, characterized by the resulting Radiative Forcing in the year 2100. RCP 4.5 is an intermediate stabilization pathway that results in a Radiative Forcing of 4.5 W/m^2 in 2100 and RCP 8.5 is a high concentration pathway resulting in a Radiative Forcing of 8.5 W/m^2 in 2100. The present chapter outlines the change in climate in Near Term (2011-2040), Mid Term (2041-2070) and End-Century (2071-2100) with respect to Baseline (1981-2010).

3.4 Observed Climate Trends

3.4.1 Temperature: State level analysis

The analysis of temperature for the period 1990-2019 indicates a rising trend in annual average maximum and minimum temperature in Assam. During the same period, annually the maximum temperature has increased at the rate of 0.049°C and the minimum temperature has increased at the rate of 0.013°C. The annual average Diurnal Temperature Range (DTR) also shows an increasing trend, the increase being 0.037°C per annum (over 1990-2019).

During 1990-2019, the annual average maximum temperature was 28.56°C. It ranged between 27.41°C – 29.46°C, where the highest annual average maximum temperature was recorded in the year 2013. The annual average minimum temperature during the same period was 18.39°C and it ranged between 17.71°C – 19.03°C. The highest average minimum temperature was recorded in the year 1999. The annual average Diurnal Temperature Range (DTR) was 10.18°C and it ranged between 9.41°C - 11.25°C, the highest being recorded in the year 2013. As shown in Figure 11 all the three indicators show seasonality throughout the time period.

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[11] *Note that the projections are built with uncertainty, downscaled temperature projections are considered to be with High or moderate confidence, while rainfall/precipitation projections are of low confidence.*
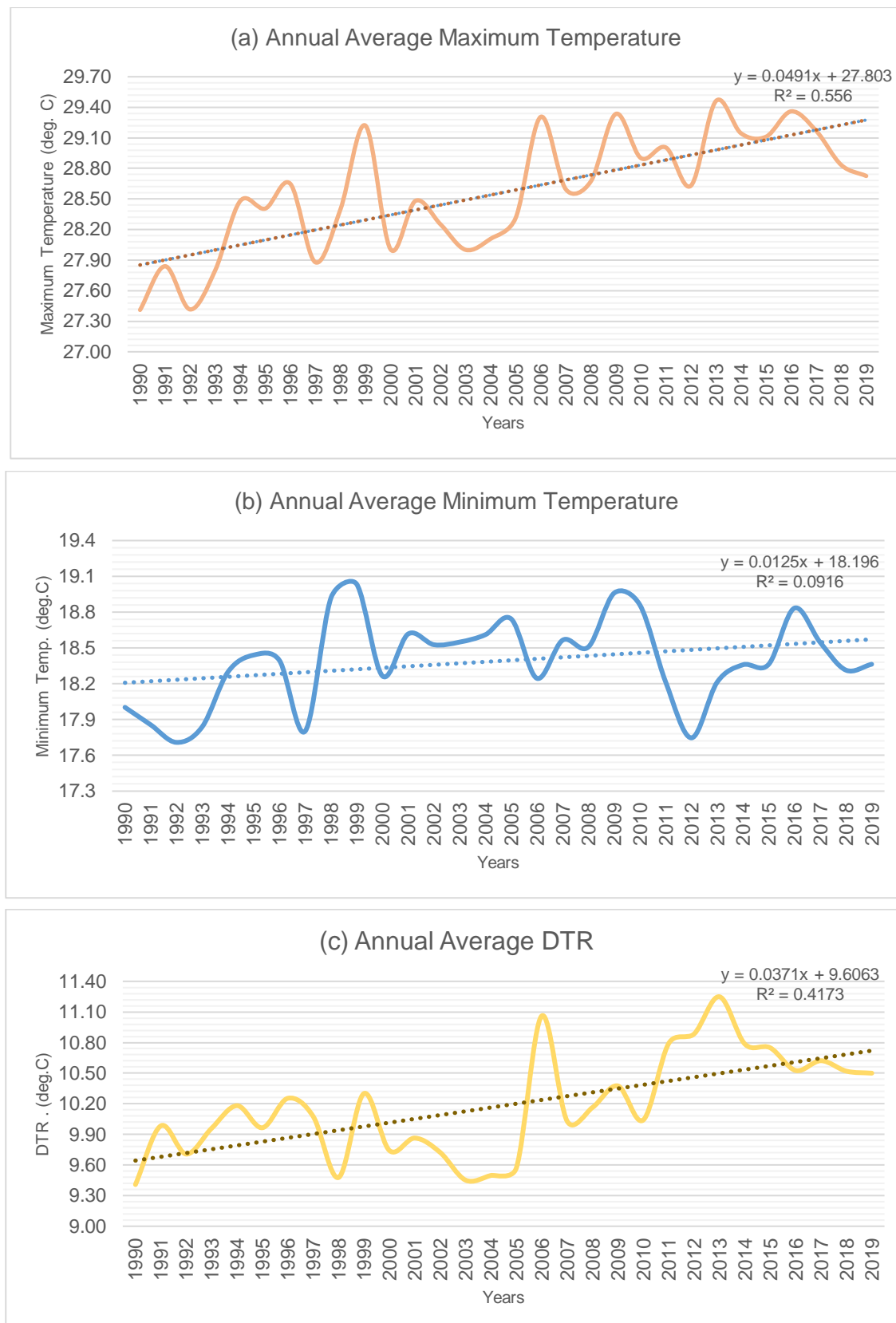
Figure 11: Trends of (a) annual average maximum temperature, (b) minimum temperature and (c) diurnal temperature range in Assam between 1990-2019

3.4.2   Temperature: District level analysis

The district-level analysis of temperature carried out for the period 1990-2019 indicates that during this period the highest average maximum temperature was recorded in Biswanath at 29.49°C (See Figure 12) while the lowest average maximum temperature was recorded in Chirang and Bongaigaon (26.94°C). On the other hand, the average minimum temperature during 1990-2019 was the highest in the district Biswanath at 19.14°C (See Figure 12).

The district-level analysis also shows a consistent increasing trend across all districts for annual average maximum temperature, and annual average minimum temperature. It is important to note that the trends are consistent with state-level analysis. The detailed data outlining results of district-level analysis has been presented in in Annexure A.
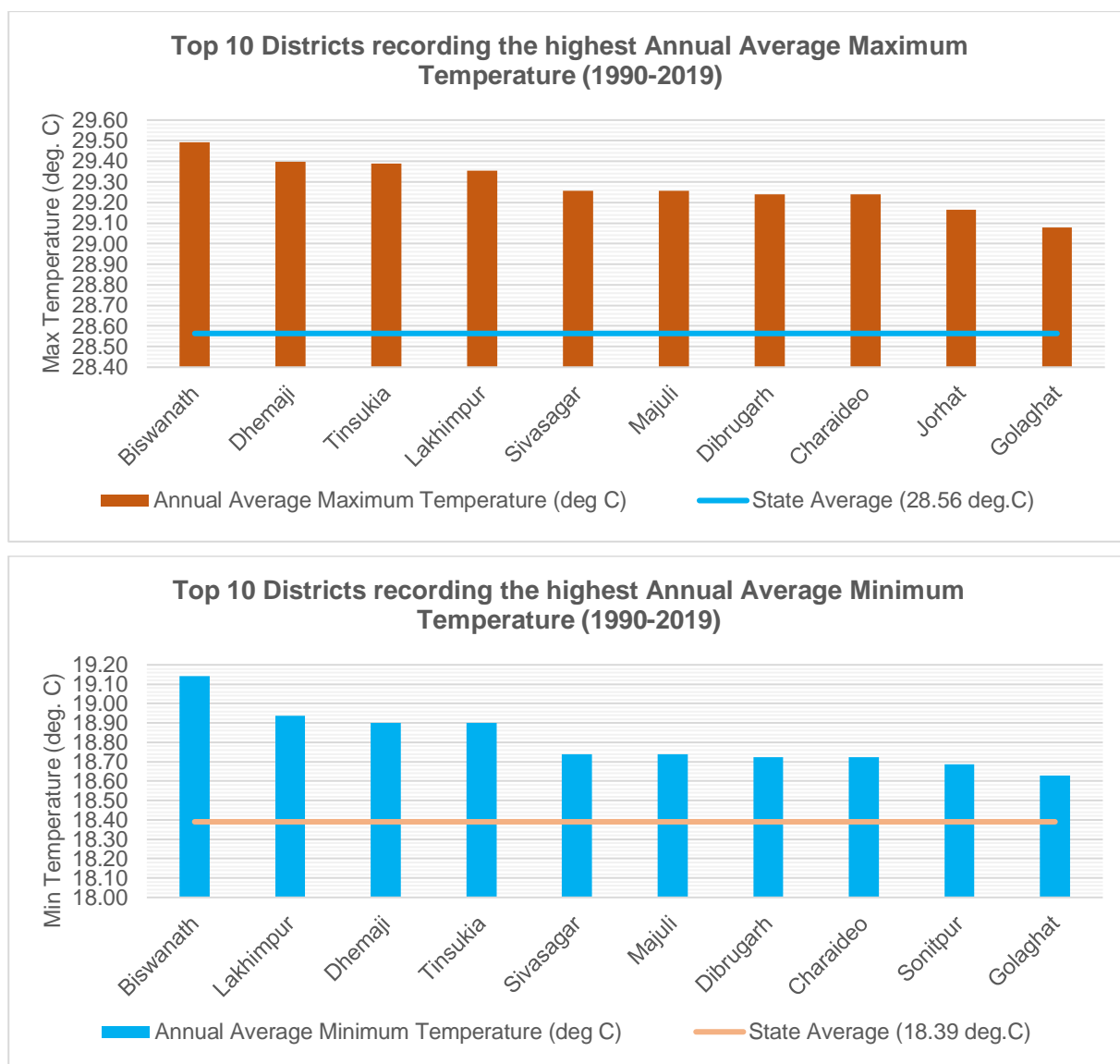
Figure 12: Districts recording the highest annual average maximum temperature, annual average minimum temperature between 1980-2019

3.4.3 Rainfall: State Level Analysis

Analysis of the rainfall data for the period 1990-2019 indicates that on an average Assam received around 2576.49 mm rainfall annually during this period The highest amount of annual rainfall of the order of 2952.87 mm was received in the year 1993 and the lowest amount of annual rainfall of the order of 2158.94 mm was received in the year 2011. Between 1990 and 2019, the annual rainfall has shown a decreasing trend by approximately 10.77 mm (annually) as has been shown Figure 13.
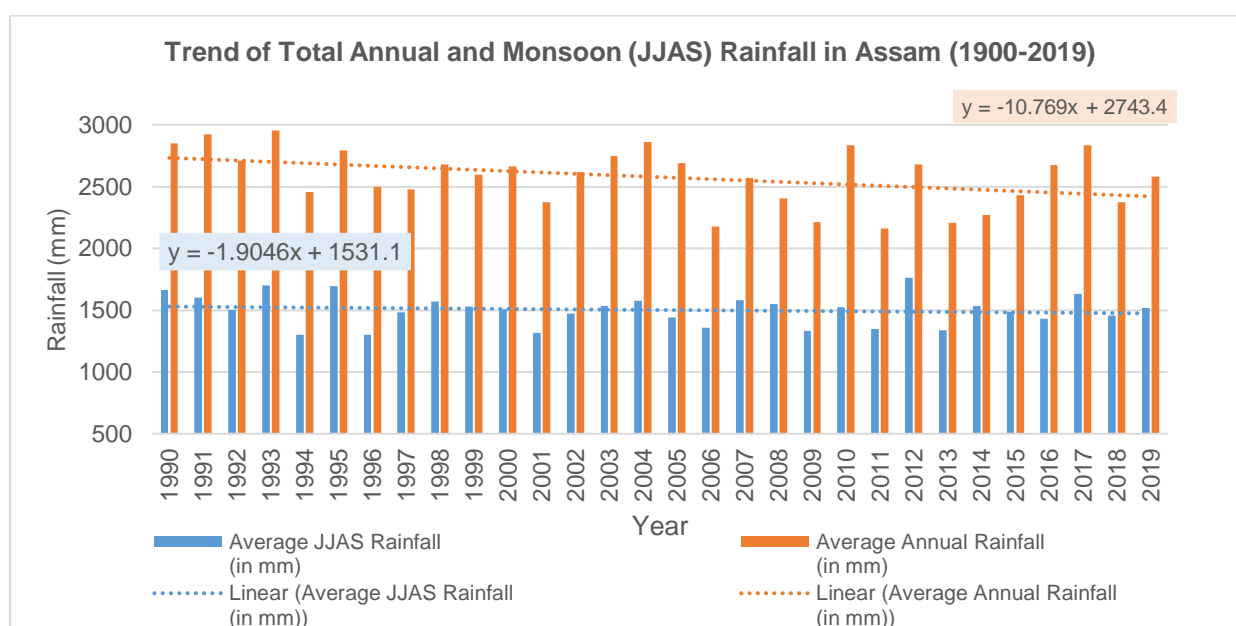
Figure 13: Trend of total annual and monsoon (JJAS) rainfall in Assam from 1990-2019

The seasonal rainfall analysis has also been carried out at the state-level. The seasons are meteorological seasons as defined by IMD. Winter Season comprises of the months of January and February; Pre-Monsoon Season covers the months of March, April and May; Monsoon Season occurs in the months of June, July, August and September; Post Monsoon Season covers October, November and December. Figure 14 below, indicates the season wise average rainfall received in Assam and share of the seasonal rainfall in total annual rainfall.
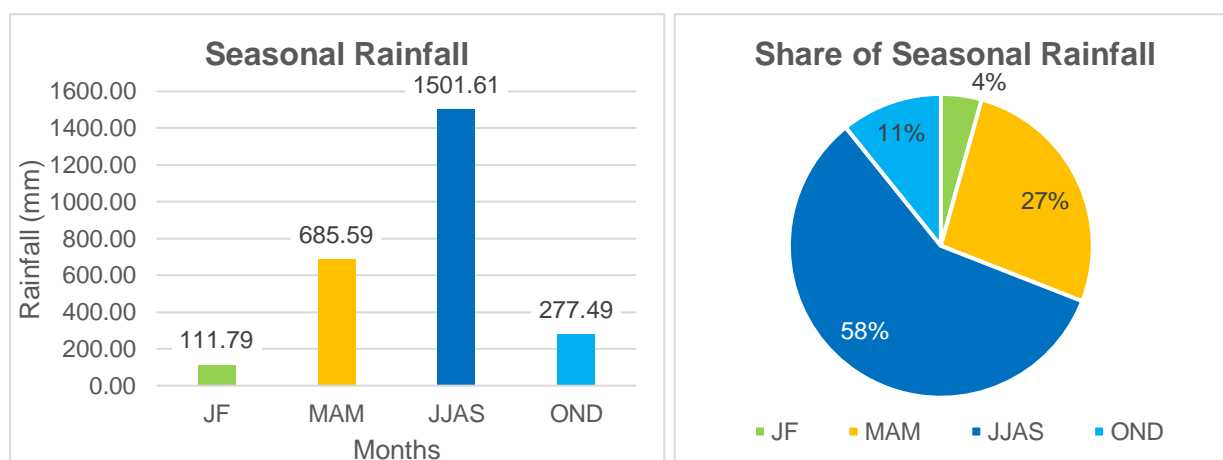
Figure 14: Seasonal mean rainfall between 1990 and 2019 and their share in the total annual rainfall in Assam

3.4.4   Rainfall: District level analysis

A district-level analysis of rainfall for the period 1990-2019 indicates that Kokrajhar district has received the highest annual rainfall followed by Chirang, Hailakhandi, Karimganj and Bongaigaon as depicted in Figure 15. During this period both Kokrajhar and Chirang witnessed rainfall higher the state average. It is important to note that there is a uniform decrease in annual rainfall in all districts between 1990 and 2019, however, three districts indicated an increase in rainfall namely Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr). The highest amount of decrease in annual rainfall over the period 1990-2019 is seen in Udalguri (46.1mm/yr).

During monsoon out of 33 districts 26 districts show a decrease in rainfall over the time period 1990-2019.While, 7 districts shown an increasing trend during monsoon Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm). During the monsoon season between the period 1990-2019, Kokrajhar has received the highest rainfall (1991.2mm), followed by Chirang (1886.5mm) and Bongaigaon (1676.4mm). While, West Karbi Anglong District witnessed the lowest monsoon rainfall recorded at 860.6mm. The district-level analysis of mean annual and seasonal rainfall in Assam during the period 1990-2019 is outlined in Annexure A.
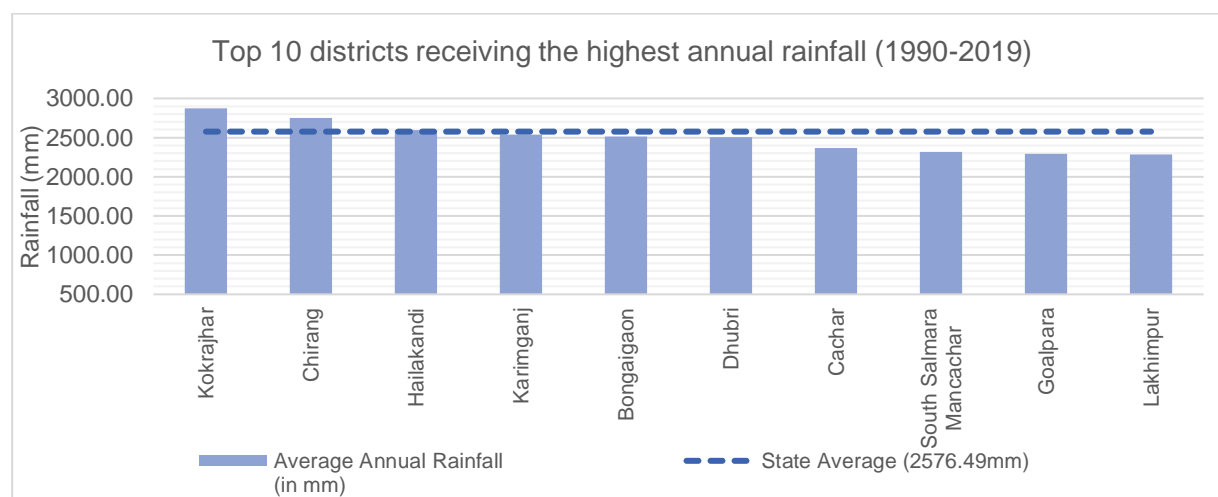
Figure 15: Districts receiving the highest Annual Rainfall in Assam between 1990 and 2019

A district-level decadal analysis has also been done for number of dry days, rainy days, heavy rainfall days as well as very heavy rainfall days for June-September i.e., monsoon period as per IMD definition (IMD, Met Glossary). The number of dry days has been defined as number of days in the monsoon months (June, July, August and September) which received 0mm rainfall whereas number of days in the monsoon months which received more than 2.5mm rainfall have been considered as rainy days. Similarly, number of days in monsoon months which received rainfall between 64.5mm to 124.4mm rainfall are considered as heavy rainfall days and which received rainfall between 124.5mm to 244.4mm are considered as very heavy rainfall days.

The result shows that Nalbari district has recorded 1128 number of dry days between 1990-2019 which is the highest across all the districts followed by 1006 and 1003 number of dry days respectively in Bongaigaon and South Salmara Mancachar districts. Similarly, Golaghat district has recorded the highest number of rainy days, i.e., 3101 rainy days between 1990-2019,

followed by 3068 number of rainy days in Karbi Anglong, 3043 number of rainy days in Dima Hasao. The district-level decadal variation in dry days and rainy days has been shown in Figure 16 below.
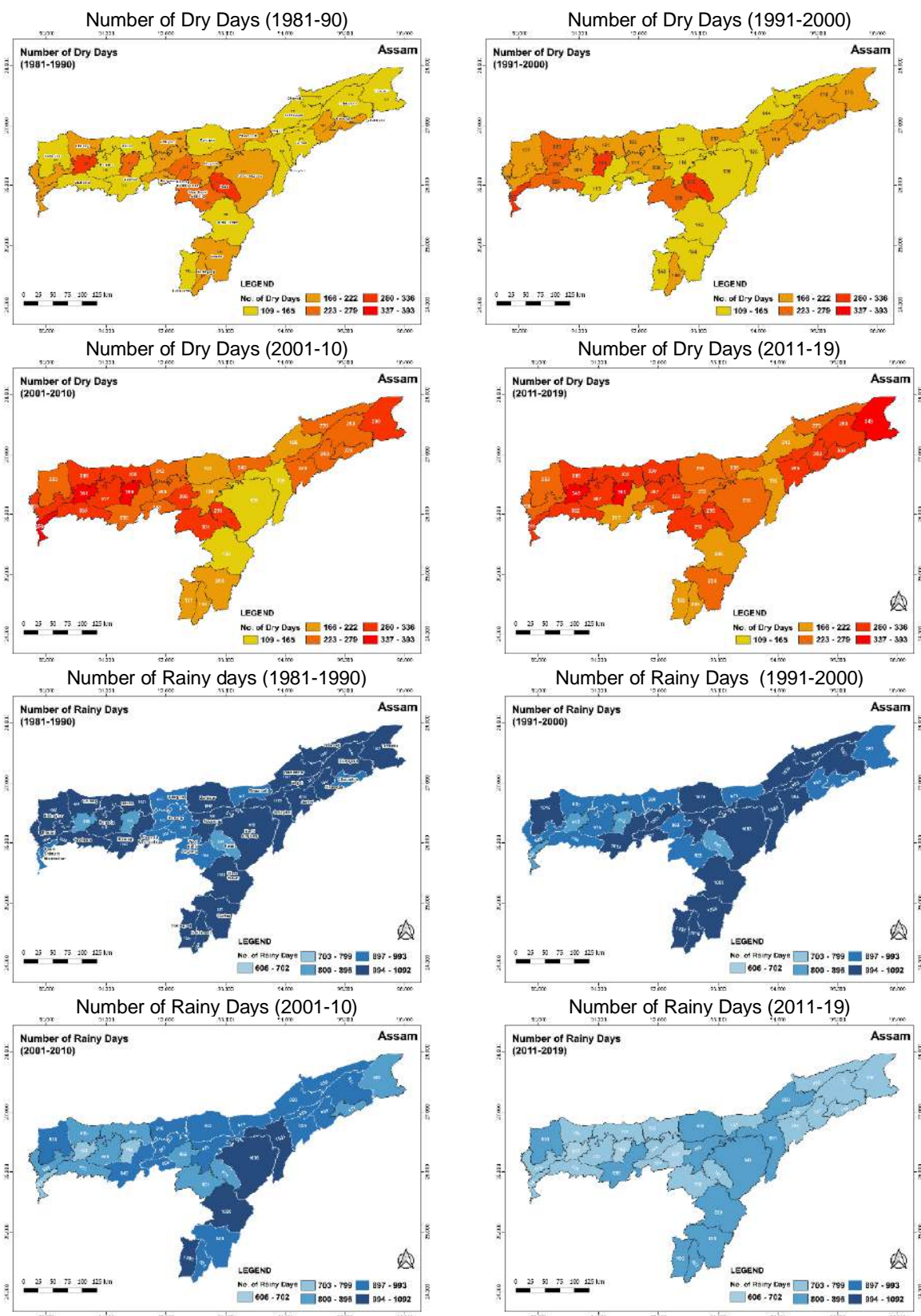
Figure 16: District-wise Decadal analysis of number of dry days and rainy days in Assam between 1981-2019

Figure 16 depicts the increasing number of districts seeing a rise in number of dry days and a decline in number of rainy days over the decades during 1981-2019. In addition to this, the analysis for heavy rainfall days shows that district Chirang has recorded a total of 119 heavy rainfall days between 1990-2019 which is the highest across the state, followed by 110 heavy rainfall days recorded in Kokrajhar, 100 heavy rainfall days in Bongaigaon. As for very heavy rainfall days, 16 days have been recorded in Kokrajhar, followed by 14 days in Chirang and 12 days each Bongaigaon and South Salmara Mancachar. In Annexure A outlines the district-level decadal analysis for heavy rainfall days and very heavy rainfall days.

3.4.5   Climate Extreme Events

Due to its topographic and climatic conditions, Assam is vulnerable to numerous extreme climate events, which may lead to the disasters. The state faces flood, lightning and heatwaves as extreme events. The intensity and frequency of the extreme event is also increasing due to climate change. (Refer Annexure A for detailed district wise data on events)

The following maps represent the data based on the *IMD Climate Hazard and Vulnerability Atlas 2021.* In India, Assam is highly vulnerable to floods due to Brahmaputra and Barak rivers. Between 1969 -2019 the districts like Barpeta, Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Jorhat, Kamrup, Lakhimpur, Morigaon, Nagaon, Nalbari, Sivasagar and Sonitpur have witnessed number of flooding events more than the average number of flooding event across the state (See Figure 17).
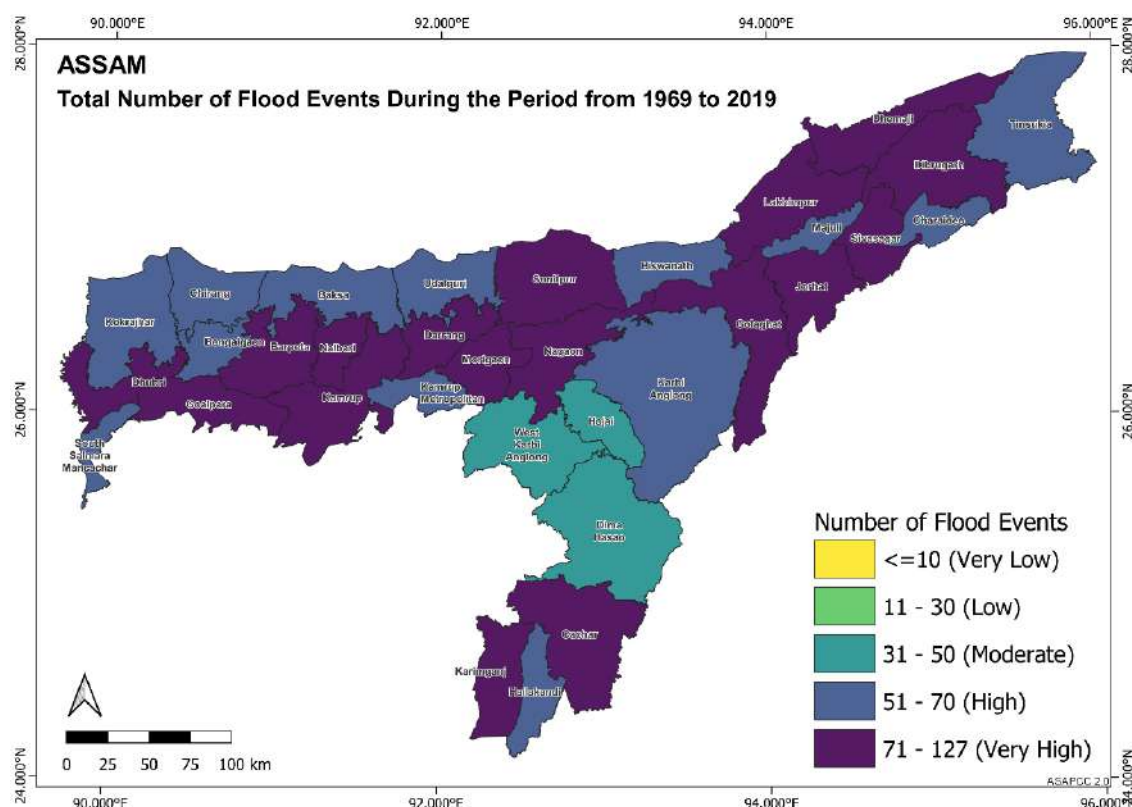
Figure 17: District wise spatial distribution of total flood events in Assam during 1969 -2019

Source: (IMD Pune, 2021)

Likewise, Cachar, Dhubri, Golaghat, Sivasagar and Sonitpur districts have witnessed lightning events more than the average number of lightning events across the state between 1969 to 2019 (see Figure 18).
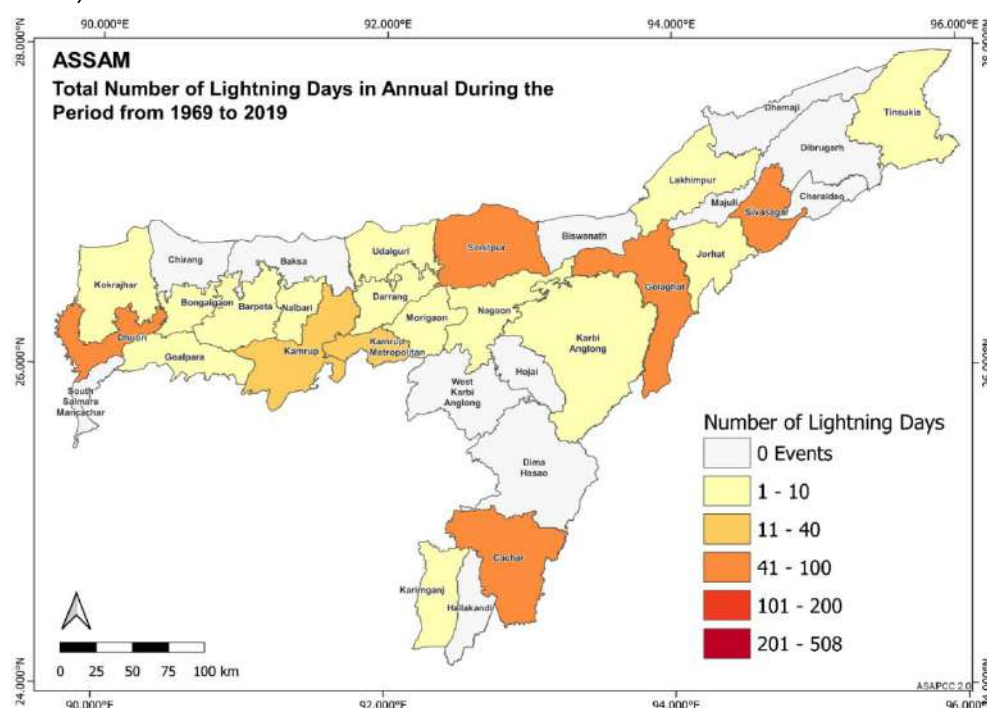
Figure 18: District wise spatial distribution of total number of lightning events in Assam during 1969 -2019

Source: (IMD Pune, 2021)

The districts like Hailakandi, Kamrup, Kamrup metropolitan, Nagaon, Nalbari, Sivasagar and Sonitpur have witnessed number of heatwaves events more than the average number of heatwave events across the state during 1969 to 2019. (See Figure 19).
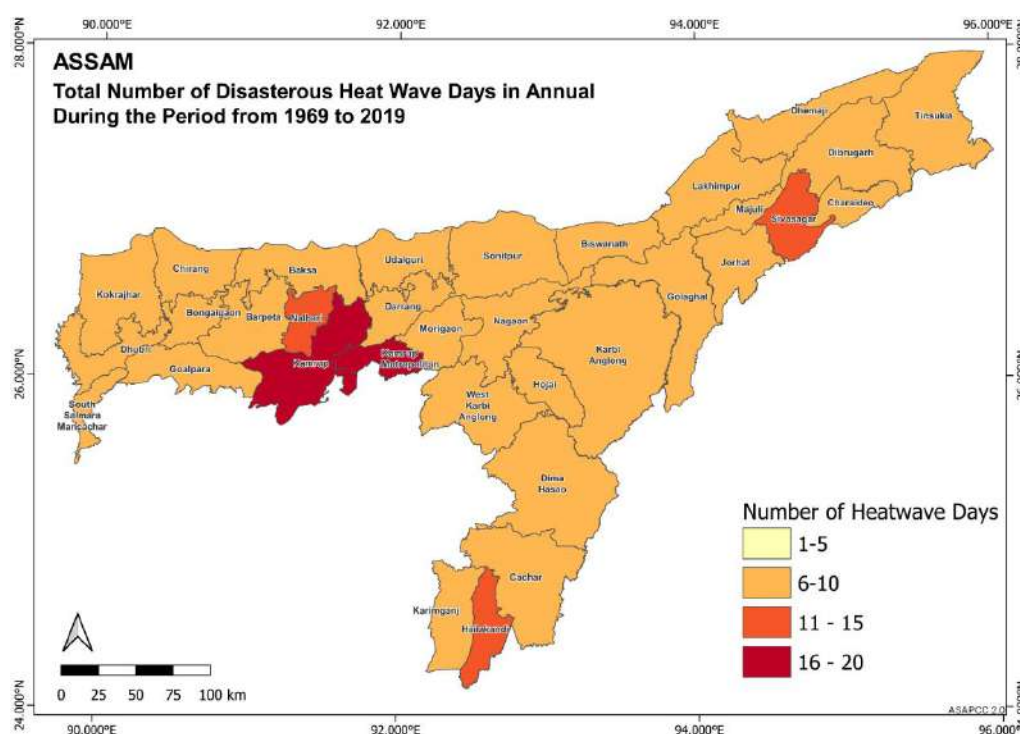
Figure 19: District wise spatial distribution of total number of disastrous heat wave days in Assam (1969 -2019)

Source: (IMD Pune, 2021)

3.5 Climate Projections

3.5.1 Temperature and Rainfall projections

Table 14 depicts the annual average maximum temperature (Tmax) ranges across Assam likely to be witnessed till end century for both the low emission scenario (RCP 4.5) and high emission scenario (RCP 8.5). The state of Assam will witness a rise in Tmax by 0.85°C and 1°C by 2011-2040 (near term) under RCP 4.5 and 8.5 scenarios respectively. By mid-term (2041-2070), the annual mean maximum temperature may rise up to 1.65°C and 2.40°C under RCP 4.5 and 8.5 scenarios respectively. As for the end-century (2071-2100), annual average maximum temperature is likely to rise by 2.15°C and 4.5°C under RCP 4.5 and 8.5 scenarios respectively. Figure 20 highlights the annual mean maximum temperature across the districts for base line (1980-2010), near-term (2011-2040), mid-term (2041-2070) and for end-century (2071-2100).

Table 14: Comparative assessment of Maximum Temperature Trends over baseline till end century for Assam

Tmax (deg C)	Baseline (1981-2010)	Near Term (2011-40)	Mid Term (2041-70)	End Century (2071-2100)
RCP 4.5	26.1 - 28.9	26.9 – 29.8 (↑0.85)	27.8 – 30.5 (↑ 1.65)	28.3 – 31 (↑ 2.15)
RCP 8.5		27.1 – 29.9 (↑1)	28.6 – 31.2 (↑2.4)	30.7 – 33.3 (↑ 4.5)

Source: Modified from ClimateVulnerbility.in
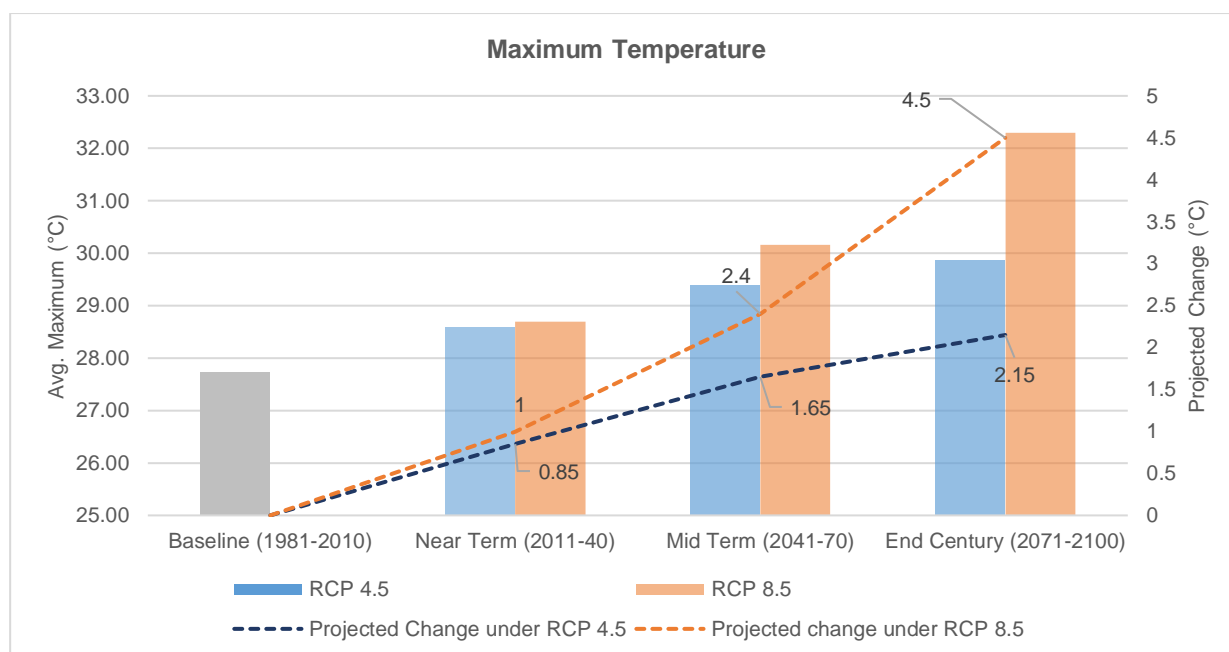
Figure 20: Climate Change Projections for Maximum Temperature till End Century (2071-2100)

Table 15 and Figure 24 shows the district level projections that are likely to occur in annual average minimum temperature in Assam. The annual average minimum temperature in the state is projected to increase up to 0.85°C and 0.95°C for RCP4.5 and RCP8.5 respectively by 2011-2040 (near term) compared to baseline period (1981-2010). It may further rise up to 1.55°C to 2.3°C by 2041-2070 (mid-term) and up to 2°C and 3.5°C by 2071-2100, under RCP4.5 and 8.5 scenarios respectively.

Table 15: Comparative assessment of Minimum Temperature Trends over baseline till end century for Assam

Tmin (deg C)	Baseline (1981-10)	Near Term (2011-40)	Mid Term (2041-70)	End Century (2071-2100)
RCP 4.5	17.1 – 19.9	18.1 – 20.6 (↑0.85)	18.7 – 21.4 (↑1.55)	19.1 – 21.9 (↑2)
RCP 8.5		18.1 – 20.6 (↑0.95)	19.4 – 22.2 (↑2.3)	20.5 - 23.5 (↑3.5)

Source: Modified from ClimateVulnerbility.in
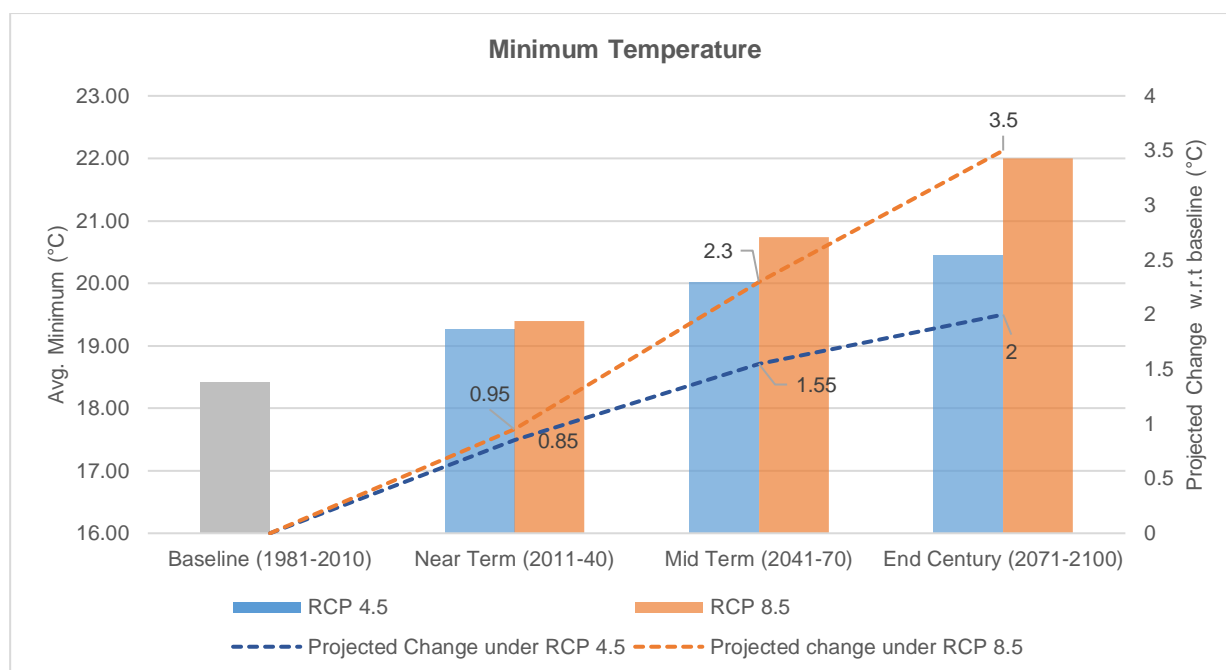
Figure 21: Climate Change Projections for Minimum Temperature till End Century (2071-2100)

Annual average rainfall in Assam is projected (low confidence12) to increase over baseline (1981-2010) by 0.97 percent and 3.04 percent towards near-term (2011-2040) under RCP4.5 and 8.5 scenarios respectively (Table 16 & Figure 22 As for mid-term (2041-2070), annual average rainfall is projected to increase by 0.72 per cent and 4.35 percent under RCP4.5 and RCP8.5 respectively. By end-century (2071-2100), annual average rainfall is projected to increase under both RCP4.5 and 8.5 scenarios by 0.72 percent and 4.35 percent, respectively. Figure 26 shows the projections for seasonal rainfall (monsoon season) for base line (1980-2010), near-term (2011-2040), mid-term (2041-2070) and for end-century (2071-2100).

Table 16: Comparative assessment of Annual rainfall trends over baseline till end century for Assam

Rainfall (mm)	Baseline (1981-10)	Near Term (2011-40)	Mid Term (2041-70)	End Century (2071-2100)
RCP 4.5	1817 – 3497	1907 – 3409	1936 – 3557	1884 – 3525
RCP 8.5		1929 – 3497	2081 – 3684	2009 – 3482

Source: Modified from ClimateVulnerbility.in

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[12] Rainfall projection are predicted with low confidence across India. Further, detailed downscaled high resolutions will enhance and provide a clear picture in future assessments.
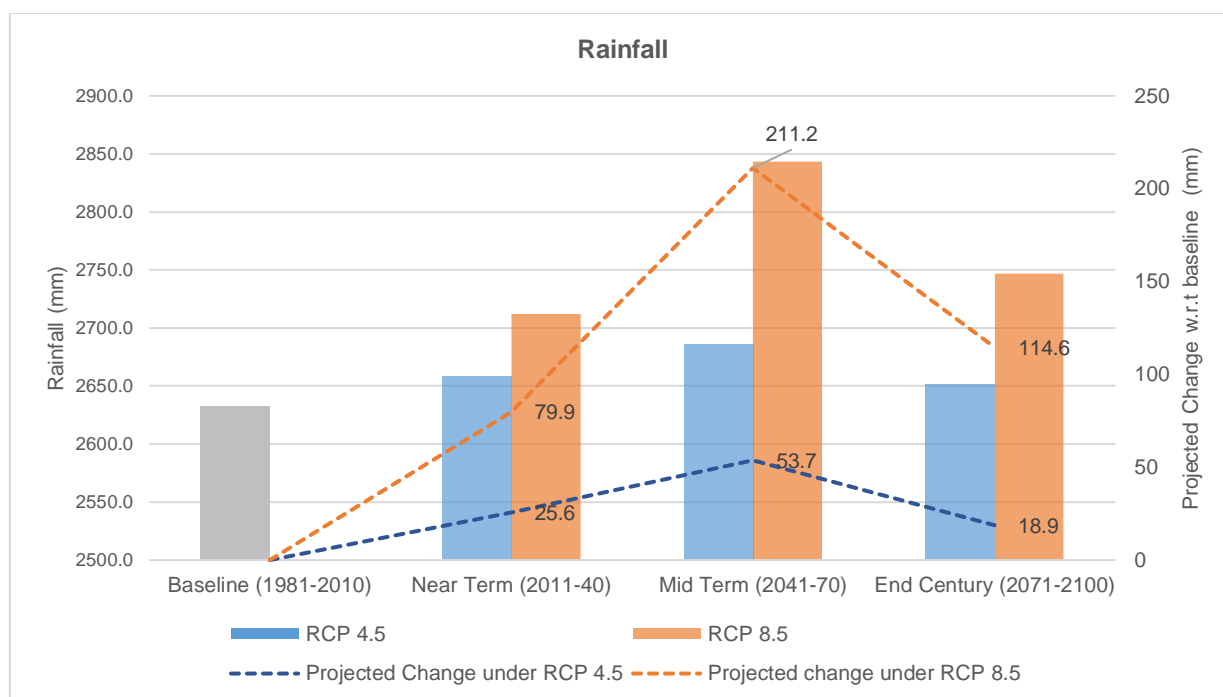
Figure 22: Climate Change Projections for Rainfall till End Century (2071-2100)

The projections for Annual Average Maximum Temperature are outlined in in Annexure A. The average annual maximum temperature during the baseline is recorded at 27.73°C. All the districts except Dimas Hasao and Cachar are expected to record higher maximum temperature in near-term under RCP 4.5 and 8.5 scenario than the annual average maximum temperature recorded during baseline.
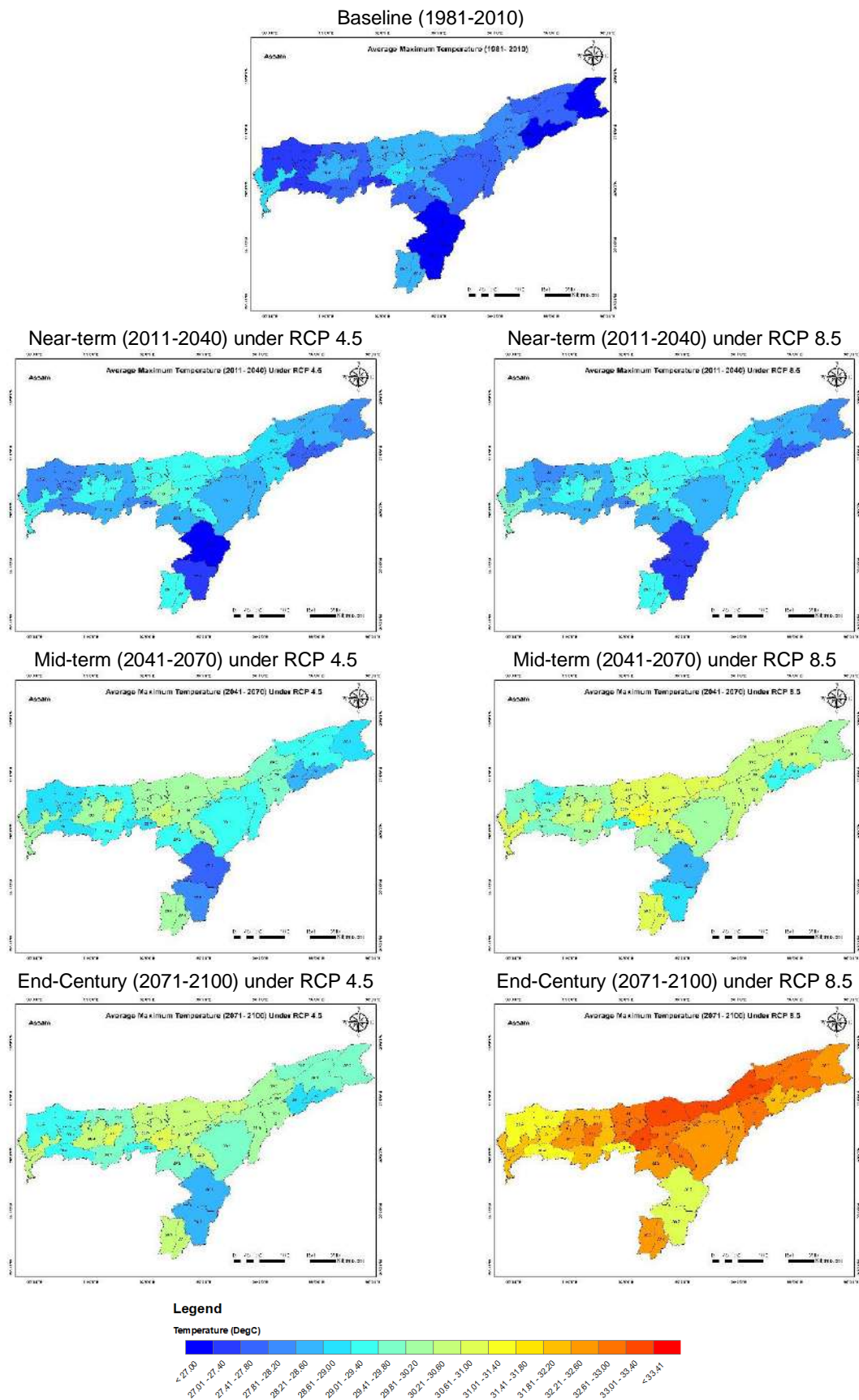
Figure 23: Annual maximum temperature for Baseline (1981-2010) and its projection in Near-term (2011-2040), Mid-term (2041-2070) and End-Century (2071-2100) under RCP 4.5 and RCP 8.5

Baseline (1981-2010)

Near-term (2011-2040) under RCP 4.5

Near-term (2011-2040) under RCP 8.5

Mid-term (2041-2070) under RCP 4.5

Mid-term (2041-2070) under RCP 8.5

End-Century (2071-2100) under RCP 4.5

End-Century (2071-2100) under RCP 8.5

Legend

Temperature (DegC)

< 18.00 | 18.01 - 18.36 | 18.37 - 18.71 | 18.72 - 19.07 | 19.08 - 19.42 | 19.43 - 19.78 | 19.79 - 20.13 | 20.14 - 20.49 | 20.50 - 20.84 | 20.85 - 21.20 | 21.21 - 21.56 | 21.57 - 21.91 | 21.92 - 22.27 | 22.28 - 22.62 | 22.63 - 22.98 | 22.99 - 23.33 | 23.34 - 23.69 | > 23.70
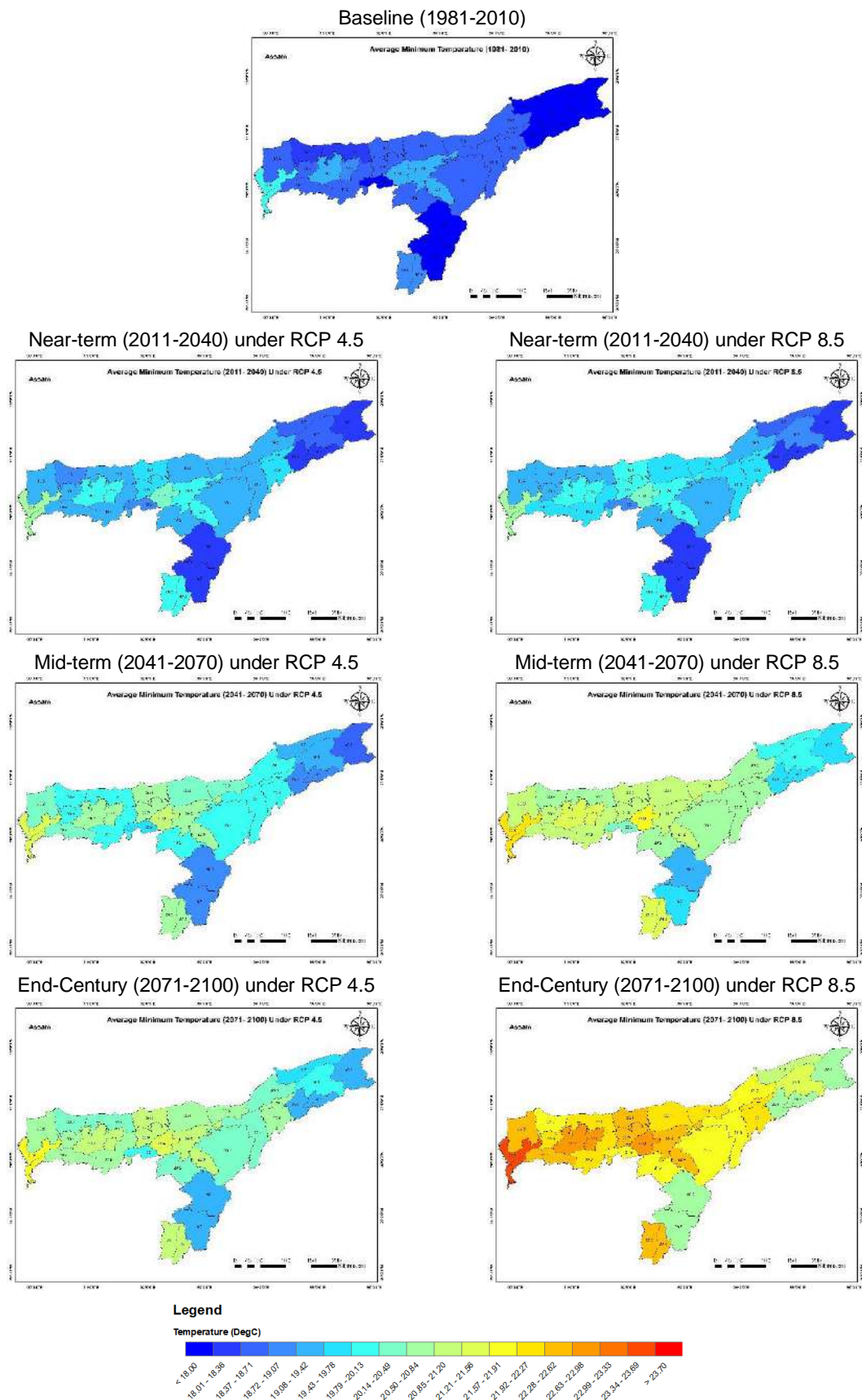
Figure 24: Annual minimum temperature for Baseline (1981-2010) and its projection in Near-term (2011-2040), Mid-term (2041-2070) and End-Century (2071-2100) under RCP 4.5 and RCP 8

Baseline (1981-2010)

Near-term (2011-2040) under RCP 4.5

Near-term (2011-2040) under RCP 8.5

Mid-term (2041-2070) under RCP 4.5

Mid-term (2041-2070) under RCP 8.5

End-Century (2071-2100) under RCP 4.5

End-Century (2071-2100) under RCP 8.5

Legend

Precipitation (mm)
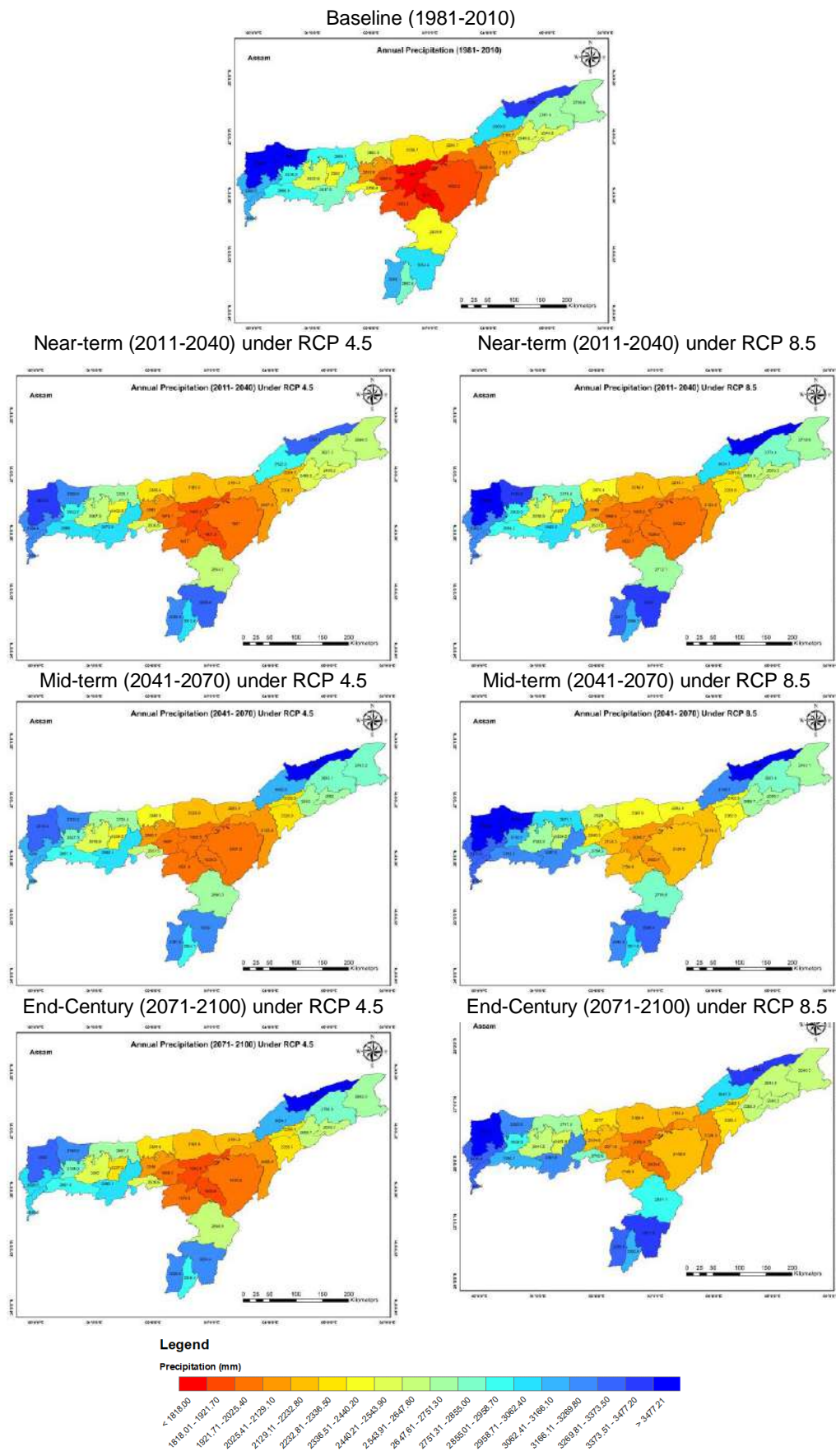
Figure 25: Annual rainfall for Baseline (1981-2010) and its projection in Near-term (2011-2040), Mid-term (2041-2070) and End-Century (2071-2100) under RCP 4.5 and RCP 8.5

Baseline (1981-2010)

Near-term (2011-2040) under RCP 4.5

Near-term (2011-2040) under RCP 8.5

Mid-term (2041-2070) under RCP 4.5

Mid-term (2041-2070) under RCP 8.5

End-Century (2071-2100) under RCP 4.5

End-Century (2071-2100) under RCP 8.5

Legend

Precipitation (mm)

< 859.00 | 859.01 - 936.21 | 936.22 - 1013.42 | 1013.43 - 1090.63 | 1090.64 - 1167.84 | 1167.85 - 1245.06 | 1245.07 - 1322.27 | 1322.28 - 1399.48 | 1399.49 - 1476.69 | 1476.70 - 1553.90 | 1553.91 - 1631.11 | 1631.12 - 1708.32 | 1708.33 - 1785.53 | 1785.54 - 1862.74 | 1862.75 - 1939.96 | 1939.97 - 2017.17 | 2017.18 - 2094.38 | > 2094.39

Figure 26: Seasonal Rainfall (JJAS) for Baseline (1981-2010) and its projection in Near-term (2011-2040), Mid-term (2041-2070) and End-Century (2071-2100) under RCP 4.5 and RCP 8.5

04
Climate Risk
&
Vulnerability
Assessment

Chapter 4. Climate Risk and Vulnerability Assessment

Understanding the climate risk and vulnerability is key aspect of building adaptation and mitigation strategies at the state level. The following chapter analyses the vulnerability of the key sectors studied under the revision of the Assam SAPCC and a composite risk assessment by following the common guiding framework provided by the MoEF&CC, IPCC AR5 methodology and national literature.

4.1 Concept

As per IPCC in the Fifth Assessment Report (IPCC. AR5, 2014), severity of the impacts of extreme and non-extreme weather and climate events depends strongly on the level of vulnerability and exposure to these events. Therefore, study of the nature of vulnerability and extent of exposure are critical to manage the risk and enhance resilience. The vulnerability of a system is one of three components of risk.

Risk = Function of (Hazard, Exposure, Vulnerability)

Hazard: hazard usually refers to climate-related physical events or trends or their physical impacts. This may not be always an extreme weather phenomenon but could be a trend e.g. dry spells, wet days, etc., derived from climate trends.

Exposure: Exposure refers to the inventory of elements in an area in which hazard events may occur (Cardona, 1990; UNISDR, 2004, 2009b) Hence, if population and economic resources were not located in (exposed to) potentially dangerous settings, no problem of disaster risk would exist.

However, it is possible that a certain area is exposed but not vulnerable. In fact, when we consider developing resilient infrastructure or systems, their vulnerability may reduce. It means either their sensitivity to certain level of hazards or exposures have reduced or their adaptive capacity has increased or both. Therefore, vulnerability has two elements (sensitivity and adaptive capacity)

Vulnerability= F (Sensitivity, Adaptive Capacity)

Vulnerability profiles can be constructed that take into consideration sources of environmental, social, and economic marginality (Wisner, 2003). Socio-economic systems further have a bearing on the adaptive capacity. Similarly, environmental factors are affected by bio-physical systems. Holistic perspectives on vulnerability aims to go beyond technical modelling approach. It attempts to embrace a wider and comprehensive explanation of vulnerability. These approaches differentiate exposure, susceptibility (i.e. sensitivity) and societal response capacities as causes or factors of vulnerability.

IPCC defines:

Vulnerability as, "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".

Sensitivity is, "the 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., damages caused by an increase in the frequency of coastal flooding due to sea level rise). Sensitivity refers to those factors that directly affect the consequences of a hazard. Sensitivity may include physical attributes of a system (e.g., house-type, soil type, irrigation type, cropping intensity, etc.), and

Adaptive capacity is, "the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences", arising out of climatic or anthropogenic causes.

The risk management framework adopted by the IPCC in the Fifth Assessment Report (IPCC 2014) depicts the interaction of hazard, exposure and vulnerability resulting in risk within the overall climatic and non-climatic physical and socio-political environment (**Figure 27**).
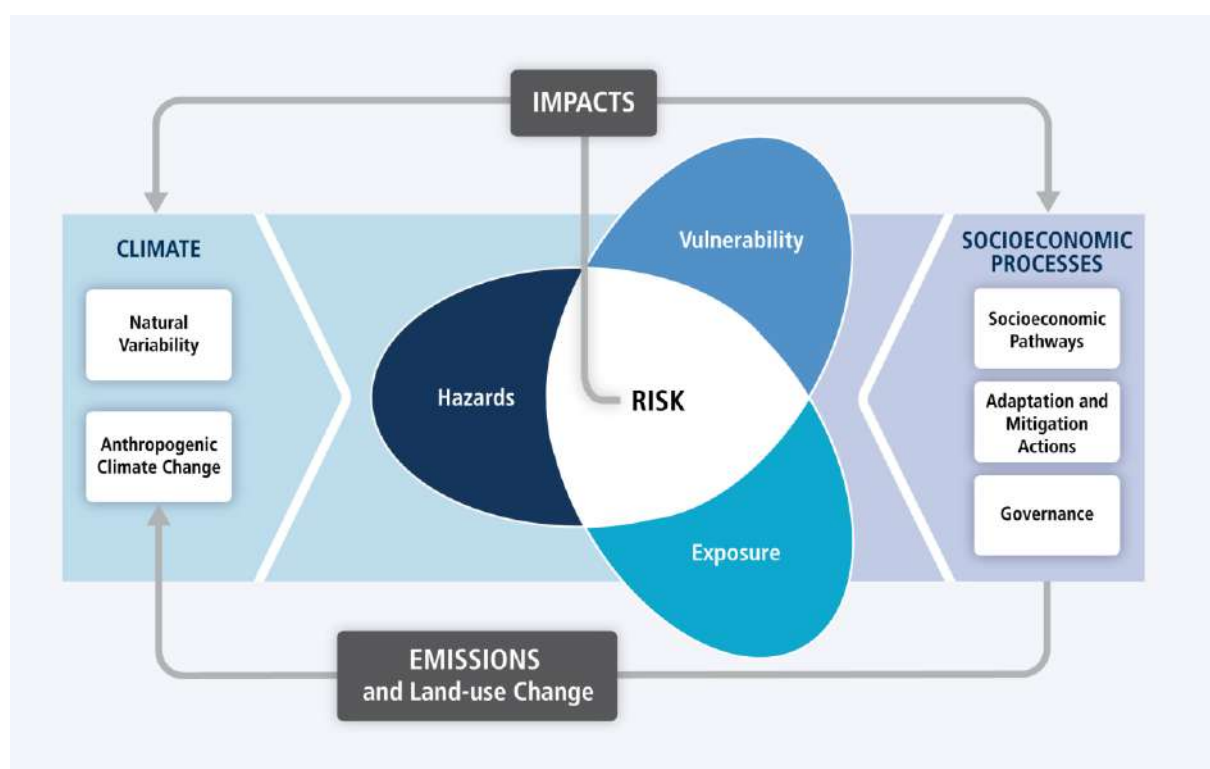
Figure 27: IPCC AR5 Risk Management Framework

Source: (IPCC 2014)

The present study has adopted this framework and has considered only sensitivity and adaptive capacity as the two cofactors that determine vulnerability.

4.2 Methodology

Conducting a vulnerability assessment is a multi-step exercise and requires identification of clear set of goals and objectives which will determine the type of vulnerability assessment, scale, tier, indicators, and methods to be adopted.

As the objective of this study is to identify, rank and prioritise the most vulnerable districts for each of the specified sectors in the State of Assam under current climate, an integrated vulnerability assessment using a tier 1 method that quantifies indicators using secondary sources of information at the district level, has been employed.

A Vulnerability Index (VI), which is a metric that characterizes the vulnerability of a system has been used. Values of VIs will lie between 0 and 1, where 0 stands for lowest vulnerability and 1 for highest vulnerability. Arrangement of the assessed VI values in decreasing or increasing orders allows for ranking of the sectors and districts. It must be noted that the vulnerability index value only provides a sense of quantified status of vulnerability and remains largely conceptual in its utility, as this value does not have any stand-alone practical significance. **Figure 28** presents the broad approach of the assessment conducted in a stepwise manner.

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 (Stakeholder Consultations)
Step 6	• Quantification and measurement of indicators
Step 7	• Normalisation of indicators
Step 8	• Assigning Equal weights to indicators
Step 9	• Aggregation of indicators and development of vulnerability index
Step 10	• Representation of vulnerability profiles and index: spatial maps, charts and/or tables
Step 11	• Vulnerability ranking of districts for each Sector/Mission
Step 12	• Identification of drivers of vulnerability for adaptation planning

Figure 28: Broad Approach and Steps to conduct a Vulnerability Assessment.

Vulnerability Index (VI) is a metric that characterizes the vulnerability of a system or as the case may be a district with respect to sectors identified. It is very important to note that VI values only provide a quantified perception of the status of vulnerability of a system and does not have any stand-alone significance. It largely remains conceptual in its utility, unless the VI value is used for ranking/prioritizing systems, which is the case here. VI values lie between 0 and 1, where a value closer to 1 means higher vulnerability relative to the other districts of the State. VI values have been ranked from on a 5-point scale of very high, high, moderate, low and very low vulnerability. Figure 29 depicts the number of indicators chosen for the study of respective 8 thematic sectors and district level overall composite vulnerability.

Food and Horticulture Crops Vulnerability Index (FHVI)
- ✓ Crop yield variability
- ✓ Food security
- ✓ % change in area under wastelands
- ✓ % of workforce primarily employed in Agriculture
- ✓ % of area under rainfed agriculture
- ✓ % of small and marginal landholdings
- ✓ Change in registered small tea growers area (2010 & 2020)
- ✓ Access to agricultural inputs (roads, markets etc.)
- ✓ Access to information and technology (literacy, electricity access etc.)
- ✓ % of gross cropped area insured under PMFBY
- ✓ Soil Health (per ha fertilizer consumption in Kg)
- ✓ Horticulture Yield Variability
- ✓ Tea Yield Variability

Livestock and Fisheries Vulnerability Index (LFVI)
- ✓ Livestock per 1,000 rural population
- ✓ Trend of AI done
- ✓ Number of veterinary facilities
- ✓ Livestock and Poultry Vaccinated (2020)
- ✓ Access to market (no. of registered fish markets)
- ✓ Milk Production Variability
- ✓ Egg production Variability
- ✓ Meat Production Variability
- ✓ Fish Yield Variability
- ✓ No. of Hatcheries

Water Vulnerability Index (WVI)
- ✓ Stage of Groundwater Extraction (2020)
- ✓ % of Functional Households Tap Connections
- ✓ % of Water conservation assets created under MGNREGS (Average 2015-19)
- ✓ Ground Water Quality (2020)
- ✓ % of total minor irrigation schemes in use (2013-14), weighted by the percentage of irrigation potential utilized
- ✓ Net water availability (water stress)

Forest Vulnerability Index (WVI)
- ✓ % change in forest area (2017-2019)
- ✓ Forest area (in ha)/100 rural population
- ✓ % of households using firewood for cooking

Energy Vulnerability Index (AVI)
- ✓ Access to clean cooking fuels
- ✓ Access to and consumption of electricity
- ✓ % of villages with solar street lighting system
- ✓ % of farmers provisioned with Solar irrigation pumps

Rural Development Vulnerability Index (RDVI)
- ✓ Proportion of total population living in rural areas
- ✓ Target achieved under PMAY 9g0
- ✓ % of rural houses at high risk to damage by wind and floods (BMTPC)
- ✓ % of rural population who are multidimensionally poor in each district
- ✓ Access to basic amenities (safe drinking water, sanitation and electricity)
- ✓ % of households with kitchens inside the house and use of clean fuels for cooking
- ✓ Literacy (Secondary school and above)
- ✓ Access to an alternate employment source (MGNREGS)
- ✓ Women participation in the labour force
- ✓ Dependency ratio
- ✓ % of natural resource management works to total works under MGNREGS
- ✓ Proportion of SHG member to total rural Population

Urban Development Vulnerability Index (UDVI)
- ✓ Population Density (person/km^2)
- ✓ Percentage of urban houses at high risk to damage by wind and floods (BMTPC)
- ✓ % of urban population who are multidimensionally poor in each district
- ✓ Access to basic amenities (safe drinking water, sanitation , electricity and Housing)
- ✓ Women participation in the labor force
- ✓ Dependency ratio
- ✓ Urban Female Literacy Rate
- ✓ Situation of Air Quality Stations in Urban Centers

Health Vulnerability Index (HVI)
- ✓ Access to functional health care facilities
- ✓ Number of doctors & health workers available per 1,000 population
- ✓ Households with any usual member covered by a health scheme or health insurance (%)
- ✓ Use of Clean Cooking Fuels
- ✓ Still Births
- ✓ Nutritional Health among Infants and Women
- ✓ % of all age appropriate Vaccines to children
- ✓ Infant Mortality Rate
- ✓ Disease incidence (Water, Vector Borne, Respiratory)
- ✓ Crude Literacy Rate
- ✓ Population Density (person/sqkm)
- ✓ % of Population <6 and >60 years of age to total population
- ✓ % of population who are multidimensionally poor in each district

Disaster Management Index (DMVI)
- ✓ Insurance coverage (Crops & Human Health)
- ✓ Access to an alternate employment source (MGNREGS)
- ✓ Percentage of houses at high risk to damage by wind and floods (BMTPC)
- ✓ Percentage of Population <6 and >60 years of age
- ✓ MPI index (literacy, access to basic infra water, sanitation, electricity)
- ✓ KVK communication to farmers (agromet services)
- ✓ Percent of SHGs disbursed with RF to Total SHGs

Composite vulnerability index (CVI)
- ✓ Crop yield variability
- ✓ Net Water Availability (Water Stress)
- ✓ % change in forest area (2017-2019)
- ✓ Percentage of households at risk to damage by wind and extreme rainfall
- ✓ MPI Index (literacy,safe drinking water, sanitation and wastewater drainage)
- ✓ Access and consumption of electricity
- ✓ Access to functional health care facilities

Figure 29: Sectoral Vulnerability Indicators used for ASAPCC 2.0

4.3 Sectoral Vulnerability profiles and ranking of Districts

4.3.1 Agricultural Vulnerability

Owing to Assam's dependence on the agriculture for economy and food security, sub-sectoral vulnerability has been studied as a part the ASAPCC update at district level. The First sub-sector will focus on understanding vulnerability of food crops (cereals) and Horticulture (including Tea); subsequently, the second sub-sector will focus on the Livestock, Poultry and Fisheries.

Food and Horticulture Vulnerability (FHVI)

A total of twelve indicators were considered to assess Food crops and Horticulture Vulnerability Index (FHVI) at the district level. Details of the indicators selected for study are attached in Annexure B. Out of the 33 districts, 2 districts (Tinsukia, Dibrugarh) were ranked as having very-high vulnerability; 8 districts (Dima Hasao, Cachar, West Karbi Anglong, Jorhat, Karbi Anglong, Karimganj, Nagaon, Kokrajhar) were ranked as highly vulnerable; 19 districts (Dhemaji, Kamrup Metropolitan, Golaghat, Goalpara, Charaideo, Hojai, Udalguri, Morigaon, Kamrup, Sivasagar, Darrang, Lakhimpur, Dhubri, Chirang, Majuli, Biswanath, Baksa, Sonitpur, South Salmara Mancachar) districts were ranked as having moderate vulnerability; 2 districts (Hailakandi, Bongaigaon) were ranked as having low vulnerability and 2 district (Barpeta, and Nalbari) were ranked as having very-low vulnerability. This is presented as a graph (*Figure 30*) and spatial map (*Figure 31*).

Figure 30: Ranking of districts based on Food Crop and Horticulture Vulnerability Index from very-high to very low vulnerability
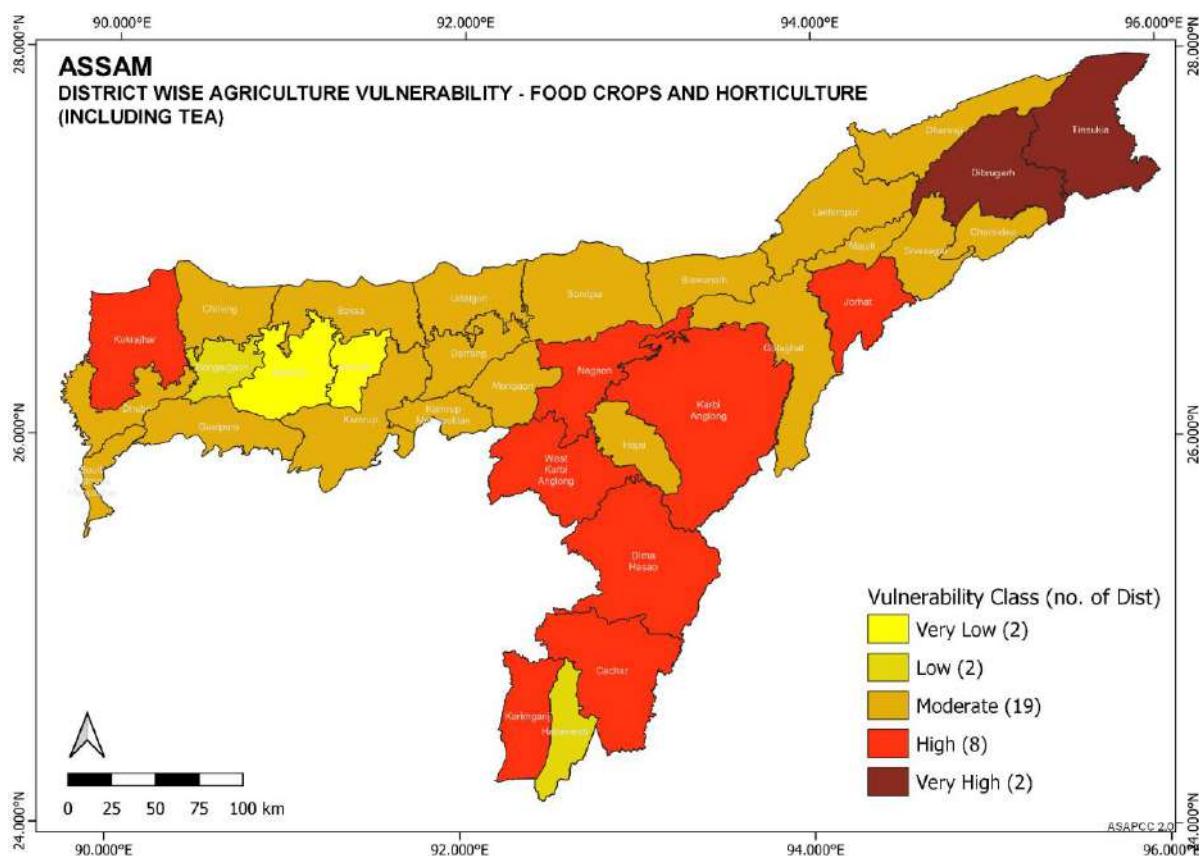
Figure 31: District Wise Agriculture Vulnerability – Food and Horticulture Crops (Incl. Tea)

4.3.1.1 *Drivers of food and horticulture vulnerability*

Percentage contribution of an indicator to vulnerability index for each vulnerability class was obtained by considering the product of its weight and normalized value. Major drivers of vulnerability for the districts in different vulnerability classes are presented in the ***Figure 32*** and Table 17.

Figure 32: Drivers of food and horticulture crops represented as a radar plot

Table 17: Drivers of food crops and horticulture vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High Vulnerability	Tinsukia, Dibrugarh	1. Less area under horticulture trees 2. Low Crop Area Insured under PMFBY 3. High Unirrigated Area
High Vulnerability	Dima Hasao, Cachar, West Karbi Anglong, Jorhat, Karbi Anglong, Karimganj, Nagaon, Kokrajhar	1. Low Crop Area Insured under PMFBY 2. High Unirrigated Area
Moderate Vulnerability	Dhemaji, Kamrup Metropolitan, Golaghat, Goalpara, Charaideo, Hojai, Udalguri, Morigaon, Kamrup, Sivasagar, Darrang, Lakhimpur, Dhubri, Chirang, Majuli, Biswanath, Baksa, Sonitpur, South Salmara Mancachar	1. Low Crop Area Insured under PMFBY 2. Low access to information and technology
Low Vulnerability	Hailakandi, Bongaigaon	1. Low Crop Area Insured under PMFBY 2. Low access to information and technology
Very Low Vulnerability	Barpeta, Nalbari	1. Low Crop Area Insured under PMFBY 2. Low access to information and technology

Livestock and Fisheries Vulnerability (LFVI)

4.3.1.2 Indicators Selected

A total of twelve indicators (list attached in Annexure B) were considered to assess Livestock and Fisheries Vulnerability Index (LFVI) at the district level. Out of the 33 districts, 7 districts (Dhemaji, Chirang, Udalguri, Dima Hasao, West Karbi Anglong, Karbi Anglong, Majuli) were ranked as having very-high vulnerability; 7 districts (Lakhimpur, Baksa, Golaghat, Jorhat, Hailakandi, Biswanath, Charaideo) were ranked as highly vulnerable; 13 districts (Goalpara, Nalbari, Cachar, Sivasagar, Bongaigaon, Darrang, South Salmara Mancachar, Kokrajhar, Dibrugarh, Tinsukia, Morigaon, Karimganj, Dhubri) districts were ranked as having moderate vulnerability; 4 districts (Hojai, Sonitpur, Kamrup Metropolitan, Kamrup) were ranked as having low vulnerability and 2 district (Nagaon, and Barpeta) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 33***)* and Map (*Figure 34*).

Figure 33: Ranking of districts based on Food Crop and Horticulture Vulnerability Index from very-high to very low vulnerability
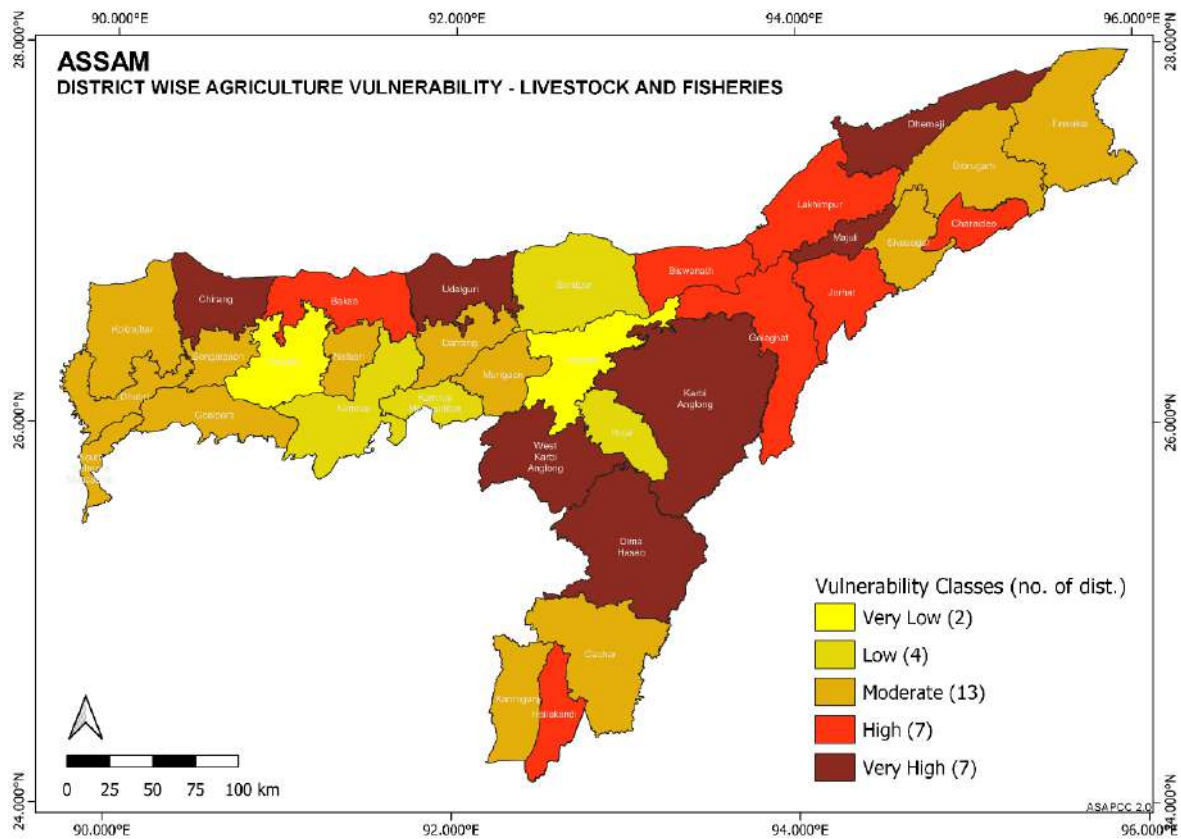
Figure 34: District Wise Agriculture Vulnerability – Livestock and Fisheries

The following Figure 35 depicts the radar plot of the drivers for the vulnerability of the sector and further Table 18 lists the key drivers against each district and vulnerability class.
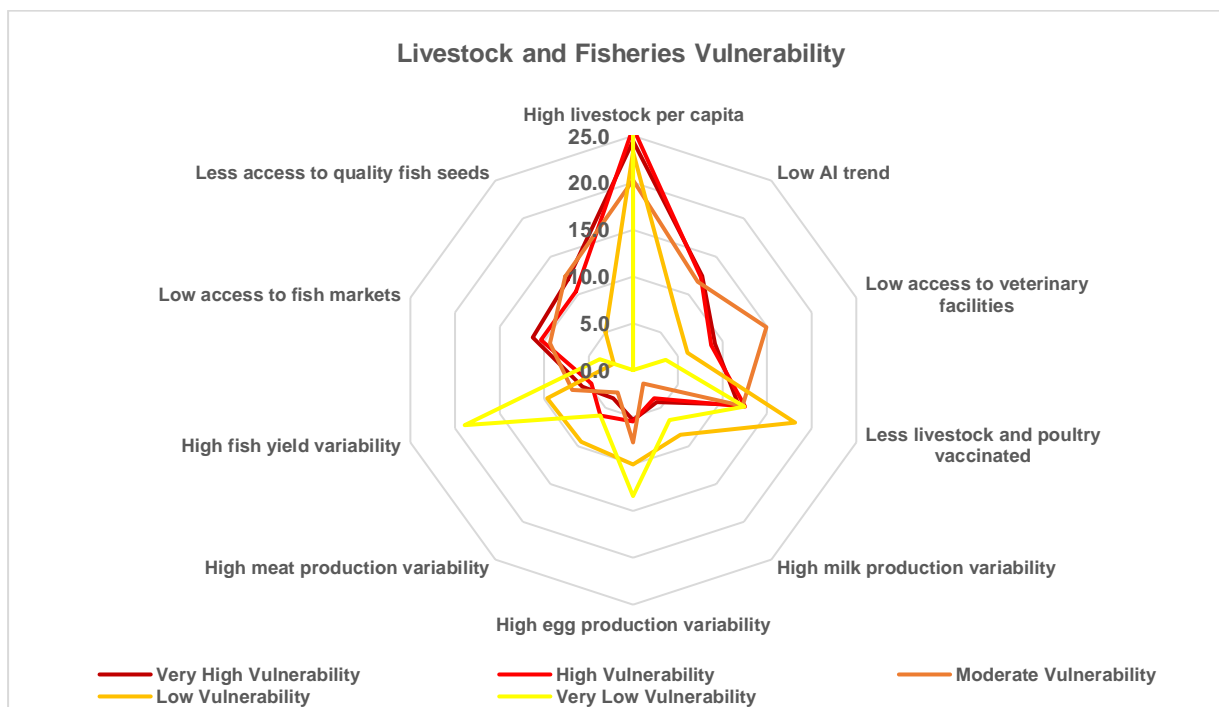
Figure 35: Drivers of livestock and fisheries sector represented as a radar plot

Table 18: Drivers of agricultural (livestock and fisheries) vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High Vulnerability	Dhemaji, Chirang, Udalguri, Dima Hasao, West Karbi Anglong, Karbi Anglong, Majuli	1. Higher livestock dependency 2. Low AI Trend 3. Less livestock and poultry vaccinated 4. Low access to fish markets 5. Low access to quality fish seeds
High Vulnerability	Lakhimpur, Baksa, Golaghat, Jorhat, Hailakandi, Biswanath, Charaideo	1. Higher livestock dependency 2. Low AI Trend 3. Less livestock and poultry vaccinated
Moderate Vulnerability	Goalpara, Nalbari, Cachar, Sivasagar, Bongaigaon, Darrang, South Salmara Mancachar, Kokrajhar, Dibrugarh, Tinsukia, Morigaon, Karimganj, Dhubri	1. Higher livestock dependency 2. Low AI Trend 3. Low access to veterinary facilities 4. Less livestock and poultry vaccinated 5. Low access to fish markets 6. Low access to quality fish seeds
Low Vulnerability	Hojai, Sonitpur, Kamrup Metropolitan, Kamrup	1. Higher livestock dependency 2. Less livestock and poultry vaccinated 3. High egg production variability
Very Low Vulnerability	Nagaon, Barpeta	1. Higher livestock dependency 2. High fish yield variability 3. High egg production variability

4.3.2 Agro - Ecological Vulnerability of Agriculture and Allied Sector

Climate variations have significant impact on agriculture production and farm livelihoods especially in India, with diverse agro-climatic settings. Since agricultural systems are impacted at micro level due to climatic variations, therefore in order to facilitate effective adaptation or policy interventions, macro level spatial contexts do not offer concrete lead lines due to uncertainties and information gaps. Hence, there is a dire need to get empirics related to the impact of climate change for major crops at agro-climatic zone level so that location specific R&D and dynamic, diversified and flexible interventions having local contexts (Singh et al., 2018, 2019) can be suggested.

Thus, due to this importance of the Agro - ecological zoning (AEZ) in agricultural developmental planning and land use management farming system the current study also identifies the climate vulnerability of the 6 Agro-Ecological Zones in Assam (i.e., North Bank Plain Zone, Hill Zone, Barak Valley Zone, Upper Brahmaputra Valley Zone, Central Brahmaputra Valley Zone, and Lower Brahmaputra Valley Zone)

The study follows the similar structure of indicators across two indices i.e., Food and Horticulture Index (FHVI) and Livestock and Fisheries Index (LFVI) across the 6 zones. List of Indicators, rationale, relationship with vulnerability, and data source are attached in Annexure B under Agriculture and Allied Sector Indicators.

Agro-ecological vulnerability across Food and Horticulture sub-sectors:

Across the 6 zones, 3 zones (Upper Brahmaputra Valley, Hill Zone and Barak Valley) are assessed to be in very high vulnerability, while no zones were categorised under high or moderate, 2 zones fall under low vulnerability class i.e., North Bank Plain and Central Brahmaputra Valley, and Lower Brahmaputra Valley found to be in very low vulnerability class. The following Figure represent distribution of classes spatially.
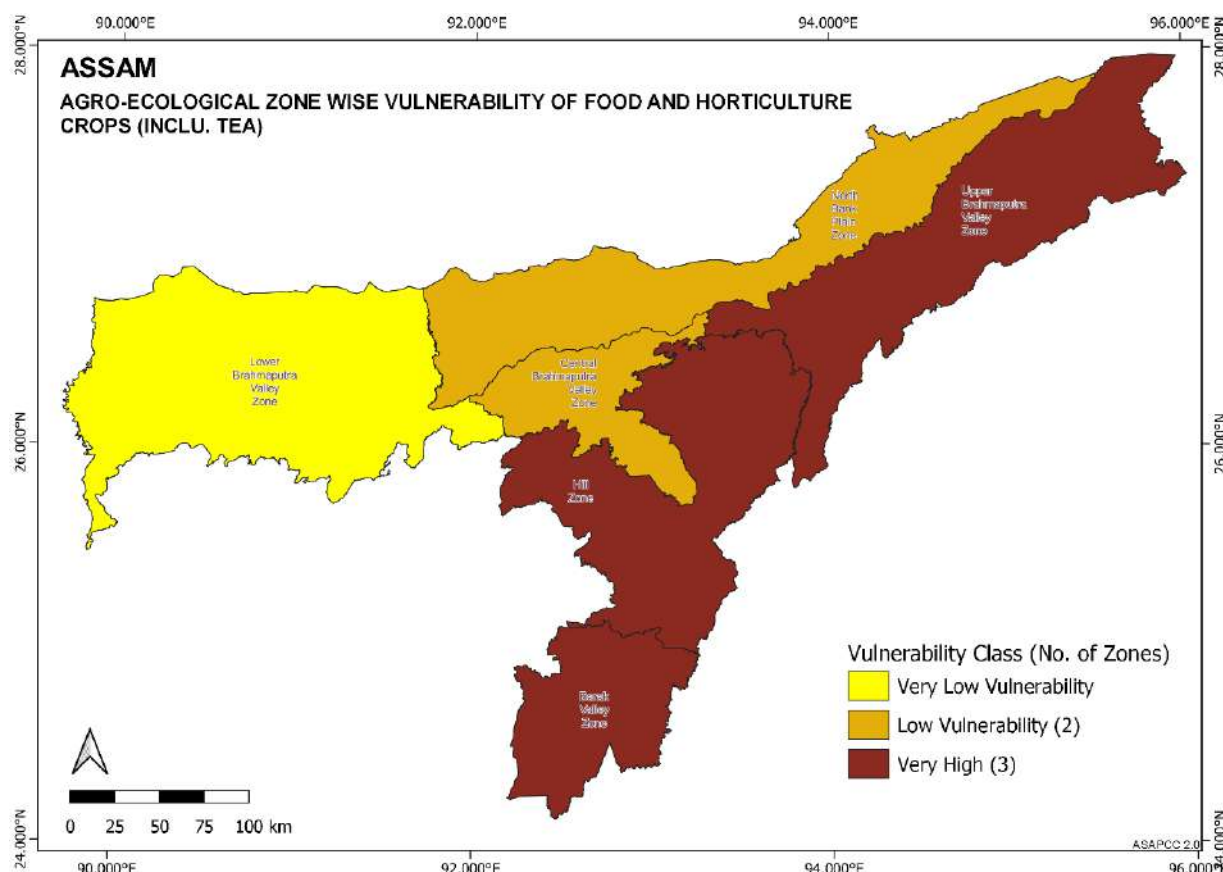
Figure 36: Spatial distribution of agro-ecological vulnerability of food and horticulture crops

The contribution of each indicator to the value of FHVI was computed as the average weighted-normalised values of indicators within each vulnerability class. Values 75% may be considered as major drivers of vulnerability. This is also represented as a radar plot (**Figure 37**), where the spokes of the plot represent the magnitude of each indicator in driving vulnerability. Further away from the centre of the plot, more strongly does the indicator drive vulnerability.
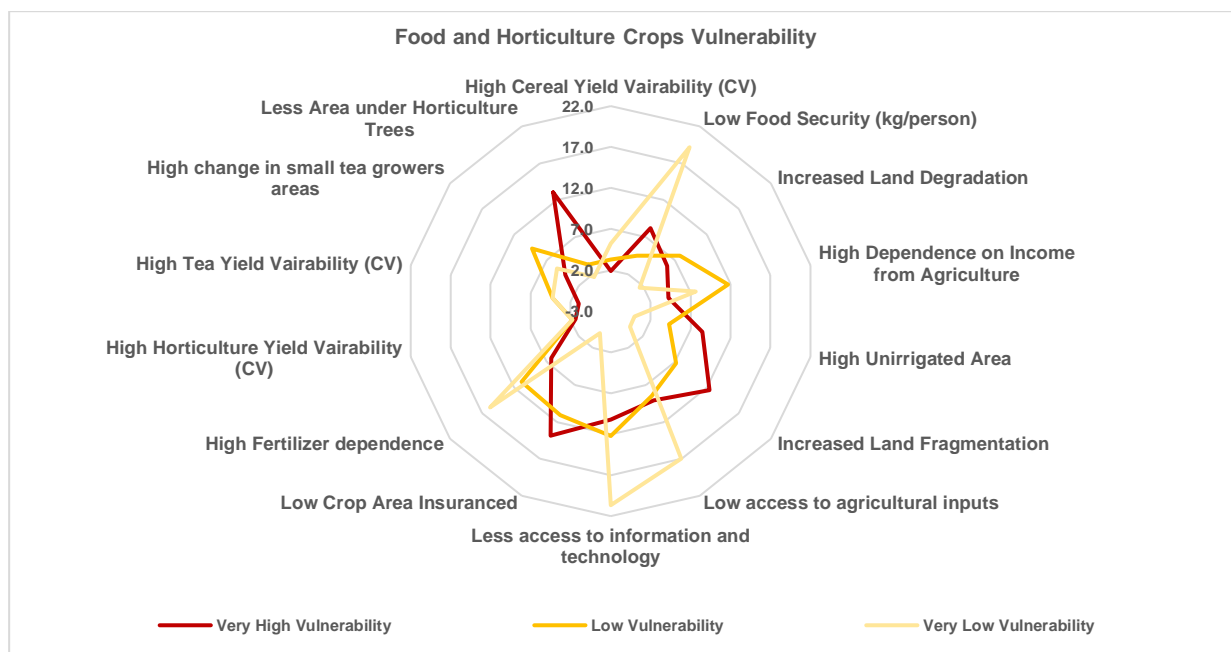
Figure 37: Drivers of food crops and horticulture crops represented as a radar plot (Agro-Ecological Zones)

Table 19: Drivers of agricultural (food crops and horticulture crops) vulnerability for the agro-ecological zones in different vulnerability classes (percentage contribution 75%)

FHVI Class	Agro-Ecological Zone	Driver
Very High Vulnerability	Barak Valley Zone, Upper Brahmaputra Valley Zone, Hill Zone	1. Low Crop Area Insurance 2. Increased Land Fragmentation 3. Less Area under Horticulture Trees
Low Vulnerability	North Bank Plain Zone, Central Brahmaputra Valley Zone	1. High Fertilizer dependence 2. Low Crop Area Insurance 3. Less access to information and technology 4. High Dependence on primary Income from Agriculture
Very Low Vulnerability	Lower Brahmaputra Valley Zone	1. Less access to information and technology 2. Low access to agricultural inputs 3. High Fertilizer dependence 4. Low Food Security (kg/person)

Agro-ecological vulnerability across Livestock and Fisheries sub-sectors:

Across the 6 zones, 1 zone (Hill Zone) is assessed to be in very high vulnerability class, while no zones were categorised under high, 2 zones fall under moderate vulnerability class i.e., Upper Brahmaputra Valley Zone, North Bank Plain Zone, also 1 zone i.e., Barak Valley Zone found to be in low vulnerability class, and remaining 2 zones Central Brahmaputra Valley Zone, and Lower Brahmaputra Valley Zone found to be in very low vulnerability class. The following Figure represents distribution of classes spatially.
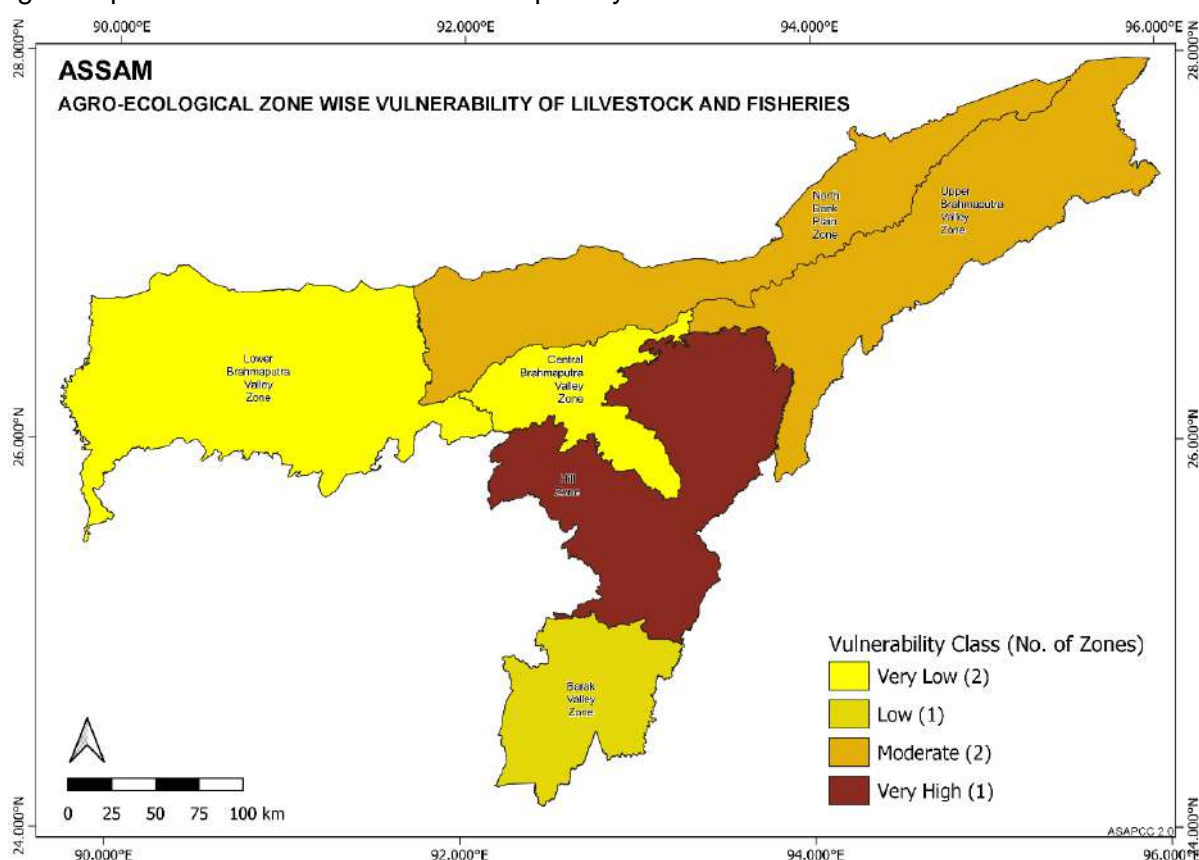
Figure 38: Spatial distribution of agro-ecological vulnerability of livestock and fisheries

The contribution of each indicator to the value of LFVI was computed as the average weighted-normalised values of indicators within each vulnerability class. Values 75% may be considered as major drivers of vulnerability. This is also represented as a radar plot (**Figure 35**), where the

spoke of the plot represent the magnitude of each indicator in driving vulnerability. Further away from the centre of the plot, more strongly does the indicator drive vulnerability.
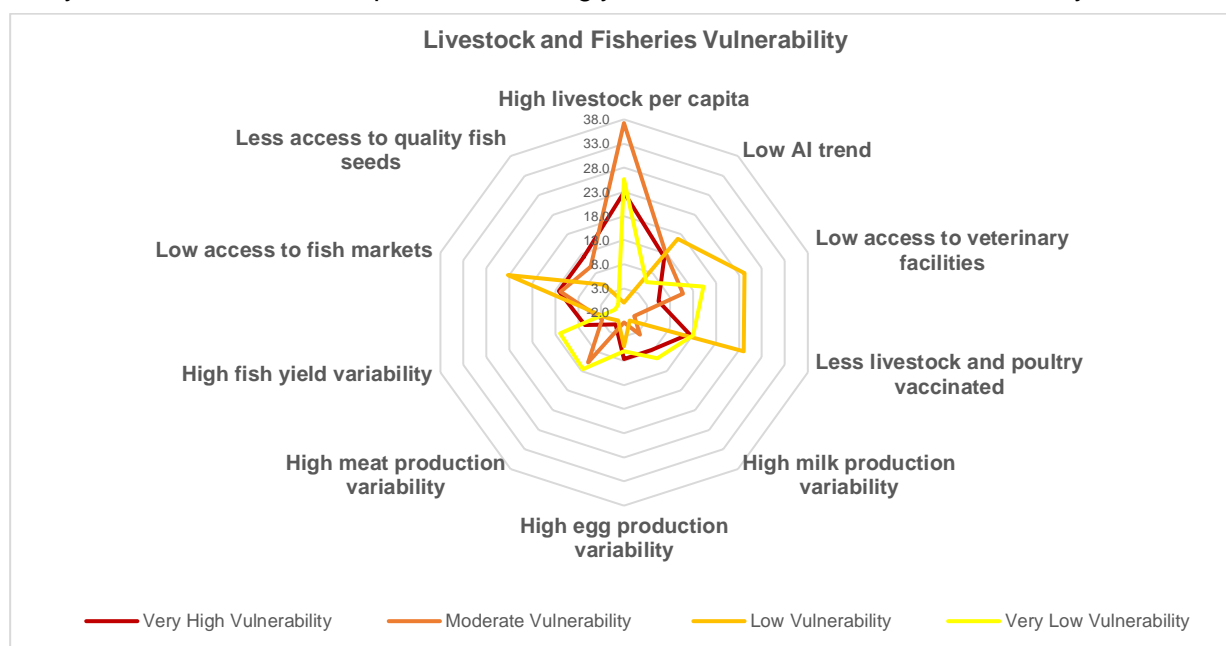
Figure 39: Drivers of livestock and fisheries sector represented as a radar plot (Agro-Ecological Zones)

Table 20: Drivers of agricultural (livestock and fisheries) vulnerability for the agro-ecological zones in different vulnerability classes (percentage contribution 75%)

LFVI Class	Agro-Ecological Zone	Driver
Very High Vulnerability	Hill Zone	1. High livestock per capita 2. Low AI trend 3. Less access to quality fish seeds 4. Low access to fish markets
Moderate Vulnerability	Upper Brahmaputra Valley Zone, North Bank Plain Zone	1. High livestock per capita
Low Vulnerability	Barak Valley Zone,	1. Low access to veterinary facilities 2. Less livestock and poultry vaccinated 3. Low access to fish markets
Very Low Vulnerability	Central Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone	1. High livestock per capita 2. Low access to veterinary facilities 3. Less livestock and poultry vaccinated

Against the studied vulnerability, hazards such as floods, droughts, cyclones, hail storms and pests and diseases cause damage to agriculture and allied sector in Assam. Hence, the following table shows the zone wise regular and occasional faced hazards.

Agro-Ecological Zone	Flood	Drought	Cyclone	Hail Storm	Pests and Disease Outbreaks
North Bank Plain Zone	-	O	-	-	-
Hill Zone	O	O	-	-	O
Barak Valley Zone	R	O	O	O	R
Upper Brahmaputra Valley Zone	R	-	-	-	R
Central Brahmaputra Valley Zone	R	R	O	O	-
Lower Brahmaputra Valley Zone	R	O	O	R	R

Note: R - Regular Event, O- Occasional

Source: Agriculture Contingency Plans, Directorate of Agriculture, GoA

Combined with the Climate Change Scenarios highlighted in Chapter 3, the future climate impacts can be mapped in detailed. It is suggested that, a detailed climate risk assessment study can be undertaken in future taking the preliminary finding of this report. Across the identified vulnerabilities of the 6 agro-ecological zones, detailed action linkages are suggested in the chapter 5 under agriculture and allied sectoral strategies and actions.

4.3.3 Water Vulnerability

A total of six indicators (attached in Annexure B) were considered to assess Water Vulnerability Index (WVI) at the district level. Out of the 33 districts, 2 districts (Darrang, Dhubri) were ranked as having very-high vulnerability; 8 districts (Morigaon, Goalpara, Kamrup, South Salmara Mancachar, Kokrajhar, Nagaon, Golaghat, Lakhimpur) were ranked as highly vulnerable; 4 districts (Karimganj, Bongaigaon, Barpeta, Kamrup Metropolitan) were ranked as having moderate vulnerability; 12 districts (Dima Hasao, Hojai, Majuli, Hailakandi, Baksa, Biswanath, Dhemaji, Jorhat, Chirang, Nalbari, Charaideo, Dibrugarh) were ranked as having low vulnerability and 7 district (Cachar, Tinsukia, West Karbi Anglong, Udalguri, Karbi Anglong, Sivasagar, Sonitpur) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 40**) and map (**Figure 41**).
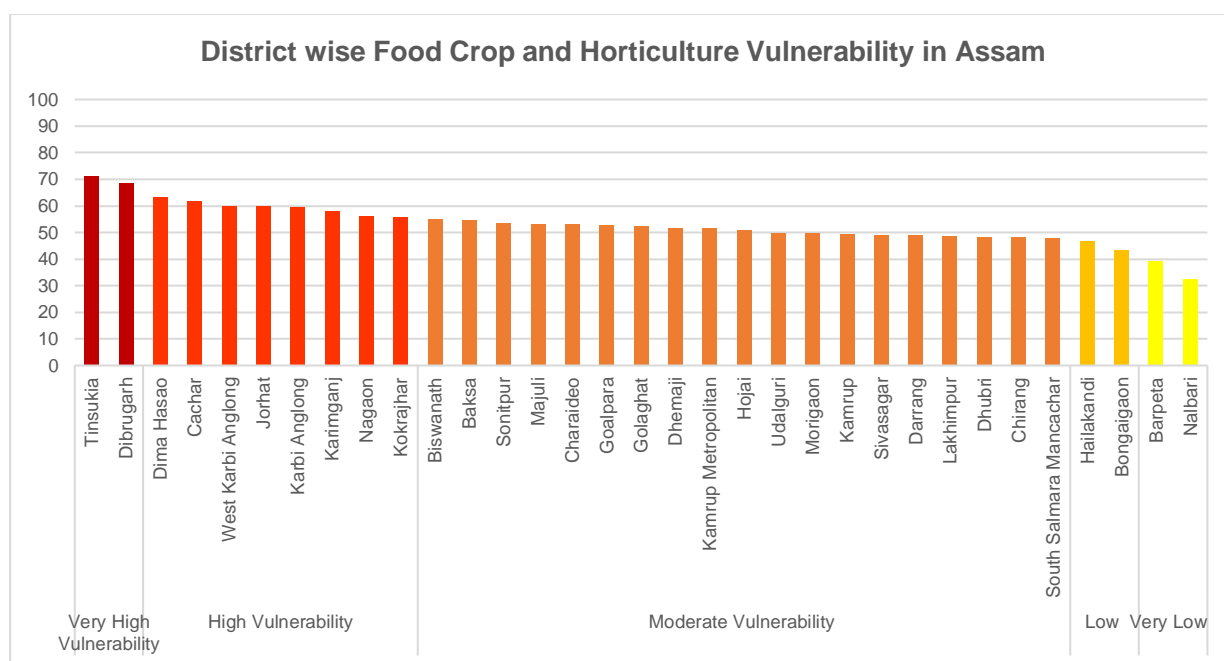

*Figure 40: Ranking of districts based on Water Vulnerability Index from very-high to very low vulnerability*
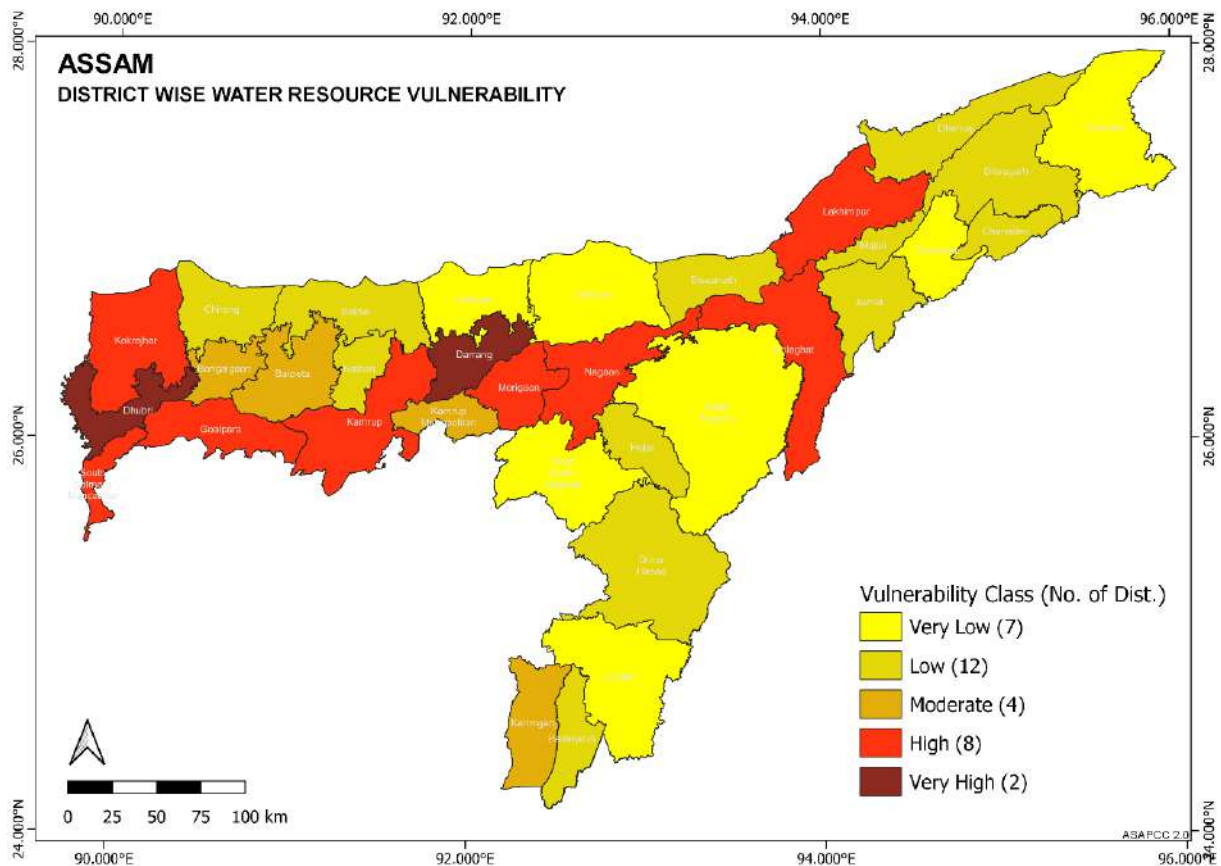
Figure 41: District Wise Water Resource Vulnerability

Percentage contribution of an indicator to vulnerability index for each vulnerability class was obtained by considering the product of its weight and normalized value. Major drivers of vulnerability for the districts in different vulnerability classes are presented in the **Figure 42** and **Table 21** respectively.
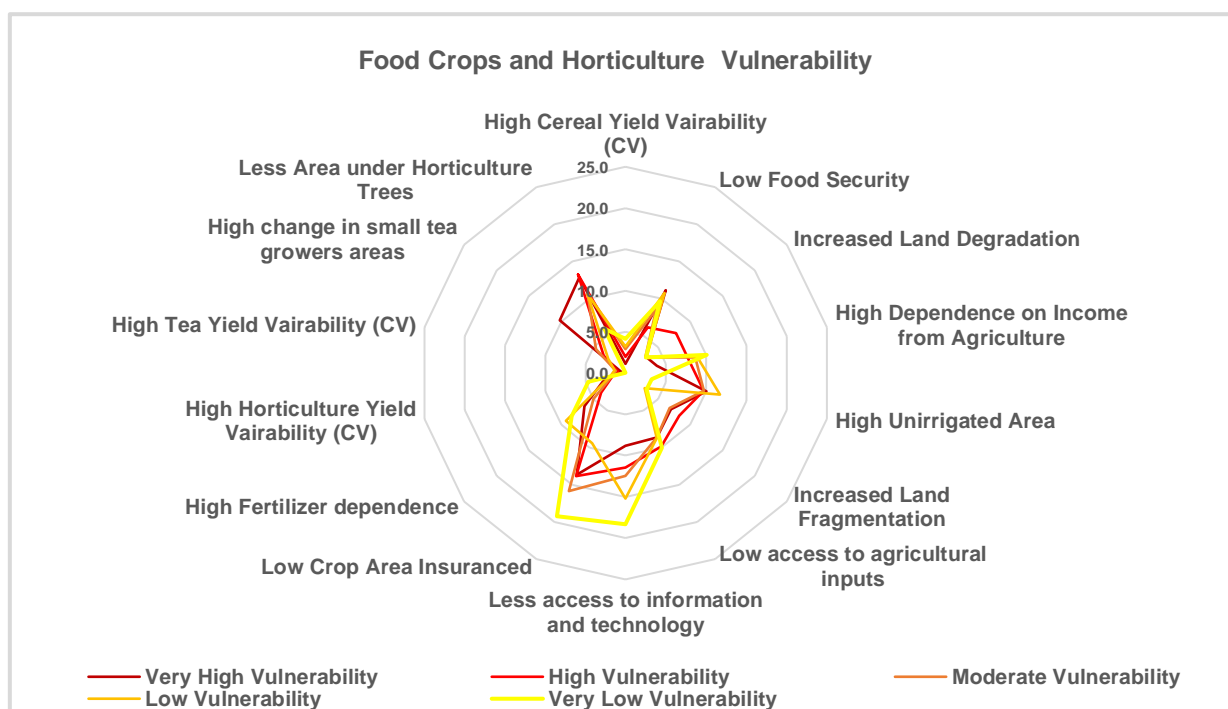

Figure 42: Drivers of water vulnerability index represented as a radar plot

Table 21: Drivers of water vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

WVI Class	Districts	Major Drivers
Very High vulnerability	Darrang, Dhubri	1. High Water Pollution (arsenic and fluoride) 2. Low Percentage of MI schemes in use 3. High Groundwater Extraction
High vulnerability	Morigaon, Goalpara, Kamrup, South Salmara Mancachar, Kokrajhar, Nagaon, Golaghat, Lakhimpur	1. High Water Pollution (arsenic and fluoride) 2. Low percentage of water conservation assets created under MGNREGA
Moderate vulnerability	Karimganj, Bongaigaon, Barpeta, Kamrup Metropolitan	1. Low percentage of water conservation assets created under MGNREGA 2. Low Percentage of MI schemes in use
Low vulnerability	Dima Hasao, Hojai, Majuli, Hailakandi, Baksa, Biswanath, Dhemaji, Jorhat, Chirang, Nalbari, Charaideo, Dibrugarh	1. Low percentage of water conservation assets created under MGNREGA 2. Low Percentage of MI schemes in use 3. Low household functional tap water connectivity
Very Low vulnerability	Cachar, Tinsukia, West Karbi Anglong, Udalguri, Karbi Anglong, Sivasagar, Sonitpur	1. Low household functional tap water connectivity

4.3.4 Forest Vulnerability

4.3.4.1 Indicators Selected

A total of three indicators (attached in Annexure B) were considered to assess Forest Vulnerability Index (FVI) at the district level. Out of the 33 districts, 6 districts (Baksa, Karbi Anglong, West Karbi Anglong, Udalguri, Hailakandi, Dhemaji) were ranked as having very-high vulnerability; 17 districts (Nalbari, Chirang, Hojai, Nagaon, Lakhimpur, Kokrajhar, Dima Hasao, Goalpara, Morigaon, Karimganj, Sonitpur, Biswanath, Golaghat, Darrang, Sivasagar, Charaideo, Cachar) were ranked as highly vulnerable; 5 districts (Tinsukia, Jorhat, Majuli, Dibrugarh, Bongaigaon) were ranked as having moderate vulnerability; 3 districts (Dhubri, South Salmara Mancachar, Kamrup) were ranked as having low vulnerability and 2 district (Kamrup Metropolitan, Barpeta) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 43**) and map (**Figure 44**).
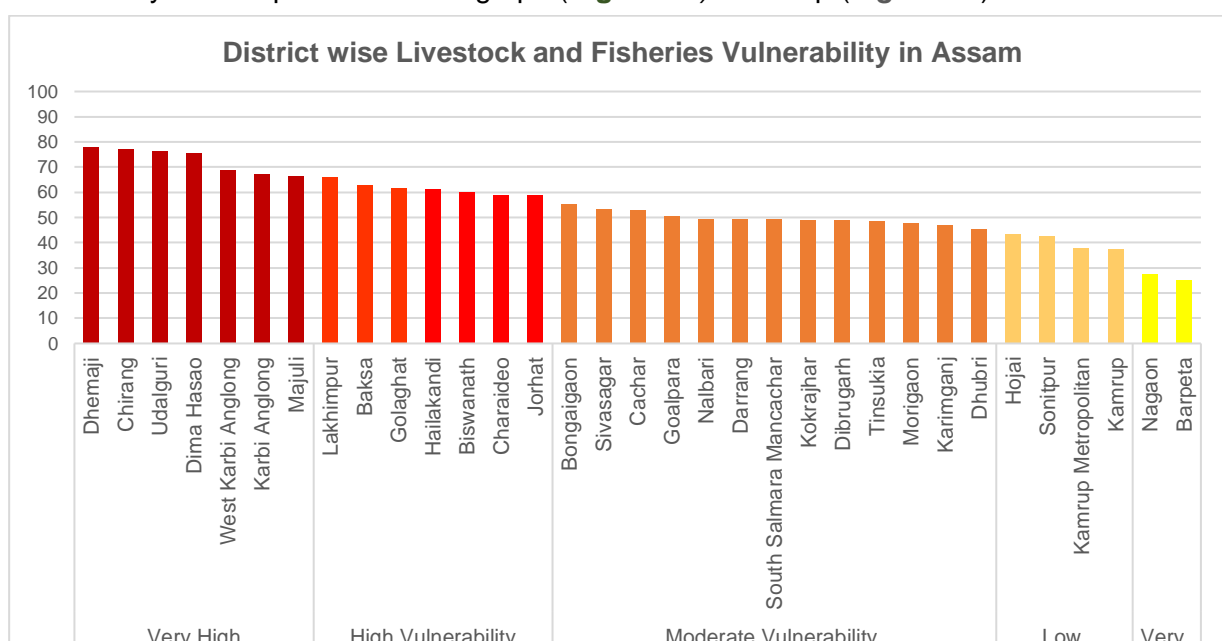

Figure 43: Ranking of districts based on Forest Vulnerability Index from very-low to very-high vulnerability
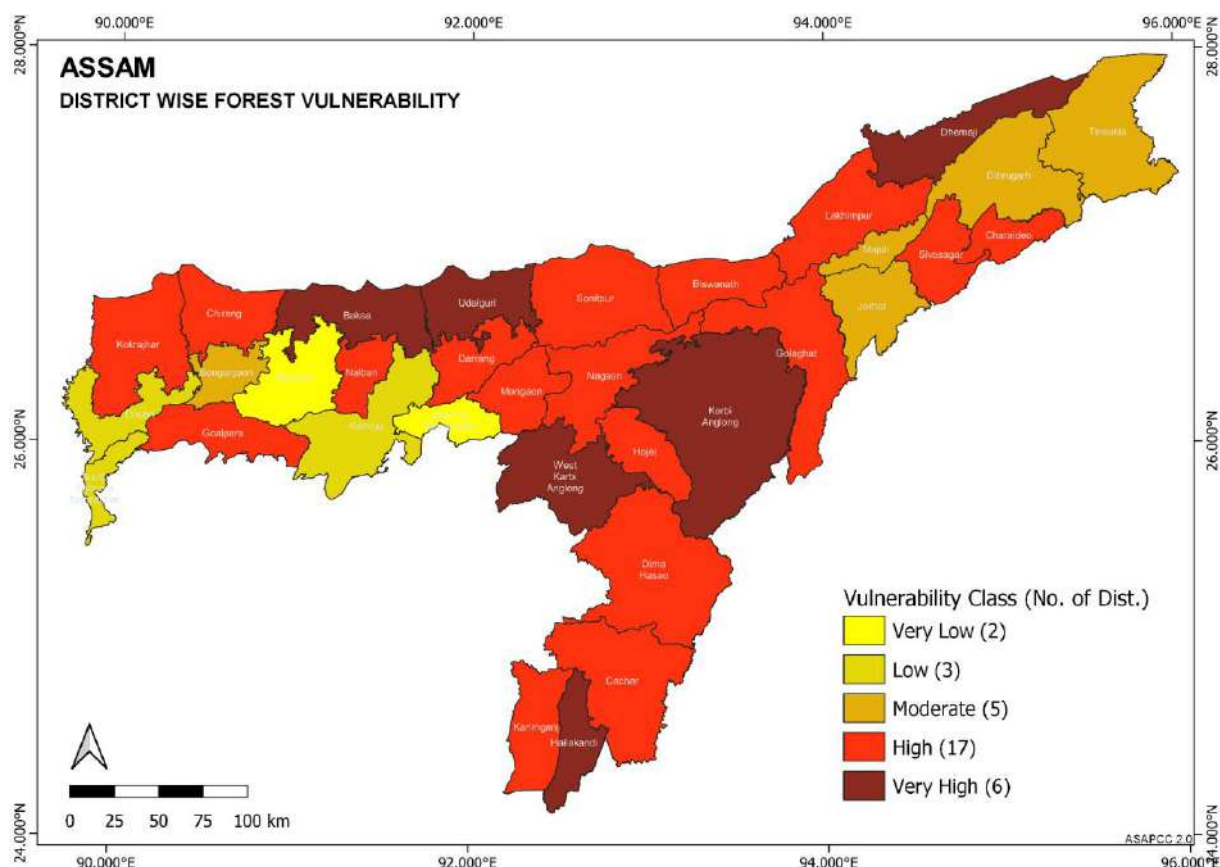
Figure 44: District Wise Forest Vulnerability Map

Percentage contribution of an indicator to vulnerability index for each vulnerability class was obtained by considering the product of its weight and normalized value. Major drivers of vulnerability for the districts in different vulnerability classes are presented in the **Figure 45**, and **Table 22** respectively.
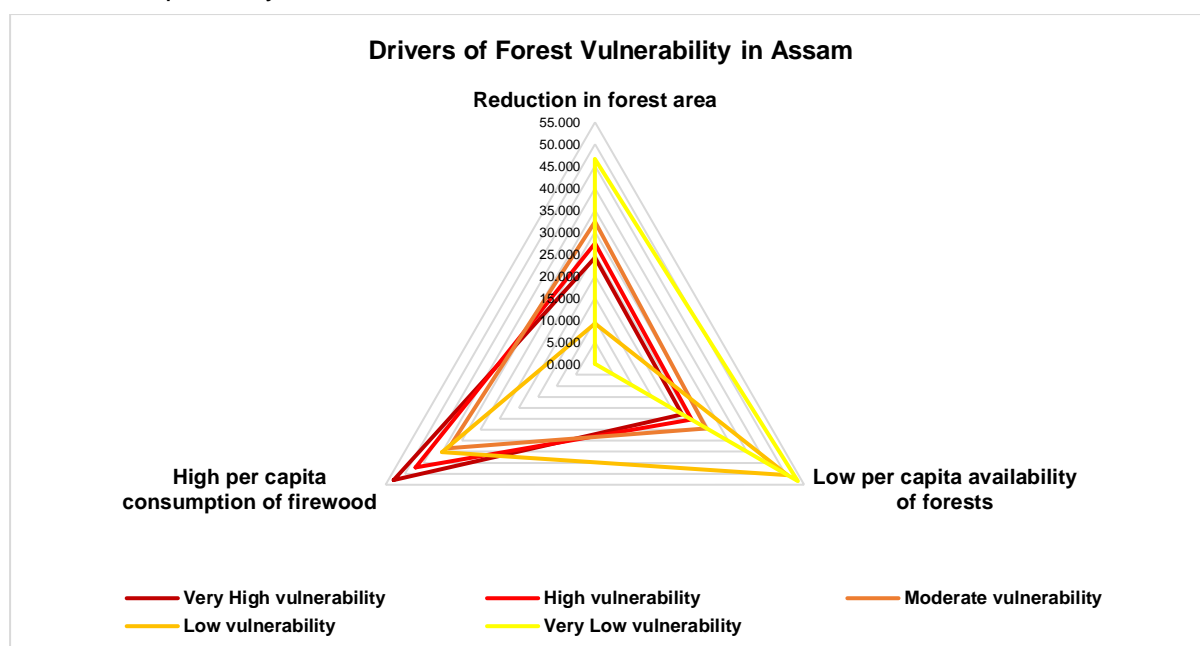
Figure 45: Drivers of forest vulnerability index represented as a radar plot

Table 22: Drivers of forest vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	Baksa, Karbi Anglong, West Karbi Anglong, Udalguri, Hailakandi, Dhemaji	1. High per capita consumption of firewood 2. Reduction in Forest Area
High vulnerability	Nalbari, Chirang, Hojai, Nagaon, Lakhimpur, Kokrajhar, Dima Hasao, Goalpara, Morigaon, Karimganj, Sonitpur, Biswanath, Golaghat, Darrang, Sivasagar, Charaideo, Cachar	1. High per capita consumption of firewood 2. Reduction in Forest Area
Moderate vulnerability	Tinsukia, Jorhat, Majuli, Dibrugarh, Bongaigaon	1. High per capita consumption of firewood 2. Reduction in Forest Area
Low vulnerability	Dhubri, South Salmara Mancachar, Kamrup	1. Low per capita availability of forests 2. Reduction in Forest Area
Very Low vulnerability	Kamrup Metropolitan, Barpeta	1. Low per capita availability of forests 2. High Per Capita of Consumption of firewood

4.3.5 Energy Vulnerability

4.3.5.1 *Indicators Selected*

Three indicators (attached in Annexure B) were considered to assess energy vulnerability at the district level, which are used for the computation of Energy Vulnerability Index (EVI). Out of the 33 districts, 7 districts (Kokrajhar, Udalguri, Baksa, Sonitpur, Morigaon, Biswanath, Barpeta) were ranked as having very-high vulnerability; 9 districts (Hojai, Nagaon, Darrang, Dibrugarh, Tinsukia, Karimganj, Dhubri, South Salmara Mancachar, Bongaigaon) were ranked as highly vulnerable; 9 districts (Dhemaji, Goalpara, Hailakandi, Cachar, Kamrup, Chirang, Lakhimpur, Sivasagar, Charaideo) were ranked as having moderate vulnerability; 7 districts (Jorhat, Majuli, Nalbari, Karbi Anglong, West Karbi Anglong, Golaghat) were ranked as having low vulnerability and 1 district (Dima Hasao) was ranked as having very-low vulnerability. This is presented as a graph (**Figure 46**) and map (*Figure 47*).
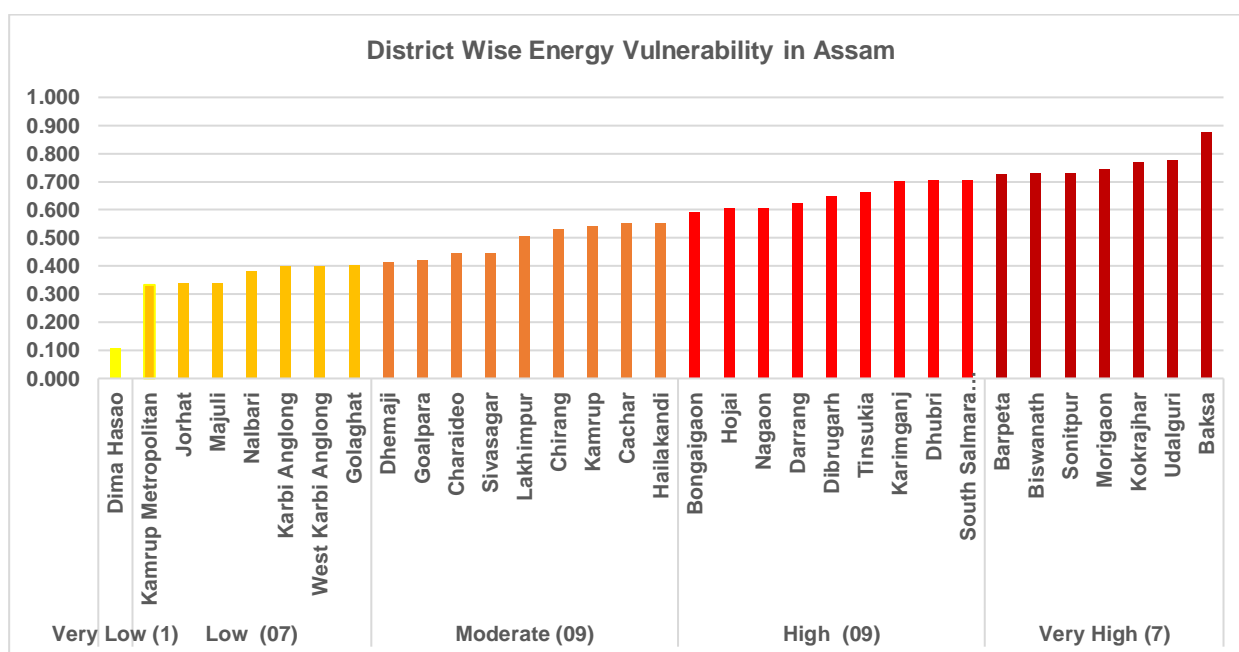
Figure 46: Ranking of districts based on Energy Vulnerability Index from very-low to very-high vulnerability
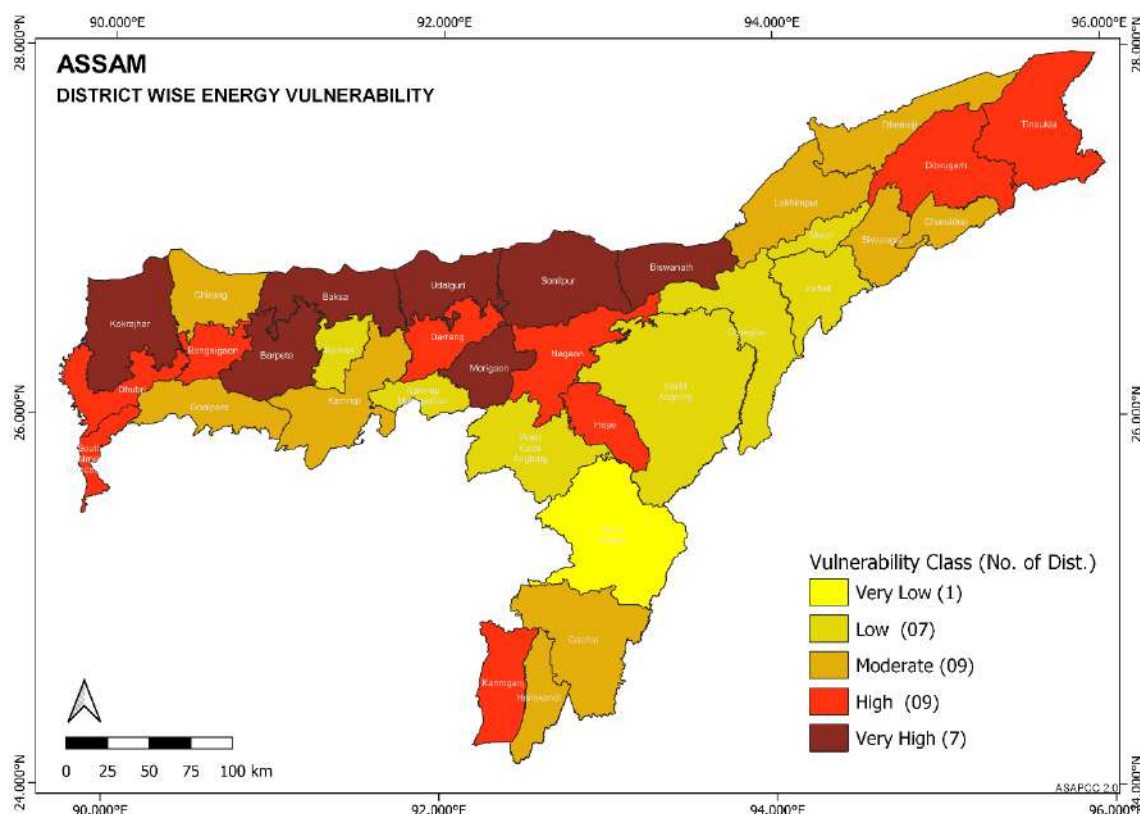
Figure 47: District wise Energy Vulnerability Map
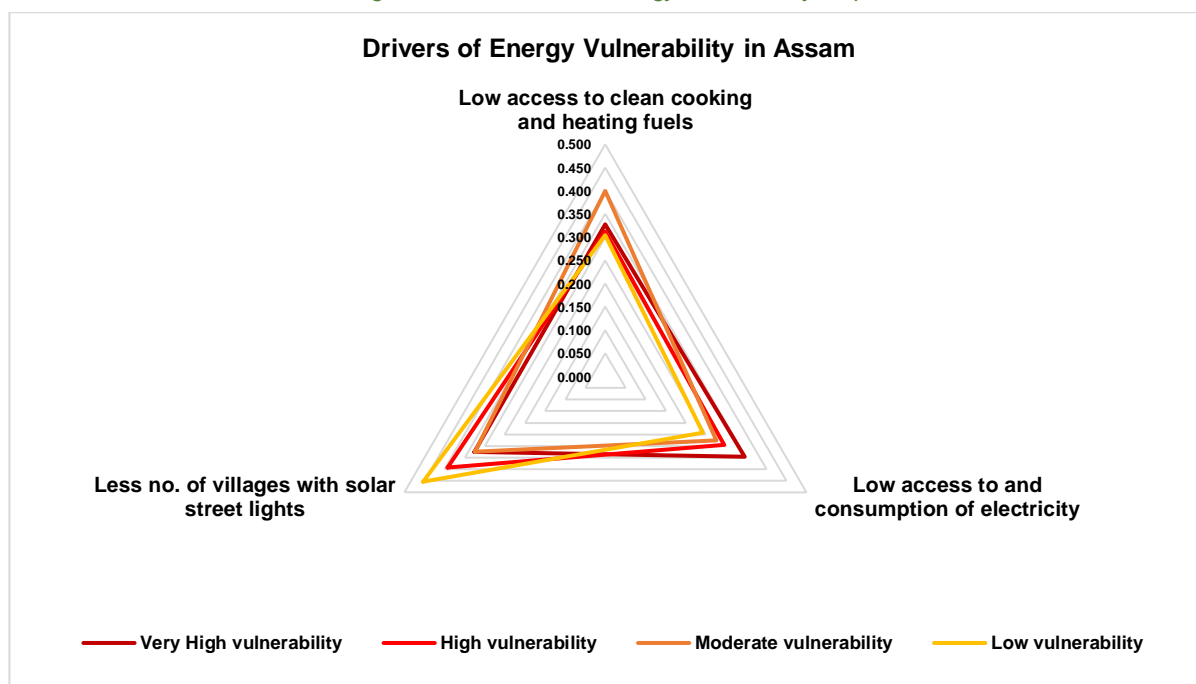
Figure 48: Drivers of energy vulnerability index represented as a radar plot

Table 23: Drivers of Energy vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	Kokrajhar, Udalguri, Baksa, Sonitpur, Morigaon, Biswanath, Barpeta	1. Low access to electricity connection
High vulnerability	Hojai, Nagaon, Darrang, Dibrugarh, Tinsukia, Karimganj, Dhubri, South Salmara Mancachar, Bongaigaon	1. Less no. of villages with solar street lights
Moderate vulnerability	Dhemaji, Goalpara, Hailakandi, Cachar, Kamrup, Chirang, Lakhimpur, Sivasagar, Charaideo	1. Low access to clean cooking and heating fuels 2. Less no. of villages with solar street lights
Low vulnerability	Jorhat, Majuli, Nalbari, Karbi Anglong, West Karbi Anglong, Golaghat	1. Less no. of villages with solar street lights
Very Low vulnerability	Dima Hasao	1. Low access to clean cooking and heating fuels

4.3.6 Rural Development Vulnerability (RDVI)

4.3.6.1 *Indicators Selected*

Twelve indicators (attached in Annexure B) were considered to assess Rural Development Vulnerability Index (RDVI) at district level. Out of the 33 districts, 4 districts (South Salmara Mancachar, Dhubri, Barpeta, Morigaon) were ranked as having very-high vulnerability; 7 districts (Darrang, Hailakandi, Karimganj, Hojai, Chirang, Kokrajhar, West Karbi Anglong) were ranked as highly vulnerable; 11 districts (Nagaon, Bongaigaon, Karbi Anglong, Sonitpur, Cachar, Dima Hasao, Baksa, Goalpara, Dhemaji, Biswanath, Udalguri) were ranked as having moderate vulnerability; 5 districts (Charaideo, Tinsukia, Sivasagar, Lakhimpur, Golaghat) were ranked as having low vulnerability and 6 district (Nalbari, Majuli, Kamrup, Kamrup Metropolitan, Dibrugarh, Jorhat) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 49**) and map (**Figure 50**).
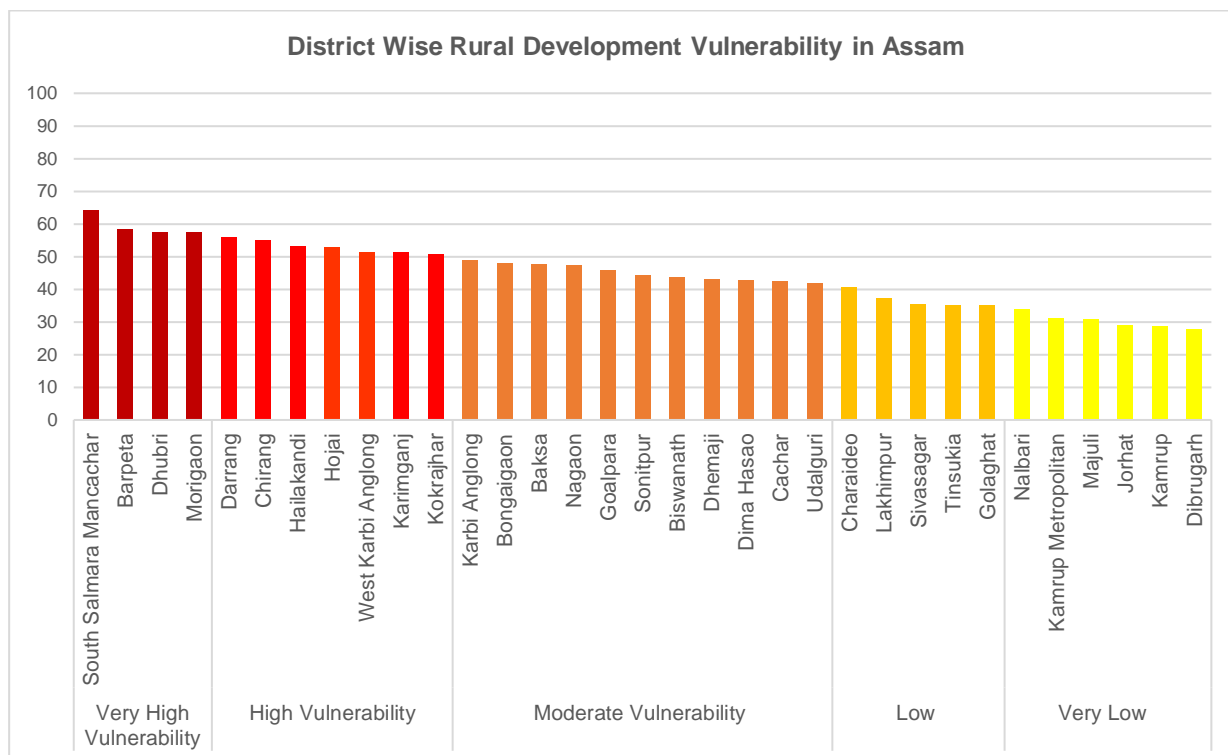
Figure 49: Ranking of districts based on rural Vulnerability Index from very-high to very-low vulnerability
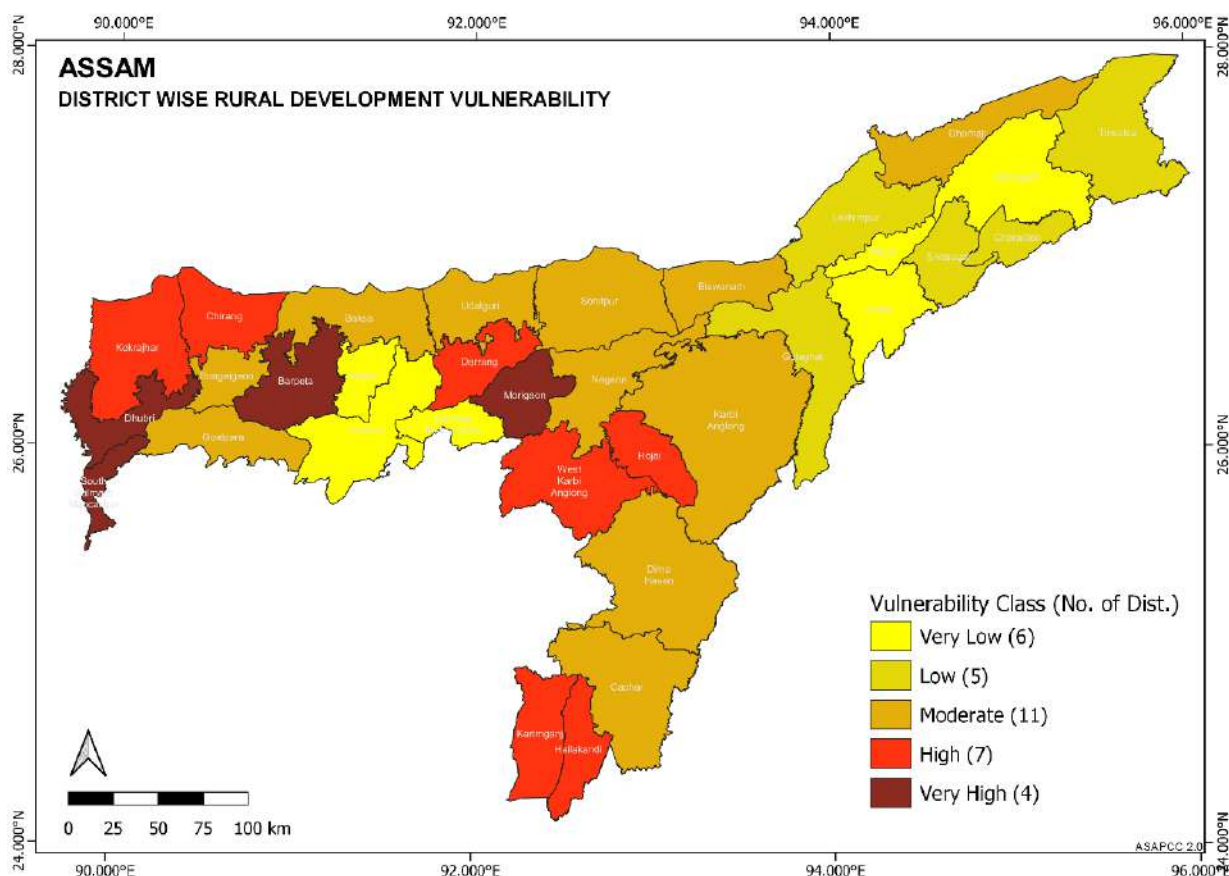
Figure 50: District Wise Rural Development Vulnerability
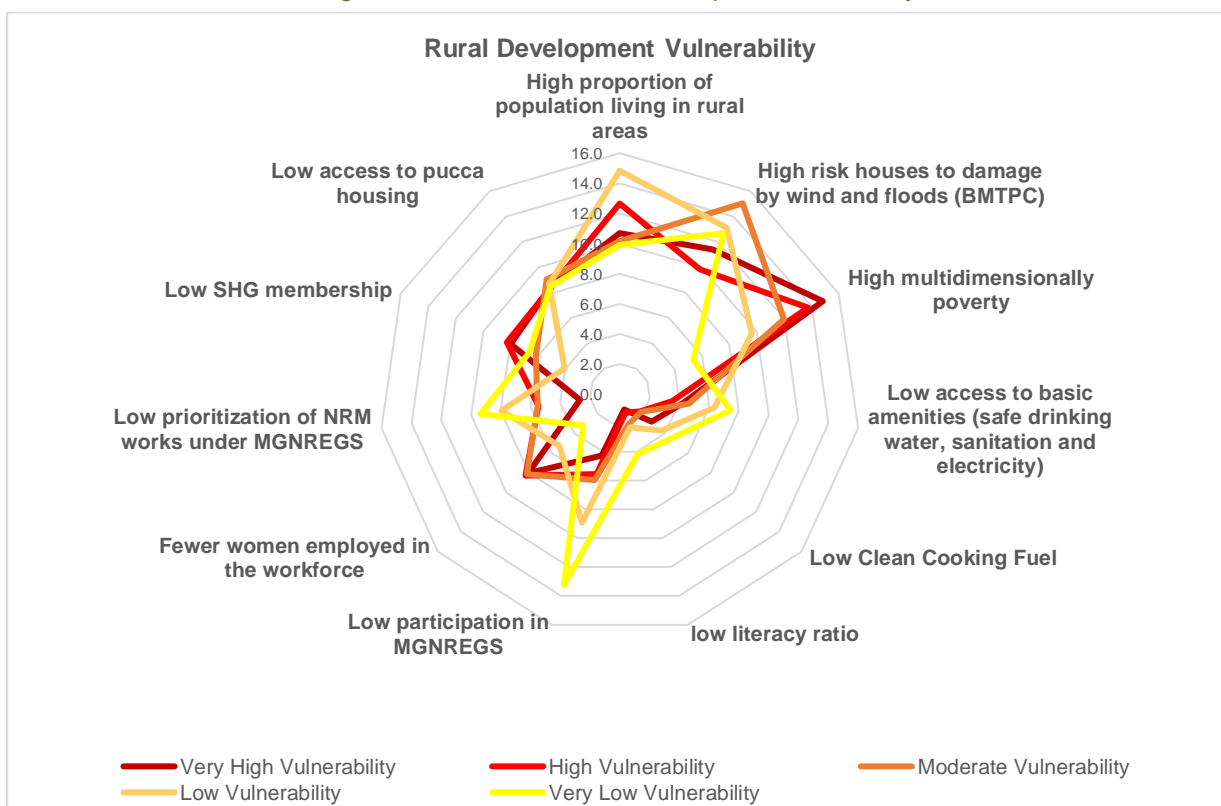
Figure 51: Drivers of rural development vulnerability index represented as a radar plot

Table 24: Drivers of Rural development vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	South Salmara Mancachar, Barpeta, Dhubri, Morigaon	1. High risk house types to damage by wind and floods (BMTPC) 2. High proportion of population living in rural areas 3. Low SHG members
High vulnerability	Kokrajhar, Darrang, Chirang, Hailakandi, Hojai, West Karbi Anglong, Karimganj	1. High proportion of population living in rural areas 2. High risk house types to damage by wind and floods (BMTPC) 3. Low access to pucca housing4. Fewer women employed in workforce
Moderate vulnerability	Baksa, Dhemaji, Karbi Anglong, Bongaigaon, Biswanath, Sonitpur, Goalpara, Nagaon, Dima Hasao, Cachar, Udalguri	1. High risk house types to damage by wind and floods (BMTPC) 2. High proportion of population living in rural areas 3. Low access to pucca housing
Low vulnerability	Tinsukia, Golaghat, Charaideo, Lakhimpur, Sivasagar	1. High risk house types to damage by wind and floods (BMTPC) 2. High proportion of population living in rural areas 3. Low access to pucca housing
Very Low vulnerability	Nalbari, Kamrup Metropolitan, Majuli, Jorhat, Kamrup, Dibrugarh	1. High risk house types to damage by wind and floods (BMTPC) 2. Low participation in MGNREGS

4.3.7 Urban Development Vulnerability (UDVI)

4.3.7.1 *Indicators Selected*

Eight indicators (attached in Annexure B) were considered to assess Urban Development Vulnerability Index (UDVI) at district level. Out of the 33 districts, 3 districts (South Salmara Mancachar, Dhubri, Goalpara) were ranked as having very-high vulnerability; 7 districts (Morigaon, Hojai, Barpeta, Baksa, Darrang, Dhemaji, Chirang) were ranked as highly vulnerable; 5 districts (Nagaon, West Karbi Anglong, Karbi Anglong, Udalguri, Karimganj) were ranked as having moderate vulnerability; 12 districts (Kamrup, Hailakandi, Majuli, Jorhat, Biswanath, Bongaigaon, Charaideo, Kokrajhar, Dima Hasao, Cachar, Tinsukia, Lakhimpur) were ranked as having low vulnerability and 6 district (Nalbari, Golaghat, Sonitpur, Sivasagar, Kamrup Metropolitan, Dibrugarh) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 52**) and map (**Figure 53**).
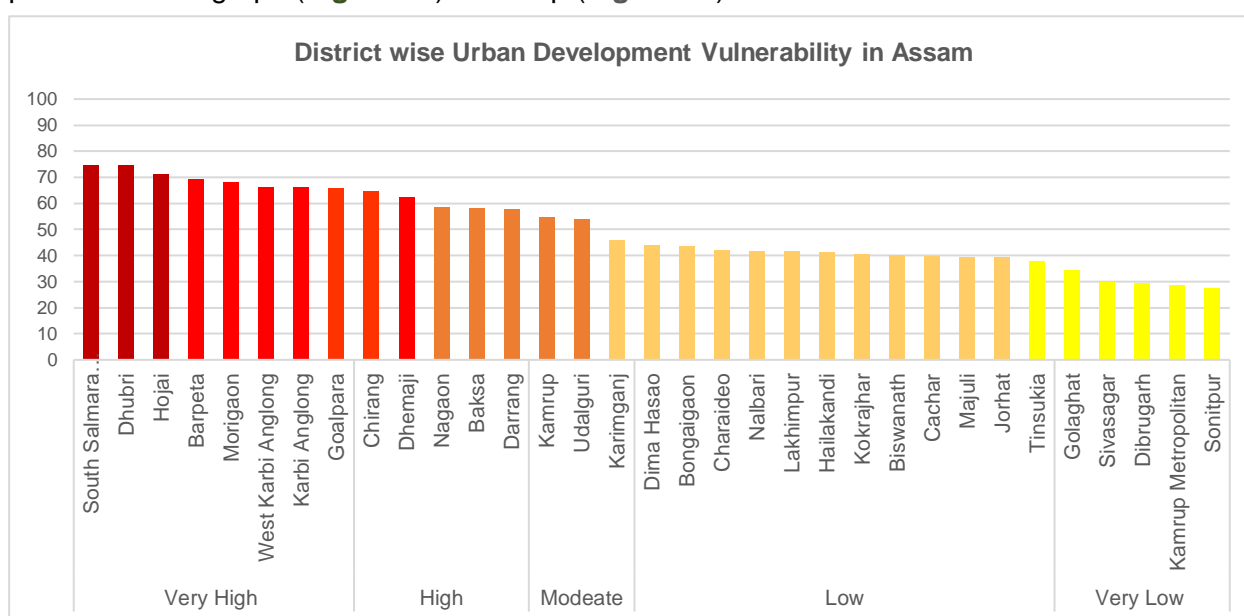
Figure 52: Ranking of districts based on Urban Vulnerability Index from very-high to very-low vulnerability
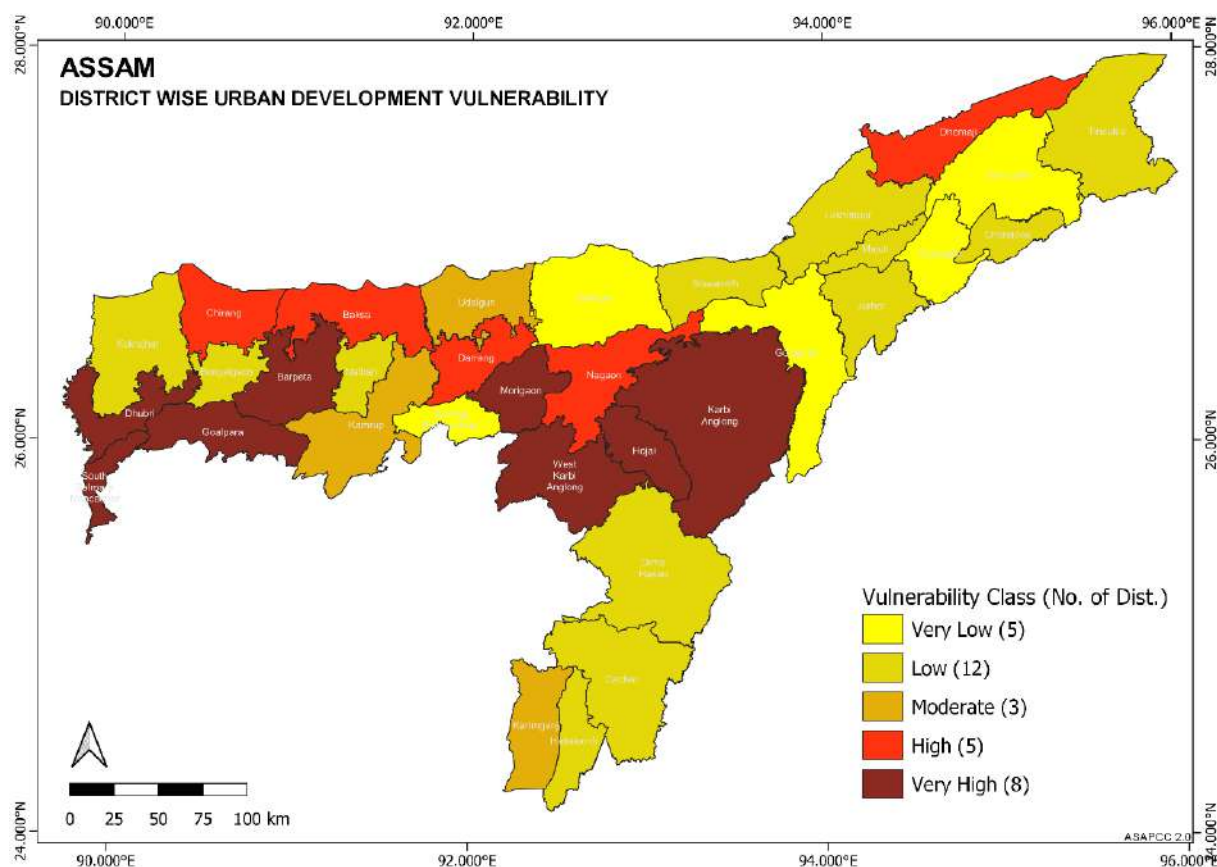
Figure 53: District wise urban development vulnerability in Assam
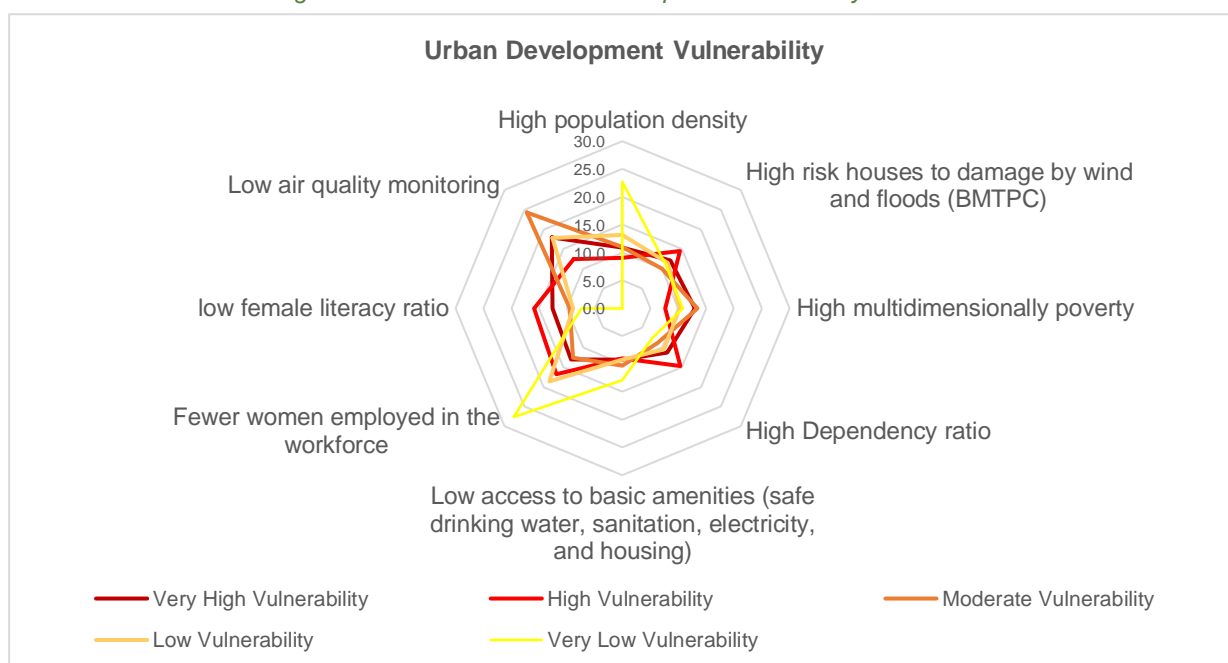
Figure 54: Drivers of urban vulnerability index represented as a radar plot

Table 25: Drivers of urban vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	South Salmara Mancachar, Dhubri, Hojai, Barpeta, Morigaon, West Karbi Anglong, Karbi Anglong, Goalpara	1. Low air quality monitoring 2. Low female literacy rate 3. Fewer women employed in the workforce 4. High multidimensional poverty
High vulnerability	Nagaon, Baksa, Darrang, Chirang, Dhemaji	1. High risk house type to damage by wind and floods 2. Fewer women employed in the workforce 3. Low female literacy rate 4. High Dependency Ratio
Moderate vulnerability	Kamrup, Karimganj, Udalguri	1. Low air quality monitoring
Low vulnerability	Tinsukia, Dima Hasao, Bongaigaon, Charaideo, Nalbari, Lakhimpur, Hailakandi, Kokrajhar, Biswanath, Cachar, Majuli, Jorhat	1. Low air quality monitoring 2. Fewer women employed in the workforce
Very Low vulnerability	Golaghat, Sivasagar, Dibrugarh, Kamrup Metropolitan, Sonitpur	1. Fewer women employed in the workforce 2. High Population density

4.3.8 Human Health Vulnerability

Thirteen indicators (annexure B) were considered to assess health vulnerability (HVI) at the district level. Out of the 33 districts, 2 districts (Kamrup Metropolitan, Hailakandi) were ranked as having very-high vulnerability; 4 districts (Majuli, South Salmara Mancachar, Karimganj, Hojai) were ranked as highly vulnerable; 11 districts (Cachar, Dhubri, West Karbi Anglong, Jorhat, Darrang, Morigaon, Udalguri, Kokrajhar, Karbi Anglong, Bongaigaon, Nagaon) were ranked as having moderate vulnerability; 6 districts (Golaghat, Barpeta, Nalbari, Goalpara, Dhemaji, Kamrup) were ranked as having low vulnerability and 10 district (Sivasagar, Chirang, Charaideo, Lakhimpur, Tinsukia, Biswanath, Dima Hasao, Baksa, Dibrugarh, Sonitpur) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 55**) and map (**Figure 56**).
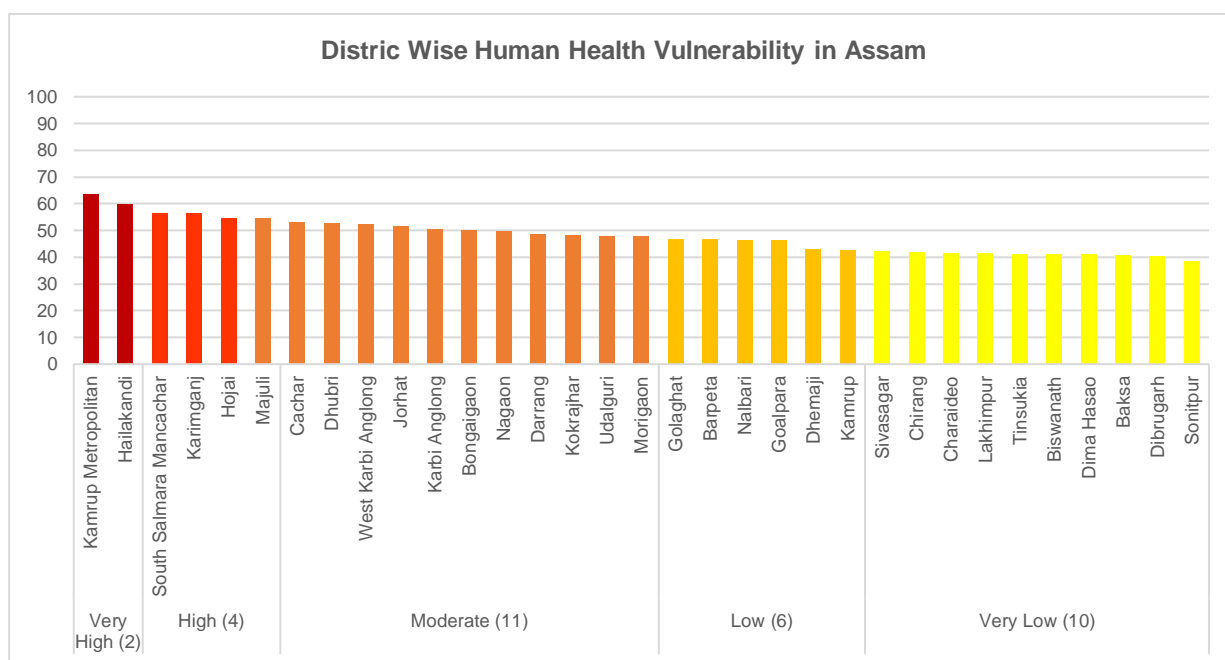
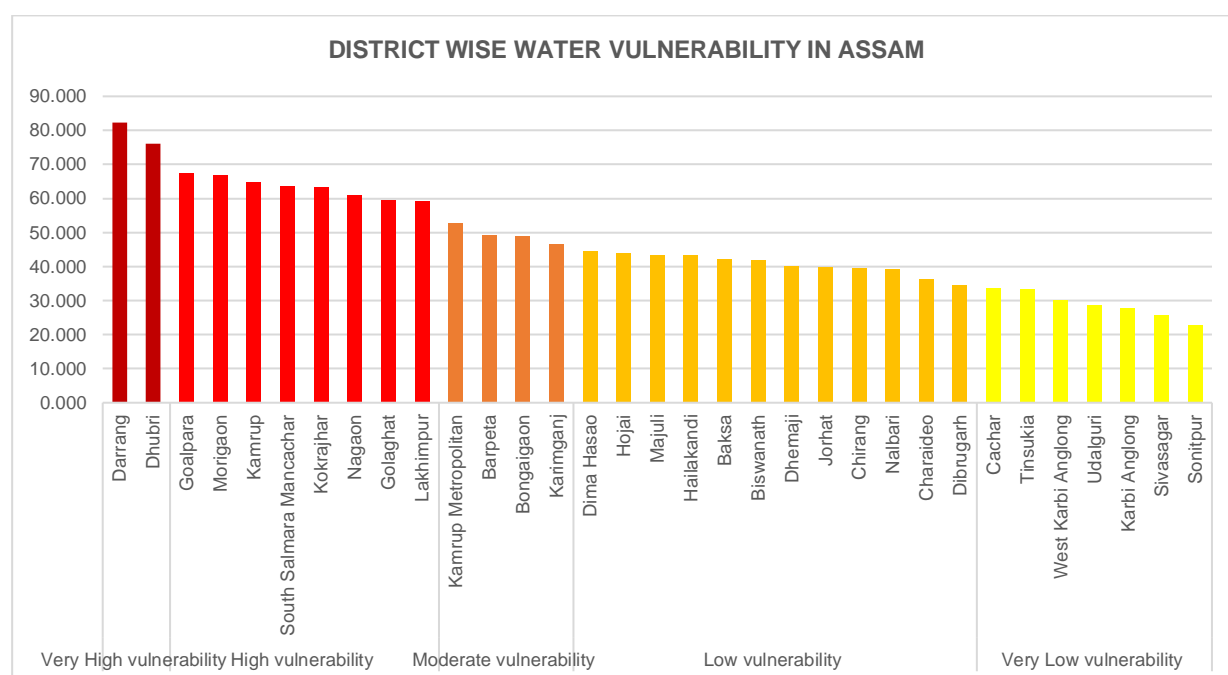*Figure 55: Ranking of districts based on Health Vulnerability Index from very-high to very-low vulnerability*

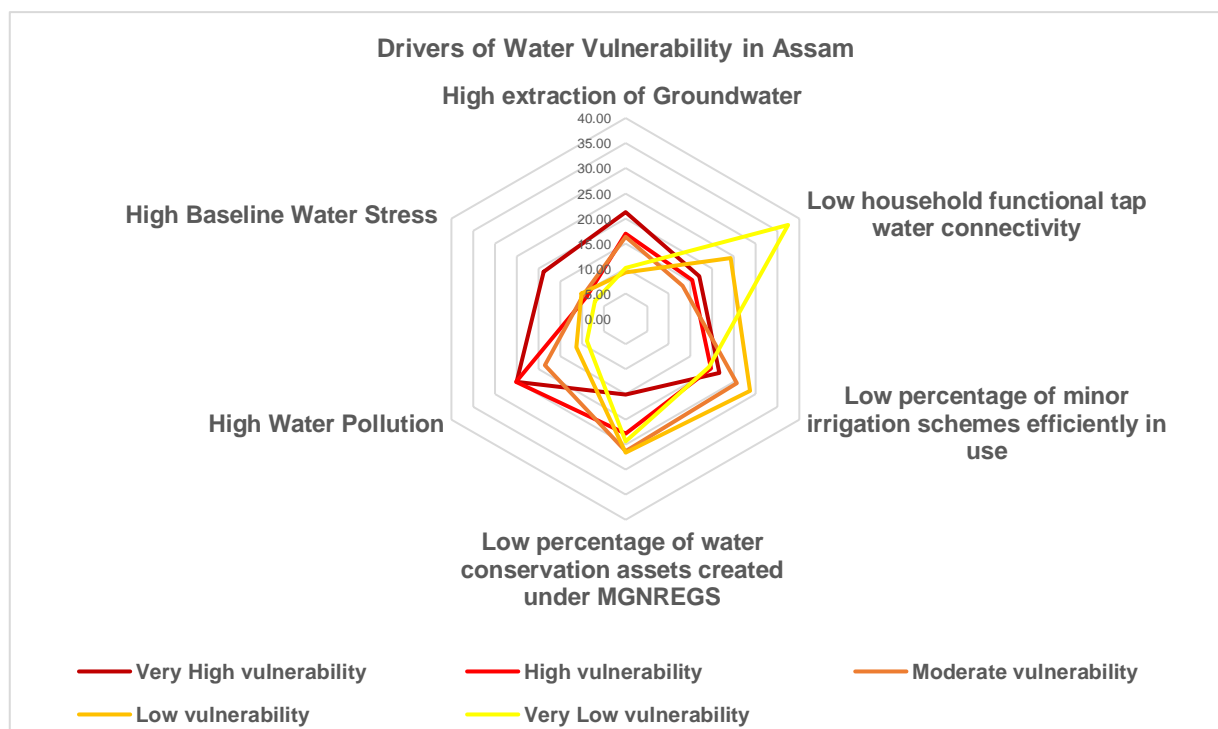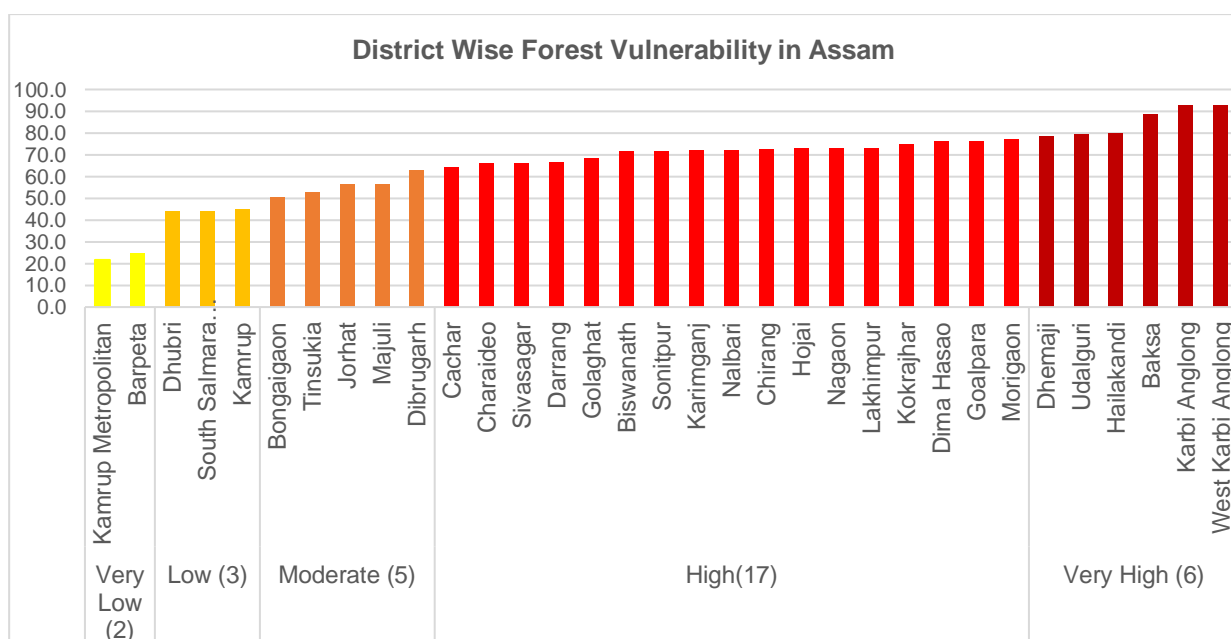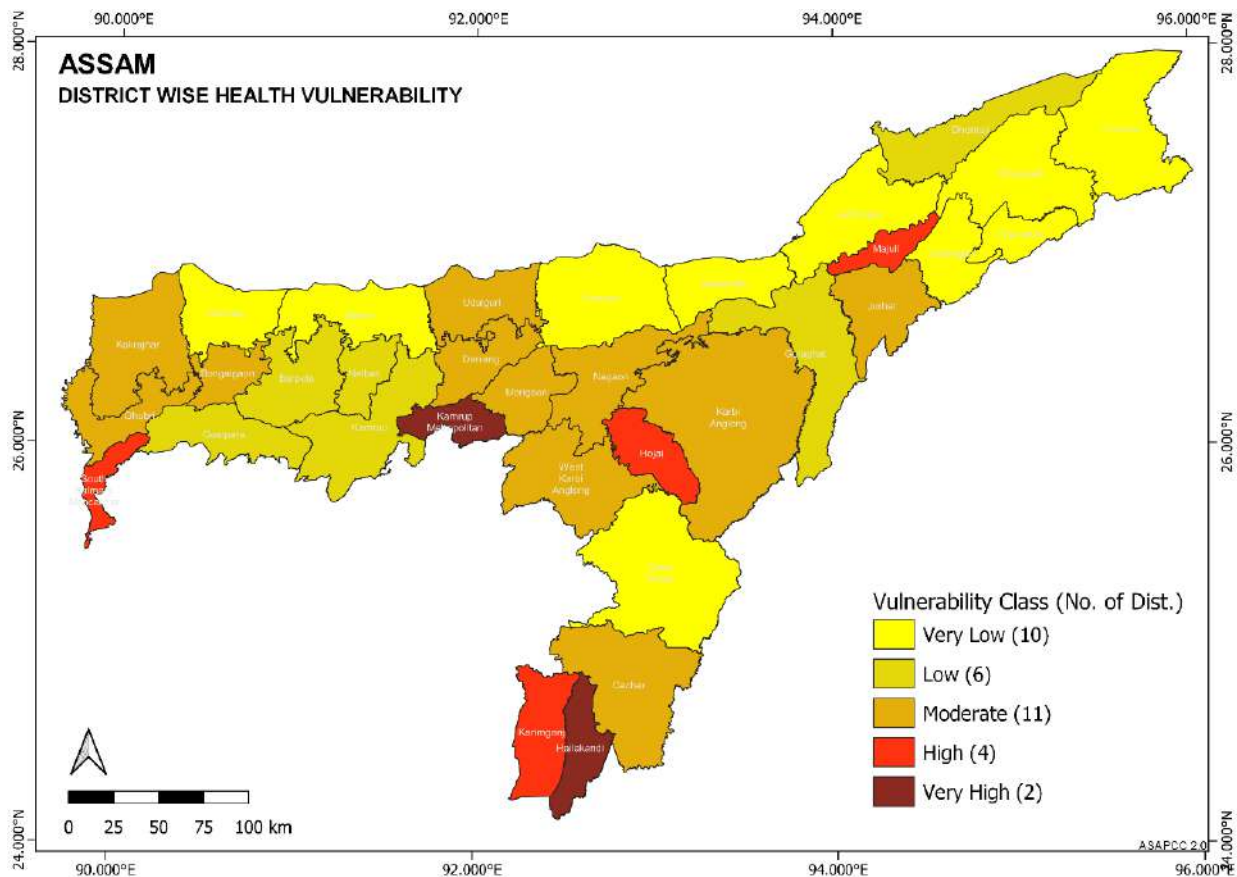*Figure 56: District wise Health Vulnerability Map*
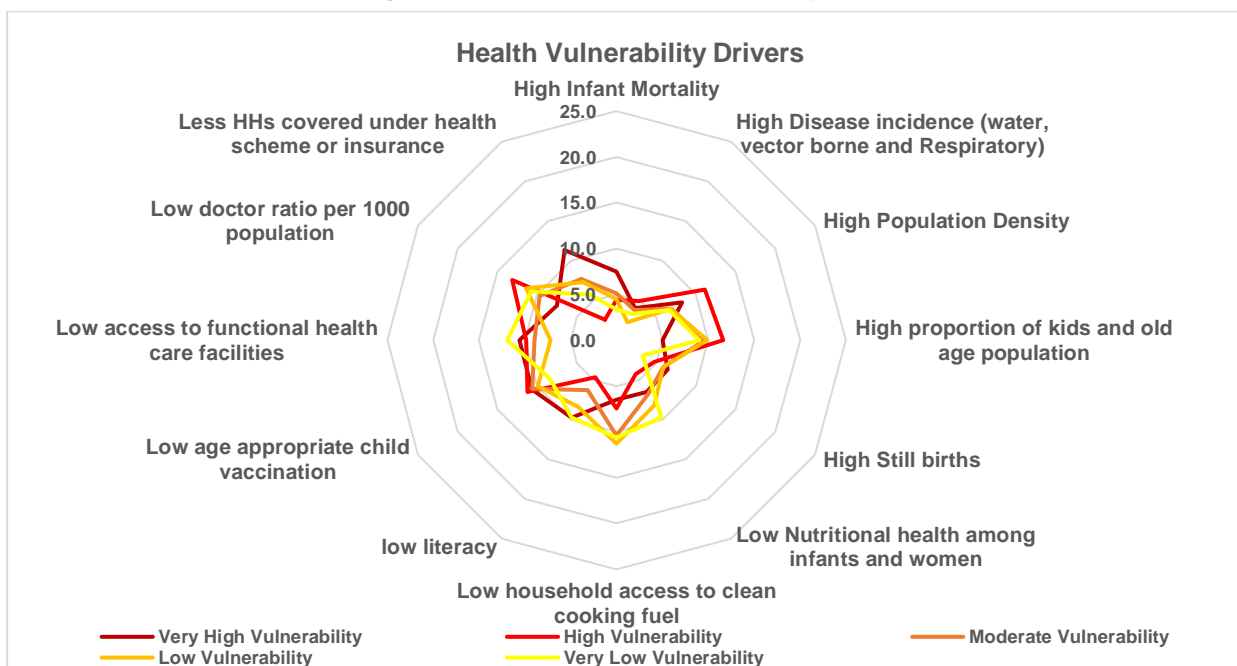
Figure 57: Drivers of health vulnerability index represented as a radar plot

Table 26: Drivers of health vulnerability for the districts in different vulnerability classes (percentage contribution 75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	Kamrup Metropolitan, Hailakandi	1. Less Households covered under health scheme or insurance 2. Low access to functional health care facilities (public) 3. Low age-appropriate child vaccination 4. High Population Density
High vulnerability	Majuli, South Salmara Mancachar, Karimganj, Hojai	1. Low doctor ratio per 1000 population 2. Low age-appropriate child vaccination 3. High age dependent population (below 6 and above 60 years) High Population Density
Moderate vulnerability	Cachar, Dhubri, West Karbi Anglong, Jorhat, Darrang, Morigaon, Udalguri, Kokrajhar, Karbi Anglong, Bongaigaon, Nagaon	1. Low age appropriate child vaccination 2. Low HH access to clean cooking fuel 3. Low doctor ratio per 1000 population 4.High age dependent population (below 6 and above 60 years) 5. Low access to health care facilities (public)
Low vulnerability	Golaghat, Barpeta, Nalbari, Goalpara, Dhemaji, Kamrup	1. Low HH access to clean cooking fuel 2. Low doctor ratio per 1000 population 3. Low age appropriate child vaccination 4. High age dependent population (below 6 and above 60 years)
Very Low vulnerability	Sivasagar, Chirang, Charaideo, Lakhimpur, Tinsukia, Biswanath, Dima Hasao, Baksa, Dibrugarh, Sonitpur	1. Low access to health care facilities (public) 2. Low doctor ratio per 1000 population 3. Low HH access to clean cooking fuel

4.3.9 Vulnerability of Disaster Management Sector

4.3.9.1 *Indicators Selected*

Six indicators (Annexure B) were considered to assess Disaster Management vulnerability (DMVI) at the district level. Out of the 33 districts, 2 districts (Kamrup Metropolitan, Hailakandi) were ranked as having very-high vulnerability; 4 districts (Majuli, South Salmara Mancachar, Karimganj, Hojai) were ranked as highly vulnerable; 11 districts (Cachar, Dhubri, West Karbi Anglong, Jorhat, Darrang, Morigaon, Udalguri, Kokrajhar, Karbi Anglong, Bongaigaon, Nagaon) were ranked as having moderate vulnerability; 6 districts (Golaghat, Barpeta, Nalbari, Goalpara, Dhemaji, Kamrup) were ranked as having low vulnerability and 10 district (Sivasagar, Chirang, Charaideo, Lakhimpur, Tinsukia, Biswanath, Dima Hasao, Baksa, Dibrugarh, Sonitpur) were ranked as having very-low vulnerability. This is presented as a graph (Figure 58) and map (Figure 59).
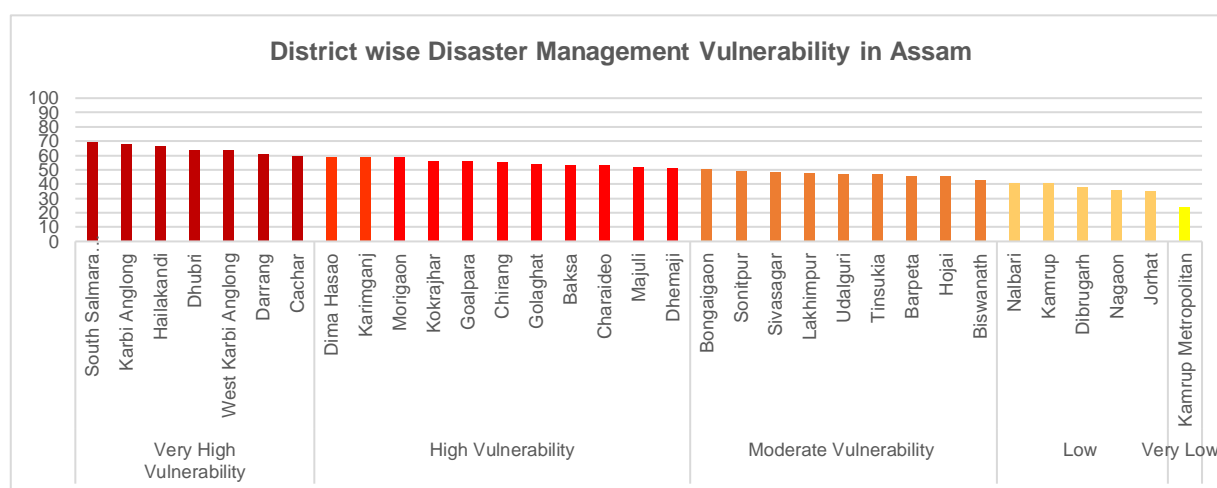
Figure 58: Ranking of districts based on DMVI from very-high to very-low vulnerability
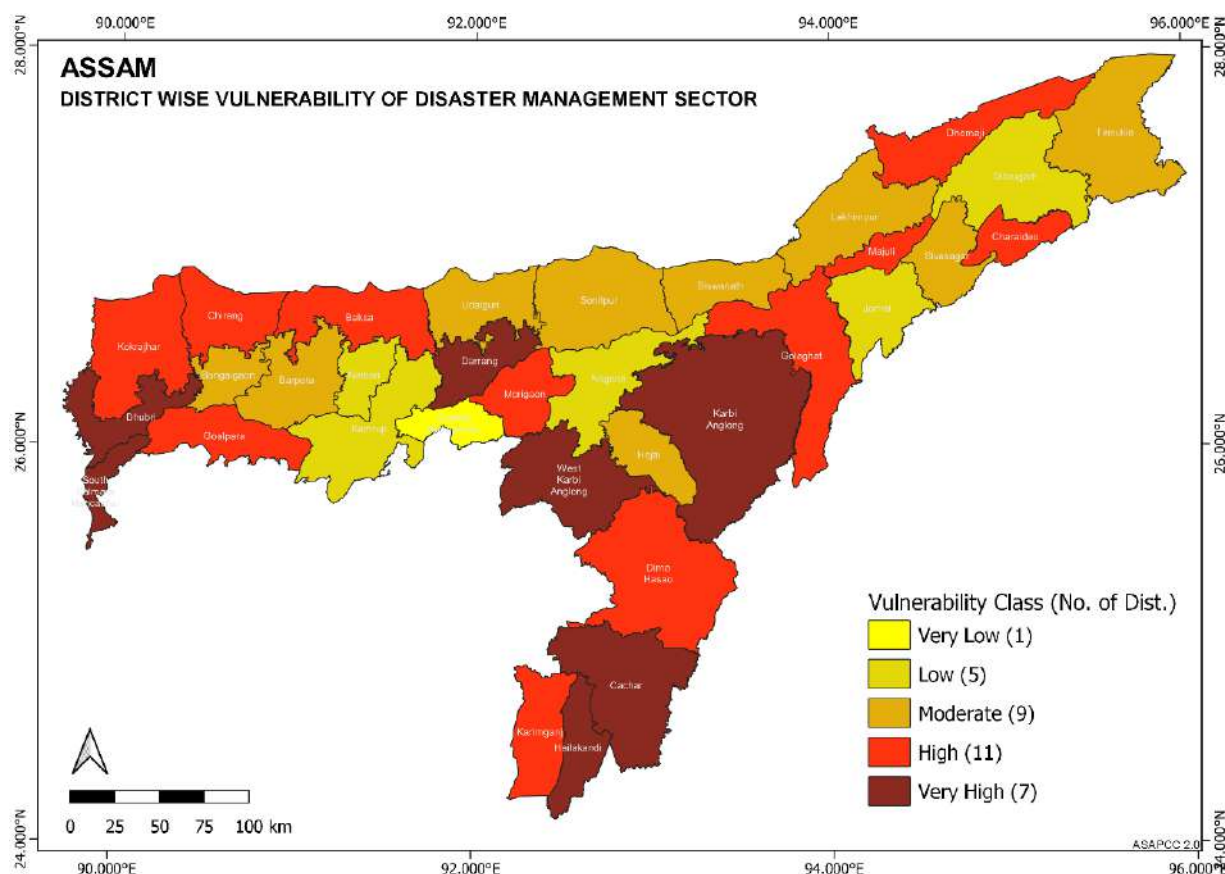
Figure 59: District wise Vulnerability Map of Disaster Management Sector in Assam
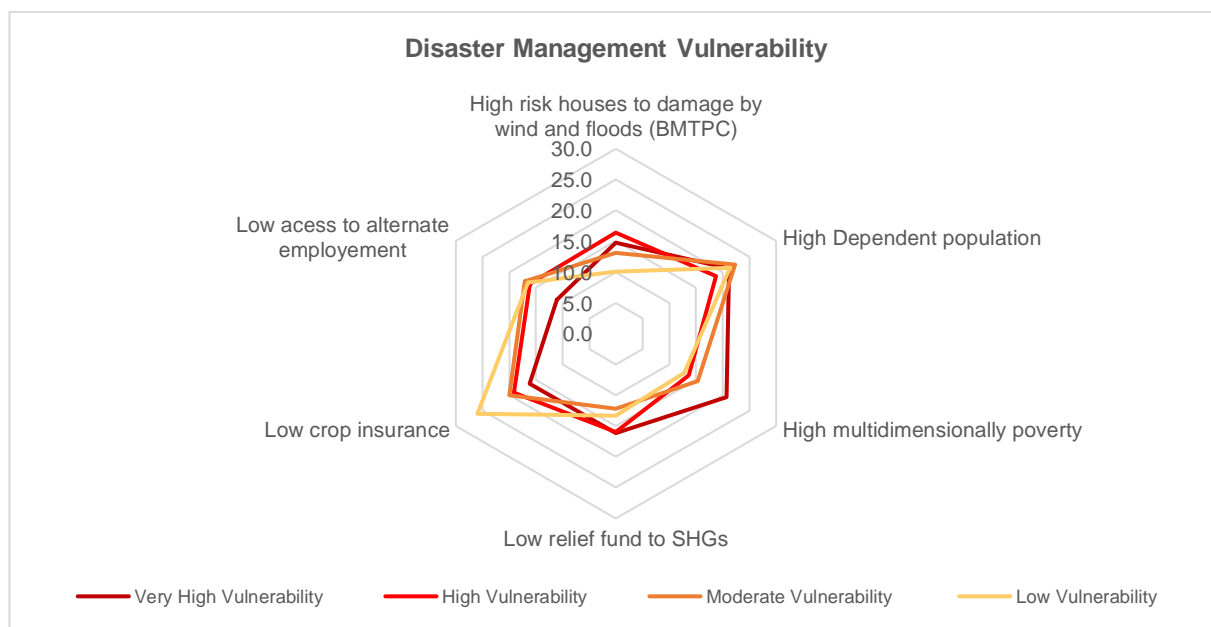
Figure 60: Drivers of DMVI represented as a radar plot

Table 27: *Drivers of DMVI for the districts in different vulnerability classes (percentage contribution >75%)*

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	South Salmara Mancachar, Karbi Anglong, Hailakandi, Dhubri, West Karbi Anglong, Darrang, Cachar	1. High dependent population 2. High multidimensional poverty 3. Low Crop Insurance Coverage
High vulnerability	Golaghat, Chirang, Kokrajhar, Goalpara, Dima Hasao, Karimganj, Morigaon, Baksa, Charaideo, Majuli, Dhemaji	1. Low Crop insurance coverage 2. High dependent population 3. low access to alternate employment
Moderate vulnerability	Sonitpur, Udalguri, Lakhimpur, Sivasagar, Bongaigaon, Tinsukia, Barpeta, Hojai, Biswanath	1. Low Crop insurance coverage 2. High dependent population
Low vulnerability	Nalbari, Kamrup, Dibrugarh, Nagaon, Jorhat	1. Low Crop insurance coverage 2. High dependent population
Very Low vulnerability	Kamrup Metropolitan	1. Low access to alternate employment 2. low crop insurance coverage

4.3.10 Inherent Composite Vulnerability

The composite vulnerability index (CVI) broadly captures the inherent vulnerability of districts. Indicators that represent all the sectors covered above were selected for the construction of Composite Vulnerability Index. **Table 28** below provides the list of indicators selected for the computation of CVI. Rationale for selection, and sources of data have been provided in previous sections.

Table 28: *Indicators selected for the construction of Integrated, Composite vulnerability Index at the districts level*

Sector	Indicator
Agriculture	Average Yield variability (Food Crops, Horticulture, Tea Crops, Egg Production, Milk Production, Meat, and Fish Yield)
Water Resources	Net water Availability (water stress)
Forests	Percentage change in forest area (2017-2019)
Socio-economic Development (rural and urban)	MPI Index (literacy, safe drinking water, sanitation and wastewater drainage and housing)
Energy	Access to electricity
Health	Access to functional health care facilities
Disaster Management	Percentage of households at risk to damage by wind and extreme rainfall

Out of the 33 districts, 8 districts (Biswanath, Nagaon, Cachar, Tinsukia, Darrang, Kamrup, Sonitpur, Dibrugarh) were ranked as having very-high vulnerability; 4 districts (Jorhat, Morigaon, Kamrup Metropolitan, Karimganj) were ranked as highly vulnerable; 10 districts (Udalguri, Kokrajhar, Hojai, Chirang, Majuli, Dhubri, Lakhimpur, Sivasagar, Barpeta, Baksa) were ranked as having moderate vulnerability; 5 districts (South Salmara Mancachar, Charaideo, Golaghat, Dima Hasao, Hailakandi) were ranked as having low vulnerability and 6 district (Dhemaji, Goalpara, West Karbi Anglong, Bongaigaon, Nalbari, Karbi Anglong) were ranked as having very-low vulnerability. This is presented as a graph (**Figure 61**) and map (**Figure 62**).
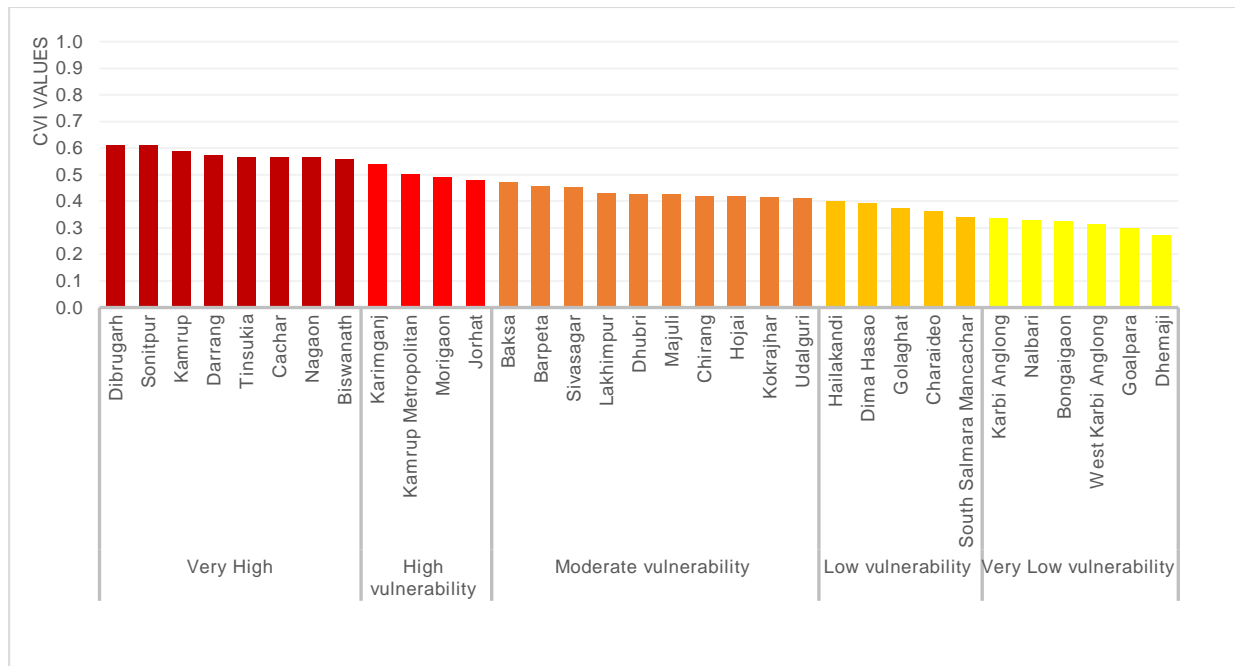
Figure 61: Ranking of districts based on CVI from very-high to very-low vulnerability
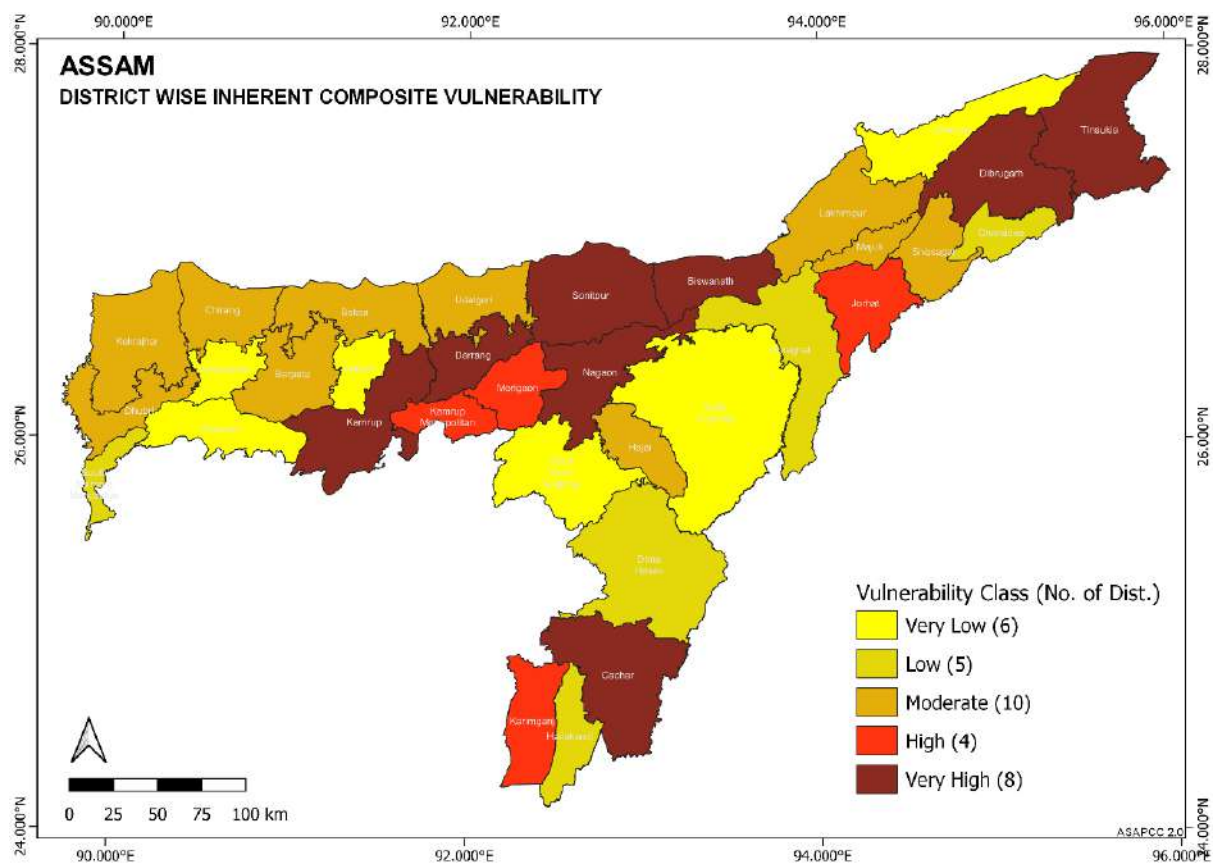
Figure 62: District wise Composite Vulnerability in Assam
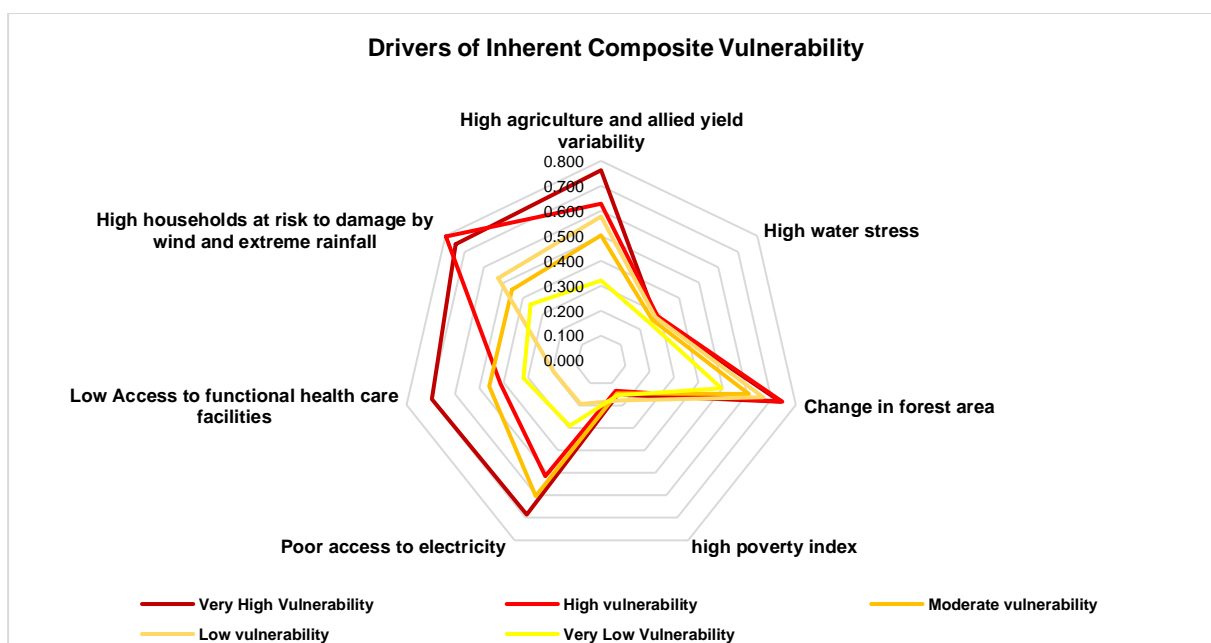
Figure 63: Drivers of CVI represented as a radar plot

The following table highlight the composite vulnerable district across the five vulnerability classes and their respective drivers of vulnerability.

Table 29: Drivers of CVI for the districts in different vulnerability classes (percentage contribution >75%)

Vulnerability Class	Districts	Major Drivers
Very High vulnerability	Biswanath, Nagaon, Cachar, Tinsukia, Darrang, Kamrup, Sonitpur, Dibrugarh	1. High Agriculture and allied sector yield variability 2. High house type at risk to damage by wind and extreme rainfall 3. Change in forest area
High vulnerability	Jorhat, Morigaon, Kamrup Metropolitan, Karimganj	1. High house type at risk to damage by wind and extreme rainfall 2. Change in forest area 3. High Agriculture and allied sector yield variability
Moderate vulnerability	Udalguri, Kokrajhar, Hojai, Chirang, Majuli, Dhubri, Lakhimpur, Sivasagar, Barpeta, Baksa	1. Change in forest area 2. Low access to electricity 3. High Agriculture and allied sector yield variability 4. Low access to functional health care facilities
Low vulnerability	South Salmara Mancachar, Charaideo, Golaghat, Dima Hasao, Hailakandi	1. Change in forest area 2. High Agriculture and allied sector yield variability 3. High house type at risk to damage by wind and extreme rainfall
Very Low vulnerability	Dhemaji, Goalpara, West Karbi Anglong, Bongaigaon, Nalbari, Karbi Anglong	1. Change in forest area

Chapter 5. Climate Adaptation and Mitigation Strategies

The chapter on adaptation and mitigation strategies, is designed to address the climate risks of the agriculture sector, water resources, forests and biodiversity, human habitats, transportation, human health, disaster management and strategic knowledge. Climate risk being a function of exposure, vulnerability and hazards, it has been identified for each sector on the basis of (a) sector wise district level vulnerability assessments undertaken (see chapter 4), (b) literature survey articulating impacts of climate change and hazards on each sector and mitigation opportunities, and through (c) discussions with technical experts and departmental officials.

A long list of potential strategies was then drafted to address the identified climate risks based on literature survey indicating state of the art feasible solutions. The next step of selection of priority strategies happened through several rounds of discussions with departmental officials who are responsible for delivery of developmental programmes and through discussions with technical experts. The priority strategies have been selected in such a way so as to allow Sustainable Development Goals of the State to progress unhampered while aligning with the NDC goals of India committed to the Paris Agreement.

5.1 Agriculture and Allied

Agriculture and allied sector in Assam is a critical sector as it governs the economic wellbeing of almost 75 per cent of the state's population that are directly or indirectly dependent on agriculture while about 69 per cent of the workforce of the state are engaged in agricultural activities[13]. Agriculture being a climate sensitive sector, wide scale adoption of climate smart practices and technologies need to take place in the State so as to ensure required production levels and related livelihood security of its population.

Climate trends analyzed for the period 1981-2019 in this report for Assam, indicates continuous increase in ambient temperature, decreasing seasonal and annual rainfall trends, increasing intensity of rainfall events, reduced number of rainy days, and increasing length of dry spells during monsoon period (see chapter 3). A recent 2022 publication of NIDM[14], notes that Assam has been regularly experiencing hydro meteorological hazards such as floods (more than 20 floods between the period 1995-2020), droughts and extreme heat events affecting agriculture and horticulture crops, livestock and fisheries. Floods during Kharif season not only damages the standing crops but also significantly impacts soil fertility via heavy siltation of the fields, often resulting in permanent loss of agricultural land. (Neog, 2016)

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[13] https://niti.gov.in/planningcommission.gov.in/docs/plans/stateplan/sdr_assam/sdr_assch7.pdf
[14] https://nidm.gov.in/PDF/pubs/GIZNIDM_21.pdf

The key climate impact drivers that create pressure on the agriculture and allied sectors are

Temperature Variability · Rainfall Variability · Flooding · Drought · Pest and Diseases · Extreme Winds & Storms

Following Table 30 depicts the key climate risk and impact findings based on secondary literature on the agriculture, horticulture, livestock, tea and fisheries sectors in Assam.

Table 30: Evidence based mapping of climate risks and impacts on Agriculture Sector

Climate Risk/Hazard	Crops/livestock affected	Findings	References
Decreasing monsoon Rainfall **High spatial variability in rainfall receipt**	Rice and Tea	• Rainfall variability is harmful to autumn and winter rice yield. • With the reduction in rainfall, the tea cultivation is impacted which led to the increase in pest.	Nath et al. (2018); Roy et al. (2019)
Rising maximum and minimum temperature	Rice & Maize, Tea, potato, mustard, and Fish	• Temperature rise projected for the future, may lead to low average yields of 5 principal crops of Assam, namely, autumn rice, summer rice, winter rice, mustard and potato. • Rice yields in the Eastern Himalayas may decrease by -3.56%, -5.49% and -6.79% by 2030s, 2050s and 2080s respectively w.r.t base line for temperature projections generated by CORDEX SA multi-RCM ensemble average run on RCP 4.5 scenario. The yields may decrease further by -3.89%, -6.72% and -11.39% respectively for higher temperature rise generated under RCP 8.5 scenarios (Singh et al, 2020). • Maize yields may rise by +1.83%, +2.97% and +3.61% by 2030s, 2050s and 2080s respectively for temperature changes generated by CORDEX SA multi-RCM ensemble average run on RCP 4.5 scenario. Yields may further increase by +2.04%, +3.56% and +6.10% for 2030s, 2050s and 2080s respectively for temperature projections generated by RCP 8.5 scenarios. • Observations indicate decrease in tea yields at monthly average temperatures above 26.6°C during growing period. Increase in precipitation intensity, is negatively affecting tea yields. An increase in average temperatures as expected with global warming will reduce the productivity of tea plantations, all else held equal. • Increased warm spells is also associated with increased pest attacks in tea plantations. • A decline in water temperature reduces the immunity of fish causing them to become more prone to disease outbreaks.	Mandal and Singh (2020); Singh et al. (2020); (J.M.A.Duncan, 2016); (B Kalita, 2019)
Extreme rainfall & Flooding	Rice, Kharif crops, livestock, Fisheries	• Floods in Assam led in the decrease of Kharif crops. • Sali rice is affected greatly due to flood. • Floods in Majuli River Island in Assam has greatly affected cropland and livestock. • Prevalence of floods in the Nagaon, Morigaon and Sonitpur districts of Assam leads to common disease incidences in fish culture ponds.	Phukan (2016); (Das D. , Changing climate and its impacts on Assam, Northeast India , 2015); (B Kalita, 2019)

Climate Risk/Hazard	Crops/livestock affected	Findings	References
Drought Proneness	Maize, Rice, Tea	• Drought leads to drying of soil and affects the cob formation stage of maize • Drought stress affects different traits of rice such as seedling biomass, stomatal conductance, photosynthesis, starch metabolism and plant-water relations. • Longer periods of drought may lead to reduced yield and pest attacks in tea plantations.	Kalita et al. (2019); Nahar et al. (2018) (Eloise M. Biggsa, 2018)

As evidenced from literature, it is clear that projections of continued rise in average temperatures, changes in precipitation pattern, increase in drought and flood incidences and intensities have the potential to threaten agricultural production, food security, and the livelihoods of farming communities in Assam and hence the achievement of the SDGs that Assam has set for itself in the agriculture sector. Therefore, adoption of agriculture technologies and practices that can enable beneficial adaptation to climate change need to be aggressively mainstreamed amongst farmers in Assam.

Some practices that lead to GHG emissions from this sector include slash and burn practices in shifting cultivation, rice cultivation in continuously flooded fields, use of synthetic fertilizer and enteric fermentation in cattle. Practices that lead to conservation as well as mitigation of GHG emissions need to be adopted in the State which can also contribute to achievements of India's NDC goals 3 and 5 towards reducing emission intensity of its GDP and increasing Carbon sequestration.

5.1.1 Stocktaking and key climate policies

The government of Assam in the past five years has taken key steps that are towards climate change adaptation and or mitigation. Some of the key actions taken are listed below.

• The Government of Assam has introduced "zero interest crop loans" by giving 100% interest subventions on agricultural loans taken by the farmers of Assam to the limit of Rs 1.00 lakh.

• Provision of Identity Cards to the farmers in Assam

• Preparation of District Irrigation Plan, Annual Action Plan for Irrigation and also State Irrigation Plan

• To raise the productivity of the agricultural sector, the state agriculture department distributed High Yielding Variety of seeds among the farmers for free of costs.

• To improve the employment opportunities and engagement of women in the horticulture sector, the Directorate of Horticulture and Food Processing of Government of Assam took a positive step by helping 15,000 rural women and supported them to engage by setting up 350 small and 4 medium fruits processing units.

• The use of bio-fertilizer, compost and green manure and organic farming practices have gradually increased.

• Constitution of an Agriculture Commission with experts and agricultural scientist to explore options for commercial agricultural production.

• To add value and improve resilience of selected agriculture value chains, focusing on smallholder farmers and agro-entrepreneurs in targeted districts, Assam launched Agribusiness & Rural Transformation Project (APART) project worth Rs. 1688 crore

- During 2016-17, Assam government budgeted Rs. 30,000 crores under Chief Minister's Samagra Gramya Unnayan Yojana (CMSGUY) over a period of five years to double the farmers' income.

Key central and state policies linked to climate adaptation and mitigation in agriculture and allied sector:

Food Crop, Horticulture and Tea:

- Green Revolution Krishonnati Yojana
  - National Mission for Sustainable Agriculture (NMSA)
  - Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)
- Mission for Integrated Development of Horticulture (MIDH)
- National Food Security Mission (NFSM)
- Pradhan Mantri KIsan SAmman Nidhi (PM-KISAN)
- National Crop Insurance Programme (NCIP)
- Rashtriya Krishi Vikas Yojana (RKVY)
- Assam Team Industries Special Incentive Scheme

Animal Husbandry and Dairy:

- National Livestock Mission
- Gokul Mission
- Char Area Development Programme
- National Plan for Dairy Development
- Umbrella Scheme for production of milk
- Milk Supply Schemes
- Heifer Rearing Package Scheme (Distribution of Jersey Cross Breed Milk Cow)
- Rejuvenation of Town Milk Supply Scheme

Fisheries:

- Matsya Jagaran–Ghare Ghare Pukhuri Ghare Ghare Maach
- Seed Bank Programme
- Majuli Development Programme
- Selection of Matsya Mitra
- Beneficiary Training
- Assistance To Women SHGs For Production of Value-Added Fish Products

5.1.2   Strategies, and Actions for Agriculture and Allied Sector

The table that follows the below mentioned examples of strategies that will be implemented by the State Govt. summarises key climate drivers faced by the sectors, along with the outcomes of the district anomalies in the observed climate trend and extreme events (chapter 3), vulnerability assessment (chapter 4), and at the end the relevant SDGs, state development targets (chapter 2).

> ### *Bringing Climate Resilience in the Tea Sector*
>
> *ACCMS is exploring climate mitigation opportunities across the value chain of the tea sector, including replacing biomass burning and fossil fuel-based energy use under a pilot project, **"Scoping Study and Pilot Implementation for Building Sustainability in the Tea Sector of Assam"**. The department will scale up the learnings from this.*

Addressing the Challenge of Jhum Cultivation

Strategies will be identified for addressing jhum cultivation across different regions in the state. Potential solutions will include:

- ***Promoting Agroforestry:*** *The State can incentivise the practice of agroforestry, where trees or shrubs are grown around or among crops. This helps retain soil fertility, improve crop yield, reduce the need for shifting cultivation, and provide additional economic benefits.*

- ***Education and Training****: Offering education and training programs to farmers about the impacts of Jhum cultivation on the environment and the benefits of alternative farming methods, including organic farming, permaculture, and others.*

- ***Crop Diversification:*** *Encouraging farmers to diversify their crops can maintain soil fertility and reduce the need for shifting cultivation. Introducing crops that enrich the soil, like legumes, can be beneficial.*

Implementing Terracing: Encouraging terracing on hill slopes can reduce soil erosion, improve water retention, increase the amount of arable land available for farming, and decrease the need for Jhum cultivation. Assam Forest Department is reclaiming the abundant jhum cultivated area and one such example is 25 ha Quick Growing

June 2019

June 2020

July 2022

Climate Impact Drivers

Temperature Variability | Rainfall Variability | Flooding | Drought | Pest and Diseases | Extreme Winds & Storms

Most Climate Vulnerable Districts/Locations **(Moderate, High, and Very High)** *Refer Chapter 4 for drivers*	**Food Crops and Horticulture (Including Tea):** Tinsukia, Dibrugarh, Dima Hasao, Cachar, West Karbi Anglong, Jorhat, Karbi Anglong, Karimganj, Nagaon, Kokrajhar Dhemaji, Kamrup Metropolitan, Golaghat, Goalpara, Charaideo, Hojai, Udalguri, Morigaon, Kamrup, Sivasagar, Darrang, Lakhimpur, Dhubri, Chirang, Majuli, Biswanath, Baksa, Sonitpur, South Salmara Mancachar *Agro climatic Zones: Barak Valley Zone, Upper Brahmaputra Valley Zone, Hill Zone* **Livestock, Dairy and Fisheries:** Dhemaji, Chirang, Udalguri, Dima Hasao, West Karbi Anglong, Karbi Anglong, Majuli, Lakhimpur, Baksa, Golaghat, Jorhat, Hailakandi, Biswanath, Charaideo, Goalpara, Nalbari, Cachar, Sivasagar, Bongaigaon, Darrang, South Salmara Mancachar, Kokrajhar, Dibrugarh, Tinsukia, Morigaon, Karimganj, Dhubri *Agro climatic Zones: Hill Zone, Upper Brahmaputra Valley Zone, North Bank Plain Zone*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 (IMD Pune, 2021)	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur

Related State SDG Targets

(Assam Agenda 2030)

Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
Average rice yield (kg/ha)	2119	3000	3500	4238
Cropping intensity (%)	149	166	189	223
Distribution of soil health cards (proportion%) of total requirement of 272,000	34.3	100	100	100
Production of Pulses (lakhs MT)	1.43	4.96	5.18	5.52
Production of oilseeds (Lakhs MT)	2.48	4.46	4.66	4.97
Per-capita fish consumption (kg/person/year)	9	11	15	20
Meat availability ('000 tonnes)/ (as %of requirement)	49 (13.5)	150(40)	300 (77.3)	405 (100)
Egg availability (million nos)/ (as % of requirement)	476 (8.0)	1500 (24.5)	4000 (63)	6624 (100)
Milk production (Million ltr)/ (as %of requirement)	908 (36.2)	1300 (50.3)	1632 (60.9)	2794 (100)

	Production of Silk Yarn (eri + Muga + Mulberry) (MT)	2712.0	2996	3786	7584
	Requirement certified Paddy seeds (MT)	53696	55448	57848	61664
	Production (MT)	55000	55448	57848	110000
	Requirement certified pulse seeds (MT)	9816	10122	10571	11265
	Production (MT)	200	10122	10571	11265
	Requirement certified oil seeds (MT)	3600	3717	3883	4142
	Production (MT)	3800	3717	3883	4300

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total **three Strategies** have been evolved to deal with impacts of climate change on agriculture and allied sector in Assam.

Overall Agriculture and Allied Sector Strategy Summary:

Across the three strategies (refer Table 31) in the sector, a total of 23 action/sub-actions are proposed to be implemented till 2030.

Table 31: Proposed Strategies, Number of Actions, Key Agencies and SDG-NDC linkage for Agriculture Sector

Strategies	Number of Proposed Actions/Sub-actions	Key Nodal Agencies and Implementing Agencies	SDG and NDC Linkages
Strategy 1: Addressing climate risk through climate smart agriculture practices	12	Directorate of Agriculture; Soil Conservation Dept., Animal Husbandry & Veterinary Department, Fisheries Dept.	SDG 01 SDG 02 SDG 13 NDC 06
Strategy 2: Improved access to risk sharing measures to increase farmer's income and livelihood security	7		
Strategy 3: Strengthening Tea Sector and build climate adaptation	4	Tea Board, Directorate of Tea (Industries Dept.)	

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Majority of 23 proposed actions are implementation activities (83 per cent) involving creation of climate smart and sustainable agriculture and allied practices. Also, considering importance of current climate change impacts 70 per cent of actions are adaptation centric (refer Figure 64).
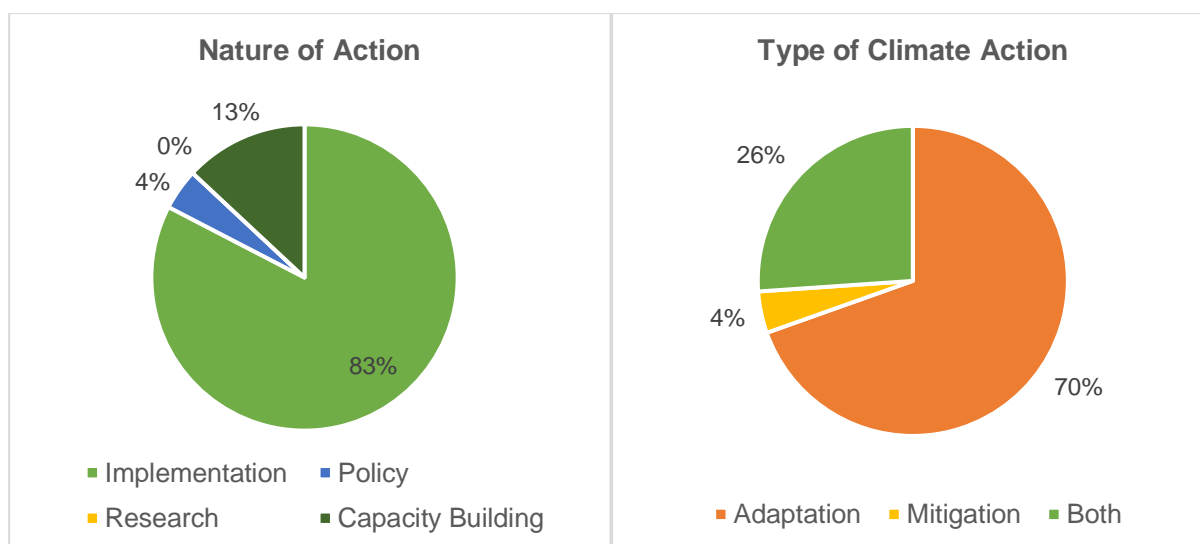
Figure 64: Distribution of Type and Nature of Actions proposed under Agriculture Sector

Strategy 1: Addressing climate risk through climate smart agriculture practices

Rationale: Strategy 1 emphasises in addressing the key climate risks and build holistic climate smart agriculture measures across value chains. Considering about 4.75 lakh hectares of land is chronically flood prone and about 0.94 lakh hectares of land is drought prone in Assam and owing to increasing likelihood of impacts of floods, droughts in future on the food crops such as rice, wheat, bajra. This strategy also focuses on the path to achieve the vision of creating 'sustainable agriculture for enough food, employment and wealth' of agriculture sector in the state. In addition to food crops, horticulture crops support farmer in doubling their income, and build resilience. With growing extreme events informed decision making on the cropping pattern, climate smart practices need to be mainstreamed into the entire value chain to support all size holding farmers. Also, fisheries a part of staple diet in Assam. Increasing population pressure to sustain the production requires a special attention within the landscape of climate change pertinent to fisheries and its supply-chain in the state.

Key vulnerability drivers at district level addressed by strategy 1:

- Low Crop Area Insured under PMFBY
- High Unirrigated Area
- Low access to information and technology
- Low access to fish markets
- Low access to quality fish seeds
- Less area under horticulture trees

Strategy 2: Improved access to risk sharing measures to increase farmer's income and livelihood security

Rationale: Strategy 2 focuses on promoting affordable weather-based crop insurance and enhancing Agri advisories play a critical role in increasing overall adaptive capacities to avoid risks. Also, to double the farmer's income, actions focusing on diversification of risk through integrated farming systems, increasing cold-storage capacities, and awareness and building capacities of farmers, training of trainers and policy makers thereby improving access to risk sharing options and protect vulnerable farmers.

Key vulnerability drivers at district level addressed by strategy 2:

- Low Crop Area Insured under PMFBY
- High Unirrigated Area
- Low access to information and technology
- Low access to fish markets
- Low access to quality fish seeds
- Less area under horticulture trees

Strategy 3: Strengthening Tea Sector and build climate adaptation

Rationale: Assam being a top tea producing state, climate change impacts on the entire tea sector needs a special attention. Also, to meet the production targets in the extreme weather events and slow-onset conditions caused by climate change holistic adaptation and mitigation measure throughout the tea value chain necessitates this strategy and actions in the state.

A brief list of strategy wise actions, responsible agencies till 2030, and potential funding sources has been depicted in the Table below.

Table 32: Agriculture and Allied Sector Strategies and action points till 2030

Sl.No	Strategies/Action	Responsible Agencies (nodal/implementation)	Potential Funding Sources
Strategy 1: Addressing climate risk through climate smart agriculture practices			
1.1	Develop FPO wise specific training packages and organise FPO wise trainings for farmers on the following aspects of climate smart approaches and technologies for food crops and horticulture crops, livestock and fisheries: · Soil health management · Pest disease management · Water management · Crop Diversification · Nutrient Management · Cultivar smart practices · Weather smart activities **Target**: All Districts [Designing of training modules by 2023 and implementation of training activities till 2030]	Agriculture and Horticulture Dept., Fishery Dept. and World Bank Project implementation unit (PIU)	Central Sponsored Schemes (CSS) and State Sponsored Schemes (SSS) - such as RKVY | NFSM SAMETI Bilateral and Multilateral Funds (APART Project etc.,)
1.2	Develop and distribute flood resilient paddy cultivars in all flood prone and water-logged areas in Assam. **Target**: Flood affected paddy area 305,204.90 ha	Agriculture and Horticulture Dept.	SOPD -Disaster Management CSS-RKVY, NFSM
1.3	Develop and distribute drought (water stress) resilient direct seeded cultivars (sahbhagi dhan) in drought prone areas and introduce the same in all districts. Promote millet production (Jowar, bajra, Ragi) in hilly areas to replace rice in drought conditions and stabilise/increase farmer's income. **Target**: Focus on 18.78 lakh ha of winter rice covering monsoon season June to Oct. In 50% of Rice areas in Karbi Anglong, West Karbi Anglong and Dima Hasao. Total rice area in these districts is 129587 ha.	Agriculture and Horticulture Dept.	SOPD -Disaster Management CSS-RKVY, NFSM
1.4	Develop and distribute good quality certified HYV seeds of short duration **Target**: All Districts	Agriculture and Horticulture Dept.	CSS & SSS- RKVY, NFSM
1.5	Ensure food security by promoting the highly biodiverse traditional Integrated Baree home gardens in Assam. (Soil Conservation, Pest & Disease Management, Management of multipurpose indigenous trees and shrubs interspersed with annual and perennial agricultural crops, Organic farming and certification).	Agriculture Department, KVKs	CSS and SSS - RKVY | NFSM I MIDH

Sl.No	Strategies/Action	Responsible Agencies (nodal/implementation)	Potential Funding Sources
	Target: Cover interested HHs with demarcated home gardens in rural areas of all 33 districts in Assam. 3 trainings each village every year.		
1.6	Ensure housing for all insured cattle to avoid heat stress **Target**: All blocks in Assam (219) Small & marginal farmers	Animal Husbandry and Veterinary Department	CSS and SSS - Gaushala and Gausadan Programmes
1.7	Invest in innovation for reducing the price of sprinkler and drip irrigation for wide scale adoption by farmers. **Target**: Undertake R&D and marketing	Agriculture and Horticulture Dept.	CSS (PMKSY)
1.8	Undertake Pilots in each of the 6 ACZs to promote landscape-based climate smart agriculture leading to enhancement of ES and hence agricultural yield. **Target**: For cereals, pulses, horticulture, oilseeds where production levels are observed to be low	Agriculture & Horticulture department	CSS (NFSM) and Multilateral and Bilateral Funds
1.9	Promote rain water harvesting based small tank fisheries in hilly areas. **Target**: All Hill Districts - 180 Ha	Fishery Department	CSS/SOPD/Donor Agencies
1.10	Establishing sanctuary/gene banks to retain indigenous fish biodiversity (indigenous fish species and fish sites). **Target**: All Districts (4 Sites)	Fishery Dept. and College of Fisheries	Gene Bank Programme
1.11	Support cultivation of green fodder through hydroponics at village level **Target**: All villages	Animal Husbandry and Veterinary Department	Fodder development scheme
1.12	Develop feed blocks with feed additives and Organise training camps to train farmers on the same. Incentivise dairies to also use these feeds. **Target**: All cross bred cattle [Awareness camps – 22 per panchayat]	Animal Husbandry and Veterinary Department	Fodder development scheme
Strategy 2: Improved access to risk sharing measures to increase farmer's income and livelihood security			
2.1	Introduce weather-based crop insurance scheme (WBCIS) to all farmers (large, medium, small and marginal) in all districts including non-loaned farmers, provide assured financial support in the event of crop failure due to floods and landslides (high rainfall), droughts (deficit rainfall), pest attacks (excess or deficit rainfall), high or low temperature, high or low humidity, hail storm, cyclonic winds etc. - Increase awareness on WBCIS - Train officials on the scheme - Disburse insurance product to all farmers **Target:** All Districts (4 Lakh Farmers)	Agriculture and Horticulture Dept., NABARD, and Insurance Agencies	CSS and SSS – WBCIS NABARD
2.2	Cover cross bred and high milk yielding cattle farmers with livestock insurance to cover loss due to floods, extreme heat and droughts. **Targets:** All Milk producing cattle	Assam Livestock development Agency	National Livelihood Mission (NLM)

Sl.No	Strategies/Action	Responsible Agencies (nodal/implementation)	Potential Funding Sources
2.3	Undertake breed upgradation – non descript to high quality Indian indigenous breed having higher milk production rate **Targets:** All GPs, 22 camps per Panchayats	Animal Husbandry and Veterinary Department	Gokul Mission
2.4	Promote integrated farming system - Model with various components like fish, paddy, duck along with horticulture crops **Targets:** All Districts	Agriculture and Horticulture Dept.	Multilateral and Bilateral Funds (e.g. APART)
2.5	Strengthen technologies and storage infrastructure to reduce post-harvest losses and to enhance value chain. **Targets:** All Pilot Districts by Fisheries Dept. Cold Storages: 24; Ice Plants: 25	Fishery Department	CSS/SOPD/Donor Agencies/ Multilateral and Bilateral Funds
2.6	Enable research, capacity building and popularizing risk management solutions in agriculture. **Targets:** Set up an institution	Agriculture Department, NABARD	NABARD
2.7	Develop and disseminate reliable weather advisory by establishing a network of Automatic Weather Stations at a finer resolution of 10kmx10km grid. **Targets:** 785 AWS across Assam	IMD, Agriculture and Horticulture Dept.	CSS | SSS [E.g. Atmosphere & Climate Research-Modelling Observing Systems & Services (ACROSS)]
Strategy 3: Strengthening Tea Sector and build climate adaptation			
3.1	Develop and disseminate climate resilient tea clones to small tea growers **Target**: All small tea growers	Tea Research Association, Tea Board, Directorate of Tea (Industries Dept.)	CSS, SOPD & SSS (E.g. Assam Team Industries Special Incentive Scheme) and Bilateral and Multilateral Funds, Private Finance
3.2	Restore/create water resources/water bodies around and within tea plantation areas (spring sheds, ponds, water harvesting structures etc.) **Target:** Covering all small tea growing areas	Tea Board, Directorate of Tea (Industries Dept.)	
3.3	Greening of commodity value chains- large tea plantations – solarisation of sprinkler systems and energy used for processing leaves and green transportation. **Target:** Large tea plantations	Tea Board, Directorate of Tea (Industries Dept.)	
3.4	Promotion of organic tea to enhance income of small growers - Training on organic practices - Certification **Target:** All small tea growers	Tea Board, Directorate of Tea (Industries Dept.)	

The detailed list of strategies, action wise implementation period, estimated budget based on stakeholder engagement, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.2 Water Sector

Assam owing to its physiography, endows abundant water resources. The two major river systems - the Brahmaputra and the Barak along with numerous tributaries constitute the rich surface water resources of the State. The ground water availability in the State is falling under safe category. But in spite of the rich resources of water in the State, irrigation has become highly essential because of adverse and unpredictable weather condition including flood, erosion and drought like situation etc.

The changes in climate are adversely affecting the livelihoods in rural locations of Assam because of dependence on subsistence agriculture and the vagaries of monsoon rain and unpredictable floods. A study on Majuli River Island reveals that the area faces threats due to continuous shifts in rainfall pattern as well as changes in the temperature. Due to constant occurrences of flood, erosion and siltation in Majuli, agriculture production has gone down excessively and agriculture production has no longer been profitable thereby impacting the income of the household from agriculture (Das D. , Changing climate and its impacts on Assam, Northeast India, 2016). Numerous other studies have been carried out in different regions of Assam in order to see any climate change impacts on water resources. The major impacts faced by water resources in the state includes declining groundwater, drying rivers, vanishing wetlands, etc.

The key climate impact drivers that create pressure on the Water sectors are

Temperature Variability | Rainfall Variability | Flooding | Drought | Water Stress
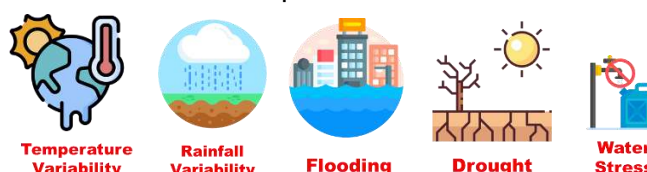
Subsequently, following are the key climate risk and impact findings based on secondary literature on the water resources sector in Assam.

Table 33: Evidence Based Mapping of Climate Impacts on Water resources

Driver of Impacts	Water Resources Impacted	Key Findings	References
Rainfall Variability	Surface and groundwater	• Frequent floods in areas like Majuli river Island are impacting livelihood • Bank erosion and loss of cropland; Salt deposition on farmland • Droughts affect the water level of wetlands leading to their shrinkage • Impact on aquatic biodiversity of wetland ecosystem • Declining trends of groundwater levels due to decline in rainfall	Deka & Sarma, (2011); Das (2016); Sarma & Hazarika (2013); Goswami & Rabha (2020)
Temperature Variability	Surface water	• Increase demand for water • Increased evaporation of water bodies • Sand deposits in wetlands by the recurring floods • Reduction in land mass of wetlands	Gupta, et al. (2019); Choudhury, et al. (2021); Das & Bhattacharjee (2020)

As mentioned in the above, varying temperature and Rainfall will have greater impact on the availability of water and the sectors related or dependent on water. The major impact of climate change on water sector is through damages caused by floods and bank erosion which are sometimes irreversible, for example, the loss of cropland to the river and salt deposition over farmland when the flood water enters the farmer's field through embankment breaches and leaves a heavy silt deposit. Study reveals that people have witnessed the loss of property and crops as a result of floods in the villages during the years of occurrence of major floods (1998, 2007, 2008 and 2013) (Das D. , Changing climate and its impacts on Assam, Northeast India, 2016).

On the other hand, wetlands are also among the worst hit areas due to climate change. Given that wetland ecosystem is significant for various ecological functions such as food storage, water resource, pollution abatement, and the aquatic life, therefore, shrinking of wetlands due to uneven precipitation pattern can disrupt these functions. A study reveals such impacts on Son Beel in Assam (Choudhury, Sharma, Singh, & Kumar, 2021). Another study outlines that Majuli has already lost as many as 371 sq.km of its land mass in last 50 years with a reduction in area from 1246 sq.km in 1950 to 857sq.km in 1998 (Das & Bhattacharjee, 2020)

Another major source of water recharge is groundwater which is largely influenced by rainfall variability. A study conducted to do trend analysis of groundwater levels and rainfall in Kamrup Metropolitan District of Assam reveals that there is a pattern of influence of rainfall over groundwater levels and shows that the effect of rainfall in a season is reflected in groundwater level in the following season. In other words, declining rainfall in monsoon and post-monsoon seasons translates into declining trends of groundwater levels in post-monsoon and winter seasons respectively (Goswami & Rabha, 2020).

5.2.1 Stocktaking and key climate policies

Following are few key achievements under water sector from 2016 to 2020.

- Till date as part of National Water Mission, a total of Rs. 51.00 lakhs were allocated to Assam as major works grant of which Rs. 21.4 lakhs were sanctioned to the nodal agency NERIWALM.
- Up to year 2019-20, a total of 4486.44 km of embankments have been constructed in the state, in addition to 1107 number of anti-erosion and town protection works, 892.216 km of drainage channel construction.
- With a budget of Rs. 100 crores, there were a total of 53 flood management and erosion schemes under NABARD during 2019-20
- Construction of "Brahmaputra Express Highway" on both banks of the river. Rs.2.50 Crores was budgeted for survey and investigation.
- In 2017-18, Rs.10.00 Crores was budgeted for survey and investigation Rejuvenation of Kollong River.
- FREMAA in collaboration with WRD have taken major initiative for River Bank Protection work, Fortification of Embankment, Construction of new Embankment & Pro-siltation measures through Trench-I & Trench-II of the ADB funded Projects at Dibrugarh, Kaziranga, Palashbari & Gumi, using blasted boulders, geo-textile material and locally available earth/sand.
- Construction of Minor irrigation schemes which include Flow Irrigation Schemes, Lift Irrigation Schemes, Deep Tube Wells, Shallow Tube Wells for irrigation under Pradhan Mantri Krishi Sinchayee Yojana(PMKSY).

- The National Hydrology Project (NHP) is being implemented by the Water Resources Department, Assam. NHP will improve and expand hydrology data and information systems, strengthen water resources operation and planning systems, and enhance institutional capacity for water resources management. The total outlay for the state for the entire project period of eight (8) years is Rs. 47.00 crore.
- Fortification of embankments of Brahmaputra River have been done at a probable cost of Rs. 4454.09 crores

Key Central and State Policies Linked to Climate Adaptation and Mitigation in Water Sector:

- National Water Mission
- Jal Jeevan Mission
- Draft Water Policy, Assam
- National Hydrology Project
- Fortification of embankment system & Construction of new embankment
- Channelization & reclamation including River training Works & corrective Dredging
- Construction of detention reservoir for flood cushioning.
- Integrated watershed Management
- Development of Advanced Flood forecasting system
- Comprehensive morphological studies
- Improvement of drainage & de-watering
- Development of Centre of Excellence
- Assam Integrated River Erosion Risk Management Investment Program (AIFRERMIP)
- Assam Integrated River Basin Management Program (AIRBMP)

5.2.2 Strategies, and Actions for Agriculture and Allied Sector

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	Temperature Variability — Rainfall Variability — Flooding — Drought — Water Stress
Most Climate Vulnerable Districts/ Locations **(Moderate, High, and Very High)**	Darrang, Dhubri, Morigaon, Goalpara, Kamrup, South Salmara Mancachar, Kokrajhar, Nagaon, Golaghat, Lakhimpur, Karimganj, Bongaigaon, Barpeta, Kamrup Metropolitan *Refer Chapter 4 for drivers*
Observed climate trend variability districts **(1990-2019)**	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:**

	Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 **(IMD Hazard Atlas 2021)**[15]	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur
Related State SDG Targets **(Assam Agenda 2030)**[16]	<table><tr><th>Indicators</th><th>Baseline 2016-17</th><th>Target 2019-20</th><th>Target 2023-24</th><th>Target 2030-31</th></tr><tr><td>Irrigation potential (all departments) created (lakh ha)</td><td>17.5</td><td>21</td><td>24</td><td>27</td></tr><tr><td>Home connection for drinking water supply (%)</td><td>1.9</td><td>70</td><td>80</td><td>100</td></tr><tr><td>Water quality affected habitation to be addressed (%)</td><td>10 (2016)</td><td>2.5</td><td>0</td><td>-</td></tr></table>

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total **Six Strategies** have been evolved to deal with impacts of climate change on water sector in Assam.

Overall Water Strategy Summary:

Across the six strategies (refer Table 34) in the sector, a total of 38 action/sub-actions are proposed to be implemented till 2030.

Table 34: Proposed strategies, Number of actions, , Key Agencies and SDG-NDC linkage

Strategies	No. of proposed Actions/ sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Enhanced monitoring and research to establish water budgets and manage water equitably	3	WRD, NHP, AWRMI, NERIWALM, PHED, DOHUA, P&RD	SDG 01 SDG 03 SDG 06 SDG 13 SDG 15 NDC 06
Strategy 2: Enhanced efforts towards ground water recharge in over draft areas	3	WRD, NHP, AWRMI, PHED, DOHUA, P&RD	
Strategy 3: Enhanced water use efficiency across sectors	10	WRD, Irrigation Department, and Soil Conservation	
Strategy 4: Strengthening water sector infrastructure to adapt to climate change	7	WRD, Irrigation Department, Agriculture and Horticulture Dept., NABARD	
Strategy 5: Conservation of wetlands and springs	6	Forest Department, P&RD, WRD, Soil Conservation, Irrigation, PHED	
Strategy 6: Enhancing resilience towards frequent and unprecedented floods	9	WRD; FREMAA, ASDMA	

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[15] https://imdpune.gov.in/hazardatlas/index.html

[16] https://transdev.assam.gov.in/portlet-innerpage/assam-agenda-2030

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Majority of proposed 38 actions are implementation activities (74 per cent) involving creation of climate smart water strategies. Also, considering increasing risk to future water scarcity, 74 per cent of actions are adaptation centric[17].
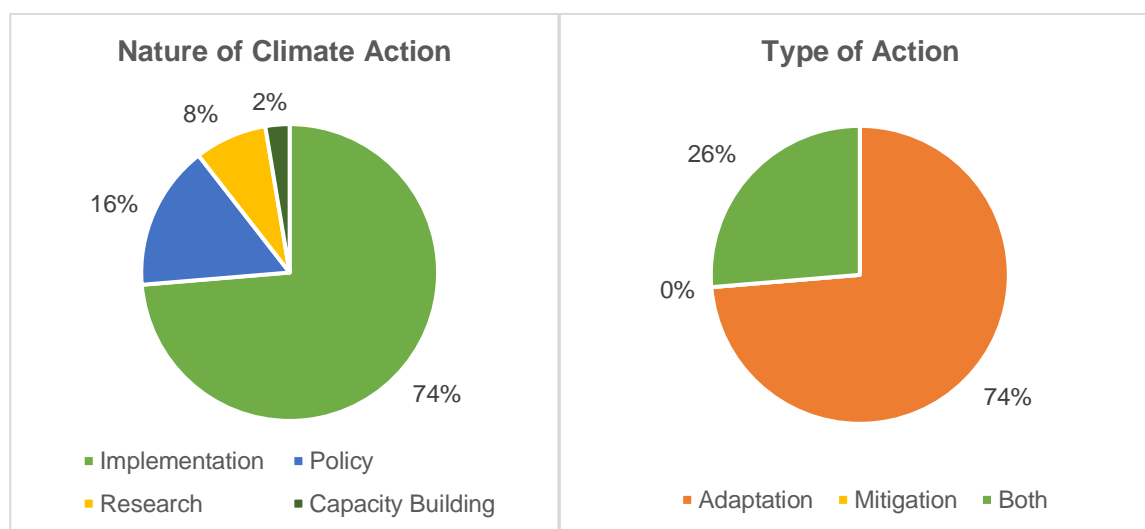
Figure 65: Distribution of Type and Nature of Actions proposed under Water Sector

Strategy 1: Enhanced Monitoring and Research to Establish Water Budgets and Manage Water Equitably

Rationale: Even though Assam is rich in water resources, it faces water shortage in the summer months from past few years and hence water budgeting is much necessary in coming years for its sustainability. Basin level water budgets may help at administrative level to take decisions of water allocations at sectoral level, but to take local adaptation specific decisions it is relevant to have water budgets at much lower spatial level i.e., micro basin. Hence, a proper network of water monitoring mechanism should be in place.

Strategy 2: Enhanced Efforts towards Ground Water Recharge in Over Draft Areas

Rationale: Despite being supported by two major river systems; the state has rivers/ tributaries which are dying due to silting and encroachments. High rainfall intensities and resulting heavy runoff provides no opportunity to go water inside the soils and support base flow, resulting in poor groundwater recharge.

Key vulnerability drivers at district level addressed by strategy 2: High Groundwater Extraction

Strategy 3: Enhanced Water Use Efficiency across Sectors

Rationale: Climate change not only affects water availability and accessibility, but also puts stress on the duration and timing of its availability and accessibility, and the distribution. Further, due to increased temperatures and population, the pressure is expected to rise further on the available resources. Hence conserving the water, recycling & reusing the water, minimizing the wastage and increasing water use efficiency in all sectors is necessary for water resource sustainability and management in Assam.

Key vulnerability drivers at district level addressed by strategy 3:

- Low Percentage of MI schemes in use
- High Groundwater Extraction

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[17] Note: More mitigation Centric activities related to agriculture and allied sector are proposed under energy sector

- Low percentage of water conservation assets created under MGNREGA

Strategy 4: Strengthening Water Sector Infrastructure to Adapt to Climate Change

Rationale: With the increase of temperature, the evaporation will also be more and subsequently the precipitation/ rainfall activities will be more and ultimately flooding and river bank erosion will also be more. Therefore, there will be a great impact on the overall water resources management structures of Assam. In that case, the fortification of the existing embankment and strengthening of bank protection will be required.

Key vulnerability drivers at district level addressed by strategy 4:

- Low Percentage of MI schemes in use
- High Groundwater Extraction
- Low percentage of water conservation assets created under MGNREGA

Strategy 5: Conservation of Forest Wetlands and Springs

Rationale: Wetlands are one of the important sources of surface water in Assam, constituting 1.29 per cent of the total geographical area of the state. Numerous studies have been carried out in different regions of Assam in order to see any climate change impacts on wetlands and springs. The major risks faced by in the state includes vanishing wetlands and dying springs.

Key vulnerability drivers at district level addressed by strategy 5: Reduction in Forest Canopy Density/Area, High Groundwater Extraction

Strategy 6: Enhancing Resilience towards Frequent and Unprecedented Floods

Rationale: Assam with its vast network of rivers is prone to natural disasters like flood and erosion which has a negative impact on overall development of the state. The Brahmaputra and Barak River with more than 50 numbers of tributaries feeding them, causes the flood devastation in the monsoon period each year. The flood prone area of Assam is four times the national mark of the flood prone area of the country. Hence a strong resilient system should be in place to overcome and minimise the losses from this hazard.

Key vulnerability drivers at district level addressed by strategy 6: High assets at risk by extreme events

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 35: Water Resources Sector Strategies and action plan till 2030

Sl.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
Strategy 1: Enhanced monitoring and research to establish water budgets and manage water equitably			
1.1	Install automatic telemetry-based rain gauge sensors and water level/reservoir level sensors wherever applicable to account for high spatial variability of hydrology. **Target**: Installation of sensors by 2026	Assam Water Research and Management Institute Society (AWRMIS), AWRMIS, CWC, IMD, NESAC	CSS and SOPD (E.g. National Hydrology Project NHP
1.2	Development of Centre of Excellence under AWRMI that will oversee basin plans, micro-watershed plans, basin level data analysis etc.	Water Resources Department, AWRMI, NHP	CSS, SSS and SOPD, Bilateral and Multilateral Funds

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	Target: Establishment of all R&D wings of WRD at AWRMI		
1.3	Establish basin wise water-analysis and information centres for micro-watershed wise automated data collection, collation and processing leading to informed decision making for improving operation, planning, and management of water. **Target**: Barak and Brahmaputra Basins (2)	Water Resources Department, State Groundwater Board, AWRMIS	CSS, SSS and SOPD, Bilateral and Multilateral Funds
Strategy 2: Enhanced efforts towards ground water recharge in over draft areas			
2.1	Develop artificial recharge structures such as Farm ponds, undertake renovation of existing water bodies, construct check dams, gabion structures, earthen Contour Bunds and Staggered trenches **Target:** To be set up by 2030 as per as per the master plan for artificial recharge for Assam 2020	Water resources department, Soil Conservation, Irrigation, P&RD and DOHUA	CSS (Atal Bhujal Yojana), SSS and SOPD, Bilateral and Multilateral Funds
2.2	Rooftop rainwater harvesting on institutional buildings in rural and urban areas **Target:** On rooftops of existing school buildings and health centres in rural and urban areas as per the groundwater recharge master plan 2020	P&RD, DOHUA, PHED	CSS (Atal Bhujal Yojna), SSS and SOPD, Bilateral and Multilateral Funds
2.3	Ensure conjunctive use of water to meet drinking water supply demand in urban areas **Target:** Dhubri, Bongaigaon, Barpeta , Darang, Sonitpur, Dhemaji, 100% by 2030	AUWS&SB, ULBs	CSS (NESIDS, NLCPR, Jal Jeevan Mission), Finance Commission (Central and State)
Strategy 3: Enhanced water use efficiency across sectors			
3.1	Strengthen the SCADA for continuous monitoring and repairing work of major and minor irrigation schemes. **Target**: All Districts	Irrigation Department	CSS, SOPD and SSS, Bilateral and Multilateral Funds
3.2	Formation and strengthening the governance of Water user associations at every major canal network/schemes [as per Section 3 (1) of the Assam Irrigation Water Users' Act, 2004] **Target:** All Districts (1656 WUAs already formed, more will be formed along with the completion of irrigation schemes)	Irrigation Department	-
3.3	Afforestation/ Plantation of trees every 25 m on both sides of irrigation canal embankments along with	Water Resource Department, Irrigation Department, Soil	CSS (Green India Mission) SOPD, Bilateral and Multilateral

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	head works, and reservoirs and beside inspection roads. **Target:** All critical embankments along Brahmaputra and Barak valley	Conservation Dept. and Forest Dept.	Funds (World Bank, ADB, AFD)
3.4	Promotion of sprinklers and Drip irrigation **Target:** 62.4 Thousand Ha under horticulture production (14.2 Thousand Ha Vegetables and Spices; 48.2 Thousand Ha - Fruit orchards)	Directorate of Agriculture and Directorate of Horticulture, Soil Conservation Dept., P&RD, RDD, GPs	Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)
3.5	Shift to Systematic Rice Intensification SRI in all continuously flooded rice fields using irrigation water during non-monsoon period (Total Winter Rice Area: 18.80 lakh Ha) **Target:** 1000 ha. Train farmers on SRI. Conduct annual trainings through FPOs of rice for targeted audience	Directorate of Agriculture, Irrigation Department, Soil Conservation Dept., P&RD, RDD, GPs	CSS, SSS and SOPD
3.6	Develop use of Waste water recycling and storm water reuse infrastructure in all ULBs **Target:** Guwahati, Silchar, Mangaldoi, Tezpur, Nagoan, Jorhat, Golaghat, Sibsagar (till 2025) [100% by 2030]	AUWS&SB DOHUA, ULBs	SBM (U) /JJM (U)/ AMRUT
3.7	Promoting tank fisheries to recycle and reuse water (Aquaponics) **Target:** Pilot in peri urban areas for below poverty line entrepreneurs	Fisheries Dept., P&RD, ASRLM, DOHUA, ULBs	Matsya Jagaran Ghare Ghare or SHG programme for women
3.8	Benchmark water use in water intensive Industries. Explore the possibility of waste water recycling and reuse therein. Issue a notification for recycling and reuse of industrial waste water for selected industries. **Target:** Target Packaged Drinking Water, Mineral Water Plants, Tannery, Distillery, Brewery, Soft Drink, Paper & Pulp, Fertilizer, Textile Dyeing Textile Printing, Textile Spinning, Sugar, Dairy Products, Water park & amusement Centre, Ice Manufacturing Units, Hollow Bricks & Tiles Manufacturing, Crusher Units & Sand Manufacturing Ready Mix, Concrete Clay Processing Units, Vehicle Service Stations	Assam Pollution Control Board (PCBA), Industries Dept.	CPCB funds for Environment Protection, Management and Sustainable Development
3.9	Promoting Climate Smart and efficient drinking water use measures at urban and rural level - Setting up of Bulk Metering all water connections at every village (domestic and commercial) - IoT Based smart water supply monitoring (Pilot) in rural areas - Water Pricing to Promote Equity, Efficiency and Sustainability	AUWS&SB (urban), PHED (rural), ULBs, GPs, District Administration	JJM (both rural & urban)/ SBM (U) / AMRUT 2.0

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	- Install IT based sensor systems or SCADA (level, quality, leakage etc.) in all water storage and distribution systems to take informed decisions on water supply and demand side management - Declare rebates/subsidy or help install water meters, water-conserving appliances, toilets and rainwater harvesting tanks. **Target**: Rural Areas: Kamrup Metro, Majuli, Hailakhandi, Cachar, Nalbari, Karimganj, Golaghat, Sivasagar, Kamrup, Darrang, Jorhat (till Mid Term) and Rest by 2030 Urban Areas: Dhubri, Bongaigaon, Barpeta , Darang, Sonitpur, Dhemaji, Tinsukia , Sibsagar, Jorhat, Golaghat , Cachar dist. Nagaon (till 2026), Rest by 2030		
3.10	Capacity Building and outreach to promote water efficiency and providing access to water efficient appliances **Target:** HHs, commercial, institutional, industrial, public sectors	AUWS&SB, ULBs	CSS - SBM (U) /JJM (U)
Strategy 4: Strengthening water sector infrastructure to adapt to climate change			
4.1	Develop guidelines for building climate resilient large dams, barrages, canals and check dams and for retrofitting exiting ones in the State to accommodate extreme rainfall as per the future projections **Target:** Develop a set of online courses around it for dissemination	WRD, Irrigation, Power Department	CADWM
4.2	Map and retrofitting requirement of large dams, barrages/Weirs, Check dams in the State as per the future projections of rainfall. + Undertake retrofitting **Target:** 5 dams, 14 barrages/ wires, all check dams	WRD, Irrigation Dept., Soil Conservation	CADWM/SOPD, Check dam construction scheme
4.3	Enhancement of Irrigation potential by implementation of irrigation schemes **Target:** Irrigation potential of 27.00 lakh Ha. By 2030	Irrigation Dept., Soil Conservation, WRD	CSS-PMKSY Multilateral and Bilateral Funds - World Bank/ADB/AFD RIDF-NABARD
4.4	Building functional access and resilient drinking water supply infrastructure in Rural Local Bodies - Universal Access to functional tap connections (FHTC) to all 57 lakh rural HHs, 40,000 Schools, other institutional areas - Installation of 50 nos of Spot sources viz. Tara Hand Pump/ MII/ M-III/ Ring Well etc. per LAC to	PHED, GPs, ULBs, Autonomous Councils, P&RD and Education Depts.'	Jal Jeevan Mission / Finance Commission Tied and Untied Grants / SOPD

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	provide Safe Drinking Water to the community [9000 Habitations] **Target:** All Districts - ULBs & GPs		
4.5	Update drought contingency plans and Emergency contingency plans taking into account climate change strategies **Target:** All Districts focusing both villages and all ULBs except 6th schedule area	AUWS&SB (urban), PHED (rural), DOHUA, ULBs, GPs, District Administration	Jal Jeevan Mission / Finance Commission Tied and Untied Grants / SOPD
4.6	Provide Water Quality Testing kits (FTKs) in Rural areas and also promote City-Wide water quality testing (surface & sub-surface) and Community wide public disclosure **Target:** All Districts	AUWS&SB (urban), PHED (rural), DOHUA, ULBs, GPs, District Administration	JJM (Rural, Urban)
4.7	Enhancing storm water infrastructure by constructing separate storm water drainage across cities above 1 lakh population **Target:** Nagoan, Tinsukia, Dibrugarh, Silchar, Guwahati [100% by 2030]	AUWS&SB (urban), DOHUA, ULBs, District Administration, PWD	15th Finance (Untied)/ AMRUT 2.0 / Multilateral and Bilateral Funding
Strategy 5: Conservation of wetlands and springs			
5.1	Identifying priority wetlands in forest areas and developing and implementing management plans for restoring/ conserving them including conservation of feeder channels **Target:** Total Natural Wetland area under Recorded Forest Area: 10,611 Ha (except river area) [ISFR 2019]	Forest Department, P&RD, WRD, Soil Conservation, Irrigation	National Plan for Conservation of Aquatic Eco-systems (NPCA) | SOPD-G | Bilateral Funds | CSR Funds
5.2	Conservation and restoration of urban wetlands **Target:** All Assam ULBs except 6th schedule area (100% by 2030)	ULBs and AWS&SB	JJM (Urban)
5.3	Hydrogeological Assessments and Recharge Interventions in wetland areas **Target:** For all 1,584 wetlands, and Barren Areas, etc.	Forest Department, P&RD, Soil Conservation, Irrigation, PHED	National Plan for Conservation of Aquatic Eco-systems (NPCA) | SOPD-G | Bilateral Funds | CSR Funds

Sl.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
5.4	Create inventory of springs within forest areas, undertake geomorphological assessments **Target:** Mapping of all the springs in forest area	Forest Department, P&RD, Soil Conservation, Irrigation, PHED	National Plan for Conservation of Aquatic Eco-systems (NPCA) | SOPD-G | Bilateral Funds | CSR Funds
5.5	Recharge of all critical springs **Target:** 2997 villages having springs covering a population of 43157 (Hill Districts of Assam)	Hill Area Development, PHED, P&RD Hill Area Development	CSS - Atal Bhujal Yojna
5.6	Create a pool of para-hydrogeologists for springshed management **Target:** Spring shed development in hilly areas to restore the perennial streams within forests: Karbi Anglong District West Karbi Anglong District Dima Hasao District	Forest Department, P&RD, WRD, Soil Conservation, Irrigation	National Plan for Conservation of Aquatic Eco-systems (NPCA) | SOPD-G | Bilateral Funds | CSR Funds
Strategy 6: Enhancing resilience towards frequent and unprecedented floods			
6.1	Development of Advanced flood forecasting system **Target:** WL forecast with 1 day lead time having 70% accuracy	Water resources department, ASDMA, CWC, NESAC, WRD, FREMAA	CSS – National Hydrology Project (NHP)
6.2	Fortification of existing embankment system & Construction of new embankments **Target:** 925 Km of fortification of existing embankment including construction of new embkt. in gaps of Brahmaputra, Borak, Beki, Manas, Aie,Subansisri & Buridehing	Water Resources Department	Flood Management and Border Area Programme (FMBAP) of GoI – available till 2026/SSS-World Bank, ADB or NEC/NABARD/ JRC
6.3	Channelization & reclamation including River training Works & corrective Dredging	Water Resources Department,	FMP, NABARD, NEC,PPP mode

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	Target: 30 important reaches, Reclamation of 100 sq. km	FREMAA, Soil Conservation, NABARD, NEC	
6.4	Construction of detention reservoir and flood cushions **Target:** Detailed surveys for feasible areas for detention reservoirs and flood cushions.	Water Resources Department, FREMAA	Flood Management and Border Area Programme (FMBAP) of GoI/ World Bank/ ADB
6.5	Improvement of urban drainage and dewatering **Target:** Major cities prone to floods	DOHUA, ULBs, PWD (Roads), AUWS&SB	AMRUT/NERUDP
6.6	Integrated Watershed management - Develop and conserve vegetation cover and soil cover **Target:** Target areas wherein soil erosion is in excess of 10 tonnes/ha/yr	Soil conservation, WRD, Environment& Forest Department,	WDC-PMKSY/CAMPA / World Bank/ ADB
6.7	Comprehensive river bed level morphological studies on South Bank of Brahmaputra and its tributaries **Target:** South Bank of Brahmaputra	WRD, Assam Water Research and Management Institute Society (AWRMIS)	GOI/World Bank
6.8	Brahmaputra Flood and Riverbank Erosion Management Project **Target:** 115 Nos of Vulnerable Reaches (of which 9 are most Vulnerable)	WRD; FREMAA, ASDMA	ADB
6.9	Repair of water supply systems damaged during flood **Target:** Relief Fund based on damage	PHED, ASDMA, PWD, AUWS&SB, ULBs, P&RD	Flood Damage Restoration (SOPD-FDR)

The detailed list of strategies, action wise implementation schedule, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.3 Forests and Biodiversity Sector

Assam is well-known for its extensive forest resources. Hills and woods form a substantial portion of Assam. The state has recorded a total forest cover of 28,312 sq. km in 2021, which is 36.09 per cent of its geographical area (ISFR, 2021). Assam is also house of many wildlife animals has several wildlife sanctuaries, the most famous of which are the Kaziranga National Park and the Manas Wildlife Sanctuary, which are UNESCO World Heritage Sites. This makes Assam most biodiversity rich state.

Latest, ISFR 2021 report highlights the detailed analysis of states with respect to the climate change. Based on the climate modelling and projections, states are categorised into hotspots and further forest area are classified into four degrees of severity ranging from High to Critical under RCP 4.5 and RCP 8.5 scenarios for three periods i.e., 2030, 2050, and 2085. The report shows that, as compared to 2019, there has been a significantly low reduction of 0.05 per cent in the forest cover. Although current area in Assam is not directly impacted by climate change till 2030 (ISFR, 2021), rapid impacts can be witnessed with the high variation of global temperature and precipitation variability during 2050 and till 2085. Thus, there is crucial need to plan for strengthening overall forest and biodiversity system in Assam in order build resilience and also act as the crucial mitigation opportunity.

The key climate impact drivers that affect the rich biodiversity and forest ecosystems in Assam are:

Following are the key climate risk and impact findings based on secondary literature on the Forest sector in Assam.

Table 36: Evidence based mapping of climate risks and impacts on Forestry Sector

Drivers of Impact	Climate Impacts/ Risks	References
Temperature Variability; Rainfall Variability	• Increasing incidents of forest fires • Change in tree species composition • Vegetation and wildlife habitat shifts • Invasive Alien Species • Increase in Pests • Loss of biodiversity • Wetland area/springshed loss within forests	Kaushik & Khalid (2010); NESAC (2014); Sharma, et al., (2017); Ravindranath, Joshi, Sukumar , & Saxena (2006)

5.3.1   Stocktaking and key climate policies

Following are few key achievements under Forest resources sector between 2016-2020.

- Government waste land, VGRS & PGRS, has been identified and brought under Social Forestry Plantation by Assam's Social Forestry Wing
- Seedlings were raised and maintained under schemes such as SFG, TSP, and SCCP.
- Artificial Regeneration, Natural Regeneration, Bamboo Plantation, and Medicinal & Aromatic Plantation are all done by JFMCs under FDAs in Assam.
- By state CAMPA, 63 nurseries of 1.5 ha is made, while the 25 nurseries are made on 3 ha. Site specific Plantation include 3975.8126 ha. Afforestation was done degraded or blank areas in RFs accounts for 1131.5 Ha. The Aided Natural Regeneration (ANR) in RFs accounts for 500 Ha
- The state government has set aside Rs 200 lakh in 2019-20 to establish up 400 medicinal plant nurseries at a cost of Rs 50,000 each under the concept of Raising People's Nurseries/Plantation of Medicinal and Aromatic Plants.
- The state government is also implementing the Tribal Sub Plan and Schedule Caste Component Plan, under which the government has acquired huge quantities of Agar and Chandan seedlings to encourage the public to grow the trees for economic gain.
- During the budget year 2018-19, the government set aside Rs. 1980.00 lakh for tiger infrastructure development and security.
- During the budget year 2019-20, Rs 278.13 lakh was allocated to the Orng Tiger Reserve, Rs 595.70 lakh to the Manas Tiger Reserve, Rs 123.88 lakh to the Nameri Tiger Reserve, and Rs 879.17 lakh to the Orng Tiger Reserve for all-round conservation and habitat management.
- The overall allocation for Project Elephant in 2017-18 was Rs. 842.99 lakh, with an utilisation of Rs. 3, 05.29 lakh.

Key central and state policies linked to climate adaptation and mitigation in Forest sector:

- Green India Mission (GIM)
- State Forest Policy
- Wetland Policy
- National Mission on Sustainable Himalayan Ecosystem
- National Afforestation Programme (NAP)
- Compensatory Afforestation Fund Management and Planning Authority (CAMPA)
- Formation of Joint Forest Management Committee (JFMC)
- Medicinal & Aromatic Plant Garden Scheme
- Cultivation Of Medicinal Plant and Cultivation of Cashewnut Scheme
- Installation of Bio-Gas Plant

- Honey Bee Scheme
- Integrated Development of Wildlife Habitat Area
- Assam Project on Forest and Biodiversity Conservation (APFBC)
- Tribal Sub Plan and Schedule Caste Component Plan
- Project Elephant
- Environment (Protection) Act, 1986
- The Water (Prevention and Control of Pollution) Act, 1974
- Forest (Conservation) Act, 1980
- The Air (Prevention and Control of Pollution) Act, 1981
- The Wild Life (Protection) Act, 1972
- The Biological Diversity Act, 2002
- Forest (Conservation) Rules, 2003
- Wetlands (Conservation and Management) Rules, 2010

5.3.2 Strategies, and Actions for Forest Sector

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	Temperature Variability, Rainfall Variability, Flooding, Drought, Pest and Diseases, Extreme Winds & Storms, Forest Fires, Land & Forest Degradation, Biodiversity Loss
Most Climate Vulnerable Districts/ Locations **(Moderate, High, and Very High)**	Baksa, Karbi Anglong, West Karbi Anglong, Udalguri, Hailakandi, Dhemaji, Nalbari, Chirang, Hojai, Nagaon, Lakhimpur, Kokrajhar, Dima Hasao, Goalpara, Morigaon, Karimganj, Sonitpur, Biswanath, Golaghat, Darrang, Sivasagar, Charaideo, Cachar, Tinsukia, Jorhat, Majuli, Dibrugarh, Bongaigaon *Refer Chapter 4 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 (IMD Pune, 2021)	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur
Related State SDG Targets **(Assam Agenda 2030)**	• Creation of 120 MtCO2 sinks by planting more than 5 crore of Saplings till 2030 (support by create about 4% of carbon sinks declared by India) • Expand growing stock from 143.7 million cum in 2016-17 to 300 million cum by 2030 • Afforestation/reforestation in degraded and attrition areas by 2030 • Controlling of erosion through suitable bio-engineering techniques by 2030 • By 2030, at least 75% of youth to be aware of values of biodiversity, and the steps they can take to conserve and use it sustainably • Terrestrial, inland aquatic, wetland ecosystems, and associated species are conserved effectively and equitably by 2030 • By 2025, all wildlife corridors shall be restored to their original status

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total **Five Strategies** have been evolved to deal with impacts of climate change on Forest sector in Assam.

Overall Forestry, Biodiversity and Tourism Strategy Summary:

Across the Five strategies in the sector, a total of 22 action/sub-actions are proposed to be implemented till 2030.

Table 37: Proposed Strategies, Number of Actions, Key Agencies for Forestry Sector

Strategies	No. of proposed Actions/ sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Enrich and restore forests and increase area under tree outside forests with co-benefits of improvement in ecosystem services and carbon sequestration	15	**Forest Department** (APFBC, CAMPA, Autonomous Councils (ACs), Finance Dept., Industries Dept., PCBA, Indian Railways (NER), APFBC (FIUs); CHD (BTC); LAZ; UAZ; Education Dept., ULBs, District Administration, Revenue Dept.	SDG 13 SDG 15 NDC 05 NDC 06
Strategy 2: Enhance tree cover in Urban and Peri-Urban areas (including institutional lands)	12	**Forest Department**, P&RD, DOHUA	
Strategy 3: Provide policy and regulatory support for improving forest and tree cover	3	**ACCMS, Forest Dept.,** Finance Dept., Industries Dept., PCBA, District Administration, Revenue Dept.	
Strategy 4: Improve incomes of forest dependent population through agroforestry in private and community lands	2	**Forest Department,** Agriculture and Horticulture Department	
Strategy 5: Conservation of biodiversity and protection of habitats	3	**Forest Department** (APFBC, ASBB, SF, Autonomous Councils), Tourism Department	

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). More than 55 percent of proposed 22 actions are implementation activities for creation of sustainable forest. Forest is a complex system where adaptation centric activities are required to restore the system, whereas forest serves as carbon sink which results in taking mitigation centric activities by conserving forest and reducing its losses. Hence out of 22 actions strategies 36 percent are adaptation centric, 23 percent are mitigation focused and 41 percent are both adaptation and mitigation centric activities.
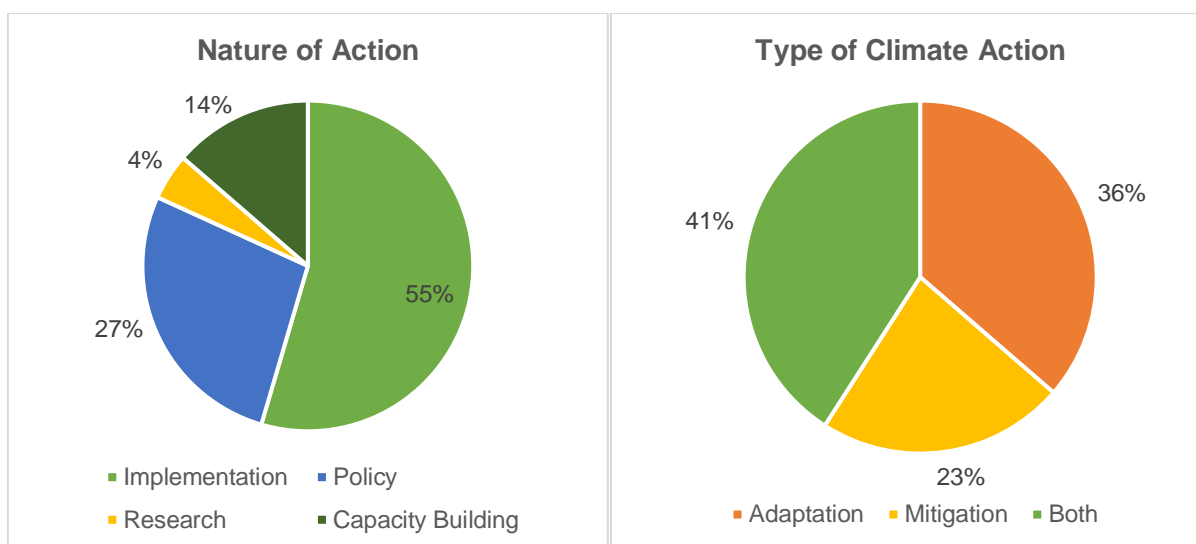
Figure 66: Distribution of Type and Nature of Actions proposed under Forest Sector

Strategy 1: Enrich and Restore Forests and Increase Area under Tree Outside Forests with co-benefits of Improvement in Ecosystem Services and Carbon Sequestration

Rationale: As compared to 2019, there has been a significantly low reduction of 0.05 per cent in the forest cover recorded (ISFR, 2019). If this continues, then the load on the existing forest may increase with respect to the increasing encroachment and population. The trees outside the forest can serve as source of food & feed, timber & wood, and fuelwood.

Key vulnerability drivers at district level addressed by strategy 1: Reduction in Forest Canopy Density/Area

Strategy 2: Enhance tree cover in Urban and Peri-Urban areas (including institutional lands)

Rationale: Urban and rural ecosystems play a significant role in protection of the biodiversity and habitats. Creation of state-of-the-art tree nurseries at local levels, promotion of tree cover outside forests especially on institutional lands enhances the overall quality of life of urban and rural dwellers. Further they also act as local gene banks.

Strategy 3: Provide policy and regulatory support for improving forest and tree cover

Rationale: Environment protection rely significantly on the contemporary policies and legislation providing a crucial ecosystem for improvement of the trees and forest covers across scales. This strategy specifically emphasises on mainstreaming climate conscious actions into forest policies and plans.

Strategy 4: Improve incomes of forest dependent population through agroforestry in private and community lands

Rationale: Non-Timber Forest produce play an important role in maintaining daily nutrition requirements of the villages rely on forests. Therefore, this strategy protects the needs and promotes livelihoods of the forest dependent indigenous and other communities by providing a climate sensitive measures for improving overall adaptation.

Strategy 5: Conservation of Biodiversity and Protection of Habitats

Rationale: The projected climate scenarios given ISFR 2021 report indicates that the although current area in Assam is not directly impacted by climate change till 2030, rapid impacts can be witnessed with

the high variation of global temperature and precipitation variability during 2050 and till 2085. Thus, there is crucial need to plan for strengthening overall forest and biodiversity system in Assam.

Key vulnerability drivers at district level addressed by strategy 5: High per capita dependency on firewood

A brief list of strategy wise actions, responsible agencies till 2030, and potential funding sources has been depicted in the Table below.

Table 38: Forests, Biodiversity and Tourism Sector Strategies and action plan till 2030

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
Strategy 1 : Enrich and restore forests and increase area under tree outside forests with co-benefits of improvement in ecosystem services and carbon sequestration			
1.1 Enrich Forest cover density of moderately dense forests (OF to MDF, Scrub to MDF)			
a	Aided natural regeneration (ANR) **Target**: 26805 ha – all forest circles	Forest Department	CSS/AFD/bilateral funds
b	Tree Planting (JFMC) **Target**: 2390 ha – all forest circles	Forest Department	CSS/SOPD/AFD/Bilateral funds
c	Fire prevention **Target**: 2000 Sq.km	Forest Department, ASDMA	CSS/SOPD/Bilateral funds
d	Solar Fencing **Target**: Critical WLS and PA boundaries- 14520 km	Forest Department, APFBC (FIUs)	CSS/SOPD/Bilateral funds
1.2	Restoration of degraded forests and other areas by addressing the drivers of degradation through assisted natural regeneration, grasslands within forest areas and greenbelts in culturable degraded lands **Target**: 1448 Ha	Forest Department, APFBC	National Plan for Conservation of Aquatic Eco-systems (NPCA), Integrated Development of Wildlife Habitat / SOPD / Multilateral & Bilateral Funding / Donor Agencies Bilateral and Multilateral Funds / CSR Funds
1.3	Develop forest plots for preserving indigenous tree species and key stone plant resources in each forest circle **Target**: Plots for preserving indigenous tree species: atleast 5 species in each of the 6 agro-climatic zones (30 climate resilient varieties and propagation plots of at least 10 ha/ species = 300 ha	Forest Department (APFBC [FIUs], CAMPA, Autonomous Councils (ACs)	Bilateral and Multilateral Funds/ Donor Agencies
Strategy 2: Enhance tree cover in Urban and Peri-Urban areas (including institutional lands			
2.1	Increase area under ToF through tree plantation (Heritage Plantations) in institutional land and develop guidelines	Forest Department	National Afforestation Programme / CAMPA / SOPD / Bilateral and

Sl.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	for species to be selected, source nursery, guidelines on pruning, felling and marketing. **Target**: 1000 Ha (assuming 100 ha each year)	(APFBC, CAMPA and ACs)	Multilateral Funds / CSR Funds
2.2	Develop nurseries for quality saplings (within Village Level and Urban Level) **Target**: One in each Gram Panchayat (at least 1.5 Ha), One in each ULB	Forest Department (CAMPA and ACs)	CAMPA / Scheme for Jhum Cultivation Areas/ SOPD / CSR Funds / Bilateral and Multilateral Funds
Strategy 3: Provide policy and regulatory support for improving forest and tree cover			
3.1	Protection of forest areas from encroachment and eviction management in encroached areas **Target**: 53890 Ha	Forest Department, Revenue Department, District Administration	State Forest Funds
3.2	Liaise with corporates to develop guidelines for use of portion of CSR funds for activities related to mitigation of drivers of degradation of forests and for afforestation **Target:** MoU with PCB and Industries Dept. to help Forest Dept. identify top polluting industries and their CSR funding requirement	ACCMS, Forest Dept., Finance Dept., Industries Dept., PCBA	
3.3	Integrate climate adaptation and mitigation in forest working plans. - Identify climate risks, vulnerable areas such as riparian zones, erosion prone zones, overland flow areas etc. and develop priority strategies to address key climate vulnerabilities and risks for each division. **Target:** Climate Risk assessment (for all 33 forest divisions), REDD+ (Nagaon) and LEDS (Majuli)	Forest Department (APFBC [FIUs], CAMPA, Autonomous Councils (ACs)	CSS Bilateral and Multilateral Funds (such as AFD) Donor Agencies
Strategy 4: Improve incomes of forest dependent population through agroforestry in private and community lands			
4.1	To prevent extraction of NTFPs from protected forest areas Incentivise NTFP based agroforestry on farmland around forest buffer zones. Explore assured returns for farmers from C markets **Target:** 10,000 ha (1000 ha each year)	Forest Department	National Afforestation Programme / CAMPA / SOPD / Bilateral and Multilateral Funds / CSR Funds

SI.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
4.2	Support issuance of sustainable forest management certificates (forest certification) of restored forests to ensure no restriction on export of timber, NTFPs and wood-based goods. **Target:** Across all districts	Forest Department	
Strategy 5: Conservation of biodiversity and protection of habitats			
5.1	Reduce pressure on forest resources by creating fuelwood plantations through JFMCs in the forest fringe villages **Target**: 550 JFMCs (90,000 ha)	Forest Department (APFBC, SF, Autonomous Councils)	CSS/SOPD/Bilateral Funds [AFD]/Donor Agencies
5.2	Encourage propagation of local endemic multi-purpose tree species in all plantation programs of the department. Build capacities and involve local communities in creating nurseries for these varieties. **Target**: One nursery in each district (33 nurseries) and at least 5 in each autonomous councils (15 nurseries) = 48 nurseries. Also, train 50 JFMCs/BMCs per year	Forest Department (APFBC, SF, Autonomous Councils)	GIM/CAMPA
5.3	Identify PLUS trees for all important forestry species and create database for enabling conservation and for generating quality planting material through department/JFMCs/BMCs and other community organisations. **Target**: Identify 5-10 significant species for each zone. Train 50 JFMCs/BMCs per year	Forest Department (APFBC, SF, Autonomous Councils)	GIM/CAMPA
5.4	Facilitate documentation of biodiversity through People's Biodiversity Registers (through Biodiversity Portal and mobile app) and support conservation actions through Biodiversity Management Committees **Target**: Random Survey design to be completed by 2023. Surveys to be undertaken 2023 onwards (preferably mobile based data storage and transmission to central server storing Assam data base)	Forest (ASBB)	CSS/SOPD/Bilateral Funds/ [AFD]Donor Agencies/CSR
5.5	For further reducing pressure on forests for fuelwood, encourage access to LPG, biogas improved chullhas to village HH residing next to forest buffer zones.	Forest department, P&RD, Food & Civil Supplies	CSS/SOPD/Bilateral Funds [AFD]/Donor Agencies

Sl.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	Target: 13, 20,314 households (Cover the entire population of 64, 69,538 (ISFR 2019) living in the Forest Fringe Villages (FFVs).	Department and AEDA	
5.6	Incentivise cropping of medicinal/aromatic plants in farmers field/community land in villages next to buffer zones to replace extraction of the similar plants from nearby forests. Try to set up Access and Benefit sharing mechanism (ABS) with end-user industries. **Target**: All Assam. Identify the location specific indigenous medicinal plants to be propagated (2021-23). Establish Value chains (2023 onwards), Test pilots and Initiate awareness on economic benefits of medicinal plant cropping for largescale uptake (2025 and beyond)	Forest (ASBB), P&RD, Agriculture and Horticulture Dept.	Pradhan Mantri Ujjawala Yojana / SOPD / Bilateral Funding
5.7	Identify and notify Biodiversity Heritage Sites (BHS), and engage communities for their conservation Provide financial and technical assistance for identified conservation actions. Encourage eco-tourism. **Target**: Priority BHs identification (2023); Development of BHS and create an eco-tourism model for all by 2026; Generate revenue and undertake BHS conservation (2026-2030)	Forest Dept., ASBB, Tourism Dept.	CSS/SOPD/Bilateral Funds/ [AFD]Donor Agencies/CSR
5.8	Develop a comprehensive database on zones of human-wildlife conflict, nature and extent of conflict, and design and implement solutions to negate the conflicts **Target**: Developing a database for human wildlife conflicts (2021-2023); Implement specific programmes targeted at conflict prevention/mitigation (2023-2030)	Forest Dept. (Wildlife), PWD	CSS/SOPD/Bilateral Funds/ [AFD]Donor Agencies/CSR
5.9	Initiate ABS mechanism for select biodiversity from Assam forests. - Develop tools, methodologies, guidelines, frameworks for implementing ABS Provisions of the BDA. - Do awareness programmes on the benefits of ABS with relevant communities, train community on sustainable methods of extraction, implement policy and regulatory	Forest Dept. (ASBB & APFBC)	Donor Agencies [AFD]

Sl.No	Strategies/Action	Responsible Agencies (nodal/ implementation)	Potential Funding Sources
	frameworks as per national ABS provisions. **Target**: All Districts		
5.10	Support preparation of comprehensive management plans for identified corridors and initiate engagement with multiple stakeholders for coordinated actions to mitigate human-wildlife conflict. **Target**: Create wildlife corridor for a particular species at a particular site on pilot basis (1000.00 Ha. For wild elephants - BTC)	Forest Department, CSOs (WWF, IUCN etc.)	Green India Mission/ SOPD/ Multilateral and Bilateral Funds/ Donor Funds
5.11	Design and implement biodiversity awareness and conservation programs **Target:** All Districts, Large Scale awareness programmes for protection of biodiversity.	Forest Dept. (ASBB & APFBC)	CSS/SOPD/Bilateral Funds [AFD]/Donor Agencies/CSR
5.12	Identify invasive and train forest dwellers to extract and convert invasive into useful products such as briquettes, baskets with assured markets. (Involves only capacity building of forest dwellers) **Target:** 177600 ha (Area under invasive species (ISFR 2019))	Forest Department, Industries Dept., P&RD (ASRLM)	CSS/SOPD/Bilateral Funds [AFD]/Donor Agencies/CSR
5.13	Identifying priority wetlands in forest areas and developing and implementing management plans for restoring/ conserving them including conservation of feeder channels	Forest Department; Water Resources Department	CSS/SOPD
5.14	Conservation and restoration of urban wetlands	Water Resources Department; ULBs	CSS/SSS

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C

5.4 Energy Sector (Renewable & Energy Efficiency)

Energy is a major requirement for holistic development of a region, Assam has a huge deficit in power generation. The energy requirement of the state for the three consecutive years of 2017-2018, to 2019-2020 has been 8694 (MU) in 2017-18, 9173 (MU) in 2018-2019 and 9413 (MU) in 2019-2020 respectively. However, the power generation during these years has been 1489.84 (MU) in 2017-2018, 1594.15 (MU) in 2018-2019 and 1545.97(MU) in 2019-2020. These numbers show a fluctuation in the generation of power over the years as well as the huge deficit in power generation within the state that leads to dependence on central grid and borrowing power from neighbouring states.

The key climate impact drivers that create stress on the energy sectors are in Assam are:

Further, the following table depicts the key impacts faced by energy sector across the different climate impact drivers.

Table 39: Evidence based mapping of climate risks and impacts on Energy Sector

Climate Driver	Impacts	References
Increase in water temperature	Increasing water temperatures will lead to evaporation of water sources generating electricity especially in the areas where water availability is low.	Arent, D. J., Tol, R. S., Faust, E., Hella, J. P., Kumar, S., Strzepek, K. M., ... & Ngeh, J. (2015); Johnston, P. C. (2012); Solaun K, Cerda E (2017)
Increase in Air temperature	Increase in Air temperature can reduce the power generation capacity as well as adding stress to power generation due to increased cooling demands of the consumers. It can reduce the efficiency of transmission and distribution infrastructure and can also damage the existing infrastructure in case of temperature extremes. Disturbance to mine infrastructure and operations	Spalding-Fecher R, Chapman A, Yamba F, Walimwipi H, Kling H, Tembo B, et al (2014); TAYLOR, M. R. H., Baglee, A. A., Harjanne, A., & Jiménez-Alonso, E. (2020) Rüttinger L et. al., 2020, Nelson J and Schuchard R, 2009
Change in Precipitation pattern	Changing precipitation pattern can affect the availability of water in drought prone areas for hydro-power generation. It can also affect the water availability required for cooling in nuclear and thermal power plants. Disturbance to mine infrastructure and operations and challenges to environmental management and mitigation in mining sites	Mukheibir P. (2013); Turner SWD, Hejazi M, Kim SH, Clarke L, Edmonds J (2017); Rüttinger L et. al., 2020, Nelson J and Schuchard R, 2009
Extreme weather events	Storms, cyclones and other extreme events such as heat waves and heavy rainfall can adversely affect the electricity grid system as well as availability of fuel required for power generation. Challenges to worker health and safety conditions in mines	Subramanian N, Nilsson U, Mossberg M, Bergh J.(2019); Rüttinger L et. al., 2020, Nelson J and Schuchard R, 2009
Change in cloud cover and wind speed	Change in cloud cover can affect the generation of electricity through solar power and change in wind speed can affect the generation through wind.	Pryor SC, Barthelmie RJ. (2013); Kabir E, Kumar P, Kumar S, Adelodun AA, Kim KH. (2018); Miu LM. (2015)

Projections for changes in temperature, precipitation, wind speeds and cloud cover in the future threaten the energy generation capacity of renewable sources of energy in the state. Given the wide climactic, topographical and ecological diversity in the state, the impact on energy infrastructure due to extreme weather events and their subsequent socio-economic impacts cannot be underestimated. Whilst adaptation is essential to maintaining access to energy despite climate change impacts, an emphasis on renewable energy generation combined with energy efficiency measures across all spheres can significantly abate GHG emissions arising through energy generation.

Assam is still predominantly dependent upon conventional sources of energy. While assessments of the functionality of Solar lighting systems and their impact on livelihoods in rural areas has been carried out, large sections of the urban populace still derive energy for their needs through coal and natural gas. There is an urgent need to increase the share of renewables in the energy consumption of the state through promotion and incentivizing use of renewable energy. Domestic, Municipal and Commercial consumers can leverage existing technologies to transition to cleaner fuels as well as improve the energy efficiency across energy infrastructure and systems. Upgrading to higher efficiency equipment, appliances and machinery improves not just the resource efficiency of the energy sector, but also provides avenues for better energy accounting and subsequent interventions to improve the health, education and livelihood opportunities.

5.4.1 Stocktaking and key climate policies

Indicative list of achievements in past five years:

- Assam Solar Energy Policy 2017 is developed to increase investment in the solar power capacity expansion along with encouraging residential and commercial users to adopt modern solar power technology with on-grid and off-grid connections. It also encourages setting up of solar parks and incorporating solar rooftops in municipal by-laws
- Under the "Deendayal Upadhyaya gram Jyoti Yojana" Assam has achieved electrification of 8359 un-electrified villages and 12821 previously electrified villages were intensely electrified
- Under the Integrated power distribution scheme launched by the central government for strengthening sub-transmission and networking in urban areas 88 statutory towns are declared eligible in Assam
- In collaboration with Asian Development Bank 4 power generation projects are sanctioned in Assam worth Rs. 242.48 Cr
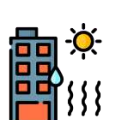
Key central and state policies linked to climate adaptation and mitigation in energy sector:

- National Solar Mission (NSM)
- National Mission for Enhanced Energy Efficiency
- National Smart Grid Mission
- Rural Electrification Initiatives; Deendayal Upadhyaya Gram Jyoti Yojana
- Integrated Power Development Scheme (IPDS),
- Ujjwal Discom Assurance Yojana (UDAY)
- National Electricity Fund (NEF)
- Charging Infrastructure for Electric Vehicles (EVs)

- New National Biogas and Organic Manure Programme (NNBOMP)
- Assam Solar Energy Policy
- Restructured Accelerated Power Development and Reform Programme (R-APDRP)
- Chief Minister's Power Supply Assurance Mission (CMPSAM)
- Draft Assam ECBC policy

5.4.2 Strategies, Actions and Implementation Schedule of Energy Sector

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	Temperature Variability	Rainfall Variability	Flooding	Drought	Extreme Winds & Storms	Heat Waves

Most Climate Vulnerable Districts/ Locations **(Moderate, High, and Very High)**	Kokrajhar, Udalguri, Baksa, Sonitpur, Morigaon, Biswanath, Barpeta, Hojai, Nagaon, Darrang, Dibrugarh, Tinsukia, Karimganj, Dhubri, South Salmara Mancachar, Bongaigaon, Dhemaji, Goalpara, Hailakandi, Cachar, Kamrup, Chirang, Lakhimpur, Sivasagar, Charaideo *Refer Chapter 4 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 (IMD Pune, 2021)	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur

Related State SDG Targets **(Assam Agenda 2030)**	Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
	Proportion of HH using electricity as the primary source of lighting (%)	37 (2011)	100	100	100
	Proportion of Renewable energy to total annual energy production by installed capacity (%)	2.08 (2016)	54.7*	27.3	31.01
	Total power generating capacity (conventional+ renewable) in MW	609.9	865.4	2949.4	3104.9

Aggregate technical and commercial (AT&C losses to total energy produced (%))	23 (2016)	17	15	8
Street Lighting (gap)	155000 lights	32%	96%	100%

- Achieve State Level Carbon Neutrality by 2030

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders and experts a total of **three strategies[18]** have evolved to deal with impacts of climate change on energy in Assam.

Overall Energy Sector Strategy Summary:

Across the three strategies in the sector, a total of 14 action/sub-actions are proposed to be implemented till 2030.

Table 40: Proposed strategies, Number of actions, , Key Agencies, SDG-NDC linkage for Energy Sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Promoting renewable energy to ensure energy access for all	3	Power Department, AEDA, APGCL	SDG 01 SDG 03 SDG 07 SDG 10 SDG 11 SDG 13 NDC 03 NDC 04
Strategy 2: Enhancing Energy Efficiency across sectors	5	Power Department, IEC, DOHUA, Industries, SLDC	
Strategy 3: Developing sustainable, resilient, and low carbon mining industry	6	Mines and Minerals Department, Science & Technology, District Mineral Foundation Trust	

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Majority of proposed 14 actions are implementation activities 43 percent involving creation of energy efficient and low carbon practices. Also, considering role of energy in climate mitigation and aligning with the National NDC goals 64 per cent of actions are mitigation centric. Further detailed breakup is represented in Figure 67.

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[18] *Strategies evolved are in line with the National Solar Mission, and National Mission for Enhanced Energy Efficiency for the Promotion of Clean Energy, Enhancing Energy Efficiency, and Emission Standard and Energy Transition.*
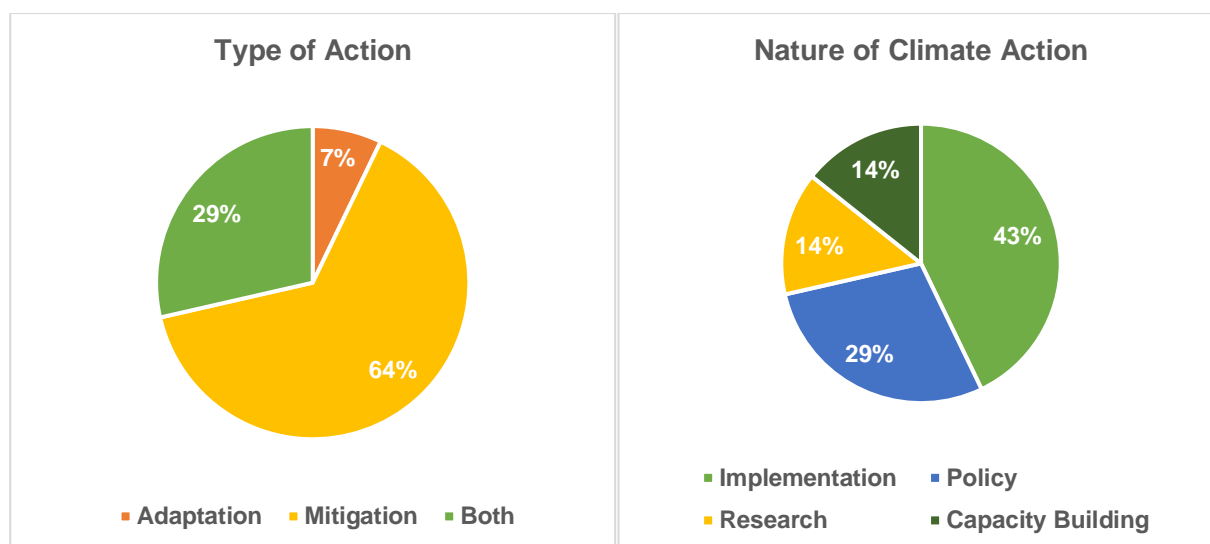
Figure 67: Distribution of Nature of Actions proposed under Energy Sector

Strategy 1: Promoting renewable energy to ensure energy access for all

Rationale: While conventional methods of energy generation such as thermal emit a huge amount of GHGs leading to climate change, it is also essential to understand that the demand for energy would continue to increase in the upcoming years. It is projected that the demand for energy in the state of Assam will be as high as 14,191(MU) and 17,257(MU) by the year 2030 and 2037 respectively[19]. Thus, a transition from conventional sources to unconventional sources of energy would serve the dual purpose of energy requirements as well as reducing the emissions of GHGs.

Key vulnerability drivers at district level addressed by strategy 1:

- Low access to electricity connection
- Less number of villages with solar street lights
- Low access to clean cooking and heating fuels

Strategy 2: Enhancing Energy Efficiency across sectors

Rationale: Incorporating measures to enhance the existing energy efficiency of the sector will improve the net energy requirement and utilization throughout the state as well as have compounding effects for other sectors.

Strategy 3: Developing sustainable, resilient, and low carbon mining industry

Rationale: Increasing frequency and intensity of the extreme and slow on-set events due to climate change will have a huge impact on the mining operations across Assam. During 2019-20, the extraction of major minerals such as crude oil, natural gas, coal, and limestone procured a revenue of more than 2000 crores rupees. Most of these mines are located in socially, politically and environmentally challenging locations makes the additional impacts of the climate change an added pressure for day-to-day operations and impact on the economic growth. Therefore, it is imperative for the industry to approach climate adaptation and mitigation measures to improve the resilience of the inputs to mining processes, employee health and safety and more.

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

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[19] https://cea.nic.in/old/reports/others/planning/pslf/Long_Term_Electricity_Demand_Forecasting_Report.pdf

Table 41: Energy Sector Strategies and Action Plan till 2030

Sl. No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Promotion of Renewable Energy to ensure energy access for all				
1.1 Increasing the share of renewable energy through On-grid projects				
1.1.1	Solar energy	420 MW	SOPD, CSS, SSS, Multilateral and Bilateral Funding	NA and IA: APGCL
1.1.2	Urban Waste to Energy Systems	11 MW	CSS, SSS, Multilateral and Bilateral Funding	NA and IA: AEDA
1.1.3	Small Hydro generation projects	166 MW	CSS, SSS, Multilateral and Bilateral Funding	NA and IA: APGCL
1.1.4	Hybrid technologies	70 MW	CSS, SSS, Multilateral and Bilateral Funding	NA: AEDA IA: PWD
1.2 Off-grid power projects				
1.2.1	Solar dryers and solar agriculture pumps	17000 Beneficiaries	PM-KUSUM/SOPD	NA and IA: AEDA
1.2.2	Solar based cold storages	750 Units	EESL/Multilateral and Bilateral Funding	NA and IA: AEDA
1.2.3	Solar street lighting systems	1.75 Lakh Street lights	CSS, SSS, Multilateral and Bilateral Funding	NA and IA: AEDA and P&RD
1.2.4	Off-grid alternatives in the urban areas which have large potential in commercial, industrial and residential buildings	All Districts 100 MW	CSS/SSS/Multilateral & Bilateral Funding	NA and IA: AEDA, DOHUA
1.3 Policy Research and Innovation				
1.3.1	Develop an indicative target for enhancing share of waste to energy in industrial operations (e.g. cement plants)	All ULBs	-	NA: PCBA IA: Industries and Commerce
1.3.2	Identification of Micro Wind Potential	Goalpara, Biswanath, Dima Hasao, Lakhimpur, Dhemaji, Dhubri, Dibrugarh, Kamrup, Sibsagar etc.	CSS/SSS/Multilateral & Bilateral Funding /Donor Agencies	NA and IA: AEDA
Strategy 2: Enhancing Energy Efficiency across sectors				
2.1 MSME, Industrial Estates and Industry Clusters				
2.1.1	All Clay brick making units to be converted to zig-zag technology & perforated brick making technology	100% brick Kilns by 2030	Lean Manufacturing Competitiveness Scheme (LMCS), ZED Certification Scheme, SIDBI Financing Schemes for Sustainable Development	NA and IA: Industries Dept.; AEDA and IEC

Sl. No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
2.1.2	Conduct assessments and develop a carbon neutrality strategy for all MSME clusters in the State	1195076 MSMEs	Lean Manufacturing Competitiveness Scheme (LMCS), ZED Certification Scheme, SIDBI Financing Schemes for Sustainable Development	NA: Industries Dept. IA: PCBA, AEDA and IEC
2.1.3	Conduct energy audits and identify potential for energy efficiency in all industrial clusters and estates	All Industrial Clusters and Estates: 299 Units	Lean Manufacturing Competitiveness Scheme (LMCS), ZED Certification Scheme, SIDBI Financing Schemes for Sustainable Development	NA and IA: Industries Dept.; AEDA and IEC
2.1.4	Training on the best practices of environmentally friendly and energy efficient technologies across supply-chain for all type of Industries	All MSMEs, Industrial Estates Units; Register factories	CSS and SSS	NA and IA: Industries Dept.; AEDA, ACCMS and IEC
2.2 Space Cooling - Residential, Commercial and Institutional Buildings				
2.2.1	Develop a cooling action plan for Assam in line with India Cooling Action Plan • Roadmap Preparation • Policy Integration • Low-cost technology research • Training and Capacity Building	Cover all cooling sectors (space cooling in buildings, cold chains and refrigeration, passenger transport air conditioning, and refrigerants) including an operational roadmap for sustainable cooling	Multilateral and Bilateral Funds (World Bank, ADB, UNDP etc.)	NA: Inspectorate of Electricity (IEC) IA: Inspectorate of Electricity (IEC), AEDA
2.2.2	Implementing ECBC by notifying it in the building bye laws	For all commercial and institutional across all ULBs	SSS	NA: Inspectorate of Electricity (IEC) IA: DOHUA
2.2.3	Introducing energy efficiency code for residential buildings (Eco Niwas Samhita or ENS)	All Towns in Assam to be covered	CSS and SSS	NA: Inspectorate of Electricity (IEC) IA: DOHUA
2.2.4	Promote energy efficiency of State DISCOM's Demand Side management · Capacity Building of the state authorities and Training of Master Trainers · Energy Audits of the DISCOM · Preparation of DSM Action Plan	All divisions/circles under APDCL	CSS and SSS	NA and IA: APDCL

Sl. No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
2.3	Reduction of Auxiliary Power Consumption in thermal power plants · LED lighting · Replacement of Cooling Tower Aluminium fan by FRP fan. · Stepless Capacity Control System · Renovation/Replacement of old heat exchangers of Gas Turbine and Gas Booster Compressor Units · Renovation of residential water supply system in thermal power plants under APGCL	NTPS NRPP LTPS	Multilateral and Bilateral Funds (World Bank, ADB, UNDP etc.) and CSS	NA: Energy Department IA: NTPS, NRPP & LTPS
2.4	Setting up of Prepaid Smart Metering & System Metering	All Districts	EESL/ RDSS	NA: Energy Dept. IA: AERC, AEDA, APDCL, ULBs, GPs
2.5 Promoting Energy efficiency for tribal and marginalised communities				
2.5.1	Fuel efficient stoves and other cooking alternatives such as gobre gas, solar cookers for fringes of Protected Areas	All Districts and PAs Cover at least 50,000 Beneficiaries till 2030	UJJWALA, Unnat Chulha Abhiyan, Other CSS & SSS | Bilateral & Multilateral Funds | CSR Funds | Pvt Donor Funds	NA: Forest Dept. IA: AEDA, APDCL, ULBs, GPs, RDD, APFBC (Forest)
Strategy 3: Developing sustainable, resilient, and low carbon mining industry				
3.1	**Develop norms to combat climate risks for all operational and potential mining sites** - undertake climate risk and vulnerability assessment - Identify opportunities for carbon mitigation Design adaptation norms to combat climate risks and address the mitigation opportunities (such as water scarcity, wildfire protection, energy and cooling demands, miners' health, land reclamation, etc.)	All mines and mineral sites which are operational and potential mining sites	SOPD-G; Research and Development funds; DMFT Funds	**Nodal:** Mines and Mineral Department I**mplementation**: DMFT, Mining Agencies, Research Institutions
3.2	**Implement supplemental protection measures for legacy mine sites to ensure stability of waste rock and tailings covers affected climate change**	All mine affected areas as per annual action plans	SOPD-G; Capital Outlay on Non-Ferrous Mining and Metallurgical industries; DMFT Funds	**Nodal:** Mines and Mineral Department I**mplementation**: DMFT, Mining Agencies, Research Institutions
3,3	**Mainstream climate change concerns into ongoing monitoring protocol of mining sites and its operations**	All mining sites where monitoring is mandatory	SOPD-G; Capital Outlay on Non-Ferrous Mining and Metallurgical industries; DMFT Funds	**Nodal:** Mines and Mineral Department I**mplementation**: DMFT, Mining Agencies, Research Institutions

Sl. No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
3.4	**Implement feasible low carbon extraction and processing technologies**	All mines and mineral operations	Research and Development Funds; DMFT Funds; Private and donor agencies, Bilateral and multilateral EAP	**Nodal:** Mines and Mineral Department **Implementation**: DMFT, Mining Agencies, Research Institutions
3.5	**Identify alternative Green Jobs and skilling for labourer** - Reskilling/Upskilling, Training of labour dependent on mining sector	Focus on old or decommissioned mines	DMFT Funds and Bilateral and Multilateral Agencies	**Nodal:** Mines and Mineral Department **Implementation**: DMFT
3.6	**Explore potential of Carbon Capture, Utilisation and Storage (CCUS) technologies using abandon underground mining sites**	Research study on CO2 storage in abandon coal mines	Central government – DST R&D; DMFT Funds; Mines and Mineral Department's Research and Development Funds; Bilateral and Multilateral Agencies	**Nodal:** Mines and Mineral Department **Implementation**: Science and Technology Dept., DMFT, Mining Agencies, Research Institutions

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C

5.5 Sustainable Habitat Sector (Urban & Rural)

Habitat Sector follows the outline and components mentioned as per the initial ASAPCC as well as keeping the components mentioned in the National Mission on Sustainable Habitat (approved by the Prime Minister's Council for Climate Change in June 2010). As per the National Action Plan on Climate Change (NAPCC), the mission on Sustainable Habitat comprises three components, i.e., promoting energy efficiency in the residential and commercial sector, management of municipal solid waste, and promotion of urban public transport. Considering that the component of energy efficiency will be dealt in detail under the Assam Energy Sector, the Sustainable Habitat Sector[20] in the revision will specifically talk about the following components depicted in the ***Figure 68***.
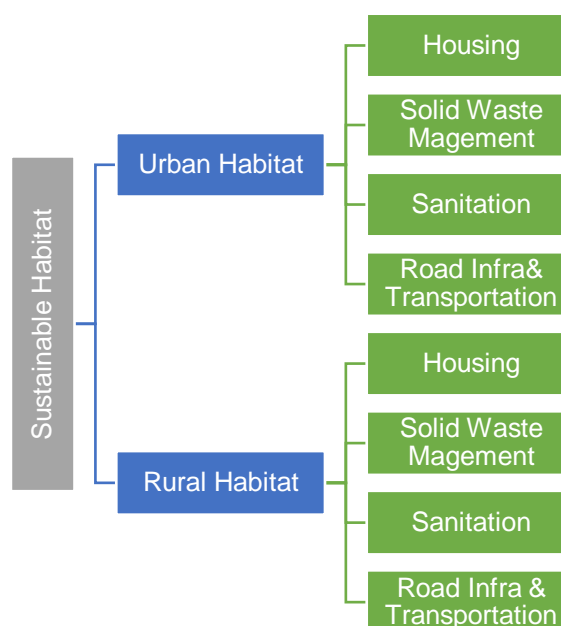
Figure 68: Components covered under Assam Sustainable Habitat Sector

The key climate impact drivers disturbing the lives, livelihood and economy in the urban and rural habitats are:

These impact drivers create havoc on patterns of settlement, livelihoods, and incomes in rural areas which will be the result of multi-step causal chains of impact. Typically, those chains will be of two sorts. One sort will involve extreme events, such as floods and storms, as they impact on rural infrastructure and cause direct loss of life. The other sort will involve impacts on agriculture or on ecosystems on which rural people depend. These impacts may themselves stem from extreme events, from changing patterns of extremes due to climate change, or from changes in mean conditions. (Dasgupta, et al., 2014)

While the impacts of the climate change in urban areas are manifold it affects not the just patterns of livelihoods, and economy. It also causes a huge health impact. Due to frequent extreme weather events the infrastructure is more exposed to damage. Cities source their water supply from far places outside the urban limits, with an event of flood or drought in the region the entire water supply and demand disturbance create water woes. With increasing temperature, the energy demands raise with the increasing cooling demand across India (WEF,

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[20] Road infrastructure and transport related strategies are further discussed in detail under section 5.6.

2021), while it also affects the already polluted cities and worsening the air quality (IPCC AR6 WGI, 2021) added to the impacts exaggerated by urban heat islands in cities. High year-to-year rainfall variability and increase in frequency and intensity of flooding events causes' damage to all critical infrastructure as well as housing. While the extreme weather events add additional pressure on cities due to distress migration from rural areas either temporarily or permanently. While the opposite of excess water i.e., creating drought causes water shortages, food demand, disruption of hydroelectricity and also distress migration from rural areas.

On the other hand, urban settlements are the central to the increasing proportion of GHG emissions across the world. From unmanaged solid waste (CH4), fossil fuel dependent transport and mobility systems (CO2, NOx, SOx etc.) and unsustainable lifestyle in cities contributes to the GHG emission. Thus, it is critical to understand the Habitat sector with both lenses of climate adaptation and mitigation in Assam.

5.5.1   Stocktaking and key climate policies

Key achievements in past five years:

- Since 2015, Guwahati Smart City has completed 6 projects worth Rs. 53 Crores, while 23 more projects worth Rs. 963 Cr are under tender stage and 13 projects worth Rs.134 Cr are in work order stage till 2020.
- Under AMRUT mission, the total approved size of state Annual action plan (SAAP) of Assam between 2015-20 is Rs. 657.14 Cr, of which Rs. 73.23 Cr Central Assistance has been released till 2020. While, Rs.625.55 Cr worth contracts were awarded across sectors and Rs. 59.41 Cr worth NITs Issued till 2020.
- During 2017-18, Assam budgeted to spend Rs.1200 Crores on big public infrastructure projects under 'Big Cities Amenities Development Fund (BCADF)' for six large cities i.e., Silchar, Tinsukia, Jorhat, Dibrugarh, Nagaon and Tezpur.
- In order to incentivize the adoption of LPG connections by BPL families, Assam Government planned to provide financial assistance of Rs 1000/- per family with an outlay of Rs. 5 Cr during budget 2017-18.
- Assam government has converted more than 1000 timber bridges into RCC bridges for improving safety of rural connectivity.
- 65% of the expenditure during 2017-18 under MGNREGA was spent for Natural Resource Management.
- Through Mukhyamantri Aranya Nirman Achoni, Assam government envisaged to develop nurseries of 2 Hectares in each Development Block, and raise 1.02 Crore seedlings and plant them along embankments, tanks, roadside, VGR etc. during FY 17-18 through fund convergence with MGNREGA.
- Under Pradhan Mantri Awas Yojana (G) during FY 2018-21, Assam has completed building 3.73 lakh houses against the allocated target 6.22 lakh houses. Similarly, under PMAY (U), around 1.23 lakh houses were sanctioned with approved central assistance of Rs. 1,863 Cr till Dec 2020.
- Between 2014-20 approx. Rs. 200.81 Cr funds were released to Assam under Swachh Bharat Mission – Urban. Also, under SBM (Gramin) around 3.54 lakh Individual household latrines and 770 Community Sanitary Complexes (CSCs) were constructed up to Dec 2020.

- Across the 9 cluster under National Rurban Mission, Assam estimated to require Rs.1306.15 Cr for all 9 ICAP estimated works, of which Rs. 1110 Cr is estimated funding to be mobilized through Convergence.
- Under Jal Shakti Abhiyan, approx. 18.22 lakh household were provided with functional tap water supply till Dec 2021 i.e., more than 30% increase in providing tap water connections since launch of mission in 2019. In addition, 0.27 lakh schools and 0.12 lakh Anganwadis were provided with tap connection till Dec 2021.

Key central and state policies linked to climate adaptation and mitigation in Habitat sector:

Urban Habitat	Rural Habitat
- Smart City Mission (SCM) - Swachh Bharat Mission (SBM) - Atal Mission for Rejuvenation and Urban Transformation (AMRUT) - DAY-NULM - PMAY- Urban - FAME II - Jal Jeevan Mission (JJM) - Cities Infrastructure Fund	- MGNREGA - PMAYG - NRLM - NSAP - SAGY - DDUGKY - Mission Antodaya - RURBAN (SPMRM)

Few Examples of On-going Work in the Habitat Sector

Project Implementation

The French Development Agency (AFD) and the Government of Assam have signed a 50-million-euro project agreement (total budget of 62.5 million euro) to support the State government's initiative to restore Assam's Forest ecosystems and preserve their biodiversity. Assam Project for Forest and Biodiversity Conservation (APFBC) project is in its Phase II to reforest an additional 12,510 hectares of land, scale up efforts in biodiversity conservation and skill the members of 125 additional communities in different trades. The project works particularly closely with the women of these communities by empowering them through participatory planning and training them in new skills that will enable them to revive the local economy, protect forest resources and increase their financial independence. A unique feature of this project is deploying a wide Forest Management Information System (FMIS) and leveraging modern technology such as GIS, Sensors, and Artificial Intelligence for sustainable forest

Management and reducing man-animal conflict. The project focuses on climate change and conservation by supporting the Forest Department.

Pilot Project – Waste management

The Government of Assam has initiated a pilot project in Gotanagar, Guwahati, aiming to transform municipal leachate into raw material for industrial use. Leachate, a liquid that extracts soluble or suspended solids when passing through matter, poses environmental challenges. The project will be replicated across other urban centres in Assam, contributing to waste management and climate action.

Pilot Project for developing a model flood-resilient village
The Assam State Disaster Management Authority, Govt. of Assam, has selected five districts of Assam for this initiative, with one village in each district chosen to be developed as a model flood-resilient village. Initial mapping exercises in two villages revealed vulnerabilities and underscored the need for special interventions for crucial utilities like schools and community halls. Dialogues with local communities and line departments helped identify challenges faced during floods, informing the creation of sketch maps for future planning. ASDMA has undertaken the same project to upscaleunder World Bank-supported Assam Integrated River Basin Management Programme(AIRBMP) Climate Resilient Village component.

5.5.2   Strategies, Actions and Implementation Schedule

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	Temperature Variability	Rainfall Variability	Flooding	Drought	Extreme Winds & Storms	Heat Waves	Water Stress

Most Climate Vulnerable Districts/ Locations **(Moderate, High, and Very High)**	**Urban Habitat:** South Salmara Mancachar, Dhubri, Hojai, Barpeta, Morigaon, West Karbi Anglong, Karbi Anglong, Goalpara, Nagaon, Baksa, Darrang, Chirang, Dhemaji, Kamrup, Karimganj, Udalguri **Rural Habitat:** South Salmara Mancachar, Barpeta, Dhubri, Morigaon, Kokrajhar, Darrang, Chirang, Hailakandi, Hojai, West Karbi Anglong, Karimganj, Baksa, Dhemaji, Karbi Anglong, Bongaigaon, Biswanath, Sonitpur, Goalpara, Nagaon, Dima Hasao, Cachar, Udalguri *Refer Chapter 3 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur

(IMD Hazard Atlas 2021)[21]	**Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur

Related State SDG Targets (Assam Agenda 2030)[22]	Indicators	Baseline 2016-17 (Current & future gap)	Target (2017-2020 Achievement	Target Achieved 2020-24 (Cumulative)	Target Achieved 2030 (Cumulative)
	No. of slum Households covered	5100	39%	89%	100%
	No. of Tenable/untenable slums	70/233	42% / 43%	90% /91%	100% / 100%
	No, of EWS HHs sanctioned	26,467	100%	-	-
	Urban housing (gap)	5,44,000 nos	26%	59%	100%
	Water Supply (gap)	429 MLD*	23%	46%	100%
	Sewerage and Sanitation (gap)	600 MLD	35%	79%	100%
	Solid Waste Management (gap)	1285 TPD**	12%	34%	100%
	Storm Water Drainage (gap)	4578 km	22%	74%	100%
	Home connection for drinking water supply (%)	1.9	70	80	100
	Water quality affected habitation to be addressed (%)	10 (2016)	2.5	0	-
	Proportion of households covered with sanitary toilets (%)	52 (2016)	100	-	-

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders and experts a total of **three strategies** have evolved to deal with impacts of climate change on Urban Habitat and **three strategies** have evolved to deal with impacts of climate change on Rural Habitat.

Overall Habitat Sector Strategy Summary:

Across the three strategies in the urban habitat sector, a total of 16 actions/sub-actions are proposed to be implemented by. Similarly, across the three strategies in the rural habitat sector, a total of 15 actions/sub-actions are proposed to be implemented by 2030. The table below provides summary of actions, nodal agencies and estimated budget.

Table 42: Proposed Strategies, Number of Actions, and Key Agencies, SDG-NDC linkage for Urban and Rural Habitat Sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
COMPONENT – A: URBAN HABITAT			
Strategy 1: Mainstreaming Climate action into urban governance and policy	2	DOHUA	SDG 11 SDG 13 NDC 6
Strategy 2: Building Climate resilient urban housing infrastructure	6	Assam State Housing Board, DOHUA	SDG 9 SDG 11 SDG 13 NDC 6
Strategy 3: Developing climate smart and resilient urban waste management infrastructure	8	DOHUA, AUWS&SB, PWD	SDG 6 SDG 11 SDG 13 NDC 6

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[21] https://imdpune.gov.in/hazardatlas/index.html

[22] https://transdev.assam.gov.in/portlet-innerpage/assam-agenda-2030

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
COMPONENT – A: URBAN HABITAT			
COMPONENT – B: RURAL HABITAT			
Strategy 1: Mainstreaming Climate Action into Rural Governance and Policy	6	P&RD	SDG 13 NDC 1 NDC 6
Strategy 2: Building Climate Resilient Rural Housing Infrastructure	3	P&RD, PHED	SDG 6 SDG 9 SDG 11 SDG 13 NDC 6
Strategy 3: Enhancing Climate Smart and Resilient Rural Waste Management Infrastructure	6	P&RD	SDG 9 SDG 11 NDC 2 NDC 6

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Out of the proposed 16 actions/sub-action for urban habitat sector, Majority (52 percent) are implementation activities promoting building urban resilient infrastructure. Also, considering role of cities in climate mitigation and aligning with the National NDC goals 59 per cent of actions are mitigation centric. In addition, urban settlements in Assam are already facing impacts of climate crisis every year thus 33 percent of the 16 actions are adaptation centric.
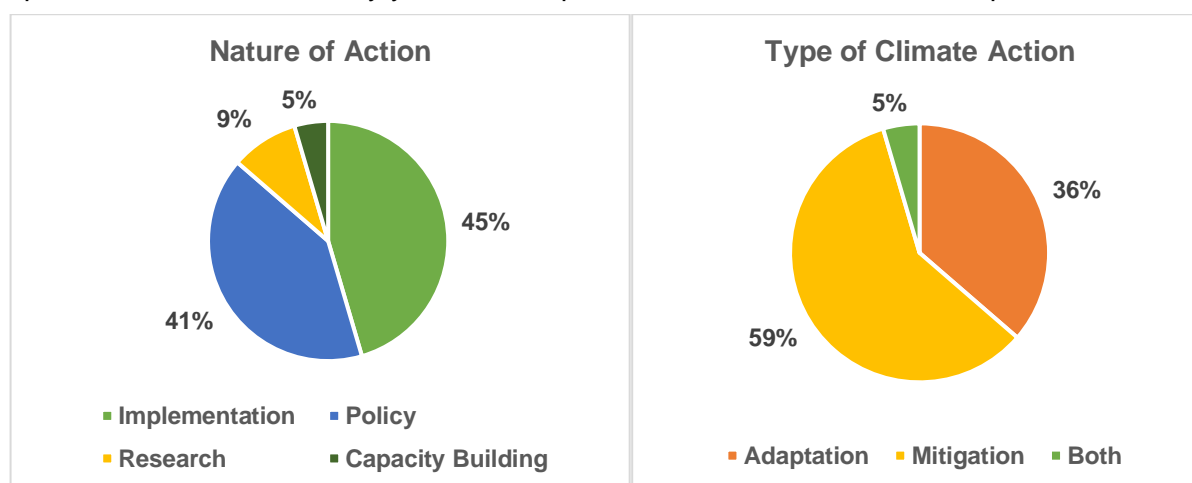
Figure 69: Distribution of Type and Nature of Actions proposed under Urban Habitats

Similarly, out of the proposed 15 actions/sub-action for rural habitat sustainability, majority (41 percent) are implementation activities which will ensure building sustainable and resilient infrastructure in rural areas. Also, considering the rural settlements in Assam are already witnessing impacts of climate extremes every year increasing loss and damages across systems forcing migration in search of better quality of life and lifestyle towards urban settlement, 53 per cent out of 15 actions are adaptation centric focused to building a safe, inclusive, resilient lifestyle in rural areas.
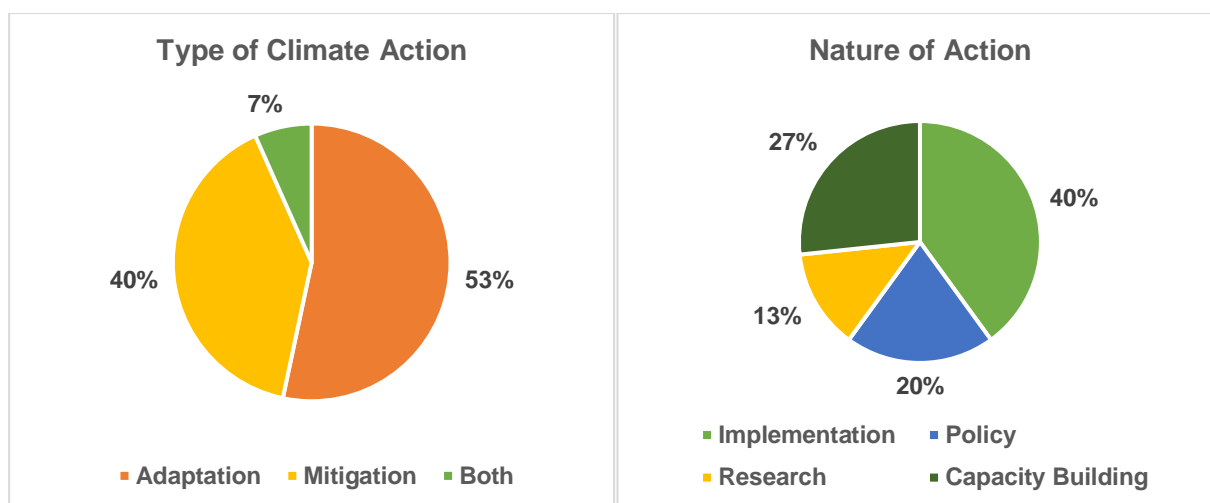
Figure 70: Distribution of Type and Nature of Actions proposed under Rural Habitats

COMPONENT A: URBAN HABITAT

Strategy 1: Mainstreaming Climate action into urban governance and policy

Rationale: Building an inclusive urban climate resilience needs a clear governance support and policy in place. One of the first step to recognise the climate change and associated risks into master plans and creation of city specific climate action plans.

Key vulnerability drivers at district level addressed by strategy 1:

- Low air quality monitoring
- Low female literacy rate
- Fewer women employed in the workforce
- High multidimensional poverty, and High Dependency Ratio

Strategy 2: Building Climate resilient urban housing infrastructure

Rationale: Resilient housing infrastructure protects all citizens from any extreme weather events. Also, pre-consideration of natural feature during construction of houses avoids any future impact on the housing. Thus, the strategy also proposed to achieve the target to reduce the urban housing gap by 2030 to achieve SDGs.

Key vulnerability drivers at district level addressed by strategy 2:

- High risk house type to damage by wind and floods, and High multidimensional poverty

Strategy 3: Developing Climate Smart and Resilient Urban Waste Management Infrastructure

Rationale: Sustainable Waste Management and promotion of circular economic concepts associated with solid and liquid waste has significant co-benefits of both climate adaptation and mitigation in cities, as well as providing alternate livelihood option including enhancing the liveability standards in urban areas.

Key vulnerability drivers at district level addressed by strategy 4:

- High risk house type to damage by wind and floods
- Fewer women employed in the workforce
- Low air quality monitoring

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 43: Urban Habitat Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Mainstreaming Climate action into urban governance and policy				
1.1	Prepare Guwahati City Climate Action Plan	Guwahati	Multilateral and Bilateral Agencies | Donor Agencies (such as C40s, ICLEI etc.)	NA and IA: DoHUA, GMC and GMDA
1.2	G.O to Mainstreaming of Climate Resilience into Environment Chapters of Master Plans/Development Plans/ Regional Plans	All ULBs	-	NA and IA: DoHUA and ULBs
Strategy 2: Building Climate resilient urban housing infrastructure				
2.1	Develop building norms that reduce exposure to flooding, and cyclones	All ULBs	-	NA and IA: DoHUA (T&CP, ASSAM) and ULBs
2.2	Relocation and provision of housing to vulnerable, marginalised households (exposed to repeated flooding)	All flood prone ULBs above 1 lakh population	SOPD	NA and IA: Revenue and Disaster Management Dept. DoHUA (T&CP, ASSAM) and ULBs
2.3	Brownfield development of old buildings or substandard buildings in consultation with local neighbourhoods	All ULBs	CSS | Multilateral and Bilateral	NA and IA: DoHUA, PWD (Buildings) and ULBs
2.4	Promote Building Level Rainwater Harvesting (Domestic, commercial & govt.)	All Buildings in ULBs [at least above 250 M^2]	SOPD | JJM |SBM	NA and IA: ULBs
2.5	Strict regulation against building housing near 50m-100m based on natural drainage size	All ULBs	-	NA: DoHUA IA: ULBs
2.6	Ensure strict adherence to no development policy in ecologically sensitive areas and landslide prone areas	Guwahati	-	NA and IA: GMC and GMDA
Strategy 3: Developing climate smart and resilient urban waste management infrastructure				
3.1	**Implementation of sustainable and circular economy measures into municipal solid waste management in Assam Cities** - Removal of Legacy waste by 2030 - Setting up of material recovery facilities or secondary storage facilities in all ULBs - Setting up of Integrated solid waste processing facilities in all cities above 5 lakh pop. - Multi Stakeholder awareness on best practices of Waste Prevention and Minimization	All ULBs	SBM (U) | Bilateral and Multilateral Agencies | CSR Funds	NA: ULBs IA: SBM(U), PCBA
3.2	Ensure mandatory segregation of waste at source (for all users) - Urban Policy inclusion and collection fee incentive mechanism	All ULBs	SBM (U)	NA: ULBs IA: SBM(U), PCBA

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
3.3	**Effective plastic waste management in all ULBs** - Stoppage use of single use plastic and encourage collection and conversion to energy - Reduction, reuse, recycle and recovery of plastic waste through a circular economy approach - Promote setting up of micro composting centre at township and building level - Awareness generation, outreach programmes on plastic pollution	All ULBs	SWM under SBM (U)	NA: DOHUA IA: SWM-SBM(U), PCBA
3.4	Create a comprehensive study for setting target numbers and dates (till 2030) to set up C&D waste storage recycling facility in all cities in Assam >1 million, between 0.5- 1million and in cities less than 0.5 million population, in Nagar Panchayats as per the timelines in the C&D waste management rules	All ULBs	-	NA: ULBs IA: District Administration and ULBs
3.5	Developing of climate resilient wastewater infrastructure and management action plan ensuring CPCB rules Focusing on protecting water bodies and natural drains, setting up of new STPs, Promote reuse of treated water, Building new underground sewer lines at critical roads	All ULBs	SBM (U) | Bilateral and Multilateral Agencies | CSR Funds	NA: ULBs IA: SBM(U), PCBA
3.6	Promoting of low carbon impact technology alternatives (DEWATS, Constructed wetlands etc.)	All ULBs	SBM (U)	NA: ULBs IA: SBM(U), PCBA
3.7	Develop an Assam policy for disaggregated society specific or RWA specific sewage treatment using new techniques to avoid large costs and better management and set implementation plan and time lines within 2021-2030	All ULBs	SWM under SBM (U)	NA: DOHUA IA: SWM-SBM(U), PCBA
3.8	Preparation of Integrated faecal sludge management plans and implementation of full septage management services (Specifically for ULBs below 1 lakh pop.)	All ULBs	-	NA: ULBs IA: District Administration and ULBs

COMPONENT B: RURAL HABITAT

Strategy 1: Mainstreaming Climate Action into Rural Governance and Policy

Rationale: Building governance and policy role in rural areas is critical for future management of urban area. Also, the critical role impacts of climate risk in rural area of has be understood by all public and private agencies involved in rural areas as prominently as urban areas for building a holistic, safe, inclusive and resilient Assam.

Strategy 2: Building Climate Resilient Rural Housing Infrastructure

Rationale: Resilient housing infrastructure protects all citizens from any extreme weather events. Also, pre-consideration of natural feature during construction of houses avoids any future impact on the housing. Thus, the strategy also proposed to achieve the target to reduce the urban housing gap by 2030 to achieve SDGs.

Key vulnerability drivers at district level addressed by strategy 2:

- High risk house types to damage by wind and floods (BMTPC)
- Low access to pucca housing

Strategy 3: Enhancing Climate Smart and Resilient Rural Waste Management Infrastructure

Rationale: In the increasing weather events, sustainable management of waste in rural areas further enhances the rural liveability standards and reduces unmanaged GHG emissions.

Key vulnerability drivers at district level addressed by strategy 3:

- High proportion of population living in rural areas
- Low access to pucca housing
- Fewer women employed in workforce

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 44: Rural Habitat Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Mainstreaming Climate action into rural governance and policy				
1.1	**Organising Capacity Building Training programmes on Climate Change and inclusion of Climate Change in GPDP** 1. State Level Trainings- for CEO, Zilla Parishad, Chairpersons & Members of ZP, Project Director, DRDA and Executive Engineers of ZP & DRDA (Total -500). 2. District Level Trainings i) For BDO, MIS Managers, DPMs, ABDO, Assistant Executive Engineers, Assistant Engineers, Jr Engineers, Accredited Engineers, Secretaries of GP, GPCs, GRS. ii) PRI members of Anchalik & Gaon Panchayats / VCDC members / VDC members (Total-9500). Duration- Two (2) Days. Target: * 10000 participants. - (500 -State Level and 9500 - District Level).	All Districts State Level – 500 Nos District Level – 9500 Nos	SOPD | CSS | Bilateral and Donor Funds	NA and IA: P&RD (SIPRD, Assam); ACCMS & ASTEC
1.2	**Promote reward mechanism at gram panchayat level for showcasing best practices**	All Districts	Rurban/ SoPD	NA and IA: P&RD
1.3	**Awareness and Outreach of general population and voluntary groups**	All Districts	SOPD | CSS | Bilateral and Donor Funds | CSR Funds	NA and IA: P&RD
1.3.1	Promote using SHGs during project designs and implementation for water infrastructure etc.	All Assam	JJM (Rural)	NA and IA: P&RD

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
1.3.2	Promote CSR activities in all aspirational districts for water conservation	Aspirational Districts	JJM (Rural)	NA and IA: P&RD
1.3.3	Awareness building programme on water conservation (rainwater harvesting) and reuse of water	All Assam	JJM (Rural)	NA and IA: P&RD
1.3.4	Capacity Build and Train all Pani Samiti members on water conservation, reuse best practices	All Assam	JJM (Rural)	NA and IA: P&RD
1.3.5	Create a compendium of local best practices / success stories / performance evaluation studies	All Assam	JJM (Rural)	NA and IA: P&RD
1.3.6	At least four GP functionaries trained for WASH service management in all villages	All Assam	JJM (Rural)	NA and IA: P&RD
1.3.7	At least five women trained on water quality surveillance in each village	All Assam	JJM (Rural)	NA and IA: P&RD
1.4	Assessment on the eco-friendly technology research studies undertaken by SIPRD	All Assam (every three years)	-	NA: P&RD IA: SIPRD, Reputed Research & Education Institute (e.g. IIT's, SPAs etc.)
1.5	For the new eco-friendly technologies to be introduced regarding PMAY-G houses and MGNREGA works for 2197 GPs and 600 VDCs/ VCDCs in phase manner.	2197 GPs and 600 VDCs/ VCDCs IEC materials will be prepared in all the three phases and updated as required.	-	NA: P&RD IA: SIPRD
1.6	Supporting rural industries to enhance sustainable livelihood opportunities: - Water Hyacinth - Cane & Bamboo - Vermicompost Production - Tamul Plate Manufacturing Unit - Paper Plate Manufacturing Unit - Integrated Farming Cluster - Organic Farming Cluster Implementing Sustainable Agro Ecological Practices	All Districts	DAY-NRLM (CSC)	SOPD	NA and IA: P&RD (ASRLM)
Strategy 2: Building Climate resilient rural housing infrastructure				
2.1	Identify low lying areas susceptible to flooding due to extreme rainfall events in every village	All Flood Prone Dist. 2375 Nos	-	NA and IA: P&RD (SIPRD, Assam); ACCMS
2.2	Capacity Building Training on New Technologies & Use of Eco-friendly materials during construction of Houses under PMAY-G. State Level Training for Technical Officers of P&RD Department.	3 days training programme for at-least 1000 participants till 2023	-	NA and IA: P&RD (SIPRD, Assam); ACCMS
2.3	Ensure clearance of flood water drainage systems	All Flood Prone Dist. 2375 Nos	MGNREGA/ 15th FC Funds	NA and IA: P&RD
Strategy 3: Enhancing climate smart and resilient rural waste management infrastructure				
3.1	Ensure infrastructure for effective GP level Solid Waste Management (SWM)	All Districts 100% by 2030	SBM Gramin	Finance Commission Tied Grants	NA and IA: PHED, and P&RD

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
3.2	Building resilient Wastewater Infrastructure and its effective management in rural areas Focus on GP level Liquid Waste Management (LWM) Community Soak Pits, Individual Household Latrine (IHHL) to be constructed, Construction of drainage Channels, institutional soak pits, Community Managed Sanitary Complex (CMSC), Community Toilets	All GPs	SBM Gramin | Finance Commission Tied Grants	NA and IA: PHED, and P&RD
3.3	Make mandatory and ensure use of recycled water to meet other water demands	Hilly Districts	JJM (Rural)	NA and IA: PHED
3.4	Target to develop an Assam policy for disaggregated sewage treatment using new techniques to avoid large costs and better management and set implementation plan and time lines within 2021-2030 for cluster of villages	GPs within 15 Km adjacent to Urban Local Bodies	SBM Gramin (convergence with DOHUA)	NA and IA: PHED, P&RD and DOHUA
3.5	Promoting of low carbon impact technology alternatives (DEWATS, Constructed wetlands etc.)	Kamrup Metro, and Hilly District Villages	JJM (rural)	NA and IA: PHED
3.6	Integrated faecal sludge management plan and implement a full septage management service in Village Clusters - Setting up of Faecal Sludge Management Plant (Deep Row Entrenchment, Planted Drying Bed, Unplanted Drying Bed) - Retrofit sceptic tank to enable mechanised cleaning - Install treatment facilities for treatment of septage	All Peri-urban Villages of cities above 5lakh population (2024), and rest of Villages (by 2030)	SBM Gramin | Bilateral and Multilateral Funds | Donor Funds | CSR Funds	NA and IA: PHED

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.6 Transport Sector

Assam is known as the gateway to northeast India as well as Bangladesh and Bhutan. With more than 3800 kms of national highways road network passing through assam and each year approx. 7000 tonne of goods transported through waterways, Assam's transportation network is critical for generation of the economy, supply of basic needs, and overall development of the region and beyond.

With India's increasing focus on the transportation infrastructure resilience, low-carbon mobility and alternate sustainable modes. Assam SAPCC 2.0, provided a special emphasis on both urban and rural transportation in order to create pathways for enhanced urban and rural sustainability and resilience and synergize with the existing national transport policies. Urban settlements are the central to the increasing proportion of GHG emissions across the world (IPCC AR6, 2022). From unmanaged solid waste (CH4), fossil fuel dependent transport and mobility systems (CO2, NOx, SOx etc.) and unsustainable lifestyle in cities contributes to the GHG emission. Moving away from traditional polluting modes, promoting use of electric vehicles, alternate modes such as inland water ways etc. are key focus areas under Transport sector.

The key climate impact drivers disturbing the transportation in the urban and rural habitats are:

Key central and state policies linked to climate adaptation and mitigation in Transport sector:

Urban Habitat	Rural Habitat
• Smart City Mission (SCM) • Atal Mission for Rejuvenation and Urban Transformation (AMRUT) • FAME II • Cities Infrastructure Fund	• MGNREGA • SAGY • PMGSY • RURBAN (SPMRM)

5.6.1 Strategies, Actions and Implementation Schedule

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	

Most Climate Vulnerable Districts/ Locations (Moderate, High, and Very High)	**Urban Habitat:** South Salmara Mancachar, Dhubri, Hojai, Barpeta, Morigaon, West Karbi Anglong, Karbi Anglong, Goalpara, Nagaon, Baksa, Darrang, Chirang, Dhemaji, Kamrup, Karimganj, Udalguri **Rural Habitat:** South Salmara Mancachar, Barpeta, Dhubri, Morigaon, Kokrajhar, Darrang, Chirang, Hailakandi, Hojai, West Karbi Anglong, Karimganj, Baksa, Dhemaji, Karbi Anglong, Bongaigaon, Biswanath, Sonitpur, Goalpara, Nagaon, Dima Hasao, Cachar, Udalguri *Refer Chapter 4 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 (IMD Hazard Atlas 2021)[23]	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur

Related State SDG Targets (Assam Agenda 2030)[24]	Indicators	Baseline 2016-17 (Current & future gap)	Target (2017-2020 Achievement	Target Achieved 2020-24 (Cumulative)	Target Achieved 2030 (Cumulative)
	Urban Transport (gap)	1900 buses	16%	37%	100%
	Street Lighting (gap)	155000 lights	32%	96%	100%
	Mortality Ratio due to Accidents (per 100000	34.4 (Baseline)	15	5	Negligible
	Street Lighting (gap)	155000 lights	32%	96%	100%
	Total length of surfaced rural roads ('000 KM)	18.3	24	31.9	43
	Road network (km)	6384	23%	83%	100%
	Total Length of Public Transport System (km)	1450	14%	41%	100%
	Green Transport Corridors (km)	3500	40%	85%	100%
	Dedicated cycle track (km)	1250	32%	81%	100%
	Pedestrian friendly environments in towns and cities (km)	6000	42%	92%	100%
	Traffic Management system (km)	6384	28%	98%	100%

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[23] https://imdpune.gov.in/hazardatlas/index.html

[24] https://transdev.assam.gov.in/portlet-innerpage/assam-agenda-2030

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders and experts a total of **two strategies** have evolved to deal with impacts of climate change on Transportation and mobility at urban and rural habitats.

Transport Sector Strategy Summary:

Across the two strategies, a total of 13 actions/sub-actions are proposed to be implemented by 2030.

Summary of strategies and actions under transport sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agencies	SDG and NDC Linkage
Strategy 1: Building climate resilient and low carbon road network and mobility	7	PWD, Transport Department, ULBs, P&RD	SDG 6 | SDG 9 SDG 11 | SDG 13 NDC 2 | NDC 6
Strategy 2: Ensuring holistic management of pollution and emission in cities and villages	6	PWD, Transport Department, AIWTDS, PCBA, ULBs, P&RD	SDG 7 | SDG 11 SDG 13 NDC 2 | NDC 5 NDC 6

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Out of the proposed 13 actions/sub-action for transport sector, Majority (71 percent) are implementation activities promoting low carbon mobility and building resilient infrastructure. Also, considering role of transportation in climate mitigation and aligning with the National NDC goals 57 per cent of actions are mitigation centric.
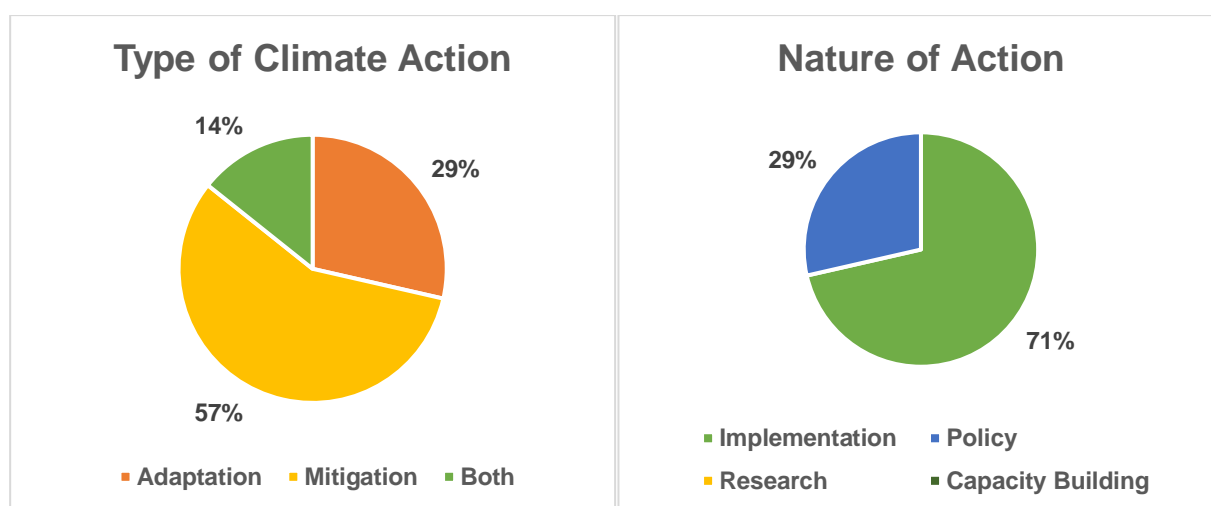
Figure 71: Distribution of Type and Nature of Actions proposed under Transport Sector

Strategy 1: Building climate resilient and low carbon road network and mobility

Rationale: Sustainable mobility and resilient road network promote development and logistics during all emergency events. Creation of such infrastructure builds urban and rural resilience and also achieves the SDGs.

Key vulnerability drivers at district level addressed by strategy 1:

- High risk house type to damage by wind and floods
- High multidimensional poverty
- Low air quality monitoring

Strategy 2: Ensuring holistic management of pollution and emission in cities and villages (other than Transport related)

Rationale: Urban pollution such as particulate matter, NOx, SOx, CO often leads to several health hazards and also leads to heating up of local climate. Further, rural roadside plantation helps mitigating the effects of GHG emissions by fossil dependent public and private mobility within rural and state roads. Thus, the strategy focuses on pollution management to build a better quality of life in both urban and rural habitats in Assam.

Key vulnerability drivers at district level addressed by strategy 2:

- High multidimensional poverty
- High Dependency Ratio
- Low air quality monitoring

Table 45: Transport Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Building climate resilient and low carbon road network and mobility				
1.1	Road embankments to be raised in critical sections to prevent water stagnation and flooding impacts	All Flood Prone ULBs	-	NA and IA: ULBs and District Administration
1.2	**Implementing EV policy roadmap in large and metropolitan cities** - Create setting up for adequate EV charging stations aligned with EV growth - Deployment of EVs either under commercial use or individual use over next five years - Procurement of EV public buses under Assam SRTC (buses) - Provide fiscal incentives to general public for buying EVs	EV Policy Targets - Two-wheeler (2W) EVs – 100,000 units - Three-wheeler (3W) EVs – 75,000 units - Four-wheeler (4W) EVs – 25,000 units - 100% bus fleet by 2030 (*Budget estimated only for subsidy provisions)	FAME -II/ PPP/ Bilateral and Multilateral Agencies/ CSR/ Donor Funds	NA and IA: Transport Department, ULBs, District Administration, Finance Department
1.3	Setting up of scrapping facilities for old and unfit vehicles	Guwahati	CSS/SSS/ Bilateral & multilateral	NA and IA: Transport Dept., District Administrations
1.4	**Promoting low carbon and resilient Inland Water Transport Measures** - Conversion of existing diesel marine engine to CNG driven engines - Development of IWT terminal - Solar powered passenger vessel	Transition of all IWT owned vehicles and Terminal locations by 2030	SOPD-G/ AIWTDS (EAP)	NA and IA: Inland Water Transport Dept. (IWT)

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
1.5	**Develop comprehensive mobility plans that integrates GHG mitigation actions in all 1 lakh+ population cities** Focusing on following themes: • Enhanced coverage of pedestrian walkability and cycling tracks • Smart Traffic Management Systems • Non-motorized transport modes • Study the current share of different transportation modes and design required modal shifts to enable reduction in traffic congestion • Study Sustainable mass rapid transit and public transport to shift from private transport modes options	All 1 Lakh + pop. ULBs Guwahati, Silchar, Dibrugarh, Jorhat, Tezpur, Nagaon, Tinsukia	AMRUT / Multilateral and Bilateral Funding	NA and IA: ULBs and Transport Department
1.6	Encourage plantation and maintenance of tree line along roads	All Districts	MGNREGA / Forest Dept.	NA: P&RD IA: Forest Dept., PWD (NH, Roads), GPs
1.7	Responsibility of trees should be given to local people/SHGs	All Districts	MGNREGA	NA and IA: P&RD, ASRLM
Strategy 2: Ensuring holistic management of pollution and emission in cities and villages (other than Transport related)				
2.1	Prepare and ensure implementation of Action plans (micro plans) for all cities in the state – Water & Air Pollution (convergence with urban master plans, annual actions of major schemes such as Jal Jeevan Mission, SBM, etc. and district environment action plan)	All Statutory Towns (88 Nos) (Assumption @Rs5lakh per plan)	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA and ULBs
2.2	Installation of new and Regular upkeep of all monitoring CAAQMS stations in the Non-Attainment Cities	Guwahati, Silchar, Nalbari, Sivasagar, Nagoan [7 Stations (by 2022)]	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA and ULBs
2.3	Study potential on bioremediation/capping of old landfills (legacy waste)	All old landfills	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA and ASTEC
2.4	Enforce EPR for local plastic producers	EPR is mandatory to all Plastic producer.	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA and ULBs
2.5	Establishing E waste disposal as per e-waste management rules 2016 and amendment 2018	All ULBs	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA and ULBs

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
2.6	**Awareness, Outreach and Capacity Building for effective pollution management** · Undertake inter-departmental training and workshops to aid coordination between departments with areas/ subjects that come under the common jurisdiction · Extend Activities on awareness generations on Biomass burning and continue imposing penalties for Biomass burning, throughout the year. · Promote source segregation awareness camps in schools, Upcycle, Recycle and Reuse Camps for school children from Plastic Waste	All Districts and ULBs	CPCB - Central Sponsored/ PCBA - State Own Fund	NA and IA: PCBA , ULBs, ASTEC, Education Depts.', and ACCMS

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.7 Human Health Sector

Human Health is greatly affected by shifts in weather patterns and other aspects of climate change. These effects may occur directly, due to changes in temperature and precipitation and occurrence of heat waves, floods, droughts, and fires. Indirectly, health may be damaged by ecological disruptions brought on by climate change (crop failures, shifting patterns of disease vectors), or social responses to climate change (such as displacement of populations following prolonged drought).

Government of India has drafted the National Action Plan on Climate Change and Health (NAPCCH). Similarly, mainstreaming of health aspects in State level Climate Action Plan is a stepping stone in the direction of protecting health of individuals in India against the climate sensitive diseases, especially among vulnerable sections of the society. Following the NAPCCH framework, the current sector understands the critical linkages of climate change on the health sector in Assam.

All the impacts of extreme weather and slow onset events on the human health can be either direct or indirect. Certain direct impacts of climate change include heat and cold waves, rainfall variability, floods, storms and drought. Indirect impacts, on the other hand, include incidence of certain vector borne, water borne, zoonotic diseases (akin to COVID19), respiratory and air borne diseases, and malnutrition. (MOH&FW, 2016)

In Assam, Health and Family Welfare Department (H&FWD) has important to play in mitigating and responding to climate change or variation in climate in any geographic location as such change may affect the pattern of morbidity and mortality among dwelling population. The commonly identified illnesses may be grouped as (i) Extreme events (heat related illness). (ii) Air pollution and health related issues. (iii) Vector borne disease. (iv) Water borne illnesses. (v) Malnutrition. (v) Various NCDS.

As per H&FWD, following six objectives are states priority to achieve and build climate resilient of healthcare in Assam:

1. To create awareness on human health.
2. To strengthen capacity of health system in terms of infrastructure, training for effective response to climate sensitive illness.
3. To assist districts in assessment of health vulnerabilities in content of climate change and in building capacities to adopt and mitigate vulnerabilities.
4. To perform situational analysis to strengthen response at all levels to cope up with adverse health impacts.
5. To develop partnership with other departments sectors missions' civil society private sector.
6. To strengthen monitoring surveillance research capacity building about impact of climate change.

The key climate impact drivers causing mortalities, diseases and affecting human health in Assam are:

All associated mortality occurrence and diseases and nutritional health deterrents caused by above events.

Following Table 46 further highlights the relation between climate impact drivers and disease incidence in Assam.

Table 46: Evidence based mapping of climate risks and impacts on Health Sector

Climate Impact Drivers	Impact	Disease	References
Rainfall Variability	- Water scarcity - Water borne diseases - Water contamination due to floods - Vector borne diseases Respiratory diseases	- Transmission of malaria is the state is typically perennial, with a high rise in cases during the months of April to September due to heavy rainfall. - Heavy rainfall during June to August leads to an increase in the cases of JE in Assam. - Districts of upper Assam, including Dhemaji, Dibrugarh, Golaghat, Jorhat, Lakhimpur, Sibsagar and Tinsukia, were high risk with a history of repeated JE outbreaks and deaths. - In Assam, water borne diseases, such as Diarrhea, Dysentery, Cholera, Gastroenteritis etc. are most common in rural areas due to the contaminated drinking water associated with aerobic & anaerobic microbes. - Open drains and the water logged areas coupled with hot and humid climatic condition favoured the mosquito breeding and transmission of water borne diseases. - High incidence of Acute Respiratory Infections and Influenza like Illness is prevalent in the state due to excessive humidity.	(SHARMA, 2014); (V Dev, 2021); (MoEF&CC, 2016);
Temperature Variability	- Vector borne diseases - Respiratory diseases - Cardiovascular Skin diseases	- The increase in temperature is a major cause of heat-related diseases in cities such as dehydration, heat cramps, heat exhaustion, skin cancer, heat stroke, heart disease, diarrhoea, and increased mortality. - Increased temperature also increases the development rates and survival of malaria parasites and other mosquito vectors in the state.	(Das N. D., 2015) (MoEF&CC, 2016); (Nani Gopal Das, 2015)
Flood Proneness	Water borne diseases Vector borne diseases	- More than 70% cases of skin allergies, diarrhoea, gastrointestinal, fever and blood pressure problems were diagnosed by the doctors in Assam. The cause of these ailments was reportedly due to stagnant water and consumption and use of untreated water. - Floods in Lakhimpur district of Assam is prone to certain water borne diseases like diarrhoea, bacillary dysentery, viral hepatitis and typhoid. - The district of Sonitpur experiences flood water stagnation which contaminated the water sources leading to an acute diarrheal disease outbreak in the area.	(ACAPS, 2019); (V Dev, 2021);

Climate Impact Drivers	Impact	Disease	References
		Stagnant floodwater in the State creates new breeding grounds for mosquitoes exacerbates the spread of diseases like Dengue, malaria, chikungunya, and Japanese encephalitis.	

Overall, the identified climate risks for the health sector in Assam are as follows:

- Enhanced morbidity and mortality due to unexpected disease outbreaks.
- Increase in mortality and morbidity caused by heat stress
- Increased risk of vector-borne diseases. Vector borne diseases include: Malaria, Dengue, Chikangunya, Pyrexia, Lymphatic filariasis, Japanese Encephalitis.
- Increased risk of respiratory ailments of general population exposed to outdoor air pollution exacerbated by climate change
- Enhanced risk of water-borne diseases due to extreme rainfall events (Gastroenteritis/Cholera, Viral Hepatitis, Worm infestation, Diarrhoea, Dysentery etc.)
- Household air pollution causing non-communicable diseases such as stroke, ischemic heart disease, lung cancer
- Nutritional deficiencies
- Impact of climate change on health care infrastructure and facilities

As discussed above, Climate change can affect human health directly, undermine the social determinants of health, and threaten the viability of a number of environmental services provided by natural systems. Additionally, it can introduce multiple hazards which can interact with pre-existing vulnerabilities to cause worse health outcomes. However, most of these health impacts are moderated by the strength of the health system, and its capacity to adapt to climate induced health risks. (WHO (a), 2015)

Hence, there has been a growing acknowledgement of many health co-benefits that may be realized from well-designed climate mitigation policies. The impact of climate mitigation policies on health is a result of corresponding changes in environmental and social determinants or root causes of health. The health sector has a critical role to play in eradicating those impacts, and by engaging with other sectors to inform and promote climate change mitigation measures that are most beneficial to health. (WHO (b), 2015)

Certain health co benefits from measures to reduce climate change particularly in health sector is provided below:

- Health care waste management: The greenhouse gas emissions released by procured goods and services often comes from the waste management options used to dispose of them. Measures to reduce waste volumes include the separation of hazardous health care waste from general waste that can be recycled; composting of kitchen waste or other general biodegradables; and careful disinfection and reuse of certain medical instruments in the case of infectious and hazardous health care wastes. For infectious waste, advanced disposal techniques such as autoclaving or treatment with chemical or biological processes, and under appropriate conditions incineration, is usually required. (WHO (b), 2015)
- Low carbon models of care: Interventions like telemedicine and e-health allow patients to obtain consultations for minor conditions, and obtain treatments for chronic conditions,

without leaving their homes. This can further allow health workers in remote areas to connect with better trained nurses or doctors elsewhere on appropriate treatment of urgent conditions or on the management of health issues for which specialised expertise is lacking. This is one of the overarching strategy to decrease the health system's GHG emissions. (ibid)

- Transforming health sector on a low-carbon trajectory can significantly benefit health systems via greater energy efficiency, green forms of power generation through renewables and shifting to greener procedures at every step in the health service procurement and delivery chain. (ibid)

The recent global COVID 19 pandemic has put spotlight on the health sector's responsibility to reduce its carbon footprint by adopting a low-carbon pathway to prepare itself for the increased disease burden. India's health sector accounts for about 1.5% of its total GHG emissions. Even though the share of GHG emission contribution seems low, it can rise steeply in future projections. Therefore, decarbonising healthcare in both the government and private sector in India is essential to prepare for public health emergencies and increase the resilience of the sector (Basu, 2021).

5.7.1 Stocktaking and key climate policies

Key policy achievement in past five years:

- Assam Arogyam Nidhi' scheme provides financial assistance of upto Rs.150000 to families having monthly income of less than Rs.10000 for general and specialized treatment in case of threatening disease or manmade and natural disaster. Under this scheme 5548 beneficiaries were provided support between the periods of 2012-2021.
- Boat clinics were launched in Assam to provide medical facilities to more than 2000 villages that lie on the islands on Brahmaputra River. As there are frequent floods in these areas building permanent infrastructure was not a viable option. When the project was first launched in 2008-09 a total of 998 boat camps were launched and by the 2016-17 there were a total of 3339 boat camp facilities
- The chief Ministers free diagnostic service was started with the aim of providing free and quality diagnostic services such as x-ray, CT scan and Laboratory service. The beneficiary for these services till September 2020 were 461235 for CT scan, 1372424 for X-ray and 3239793 for Laboratory service

Key central and state policies linked to climate adaptation and mitigation in Human Health sector:

• National Action Plan on Climate Change and Human Health	• Dengue Fogging Programme of Guwahati Municipal Corporation
• National Health Mission (urban and rural)	• National Vector Borne Disease Control Programme
• Communicable Disease Control Programme	• Mission Indradhanush
• Non Communicable Disease Programme	• Universal Immunization Program
• Tertiary Care Programs	• National AYUSH Mission
• Human Resources for Health and Medical Education	• Pradhan Mantri Swasthya Suraksha Yojana
• Ayushman Bharat – Pradhan Mantri Jan Arogya Yojana (AB - PMJAY)	• Rashtriya Swasthya Bima Yojana

5.7.2 Strategies, Actions and Implementation Schedule

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.
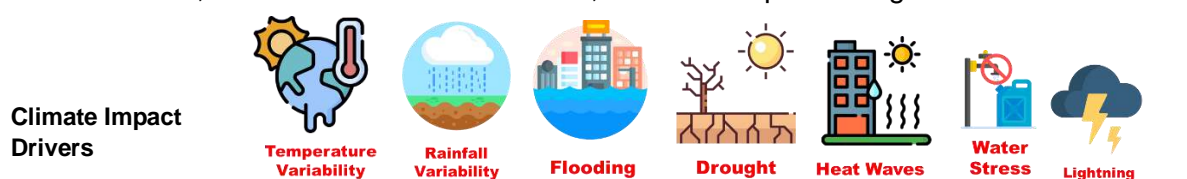
Climate Impact Drivers	Temperature Variability, Rainfall Variability, Flooding, Drought, Heat Waves, Water Stress, Lightning *All associated mortality occurrence and diseases and nutritional health deterrents caused by above events.*
Most Climate Vulnerable Districts/ Locations **(Moderate, High, and Very High)**	Kamrup Metropolitan, Hailakandi, Majuli, South Salmara Mancachar, Karimganj, Hojai, Cachar, Dhubri, West Karbi Anglong, Jorhat, Darrang, Morigaon, Udalguri, Kokrajhar, Karbi Anglong, Bongaigaon, Nagaon *Refer Chapter 4 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) *All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 **(IMD Hazard Atlas 2021)[25]**	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur

Related State SDG Targets **(Assam Agenda 2030)[26]**	Indicators	Baseline 2016-17	Target 2019-20	Target 2023-24	Target 2030-31
	Maternal Mortality Ratio (00 per lakh)	300 (2011-13)	203	155	70
	Infant Mortality Ratio (per 1000 live births)	44 (2016, SRS)	41	33	19

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[25] https://imdpune.gov.in/hazardatlas/index.html

[26] https://transdev.assam.gov.in/portlet-innerpage/assam-agenda-2030

Immunization (%)	47.1 (NFHS-4, 2015-16)	85	92	100
Functional 24x7 PHCs out of 1014	563	676	800	1014
Sub centres out of 4621, equipped for handling deliveries	696	1201	1709	2310
Functional hospitals out of 758 surveyed tea gardens	428	538	652	758
Hepatitis B service coverage rate (child age 12-23 months received 3 doses of hepatitis B vaccine) (%)	52 (NFHS-4)	90	90	90
Malaria incidence rate (%)	0.23 (2016)	<1	<1	elimination
Dengue incidence (No of cases)	6157 (2016)	3079	1540	770
Japanese encephalitis incidence (no of cases)	427 (2016)	214	107	54
Cardiovascular disease among 30-70 years early detection rate (%)	-	20	50	75

Based on the identified climate risks, vulnerability assessment and discussions with department stakeholders, experts and state objectives a total of **two strategies** have evolved to deal with impacts of climate change on Human health in Assam.

Overall Human Health Sector Strategy Summary:

Across the two strategies in the human health sector, a total of 8 action/sub-actions are proposed to be implemented till 2030.

Table 47: Proposed Strategies, Number of Actions, Key Agencies for Health Sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Assess the health risks associated with current and future climate change in the state and provide action plans for response at a state level	3	Health and Family Welfare Department, and NHM	SDG 3 NDC 1 NDC 6
Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam	5	Health and Family Welfare Department and NHM	SDG 3 NDC 1 NDC 6

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Considering the importance of emerging science and understanding of linkages with climate change, 38 percent of actions are research related actions. While, 25 percent of actions are associated to policy related activities such as building climate resilient plans, policy inclusions for betterment of human health in the society. In addition, healthcare system and human health in Assam are already facing impacts of climate crisis every year through various diseases, thus all actions are centred on building climate adaptation in Assam.
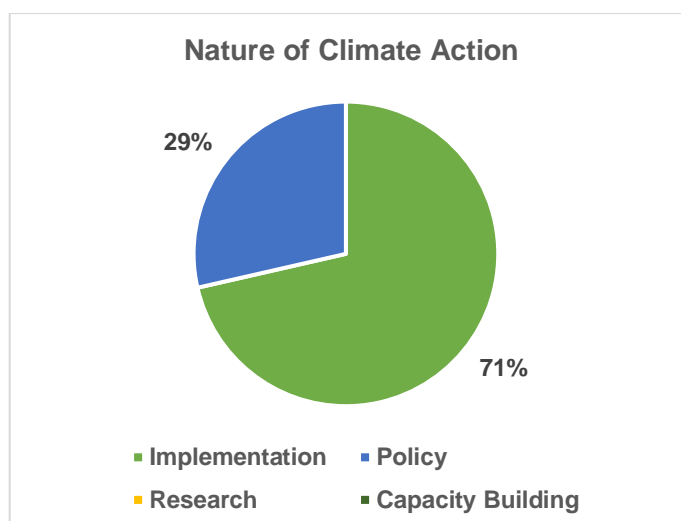
Figure 72: Distribution of Nature of Actions proposed under Health Sector

Strategy 1: Assess the health risks associated with current and future climate change in the state and provide action plans for response at a state level

Rationale: Preparation of state wide health specific adaptation plan along with the creation a muti-scale, multi-disease research knowledge products to enable informed decision making and policy creation is critical for building climate resilient healthcare in Assam by 2030.

Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam

Rationale: Developing institutional convergence for effective coordination and also capacity building to enable lifestyle, behavioral change and create awareness on health vulnerability to climate change is critical adaptation measure in Assam.

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 48: Health Sector Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Assess the health risks associated with current and future climate change in the state and provide action plans for response at a state level				
1.1	Assess the extent of spatial spread of health risks due to current and future climate change in the state at highest possible resolution to facilitate location specific adaptation actions. • Vector-borne diseases • Water-borne diseases • Respiratory diseases Heat Stress & other related diseases	Complete assessment within a year and repeat after every 5 years	NHM	NA & IA: Health and Family Welfare Department (H&FW)
1.2	Map vulnerable population and socio-economic and climate drivers for disease spread	All districts	CSS/ NHM	NA & IA: H&FW

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
1.3	Design an action plan encompassing adaptation strategy to mitigate the drivers of disease spread.	All districts	NHM/ SOPD	NA & IA: Health and Family Welfare Department (H&FW), ACCMS
Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam				
2.1	Establishing CC Cell in the State Health Department.	All districts	National Health mission	NA & IA: Health and Family Welfare Department
2.2	Formation of task force with representation of vector borne disease, infectious diseases, nutrition along with that of Disaster Management of Authority, Pollution Control Board, Water and Sanitation, Public Works Department	All districts	-	NA & IA: Health and Family Welfare Department
2.3	Add to the existing capacity to address the exacerbated impacts of climate change as deduced from the modelled future projections of disease spread in the state	All districts	National Health mission	NA & IA: Health and Family Welfare Department
2.4	Raise awareness on the impacts of climate change on health by IEC and engaging local leaders	All districts	National Health mission	NA & IA: Health and Family Welfare Department
2.5	Training on Risk mapping and seasonal trend for CSWs multi sectoral management approach	All districts	NHM	NA & IA: H&FW

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.8 Disaster Management

Assam with its vast network of rivers is prone to natural disasters like flood and erosion which has a negative impact on overall development of the state. The Brahmaputra and Barak River with more than 50 numbers of tributaries feeding them, causes the flood devastation in the monsoon period each year. The flood and erosion problem of Assam is singularly different from other states so far as extent and duration of flooding and magnitude of erosion is concerned and is probably the most acute and unique in the country. The flood prone area of the state as assessed by the Rastriya Barh Ayog (RBA) is 31.05 Lakh Hectares against the total area of state 78.523 Lakh Hectares i.e., about. 39.58 % of the total land area of Assam (ASDMA, 2016). This is about 9.40% of total flood prone area of the country. Records show that average annual area affected by flood is 9.31 lakh Hectares. The flood prone area of the country as a whole stand at about 10.2 % of the total area of the country, but flood prone area of Assam is 39.58 % of the area of the state (ASDMA, 2016). It signifies that the flood prone area of Assam is four times the national mark of the flood prone area of the country. In addition to flood and erosion, Assam is also at risk of increasing droughts and storm/wind related disasters.

The key climate impact drivers that are responsible for increasing incidence of disaster in the state are

Following are the key climate variables which results in different types of disasters in the state of Assam:

Table 49: Evidence based Mapping Climate Risks and Impacts for Disaster Management

Climate Risk/Hazard	Disaster Type	Findings
Rainfall variability	Floods Soil Erosion Droughts	• Rainfall variability resulting in floods in 39.58% of the area of Assam • Rainfall variability resulting acute erosion of river banks resulting in average soil erosion of 8000 ha • Rainfall variability resulting in drought situation in summer monsoon months
Temperature variability	Droughts Heatwaves	• Temperature variability resulting in drought situation and heatwave in monsoon and summer months respectively.

As mentioned in the above, the changes in climatic variables results in different disasters which in turn threaten agricultural production, food security, livelihood security and infrastructure of Assam.

5.8.1 Stocktaking and key climate policies

Following are few key achievements under disaster management sector in past five years.

- Assam State Disaster Management Authority (ASDMA) has prepared the district wise flood Hazard maps for Assam State using satellite remote sensing data sets.

- Initiative of building up its GIS database to develop an Emergency Management Information System for Assam.
- National School Safety Programme in 200 schools in Kamrup and 200 schools in Tinsukia District.
- Development of Flood Early Warning System (FLEWS) and all districts
- Unique research project named "Disaster Risk Reduction Including Climate Change
- Adaptation of Guwahati in the Context of Dynamic Growth" - associating with Earth Institute.
- Research project named "Water Resource and Flood & Erosion Risk Mitigation Planning in Assam" - associating with Earth Institute.
- ASDMA engaged with North East Space Application centre for conducting the Hazard vulnerability assessment (HRVA) for Dhemaji district and Guwahati city, Dibrugarh & Silchar towns
- Development of Flood Early Warning System for Guwahati
- Aapada Mitra for 18 districts (Kamrup M, Jorhat, Cachar, karimganj, Halakandi, Dima Hasao, Nagaon, Morigaon, Barpeta, Nalbari, Baksa, kokrajhar, Dhubri, Udalguri, Sivsagar Dibrugarh, Tinsukia, Darrang)
- Inclusion of sanitary napkin & Baby food in GR items
- Formation of Circle Quick Response Team (CQRT)
- Flood Reporting and Information Management System (FRIMS)
- 3 Flood Shelter (Majuli, Lakhimpur & Barpeta)
- Installation of Sanitary Vending Machine & Disposal machine in relief camp cum school as school act as relief camp to build gender friendly camps (Majuli, Morigaon, Goalpara) under process in Tinsukia & Barpeta district
- Guidelines of Child Friendly Space CFS under National School Safety Program

DRR road Map

- Automatic Weather Station (AWS) 3 nos in Guwahati
- 19 satellite phone (Dist- Karimganj, Dibrugarh, West Karbi Anglong, South Salmara, Kokrajhar, Majuli, Dima Hasao, Lakhimpur, Karbi Anglong, Barpeta, Cachar, Dhemaji)
- Lighting Early Warning System (LEWS) for all district
- Psychosocial support help line (14410)
- Dissemination of rain fall forecast from IMD for all district
- Preparation of River Atlas for all the district of Assam along with the development of River Atlas Portal

Key central and state policies linked to climate adaptation and mitigation in Disaster Management:

- Disaster Management Act 2005
- National Policy in Disaster Management 2009
- Assam Disaster Management Policy 2010
- Assam State Disaster Management Plan
- Rehabilitation Grant
- District Disaster Management Plans
- National School Safety Programme
- Prime Minister's Ten Point Agenda on DRR

5.8.2   Strategies, and Actions for Disaster management Sector

The following table summarises the key climate drivers faced by the sectors, along with the outcomes of the vulnerability assessment, district anomalies in the observed climate trend and extreme events, at the end the relevant SDGs, state development targets.

Climate Impact Drivers	Temperature Variability	Rainfall Variability	Flooding	Drought	Heat Waves	Water Stress	Lightning
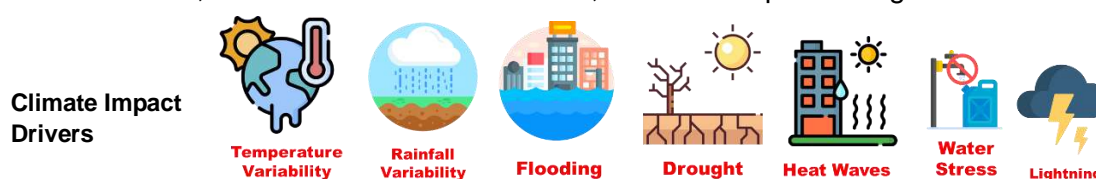
All associated mortality occurrence caused by above events.

Most Climate Vulnerable Districts/ Locations (Moderate, High, and Very High)	South Salmara Mancachar, Karbi Anglong, Hailakandi, Dhubri, West Karbi Anglong, Darrang, Cachar, Golaghat, Chirang, Kokrajhar, Goalpara, Dima Hasao, Karimganj, Morigaon, Baksa, Charaideo, Majuli, Dhemaji, Sonitpur, Udalguri, Lakhimpur, Sivasagar, Bongaigaon, Tinsukia, Barpeta, Hojai, Biswanath *Refer Chapter 4 for key drivers*
Observed climate trend variability districts (1990-2019)	**Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivasagar, Majuli, Dibrugarh, Charaideo, Jorhat, Golaghat **Highest Annual Average Maximum Recorded during 1990-2019:** Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivasagar, Majuli, Dibrugarh, Charaideo, Sonitpur, Golaghat **Increasing Rainfall Trend Annually during 1990-2019:** Salmara Mancachar (5.5mm/yr), Kokrajhar (1.9mm/yr), and Chirang (0.3mm/yr) **Increasing Rainfall Trend during Monsoon during 1990-2019:** Bongaigaon (3.1mm/season), Chirang (4.9mm), Dima Hasao (1.0mm), Goalpara (3.2mm), Hojai (0.4mm), Kokrajhar (4.1mm), and Salmara Mancachar (3.1mm) **All districts apart from above mentioned under rainfall witnessed a decreasing trend*
Observed High Hazard Event Locations 1969-2019 (IMD Pune, 2021)**)**	**Number of Flood Events (above 51) During the Period from 1969 to 2019:** Baksa Barpeta, Biswanath. Bongaigaon. Cachar. Charaideo. Chirang. Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Kamrup Metropolitan, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Majuli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, Tinsukia, Udalguri **Number of Heat Wave Days (above 10) in Annual:** Hailakandi, Kamrup, Kamrup Metropolitan, Nagaon, Nalbari, Sivasagar, Sonitpur **Severely and Extremely Drought Proneness (based on Standardised Precipitation index [high and very high Vulnerability]):** Tinsukia, Majuli, Jorhat, Darrang, Biswanath, Sonitpur

Based on the understanding of the vulnerability assessment, climate risks and expert consultation with the departmental stakeholders total **Six Strategies** have been evolved to deal with impacts of climate change on Disaster Management in Assam.

Overall Disaster Management Strategy Summary:

Across the Six strategies in the sector, a total of 25 action/sub-actions are proposed to be implemented till 2030.

Table 50: Proposed Strategies, Number of Actions, Key Agencies, for Health Sector

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Risk Assessment and mapping for holistic Disaster Management In state	2	Assam State Disaster Management Authority (ASDMA)	SDG 11 SDG 13 NDC 06
Strategy 2: Developing institutional convergence, generate capacity building, awareness on climate risk and vulnerability of human health in Assam	6	Assam State Disaster Management Authority (ASDMA)	
Strategy 3: Enhanced flood forecasting mechanism for minimum human and economic loss	4	Assam State Disaster Management Authority (ASDMA)	
Strategy 4: Enhanced mechanism for landslides preparedness and mitigation	5	ASDMA, PWD (Roads), CGWB, PHED	
Strategy 5: Minimizing the soil erosion due to floods through appropriate construction regulation and vegetation measures	3	ASDMA, Soil Conservation Dep't., WRD, Forest Dep't.	
Strategy 6: Ensuring minimum losses from wind and storms	5	ASDMA, Rev. & DM Dep't., GMDA, DOHUA & GDD, PWD Bldg.	

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). Around 48% of the 25 actions proposed are implementation based and nearly all actions (96%) are adaptation centric owing to increasing climate extreme and slow on-set events.
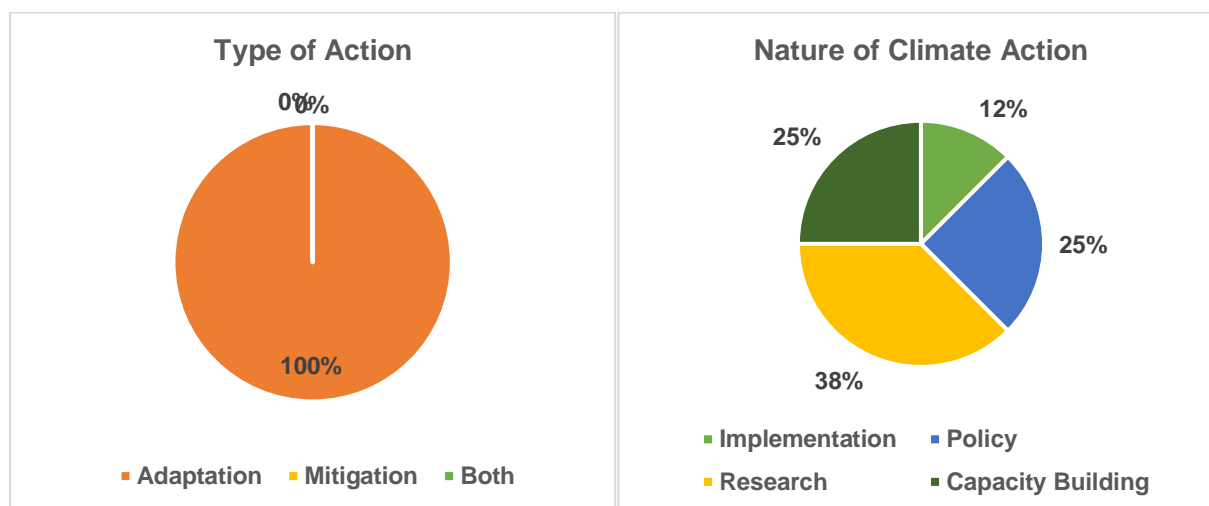
Figure 73: Distribution of Type and Nature of Actions under Health Sector

Strategy 1: Risk Assessment and mapping for holistic Disaster Management In state

Rationale: Considering the high vulnerability of state towards disasters like flood, drought, cyclones and erosion, it is at most important to map the risks and hazards in order to reduce the physical, financial and social losses.

Strategy 2: Strengthening Policy, administrative and individual level interventions for pre and post disaster preparedness and mitigation

Rationale: In order to locally adapt and build resilience towards any hazard a proper channel to execute the interventions is very important and hence strong convergence mechanism is required to set things in place within the state resulting into reduction of losses.

Strategy 3: Enhanced Flood Forecasting Mechanism for Minimum Human and Economic Loss

Rationale: Flood is an annual event in the State of Assam. More than 40 percent of its land surface is susceptible to flood damage. In order to take necessary measures by local people, it is mandatory to provide location specific advance precautionary measures and flood alerts and hence enhanced early warning system is very significant for administrators and communities.

Strategy 4: Enhanced mechanism for landslides preparedness and mitigation

Rationale: With Barak Valley and Hill Regions of Assam prone to landslide, it is important to be prepared to minimise the incidences and impacts of landslides as it takes massive toll of human lives and lead to huge economical losses every year besides damages to environment, resources infrastructure and services.

Strategy 5: Minimizing the Soil Erosion Due to Floods through Appropriate Construction Regulation and Vegetation Measures

Rationale: Damages caused due to erosion runs into several hundred crores every year. Bank erosion by the rivers has been a serious issue since last six decades as more than 4.27 Lakh Hectares of land was already eroded away by the river Brahmaputra and its tributaries since 1950, which is 7.40 % of area of the state. Thus, to minimise the soil erosion, appropriate measures need to be taken.

Strategy 6: Ensuring minimum losses from wind and storms

Rationale: Southern districts of Assam are in very high and high wind zone (BMTPC, 2019). In this zone wind speed can reach up-to 55 m/s, can resultant into large scale damage such as damages of lives, infrastructures, and transmission and communication infrastructure. In order to minimise the losses, appropriate measures are required.

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 51: Disaster Management Sector Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Risk Assessment and mapping for holistic Disaster Management In state				
1.1	Preparing a detailed multi-hazard risk assessment and vulnerability mapping with the help of Remote Sensing and GIS at district level.	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
1.2	Strengthening the Disaster Early warning mechanism in the state to improve preparedness for disasters	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 2: Strengthening Policy, administrative and individual level interventions for pre and post disaster preparedness and mitigation				
2.1	Preparing response function for all types of prevailing risks through policy strengthening at all levels.	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
2.2	Establishing and strengthening Inter Agency Groups (IAG) at state and district level with the intervention of SDMA and DDMA.	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
2.3	Training and capacity building of volunteers' network for identifying disaster warning signs and providing emergency response	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
2.4	Strengthen real time call centre helpline and guidance during disasters that can provide help and relief measures to affected citizens	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
2.5	Developing gender based and child sensitive localized disaster management plans (e.g. separate toilets, sanitary pad wending machine for women, Separate rooms for lactating mothers, and space for children)	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
2.6	Promote mandatory retrofitting of renewable energy usage in Assam Disaster Management Authority offices and local offices	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
Strategy 3: Enhanced flood forecasting mechanism for minimum human and economic loss				
3.1	Establish infrastructure for flood warning and dissemination (e.g. rain gauges, trained staff etc.)	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
3.2	Ensure proper communication between IMD, district authority and SEOC	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
3.3	Prepare departmental flood contingency plan	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
3.4	Train flood rescue teams and ensure the availability of functional rescue materials	All Districts	SOPD-G/SOPD-GSP/ SDRF Fund/ Central Assistance	NA and IA: ASDMA
Strategy 4: Enhanced mechanism for landslides preparedness and mitigation				
4.1	Mapping of high-risk areas and roads at micro level/high spatial resolution (GIS Based)	All Hilly Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA, PWD (Roads)
4.2	Stabilization measures such as groundwater drainage, slope modification to control contributing factors, Soil Bioengineering Techniques, Soil Anchoring, Hybrid solutions etc.	All Hilly Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA, CGWB, PHED

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
4.3	Reduce the consequences by relocation of the vulnerable settlement and/or infrastructure to a more favourable location	All Hilly Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
4.4	Consideration of Landslide Risk Zone as a thematic layer during Land use suitability assessment	All Hilly Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
4.5	Preparation of community level preparedness plans	Guwahati	SOPD/ Central Assistance/Multilateral Funding	NA and IA: ASDMA
Strategy 5: Minimizing the soil erosion due to floods through appropriate construction regulation and vegetation measures				
5.1	Avoid digging of soil on erosion prone areas.	All Flood Prone Districts	State Disaster Mitigation Funds /SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	Soil Conservation Dept., GSI
5.2	Use of erosion control blankets such as planting of trees and shrubs	All Flood Prone Districts	State Disaster Mitigation Funds /SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	Soil Conservation dept., WRD, Forest dept.
5.3	Build terrace on steep slopes prone to erosion	All Flood Prone Districts	State Disaster Mitigation Funds /SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	Soil Conservation dept., WRD, Forest dept.
Strategy 6: Ensuring minimum losses from wind and storms				
6.1	Identification of Cyclone Prone Districts/Block/Cities current and future projections	All Districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	ASDMA
6.2	Building of Multi-purpose Cyclone shelters	One in each development block based on critical assessment of three extreme wind districts i.e. Cachar, Hailakhandi, Karimganj	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	PWD Bldg., ASDMA
6.3	Capacity building of community by making community level preparedness plans and training volunteers	All blocks and villages of three critical districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	ASDMA
6.4	Relocation of people from High-Risk Zones (after detailed Hazard-Socio-Economic Impact Assessment)	All blocks and villages of three critical districts	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	Rev. & DM dept.

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
6.5	Promoting Cyclone Resistant Building Norms and Bye-laws (Encourage construction of safety shelters from storms in the basement of houses in cyclone prone areas.)	All ULBs and villages of three critical districts (ST-one in each dist.)	SOPD-G/SOPD-GSP/ Central Assistance/Multilateral Funding	GMDA, DOHUA & GDD, PWD Bldg.

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

5.9 Strategic Knowledge

The National Mission on Strategic Knowledge for Climate Change is one of the eight missions set up by the Government of India forming the base for National Action Plan for Climate Change (NAPCC). The mission seeks to build a dynamic knowledge system that would support and inform national action for responding effectively to the sustainable development. The mission has been built on the foundation of recognizing the importance of measuring and quantifying climate change elements, the dynamic and changing nature of knowledge and technology as well as importance of the ability to capture opportunities based on this knowledge and technology (DST, National Mission on Strategic Knowledge for Climate Change, 2010).

Since climate change affects all aspects of the state including natural resources, livelihood and economy, it requires engagement from all stakeholders, cross-sectoral action and interdepartmental coordination. Keeping this in mind, it is essential to establish a strong knowledge base for identifying, formulating, planning and implementing climate policies. Having a robust and strategic knowledge system is crucial not only at the national level but also at the state level. The strategic knowledge system should access and integrate information and assessments originating from a large number of inter-connected sources.

5.9.1 Stocktaking and key climate policies

Key achievements under creating knowledge portals for understanding and adapting climate change in recent years (2015-2022):

- Knowledge Management portal on Climate Change, ASTEC
- Knowledge Management portal on Disaster Management, ASDMA
- Assam State Action Plan on Climate Change, ACCMS

Key National and State Policy related to Strategic Knowledge:

- National Mission on Strategic Knowledge for Climate Change

5.9.2 Strategies, and Actions for Strategic Knowledge Sector

Based on stakeholder consultations and literature review, **three strategies** have been formulated to strengthen strategic knowledge mission in Assam.

Overall Strategic Knowledge Strategy Summary:

Across the three strategies in the sector, a total of 24 action/sub-actions are proposed to be implemented till 2030.

Table 52: Proposed Strategies, Number of Actions, Key Agencies and SDC-NDC Linkage for Disaster Management

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 1: Creation of Knowledge Management Portal for Climate Change	3	ACCMS, ASTEC	SDG 04 SDG 13

Strategies	No. of proposed Actions/sub-actions	Key Nodal and Implementing Agency	SDG and NDC Linkage
Strategy 2: Strengthening departmental and institutional capacities and generating awareness to understand climate change and impacts on sectors	7	ACCMS, ASTEC, Education, ULBs, District Administrations	NDC 06 NDC 08
Strategy 3: Build climate change relevant policies, research, and outreach for strengthening adaptation and mitigation	14	ACCMS, Finance Dept., ASTEC	

In addition, actions are bifurcated based on the type of climate actions (adaptation centric, mitigation centric or both) and nature of actions (implementation, policy, research, and Capacity building). To build a holistic climate adaptation, and thereby resilience of all ecosystems requires efficient and effective of all ecosystems there is a clear need of contemporary knowledge on both climate adaptation and mitigation measures. Thus, knowledge dissemination management mechanism and policy in the state is critical. Hence, out of the proposed 24 actions to build strategic knowledge majority of action (87 percent) are adaptation focused. At the same time, all the nature of actions i.e., Policy, Research and Capacity building are provided equal number of actions (8 each) for building this holistic knowledge management in Assam.
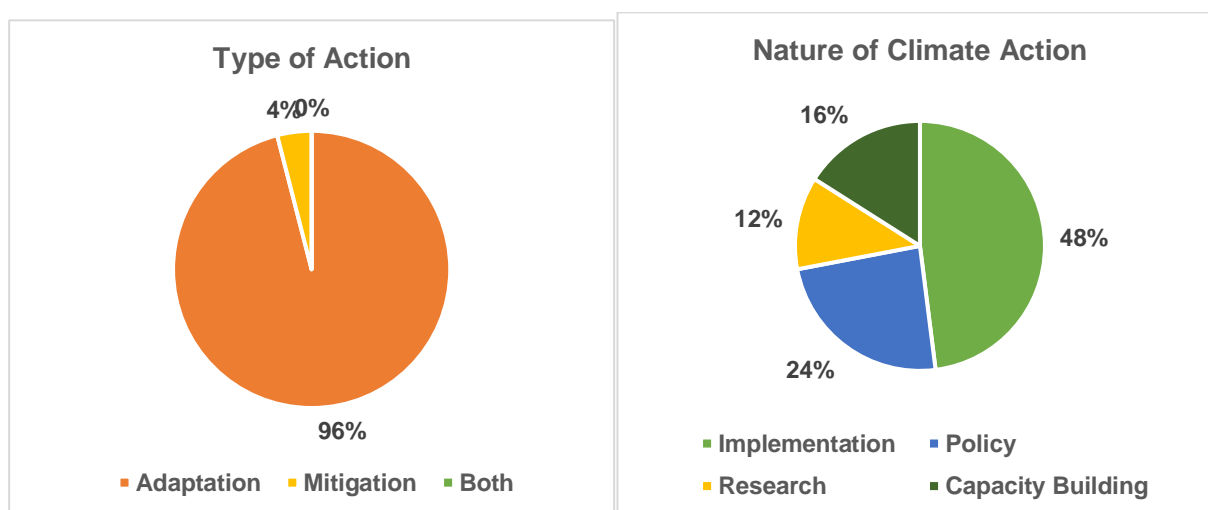
Figure 74: Distribution of Type and Nature of Actions under Strategic Knowledge

Strategy 1: Creation of Knowledge Management Portal for Climate Change

Rationale: In order to disseminate relevant information related to climate change to citizen of Assam and help all to take well informed decisions to combat climate change.

Strategy 2: Strengthening departmental and institutional capacities and generating awareness to understand climate change and impacts on sectors

Rationale: Climate change is real and is impacting all sectors in state. Every action or activity taken need to redesign with respect to climate change in order to minimise failure of those activities or projects in the State. Hence it is the first step to strengthen and build the capacity of the policy makers and executors across sectors.

Strategy 3: Build climate change relevant policies, research, and outreach for strengthening adaptation and mitigation

Rationale: Climate change poses risks to human health, ecosystems, social and cultural systems, and economic development. It also provides opportunities. Thus, building relevant climate policies helps to reduce risks and to take advantage of the opportunities.

A brief list of strategy wise actions, responsible agencies, and potential funding sources has been depicted in the Table below.

Table 53: Strategic Knowledge Strategies and Action Plan till 2030

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
Strategy 1: Creation of Knowledge Management Portal for Climate Change				
1.1	Assam Climate Change Knowledge portal and continuously update for next 10 years	Functional climate change knowledge portal	State Funds/CSS funds related to Strategic Knowledge Mission & ENVIS	NA: ACCMS IA: ACCMS, ASTEC
1.2	Incorporation of Indigenous Technical/Traditional Knowledge (ITKs) in traditional documentation.			
1.3	Collect gender-segregated data on various parameters as mentioned in sector specific strategies			
2.1	Build capacity within the state to analyse climate change trends and model projections.	ACCMS and ASTEC	State Funds, CSR, Private Investments, Multilateral and Bilateral Funds	ACCMS and ASTEC
2.2	Build capacity to run impact assessment models for various sectors	ACCMS, ASTEC and ASDMA	State Funds, CSR, Private Investments, Multilateral and Bilateral Funds	ACCMS, ASTEC and ASDMA
2.3	Institutional capacity building to handle climate change programmes (all concerned govt. directorates)	10 programmes, each 2-3 days	State Funds	ACCMS, ASTEC
2.4	Development of core group of climate change scientists in Assam (training for project development, care-support)	6 institutions	State Funds	ACCMS, ASTEC

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
2.5	Capacity building of departments across all levels of governance towards integrating CC in adaption Plans	All Core Departments	State Funds	ACCMS, ASTEC
2.6	Establishment of Research Grant Fund in Forest, Wildlife, and Climate Change	-	-	Forest Dept. / Finance Dept.
2.7	Enhance environmental Awareness and Values of Biodiversity especially among Youth and Children	At least 75% of state's youth population	Multilateral and Bilateral Funds/ Donor Agencies	NA: ACCMS IA: Education, ULBs, District Administrations, ASTEC (NGC)
Strategy 3: Build climate change relevant policies, research, and outreach for strengthening adaptation and mitigation				
3.1	Assess district wise climate change vulnerability and hydro meteorological hazard risk and develop adaptation plans for all sectors	All Districts	State Funds, Finance Commission Grants	ACCMS
3.2	Scan all future program and policies of the government and advise the government as to how all can be made climate resilient.	All Future Policies and Programmes by all core departments	State Funds	ACCMS, ASTEC
3.3	Focus on gender-budgeting in all climate vulnerable sectors and monitor it accordingly	Annual Budget	-	ACCMS, Finance Dept.
3.4	Focus on Green Tagging or Climate Tagging of departmental budgets	Annual Budget	-	ACCMS, Finance Dept.
3.5	Develop advisory manuals on for all infrastructure design requirements to address exacerbated impacts of climate change in the state of Assam in its various regions	All Key Infrastructure Projects (River Bridges, Highways, Flyovers, Dams etc.)	State Funds, Donor Agencies, Multi-lateral and Bilateral Agencies	ACCMS
3.6	Study & documentation of ground water level in the piedmont plain of northern Assam-Foot hills of Arunachal and Bhutan.	Hilly Areas of Assam	Central and State funds	ASTEC
3.7	Assessment of alternate Agri-practices in highly flood prone district	19 districts	Central and State Grants, Donor Agencies, NABARD	ASTEC

Sl.No.	Action	Target Location/Area	Potential Source of Funding	Nodal (NA) and Implementing agencies (IA)
3.8	Study of hill-slope destabilization and urban flood management system	Guwahati City, and all critical landslide prone locations	State Funds, Donor Agencies, Multi-lateral and Bilateral Agencies	ACCMS, ASDMA
3.9	Existing policy reviews in the context of climate change	Forest policy, Agri-policy, draft water policy, industrial policy	State Grants	ACCMS, ASTEC
3.10	Identification of wetlands for protection and management with proper study on hydrology, flora, fauna and economic value	4 zones	Central Funds (Jal Jeevan Mission), State Grants, CSR, Bilateral and Multi-lateral Funds	ASTEC
3.11	Identification and conservation strategies of vulnerable biologically sensitive species	4 institutions	Central Funds, State Grants, CSR, Bilateral and Multi-lateral Funds	ASTEC, ASBB
3.12	Flood Hazard Risk vulnerability including impact of climate change assessment at sectoral and departmental level with high resolution mapping (Periodical update of NRSC study)	Flood Risk and Vulnerability Mapping along the major rivers and cities	Finance Commission Grants, Bilateral and Multilateral Funds	NA: ACCMS IA: ASTEC ,ASDMA, ACCMS
3.13	Mainstream climate change into the school education curriculum (biodiversity conservation, solid waste management, individual and community health, water resources management, agriculture)	Class 1 – 8	Higher education department funds/UNICEF	NA: ASTEC IA: Higher Education Department
3.14	Creation knowledge product on best practices for promotion and usage of alternate construction materials and technologies in line with the Task Force Recommendations. • Creation of Knowledge Product • Outreach and awareness Campaigns for Construction and Real Estate Companies	All Districts	Multilateral and Bilateral Funds/ Donor Agencies	NA: ACCMS IA: Industries Dept., ULBs, District Administrations

The detailed list of strategies, action wise implementation period, estimated budget, nodal and implementation agencies and source of funding can be viewed in Annexure C.

Chapter 6. Financing the SAPCC

The current chapter outlines a snapshot of current expenditure and investment, probable windows and sources of finance.

6.1 Current climate finance landscape in Assam:

Climate Finance in Assam has a heterogeneous structure with public, private, national and international actors and includes, the national government, the state government, international donor agencies, bilateral agencies, private investors, as well as international NGOs. Majorly, the climate finance landscape can be segregated into private and public. The public sources of climate finance include budgetary outlays for the state from national programmes and state programmes including subsidies and taxes. On the other hand, private finance includes miscellaneous sources such as CSR funding, equity fund, loans etc. In addition, there are multilateral and bilateral agencies providing finance in the form of grants, concessional loans and other loans. Within the existing climate finance landscape in the state, there is a need to mobilize funds in a way that aligns with the state as well as nation's development priorities.

Figure 75 below provides a summary of climate finance avenues that Assam is availing and may avail in the future.
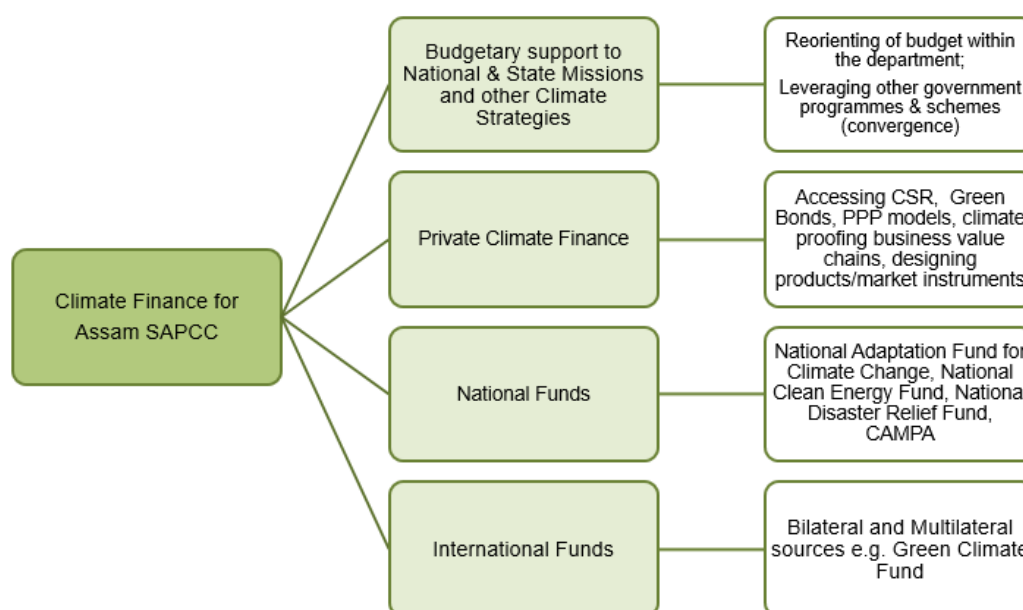
Figure 75: Climate Finance Landscape in Assam

Table below maps in details the potential sources of funds to finance climate mitigation and adaptation actions in the state of Assam. For this purpose, various types of financing windows have been identified. Further with an aim to dive deep and provide a clear understanding of the sources of funds, instruments through which finance is mobilized and the key sectors covered across each source of finance has been mapped in Table 54. The mapping provides a sense of the probable sources of finance that can be considered by Assam to finance the actions as outlined under each sector.

Table 54: Modalities of Climate Finance Instruments

Window	Source of Fund	Instrument	Key sectors
Budgetary	Union and State Budget	Budgetary allocations through Centrally Sponsored Schemes (CSS), Centre Schemes (CS), State Sponsored Schemes (SSS)	Sectoral (covering both adaptation and mitigation related aspects: Agriculture, horticulture, agro-forestry, environment, allied activities, water, forestry, urban, coastal and low- lying system, disaster management, human health, marine system, tourism, habitat sector and other rural livelihood sectors to address climate change related issues.
National Missions	NAFCC NDRF/SDRF NCEEF CAMPA	Grants; both demand-driven and as per target	Sectoral (covering both adaptation and mitigation related aspects
International climate funds	Green Climate Fund	Loan and grants	Agriculture, Water, Health, Livelihood, Infrastructure and built Environment, Ecosystem, covering both adaptation and mitigation related aspects
Multilateral and Bilateral	Facilitation of key projects contributing to climate goals: GIZ NDC JICA The World Bank UNDP ADB	Loan and grants	Sectoral (covering both adaptation and mitigation related aspects)
International Non-Governmental Organizations (INGOs)	Facilitation of key projects contributing to climate goals: ICLEI	Grants	Sectoral (covering both adaptation and mitigation related aspects)
Private Finance	Corporate Social Responsibilities (CSR), Green Bonds, loans	Loans, grants, equity	Sectoral (covering both adaptation and mitigation related aspects)
Public Private partnership	Projects contributing to climate goals	Loan and grants	Sectoral (covering both adaptation and mitigation related aspects)

Detail description of type of fund and corresponding availability of fund is presented in the following sections.

6.1.1 Public expenditure and investments

Trends of budget allocations made to different departments between the years 2016-17 to 2019-20 is mapped in Table 55. The state budget analysis (2021-22) indicates that allocation towards agriculture and allied activities (5.4 per cent of its total expenditure), rural development (5.1 per cent of its expenditure), and roads and bridges (9 per cent of its total expenditure) together are more than double the average allocation of all states in India (4.3 per cent) (PRS, 2021).

Table 55: A snapshot of department-wise budget allocations (revised estimates) between 2017-18 to 2019-20

Sector	Key Departments	Departmental Budgeted (Revised Estimates) Rs. In Crores		
		2017-18	2018-19	2019-20
Agriculture and Allied	Agriculture	1893	1926	2648
	Animal Husbandry	589	507	579
	Dairy Development	31	35	32
	Fisheries	189	161	

	Horticulture	54	113	202
Habitat	Rural development	4205	5870	8768
	Urban Development (Including Municipal Admin. And GDD)	3249	3331	3376
	Housing	18.51	6.04	9.48
	Transport (incl. Roads and Bridges)	4723	8734	12167
Forestry and Biodiversity	Forest	942	601	1084
Health	Health	5451	7258	7686
Water	Irrigation a	1036	1711	1489
	Soil and Water Conservation	182	198	226
	Water Resources	2739	1141	1680
	Water Supply and Sanitation	2671	3317	8521
Energy	Power	3917	4952	4249
Disaster Management	Natural Calamities	1289	1283	1386

Source: Grant-wise Budget Documents of Assam (2018-19 to 2020-21)

It is interesting to note that in the year 2021-22, Rs 253 crore was allocated towards crop insurance programme whereas Rs 334 crore were allocated towards Pradhan Mantri Awas Yojana (PRS, 2021). Similarly, budget provisions of the year 2020-21 suggest that Rs 1,823 crore were allocated for Pradhan Mantri Awas Yojana (Gramin) and Rs 383 crore for MGNREGA and Rs 694 crore were allocated for Brahmaputra Flood Control Project (PRS, 2020). In the year 2019-20, Rs 780 crore were allocated for construction of toilets under the Swachh Bharat Mission, Rs 560 crore were allocated for the Mukhyamantri Krishi Sah Sajuli Yojana, farmers' interest relief scheme, and farmers' credit subsidy scheme, Rs 921 crore were allocated for expenditure on minor irrigation, Rs 672 crore were provided as capital outlay for flood control projects (PRS, 2019).

In the year 2017-18, a total of 3, 96,776 Kisan Credit Cards were issued with a credit limit of a total of Rs 952.55 crores. With the objective to overcome the shortcoming regarding delay in settlement of claims etc. under National Agricultural Insurance Scheme (NAIS), a Pilot Weather Based Crop Insurance Scheme (WBCIS) was introduced for implementation in 20 States on pilot basis. WBCIS has been implemented in Assam since Rabi (2013-14). WBCIS is intended to provide insurance protection to the farmers against adverse weather incidence adversely impacting the crop production, such as deficit and excess rainfall, high or low temperature, humidity etc. (Economic Survey of Assam, 2017-18).

100% interest subventions on agricultural loans have been introduced in the State through the "zero interest crop loans" scheme to farmers in Assam up to the limit of Rs 1.00 lakh. Further, to support livelihoods Assam Agribusiness & Rural Transformation Project (APART) project worth Rs. 1688 crore was launched during 2017-18. Also, during FY 17-18, Government of Assam has set up a "Price Stabilization Fund" worth Rs. 150 Crore at the disposal of the Food & Civil Supplies Department for them to step in and correct any market failures that may arise.

Till date, Fortification of embankments of Brahmaputra River alone have been done at a probable cost more than Rs. 4454.09 crores. This highlights the total potential for the public investment in building resilience and mitigation measures.

6.1.2 National Funds

<u>NAFCC:</u> With an objective to prioritize the need to build climate resilience in the areas identified under relevant missions of NAPCC and SAPCCs, the National Adaptation Fund for Climate Change (NAFCC) was established in August, 2015. The project sanctioned under NAFCC is outlined in the below.

Table 56: Project sanctioned under NAFCC in Assam

Name of Project	Executing Entity	Project outlay (in Rs. Crores)
Management of Ecosystem of Kaziranga National Park by Creating Climate Resilient Livelihood for Vulnerable Communities through Organic farming and Pond Based Pisciculture	Kaziranga National Park (KNP) under Department of Environment & Forests (DoEF), Government of Assam	24.57

Source: NABARD (2015)

State Disaster Response Fund (SDRF): SDRF is the primary fund available with State Governments for responses to notified disasters: Cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloudburst, pest attack, frost and cold waves. In case of disaster of severe nature, the National Disaster Response Fund (NDRF) supplements SDRF due to inadequate availability of funds. The allocation under SDRF to Assam for the FY 2020-21 was Rs. 858 crores, of which the Centre's share of SDRF released was Rs. 308.80 crores (MoHUA, 2021).

National Clean Energy Fund (NCEF): NCEF had been created out of cess on coal produced / imported, through Finance Bill 2010-11. However, the guidelines were revised in 2017 to expand the scope of the fund to include clean environment initiatives (MNRE, 2018).

6.1.3 Finance deployed through Multi-lateral and Bilateral Organizations

Currently, a number of projects are ongoing in Assam that are supported by Multi-lateral/ Bi-lateral organisations. A snapshot of climate relevant projects and budget allocated against each project have been provided in the table below.

Table 57: A snapshot of projects funded by Multi-lateral and Bi-lateral Organisations in Assam

Name of Project	Allocated during (Actual) 2016-17	Allocated during (RE)2017-18	Allocated during (BE)2018-19	Budget Allocated 2019-20 (RE)	Budget Allocated 2020-21 (BE)	Budget Allocated 2021-22 (BE)	Donor
Assam Project on Agri-business & Rural Transformation (APART)	20.00	150.00	80.00	153	122	272	World Bank
Assam State Road Project	510.00	510.00	500.00	700	-	100	World Bank
Brahmaputra bridge project	-	-	-	425	240	700	NDB
Assam Road Network Improvement Project (ARNIP)	-	-	-	0	80	100	ADB
Assam power Sector Enhancement Investment Programme	174.00	110.00	40.06				ADB
Assam Power Sector Investment Programme	35963.00	34792.00	200.00				ADB
North Eastern Region Power System Improvement Project (NERPSIP)- for strengthening of transmission & distribution system	1800.00	1200.00	7.50				ADB
South Central Guwahati & North Guwahati Water Supply Project (JICA)	20528.00	20528.00	252.23				JICA
Guwahati Sewerage Project	6.82	6.82	6.82				JICA
Assam Urban Infrastructure Investment Prog.	292.73	292.73	358.07				ADB
Assam Integrated Flood & River Erosion Management Investment Programme	207.44	133.46	170.00				ADB

Rural Water Supply & Sanitation Project- Low income states (RWSSP-LIS)	374.91	203.45	150.00				World Bank
Citizen Centred Service Delivery Project	34.10	34.10	50.00				World Bank
Assam Project on Forest & Biodiversity Conservation	220.00	218.12	52.37				ABD
Capacity Building for Forest Management & Training of Personnel	86.89	195.00	0.00				JICA
Assam Public Financial Management Strengthening Project	51.20	93.40	50.00				World Bank
Assam Inland Water Transport Project	16.00	51.27	50.00				World Bank

6.1.4   Private sector finance

In addition, private finance is one of the key sources of climate finance in the Indian landscape. In this respect, green bond is one emerging mechanism to finance green initiatives, which are debt instruments that can be used by governments, international organisations as well as private sectors to raise money for the projects that contribute to climate mitigation/adaptation. India has become the second-largest issuer of green bonds (after China) among emerging markets with cumulative issues worth more than $10 billion by private companies and public sector entities such as the State Bank of India (SBI) (Financial Express, 2021). The sectors across which the projects can be financed under green bonds include waste management, storm water management, energy, green infrastructure, clean water and utilities, transportation and industrial efficiency (GIZ, 2017).

Further, CSR has been made a mandatory provision by imposing statutory obligation on Companies to take up CSR projects towards social welfare activities. As per the National CSR Portal, a total of 117 companies have spent a total of Rs 161 crore on CSR in Assam during the year 2020-21. The CSR initiatives were taken across 20 districts in the state (MoCA, 2021). Of the total amount, Rs. 359.59 lakhs were spent on Environmental sustainability and Rs 5 lakhs on Conservation of natural resources (MoCA, 2021). The portal has provided a snapshot of total amount spent on CSR in the state between 2014-15 to 2020-21 (Figure 76).

FY 2014-15 Rs. 134.78 crores	FY 2015-16 Rs. 164.6 crores	FY 2016-17 Rs. 269.91 crores	FY 2017-18 Rs. 213.59 crores	FY 2018-19 Rs. 210.22 crores	FY 2019-20 Rs. 288.48 crores	FY 2020-21 Rs. 160.77 crores

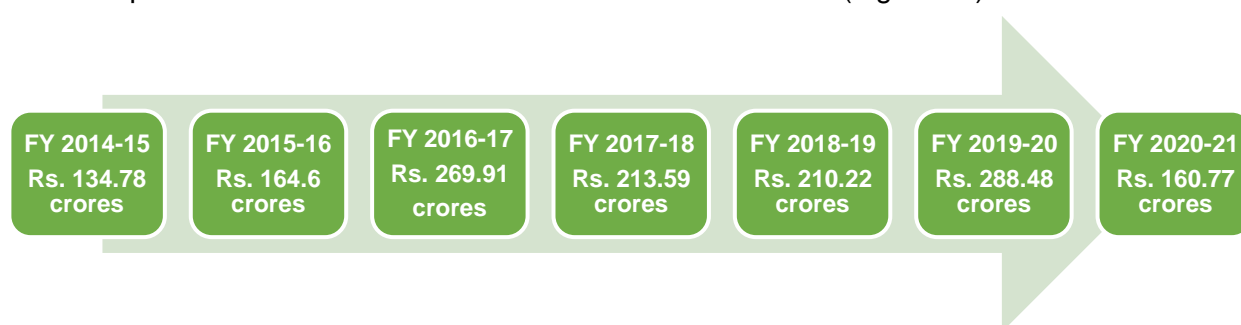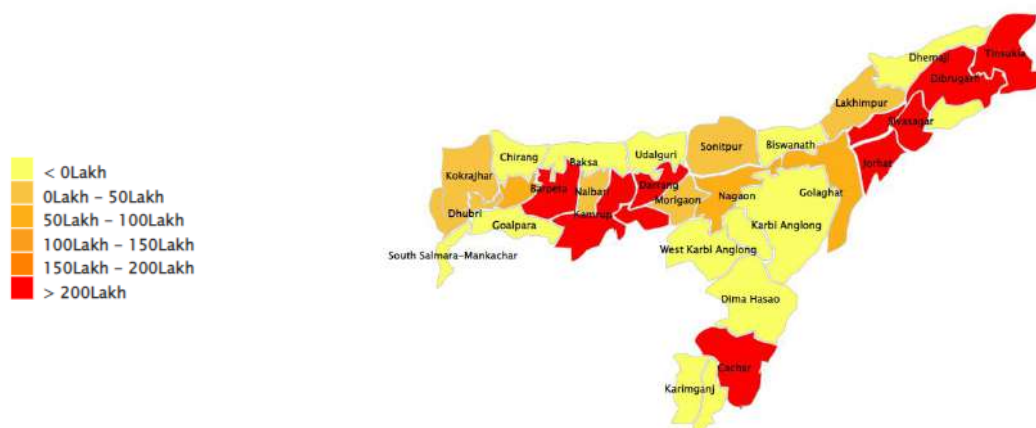*Figure 76: Total amount spent on CSR in Assam between FY 2014-15 to FY 2020-21*

Source: MoCA (2021)

District Dibrugarh has received the highest CSR funding of Rs. 1375.95 lakhs by 11 companies, where Rs. 132 lakhs were spent on environment sector (Figure 77) (MoCA, 2021).

Source: MoCA (2021) | Map not to scale

Figure 77: District-wise distribution of expenditure by companies on CSR in Assam

Chapter 7. Institutional Mechanism

7.1 Role of Government Stakeholders:

For the purpose of coordinating the preparation and revision of State Action Plan on Climate Change (SAPCC) and all strategic decisions related to climate change with different departments in the State of Assam. In August 2018, the Assam Cabinet constituted the Assam Climate Change Management Society (ACCMS), a Special Purpose Vehicle (SPV).

The society was registered under the Registration of Societies ACT XXI of 1860 on 15 October 2018 the Governing Council of the Society is headed by the Hon' Chief Minister and is further supported by the council of Ministers as its members. The steering committee is chaired by the Chief Secretary of the state. Each department in the state will nominate a representation to the Society, a Nodal Officer responsible for climate change matters pertaining to their department and will also coordinate as necessary with the technical officers hired in the Society. The Department of Environment and Forest, Government of Assam, is the nodal department for coordinating ACCMS.

The Assam Climate Change Management Society: Roles and Responsibilities

- Implementation of the SAPCC and the projects and programmes emanating from it
- Updating the SAPCC on a regular basis as per the advancement of knowledge on climate change,
- Addressing the requirements of the National Action Plan on Climate Change periodically
- Facilitating the implementation of India's commitment if any to the UNFCCC
- Creating a knowledge management platform and data base for informed decision on integrating climate change adaptation in planning, in consultation with various agencies in the country
- Liaison with state departments through their climate change nodal officers
- Formulating a Monitoring and Evaluation framework to assess progress of projects and to assess that adaptation is taking place
- Undertaking new studies to address mitigation and adaptation concerns, with funding from the State governments/ central government/ various missions of the NAPCC/climate change funds – national and international
- Building capacity of natural resource and energy managers to address climate change within their domain
- Give advisories to the various departments of the Government and agencies and bodies to adopt new technologies, methodologies, and systems, and practices to move away from the Business As Usual (BAU) scenario to make Assam a Carbon Negative State
- Undertake climate audits of the various projects and schemes and suggest new pathways to the implementing departments and agencies
- Help departments and agencies of the government to adopt climate-neutral/ negative policies, mitigation mechanisms, and guidelines
- Help Departments build adaptive capacities of the communities, incorporate adaptive measures in the existing schemes where possible or help the departments undertake specific adaptation projects

- Engage actively with state/national and international agencies, bodies, and organizations for bringing the best practices from across the globe in climate change mitigation and adaptation
- Any other activity to be undertaken to fulfil the above objectives. This involves bringing together and harnessing the power of people, institutions, technology, and knowledge by undertaking a wide range of activities such as:
  a. Networking and partnering with state, regional, and international institutions /Centres, Corporate and Private Sector, Professionals, Non-Government, and Civil Society organizations for convergence and synergy in the use of human and material resources.
  b. To serve as a Knowledge Centre and Think-tank for the government on areas of expertise on governance and Cultural Studies.
  c. To support change management and management development programmes in government and non-governmental organizations to effectively carry forward initiations for Scheduled Tribe and Scheduled Caste development.
  d. To function as a resource centre for documentation and dissemination of best practices, success stories, and successful tried experiments and tools in SC and Tribal Area Development.
  e. To work for the convergence and synergy of Public-Private-partnership on the principles of transparency and accountability.
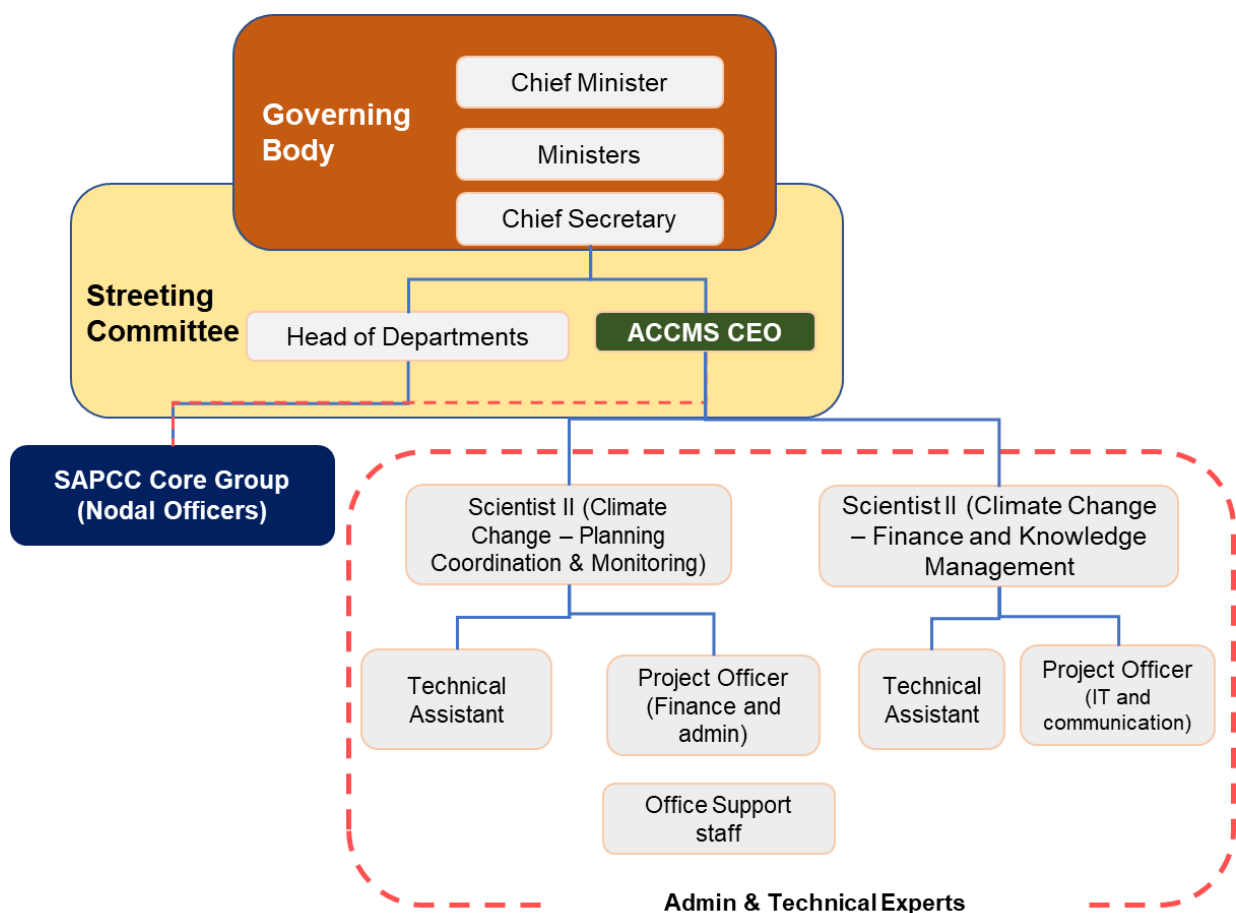 f. To assist concerned Government departments in their climate reform agenda.

Figure 78: Existing Organogram of ACCMS

The Governing body headed by the Chief Minister, is responsible for policy planning and coordination, innovation, resource mobilization and for synergizing the efforts of the various stakeholders. The members of governing body will be the Ministers of various departments in the State and distinguished experts.

The Steering Committee will be headed by the Chief Secretary of the State and the members will be the head of departments. The role of the Steering Committee will be to provide guidance on all activities that will be undertaken by the Society.

SAPCC Core Group comprises of Nodal officers nominated by departments that are key to the formulation of ASAPCC and represent the sectors; Agriculture and Allied, Water Resources, Forestry and Biodiversity, Human Health, Habitats, Energy, Disaster Management and Strategic Knowledge.

Technical experts will be subject matter specialist with a knowledge of climate change science, impacts and mitigation. They will ensure implementation of all the envisaged activities mentioned as the role of the Society. The following specialists will be / are part of the team:

- Data Management, GIS and web portal hostile
- Water Resource
- Agriculture and Allied Activities
- Forest and biodiversity
- Urban Development
- Energy
- Rural Development
- Health
- Infrastructure

The nodal department for coordinating ACCMS is Department of Environment and Forest, Government of Assam. Figure below schematically represents the implementation arrangement of all matters related to climate change in the state including implementation of the SAPCC comprising of the nodal agency and core group departments oversee and decisions taken by the governing and steering committee as described above. The figure below further elaborates the SAPCC Core Group

Institutional mechanism for implementation of Assam SAPCC 2.0 is depicted below involving 21 core departmental stakeholders:
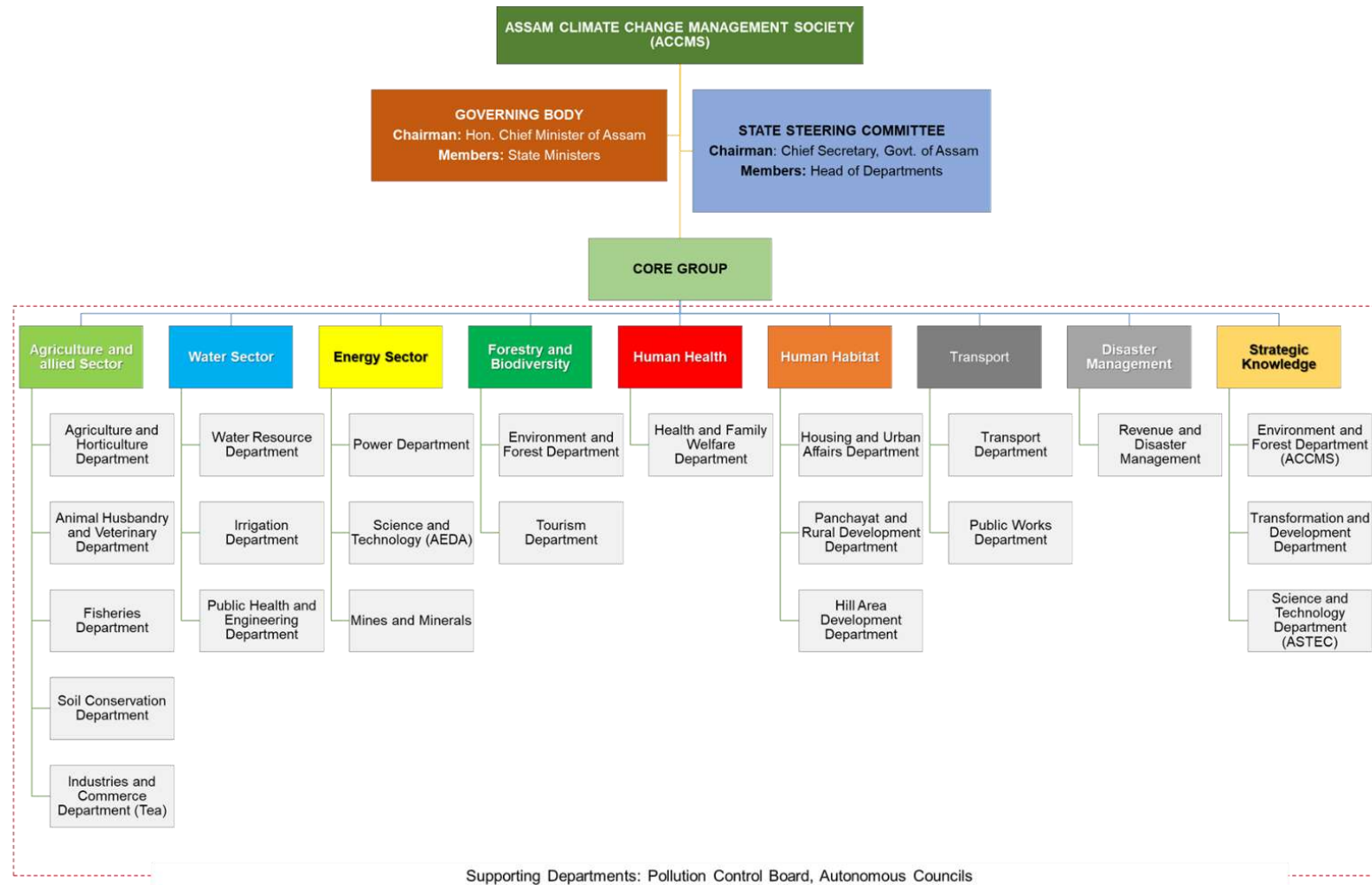

Figure 79: Assam State Climate Change Institutional Architecture

*Energy Sector (includes both Renewable Energy and Enhanced Energy Efficiency)

Following figure presents the indicative governance mechanism for managing climate change and related issues in Assam.
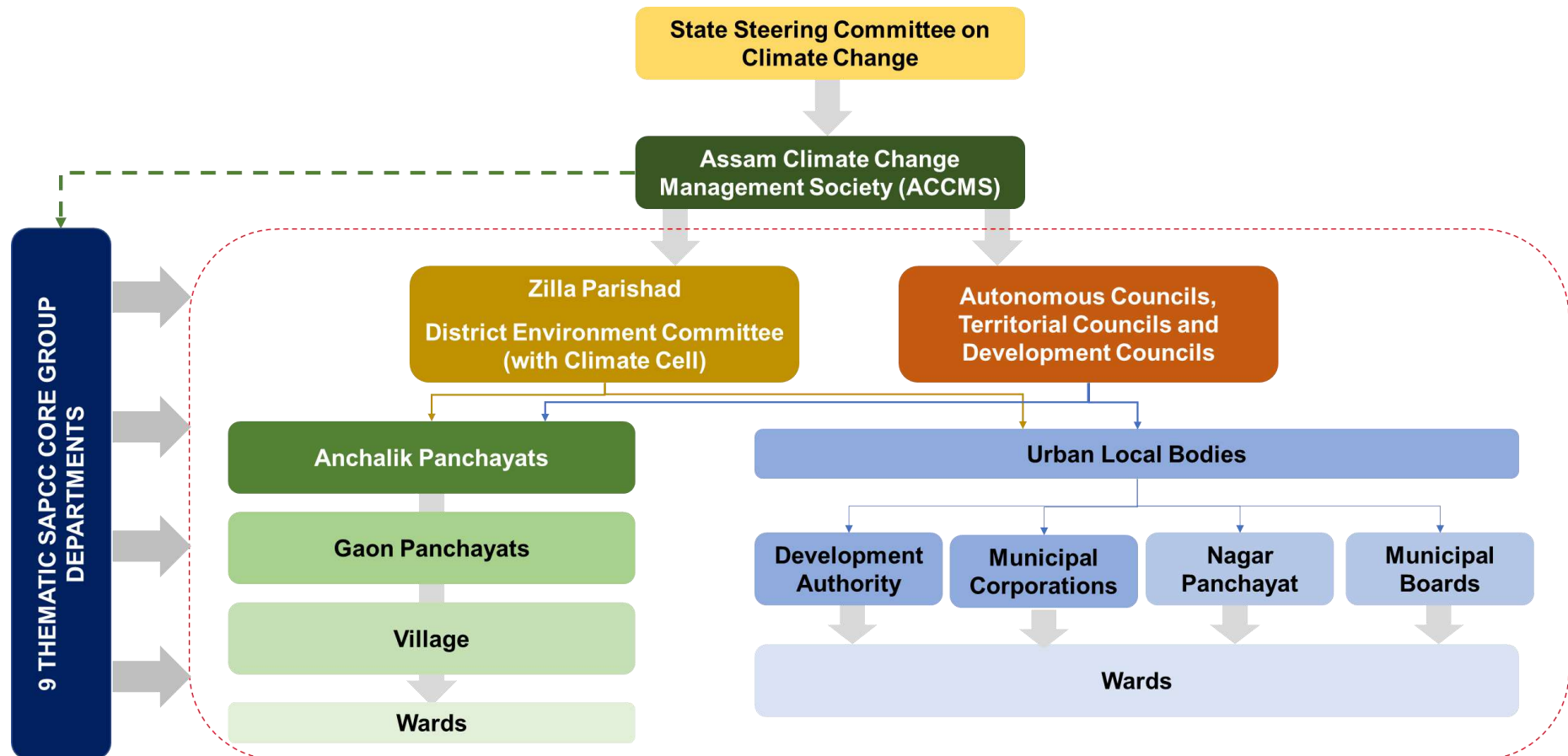

Figure 80: Indicative Climate Change Governance Architecture in Assam

7.2 Roles of private sectors, civil societies and individuals:

In order to undertake the proposed strategies in all 9 sectors, all stakeholders along with Governmental bodies also need to be considered. Most of the developing countries while implementing adaptation or mitigation related activities often face challenges in terms of a limited resource availability, lack of financial capacity, limited access to financial resources, and competing uses for available finance. The role of private sector majorly involves to assess this financial gap and to aid with appropriate financial investment plans for sustainable future. Thus, the private sector can play a dual role in providing not only necessary finance and technical services for managing climate risk, but also in ensuring future investments prioritizing climate resilience. With its greater financial capability, the private sector can better mobilize financial resources and technical capacity at the sectoral level, and boost the efforts of public interventions. Depending on the type of the private sector the role can be further customized either for implementation, or finance/investments. For example, the small scale local entrepreneurs can focus on their own adaptation towards climate change through their operations and assets management; whereas larger companies can develop their potential to adapt towards climate change by protecting their own assets and also to provide financial support and service support to other stakeholders. Greater private participation may also catalyse participation from civil society and communities, and further act as a catalyst for creating an enabling environment, increasing climate investments and reducing societal vulnerability to climate change (Dominic Molloy, 2021).

As mentioned in Finance chapter of this report, the sectors across which the projects can be financed under green bonds include waste management, storm water management, energy, green infrastructure, clean water and utilities, transportation and industrial efficiency. Also, CSR has been made a mandatory provision by imposing statutory obligation on Companies to take up CSR projects towards social welfare activities. The same fund can be utilized to complete climate adaptation and mitigation work in Assam. Private players like World Bank, Asian Development Bank (ADB), Japan International Cooperation Agency (JICA) etc. have already invested in Assam through different projects like Assam Project on Agribusiness & Rural Transformation (APART), Assam Road Network Improvement Project (ARNIP), South Central Guwahati & North Guwahati Water Supply Project, and Assam Project on Forest & Biodiversity Conservation (APFBC) etc. Such channels of investments need to be strengthen further for implementing the strategies given in the report.

Civil society organisations (CSOs) are basically non-governmental organisations (NGOs) including non-profit organizations, associations, foundations, forums (formal and informal), labour unions, professional associations, and educational and research institutions. Among the many functions of civil society, it considers that the main functions of CSOs are monitoring and advocacy function of public policies and the function of community empowerment (T Samnuzulsari, 2021). Through its functions, civil society mostly ensures that development carried out by the government and the bureaucracy must be able to anticipate climate change, including climate change adaptation and mitigation. CSOs can be majorly involved in implementing the strategies and building the capacities of local government and communities. For example CSOs like World Wide Fund (WWF), International Union for Conservation of Nature (IUCN) etc. has potential to implement the strategies related to forest sector. Because of the strong presence on ground, research related strategies can also be effectively carried out by civil societies.

It is evident that the ultimate stakeholder which is greatly impacted by climate change is an individual or society or community. It is fact that in order to ensure any strategy or innovative technologies which are widely adopted will not only require large investments and partnerships between private and public sectors but also demands from individuals. Individual actions will send market signals that will encourage governments and businesses to invest in these innovations and create the breakthroughs we need. The Mission like LiFE announced by Hon'ble Prime Minister at the 2021 UN Climate Change Conference (UNFCCC COP26), can be adopted at state level through peoples' participation and support. The individuals can come forward to adopt the climate-friendly social norms, beliefs and daily household practices that can result in reduction in their footprints further helping in improving climate change mitigation and adaptation strategies in the sector of water, transport, food, electricity and waste management.

Chapter 8.   Monitoring and Evaluation

A Monitoring and Evaluation or M&E system in place is essential to ensure building of climate resilience of the State. The key objectives of a Monitoring and Evaluation system would be to:

- Track of whether adaptation and mitigation actions are being implemented as planned under the SAPCC.
- Ensure achievement of state development priorities including SDGs
- Contribute to the national NDC targets
- Support the achievement of the National Missions of climate change
- Assess effectiveness of the strategies and actions outlined in the SAPCC – effectiveness of the process as well as those of outcomes of
- Use the learnings to strengthen future climate actions
- Institutionalize rigorous tracking of performance metrics and comprehensive policy evaluations

The ACCMS, being the key nodal department on climate change in the state will be responsible agency for monitoring and evaluating the activities envisaged under ASAPCC with the overall support from SAPCC core departments.

Individual strategies proposed under respective nine sectors in ASAPCC will have their respective result framework highlighting the output and impacts. In order to aggregate the outputs/impact of each strategy under nine sectors proposed under ASAPCC up to the national level, following approach is envisaged to monitor and evaluate the interventions. This uses a sectoral approach for measuring the achievement towards India's NDC and SDGs.

Strategy Level	Strategy/Action specific indicators	Sector Level	SDG and NDC indicators across 8 thematic sesctor.	State Level	Progress implementation of overall SAPCC Targets
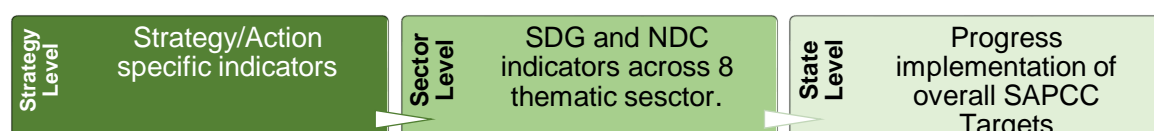
Figure 81: Approach for M&E

8.1 SAPCC Level Monitoring and Evaluation

At the SAPCC level, monitoring actions, implementation progress and mapping of roadblocks or challenges are critical for the M&E of the ASPACC 2.0.

Following are the key indicators at the SAPCC level:

Table 58: State Level Key M&E Indicators for ASAPCC 2.0

Indicator	Monitoring Periodicity
Percentage of actions initiated	Quarterly
Percentage of actions implemented	Yearly

Based on the indicator-based performance evaluation, the nodal agency i.e., ACCMS will prepare a year-on-year progress report on the performance, outcome achievements and key challenges faced by the departments during implementation of actions.

8.2 Detailed level indicators at State level considering SDGs, NAPCC and strategies proposed for all sectors

At state level, each year all the core group departments will report to ACCMS about the progress of implementation, key challenges during implementation etc. While at sector and strategy level these core departments will support ACCMS in monitoring based on the following table depicting key performance indicators that are mentioned in Assam Vision document 2030, and State Indicator Framework which is relevant to climate change, along with the additional indicators for monitoring development as per 9 National Missions under NAPCC (Excluding National Coastal Mission) which are relevant for nine sectors mentioned in ASAPCC 2.0. For effective evaluation of the strategies mentioned in each sector, relevant implementing agencies should mandatorily submit annual report elucidating the progress of physical and financial targets. Further, a mid-term review post 5 yrs is suggested for evaluating the overall progress of strategies from the period of SAPCC implementation.

Table 59: Key Performance monitoring indicators at SDG/NAPCC/Strategy level for all sectors under ASAPCC 2.0

Sector	Key Indicators for Monitoring and Evaluation of SAPCC progress in Assam
Agriculture and allied	Increased coverage under climate resilient crop varieties (like millet) (lakh ha)
	Increased area under organic farming – Including Tea (lakh ha)
Water Resources (including irrigation, flood and erosion)	Proportion of households with access to functional tap connections (%)
	Development of area resilient to flooding & erosion (ha)
Forests and Biodiversity (including tourism)	Enhancement of area/density of forests in the state (ha or trees/ha)
	Enhancement of area under tree cover (ha)
Energy (Renewable energy and enhanced efficiency)	Proportion of renewable energy to total annual energy production by installed capacity (%) (for measuring renewable work)
	Proportion of Aggregate Technical & Commercial (AT& C) losses to total energy produced (%) (for measuring efficiency)
Human Habitat (Urban and Rural)	Inclusion of Climate Actions and their implementation into Gram Panchayat Development Plans (GPDP) [Refer proposed actions for climate actions]
	Number of ULBs with climate sensitive master plans - prepared/updated/notified

Transport	Enhanced coverage under all-weather roads (kms) and Share of EV to total vehicles (%)
Human Health	Adaptive preparedness of the PHCs/CHCs against diseases induced by climate change (vector borne, water borne, respiratory, zoonotic etc.)
Disaster Management	Vulnerability based disaster management preparedness at district level resulting in reduced loss to life and property
Strategic Knowledge Management	Number of knowledge products created and trainings/workshops conducted for awareness generation

The revised SAPCC has also devised cross-cutting indicators under various strategies for adaptation and mitigation actions which are as follows:

Table 60: Cross-cutting indicators for mitigation and adaptation strategies

Sector		Strategy	Monitoring Indicators at the Strategy level
Agriculture	• **Agriculture and Horticulture Department** • **Animal Husbandry and veterinary Department** • **Fisheries Department** • **Soil Conservation Department** • **Directorate of Tea**	Addressing climate risk through climate-smart agriculture practices	% of farmers who knows climate-smart agricultural practices
			Increase in % of the area under millet
			% of districts having Farmer Producer Organisations/ Company's including Fish
			% of climate resilient cattle sheds
			% of farmers using green fodder
			% of area under climate resilient varieties
		Improved access to risk sharing measures to increase farmer's income and livelihood security	% of farmers covered under weather-based crop insurance scheme
			Number of research, and capacity building activities per year per district
			Number of state-of-the-art storage units (cold, godowns, ice plants, etc.) per district

Sector		Strategy	Monitoring Indicators at the Strategy level
			% of area under integrated farming (crop-fish husbandry)
		Strengthening Tea Sector and build climate adaptation	% of area under organic tea
			% of area under micro irrigation for tea gardens
Water	• **Water Resource Department**	Enhanced monitoring andresearch to establish waterbudgets and	% of mapping of micro watershed
			% of number of installed automatic telemetry-based rain gauge sensors
	• **Irrigation Department**	Manage water equitably	% of micro watershed covered under water budget estimations
		Enhanced monitoring and research to establish water budgets and manage water equitably	% of institutional area covered under roof top rainwater harvesting
			% of area covered under artificial recharge structures
			% of number of recharged springs
		Enhanced water use efficiency across sectors	% of water intensive industries covered under benchmarking
			% of area under SRI
		Strengthening water sector infrastructure to adapt to climate change	% of macro water infrastructure under retrofitting
			% of villages with Functional household tap connections (FHTC)
			Number of contingency plans made
		Conservation of wetlands and springs	% of area under wetlands mapped

Sector		Strategy	Monitoring Indicators at the Strategy level
			% of area under springs mapped
		Enhancing resilience towards frequent and unprecedented floods	% of reclamation of embankments
Forests and Biodiversity	• **Environment and Forest Department**	Enrich and restore forests and increase area under tree outside forests with co- benefits of improvement in ecosystem services and carbon sequestration	% increase in forest density of moderately dense forest with current baseline of ISFR 2021
			% increase of area under tree planting (AR)
		Enhance tree cover in Urban and Peri Urban areas (including institutional lands)	% of area under tree planting (JFMC)
			% of area restored under degraded forest
		Provide policy and regulatory support for improving forest and tree cover	% of area under fuelwood plantation
		Improve incomes of forest dependent population through agroforestry in private and community lands	% area under medicinal/ aromatic plants
		Conservation of biodiversity and protection of habitats	% of climate sensitive tourism sites conserved
Energy	• **Power Department** • **Assam Energy Development Agency**	Promotion of Renewable Energy to ensure energy access for all	% of number of buildings having solar rooftop
			% of number of solar pumps installed in agriculture
			% of number of cold storages with solar power

Sector		Strategy	Monitoring Indicators at the Strategy level
			% of number of solar street lights
		Enhancing Energy Efficiency across sectors	% of number of hydroelectric projects
			% of number of carbon neutral plans for MSMEs
			% of number of fuel-efficient stoves
			% of number of high voltage grid substations
Human Habitat	• **Housing and Urban Affairs Department** • **Assam State Disaster Management Authority** • **Irrigation Department** • **Public Work Department** • **Transport** • **PHED** • **Hill area Development Department** • **Panchayat and Rural Development**	Mainstreaming Climate action into urban governance and policy	% of ULBs with Climate Action Plans (above 1 lakh)
		Building Climate resilient urban housing infrastructure	% of households exposed to floods relocated or provided protective measures
			% of buildings with rooftop rainwater harvesting
		Developing climate smart and resilient urban waste management infrastructure	% of number of ULBs removing legacy waste
			% of number of ULBs plastic free
		Building climate resilient and low carbon urban road network and mobility	% of number of flood prone ULBs having raised roads
		Ensuring holistic managementof urban pollution and emission in cities (other than Transport related)	% of number of towns with micro action plans to manage water and air pollution
			% of number of industries following pollution norms

Sector		Strategy	Monitoring Indicators at the Strategy level
Rural Habitat	**Department** • **Directorate of Municipal Administration**	Mainstreaming Climate action into rural governance and policy	% of number of women trained on water quality aspect
		Building Climate Resilient Rural Housing Infrastructure	% of rural construction workers trained on sustainable material usage
		Enhancing climate smart and resilient rural waste management infrastructure	% of number of HHs with individual latrines
		Building climate resilient and low carbon rural road network	% of area under road side plantation
HumanHealth	• **Health and Family Welfare Department**	Assess the health risks associated with current and future climate change in the state and provide action plans for response at a state level	% of number of districts having risk response mechanism
			% of number of districts with state adaptation plan for climate change related illness
			% of number of districts with contingency plans for climate sensitive illnesses
		Develop institutional convergence for effective coordination and capacity building to enable lifestyle and behavioural change and create awareness on health vulnerability to climate change	% of number of districts with environment health cell
Disaster Management	• **Revenue and Disaster Management Department**	Risk Assessment and mapping for holistic	% of number of districts with muti-hazard risk assessment and vulnerability mapping
		Disaster Management In state	% of number of districts with disaster early warning mechanism

Sector		Strategy	Monitoring Indicators at the Strategy level
		Strengthening Policy, administrative and individual level interventions for pre and post disaster preparedness and mitigation	% of number of districts with gender based and child sensitive localized disaster management plans
		Enhanced flood forecasting mechanism for minimum human and economic loss	% of number of districts having flood contingency plans
		Enhanced mechanism for landslides preparedness and mitigation	% of number of districts with community level preparedness plan
		Minimizing the soil erosion due to floods through appropriate construction regulation and vegetation measures	% of area under terrace
		Ensuring minimum losses from wind and storms	% of number of blocks with multipurpose cyclone shelter
Strategic Knowledge	• **Environment and Forest Department** • **ACCMS** • **Science and Technology** • **Education Department** • **Finance Department**	Creation of Knowledge Management Portal for Climate Change	Number of Indigenous Technical/Traditional Knowledge (ITKs) into traditional documentation
		Strengthening departmental and institutional capacities and generating awareness to understand climate changeand impacts on sectors	% of departments trained at least one official across governance hierarchy in mainstreaming climate change concerns into policies and planning
			% of departments with green tagged budgets
		Build climate change relevant policies, research, and outreach for strengthening adaptation and	% Number of school students trained and awareness programmes on Climate Smart Lifestyle and sustainable practices

Sector		Strategy	Monitoring Indicators at the Strategy level
		mitigation	Number of knowledge products/ handbooks/ guidance material created across sectors on Climate-smart and resilient best practices

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