Theme: Blue-Green Intervention and Urban Resilience

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Urban Centre and Climate Change

Contribution to Climate Change

- Cities are the major consumers of energy and responsible for high emission of GHGs
- Traffic congestion and reliance on fossil-fuel-powered vehicles contribute to high emissions
- Concentration of industrial activities, emit large quantities of CO_2, methane (CH_4), and other GHGs
- Cities generate large amounts of solid and liquid waste. Prone to release methane and other GHGs into the atmosphere
- Large-scale constructions require substantial energy and materials, leading to GHG emissions
- Deforestation and Land Use Changes reduces the carbon sequestration capacity, and releases stored carbon into the atmosphere

Urban Centre and Climate Change

Impact of Climate Change

- **High Population Density** results in more vulnerability to climate extremes
- **Heat Island Effect:** Abundance of concrete, asphalt absorbs and retains heat leading to exacerbated heat wave
- **Impervious Surfaces:** prevent water from infiltrating the ground, leads to more runoff
- Water supply disruption due to floods or droughts.
- Increased cooling demand due to rising temperatures raises energy demands.
- Air Pollution and health issues
- High rainfall variability and increased flooding damage critical infrastructure and housing.
- Extreme weather events cause distress migration from rural to urban areas.

In the context of Assam..

- Assam has the **largest urban population of 4.3 million (Census 2011)** among the North-eastern States.
- Guwahati has about 0.9 million urban population.
- More than 25% of Assam's urban population is concentrated in Guwahati and surrounding urban agglomeration
- The state's level of urbanization is 14% (Census 2011).
- This is a 1.2 percentage point increase from the Census 2001 urbanization level of 12.9%.
- Assam's annual rate of urbanization is lower than the all-India rate of 2.82% per annum (2001-2011)
- Rapid urbanization and environmental degradation:
  - Open spaces reduced by **14.47%** in 2000–2010 in Guwahati.
  - Shrinking water bodies
  - Reduction in green cover

Climate Change in Assam (1990-2019)

Maximum Annual Average Temperature has increased at a rate of **0.049 °C per year** (between 1990-2019)

Minimum Annual Average Temperature has increased at a rate of **0.01254 °C per year** (between 1990-2019)

Annual Average Rainfall has decreased at a rate of **10.77 mm per year** (between 1990-2019)

Monsoon Rainfall has decreased at a rate of **1.90 mm per year** (between 1990-2019)

OBSERVED CLIMATE TRENDS (1990-2019)				
	Max. Temp	Min. Temp	Annual Rainfall	Monsoon Rainfall
Average (1990-2019)	28.56°c	18.39°c	2576.49	1501.61
Rate of Change (90-19)	0.049	0.01254	-10.77	-1.90

Highest Annual Average Maximum Temperature Recorded during 1990-2019: (Top 10)

Biswanath, Dhemaji, Tinsukia, Lakhimpur, Sivsagar, Majuli, Dibrugarh, Charideo, Jorhat, Golaghat

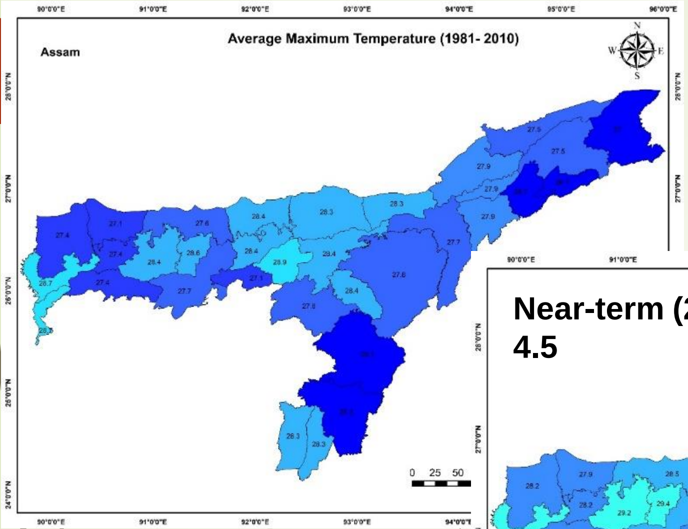
Highest Annual Average Minimum Temperature Recorded during 1990-2019: (Top 10)

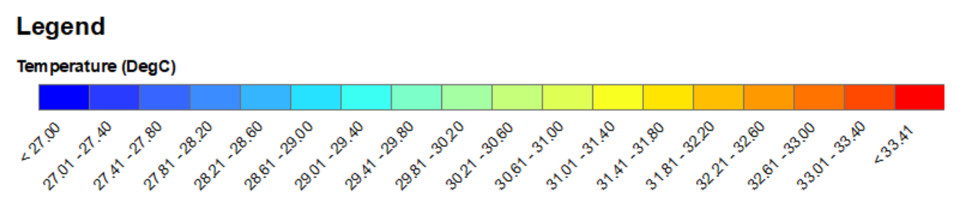
Biswanath, Lakhimpur, Dhemaji, Tinsukia, Sivsagar, Majuli, Dibrugarh, Charideo, Sonitpur, Golaghat

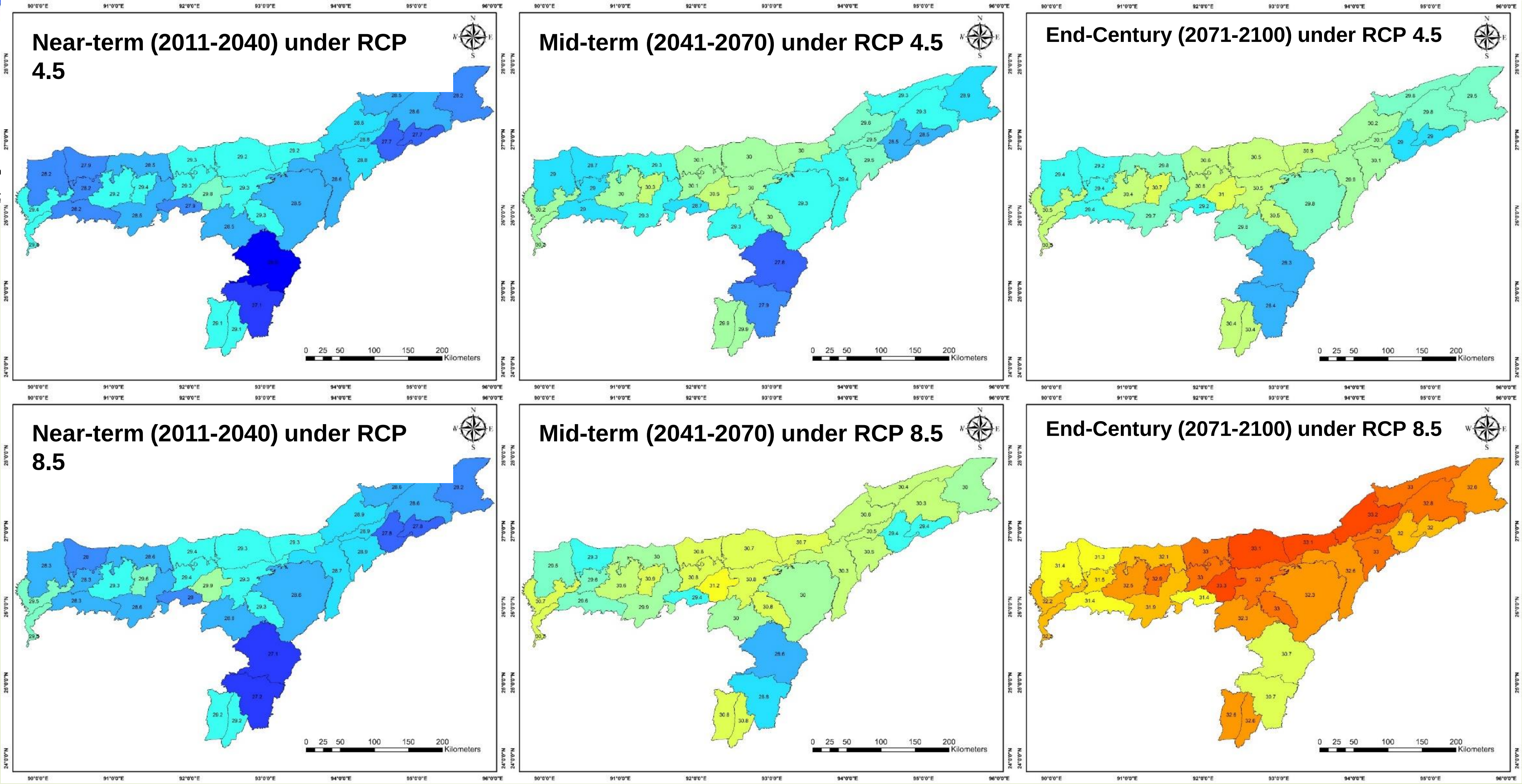
Source: ASAPCC 2.0 (2021-2030)

Average Maximum Temperature Projection Scenarios Till 2100

Baseline (1981-2010)

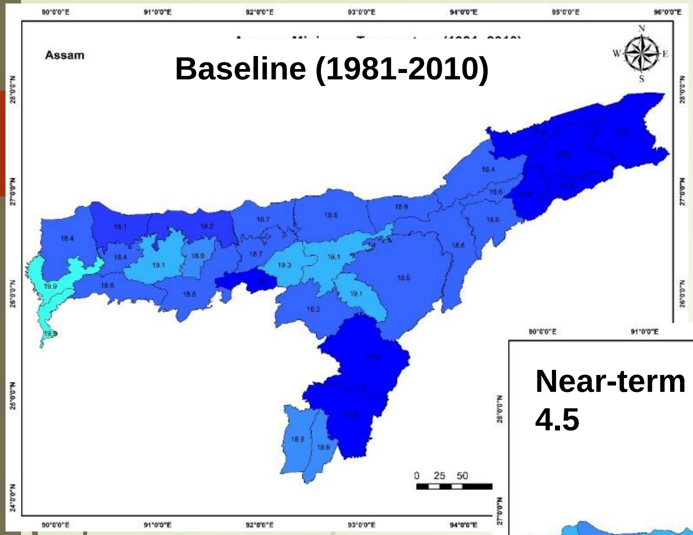






Source: ClimateVulnerability.in

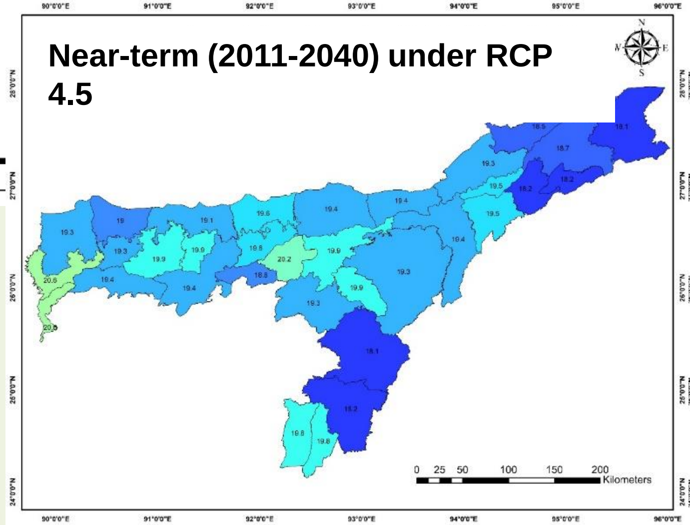
Average Minimum Temperature Projection Scenarios till 2100

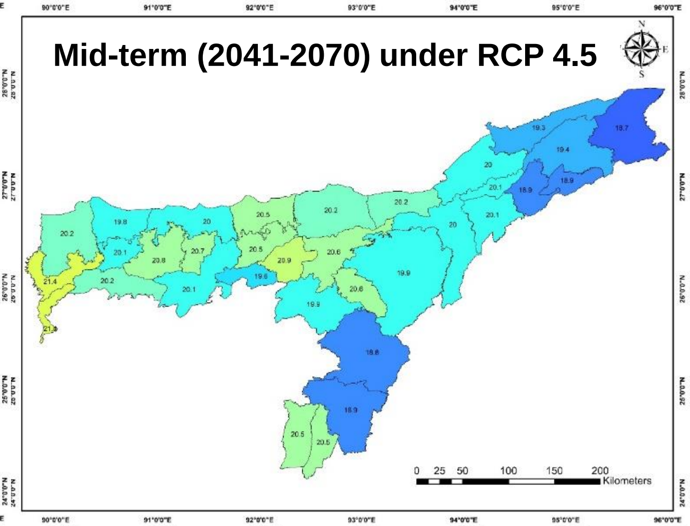


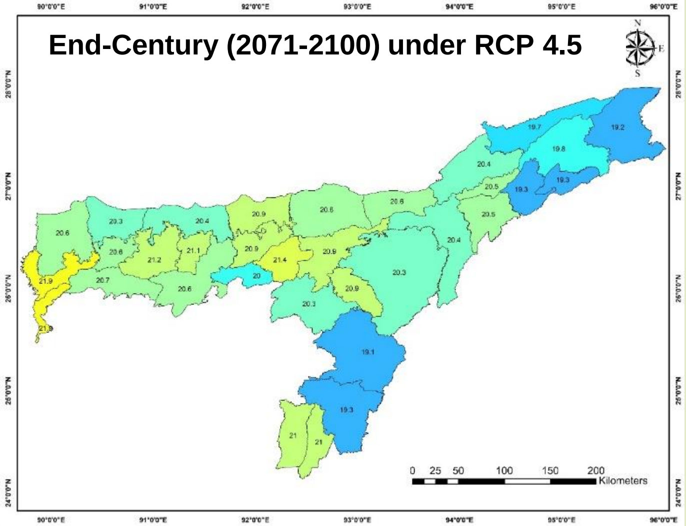
Legend

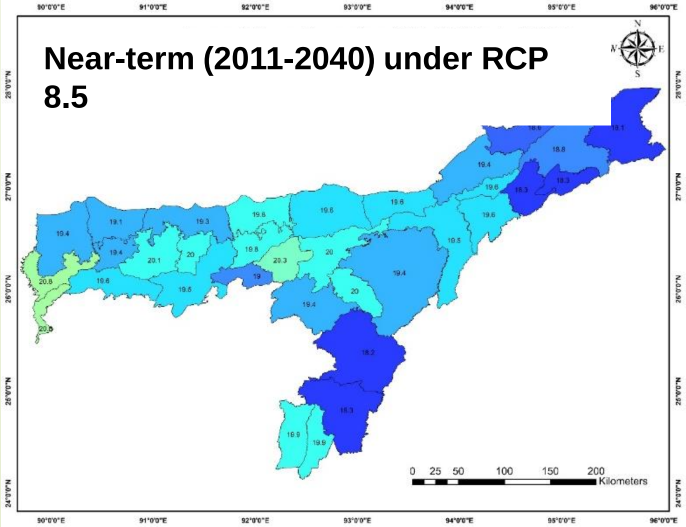
Temperature (DegC)

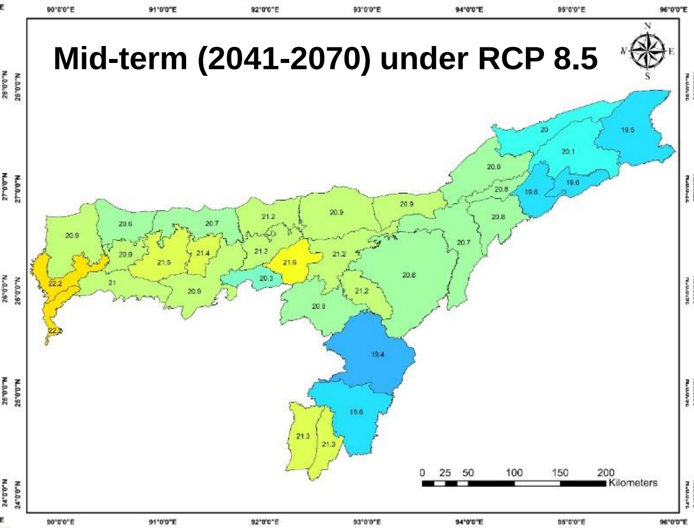
< 18.00
18.01 - 18.36
18.37 - 18.71
18.72 - 19.07
19.08 - 19.42
19.43 - 19.78
19.79 - 20.13
20.14 - 20.49
20.50 - 20.84
20.85 - 21.20
21.21 - 21.56
21.57 - 21.91
21.92 - 22.27
22.28 - 22.62
22.63 - 22.98
22.99 - 23.33
23.34 - 23.69
> 23.70

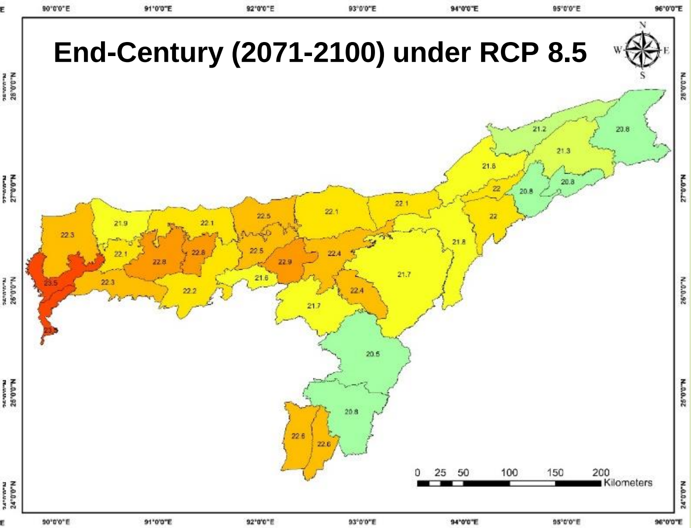












Source: ClimateVulnerability.in

Average Rainfall Projection Scenarios till 2100

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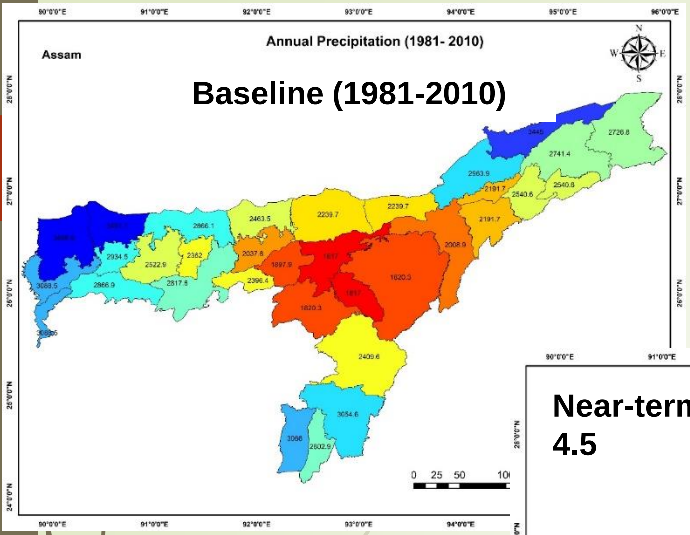
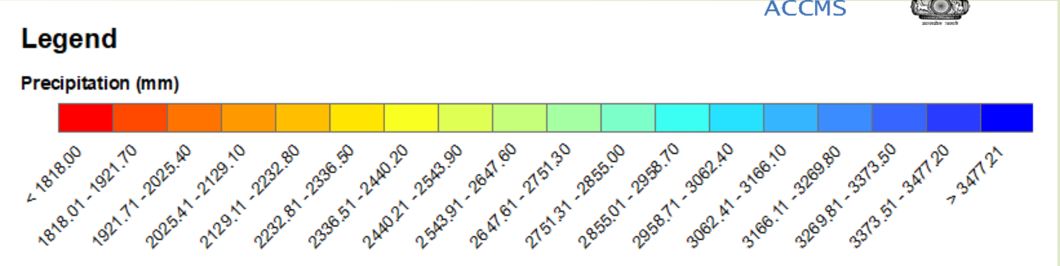
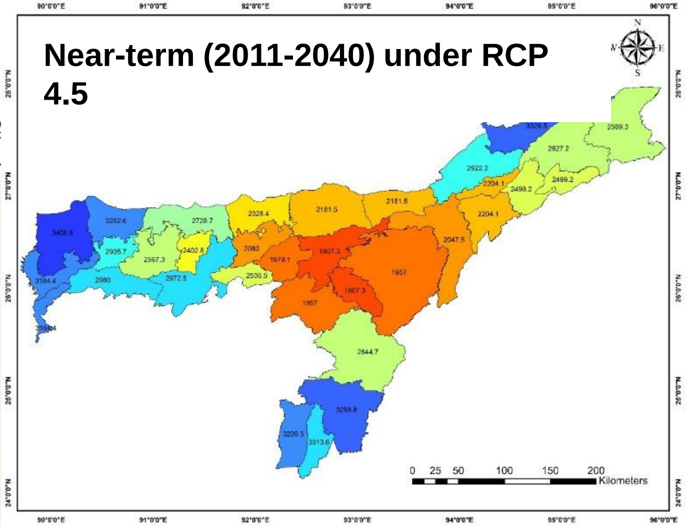
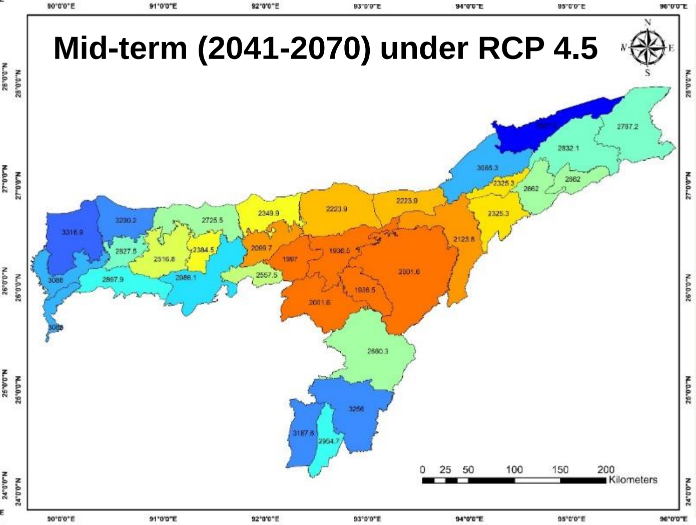
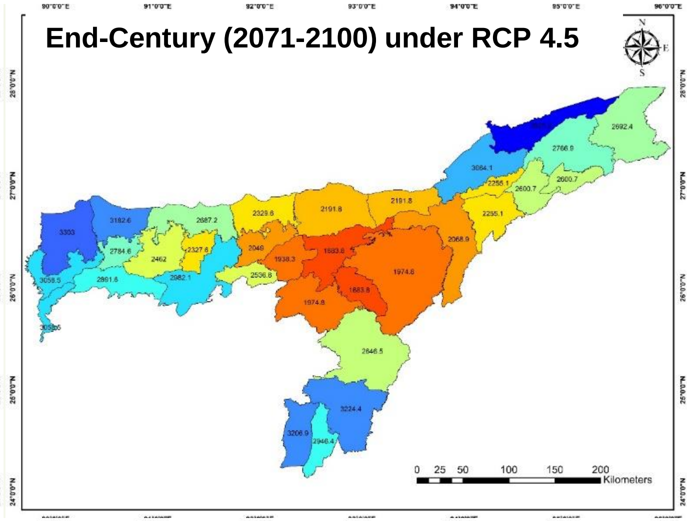
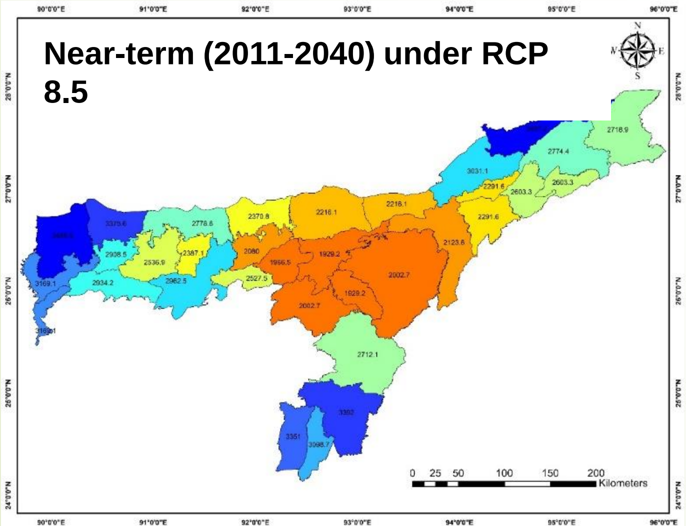


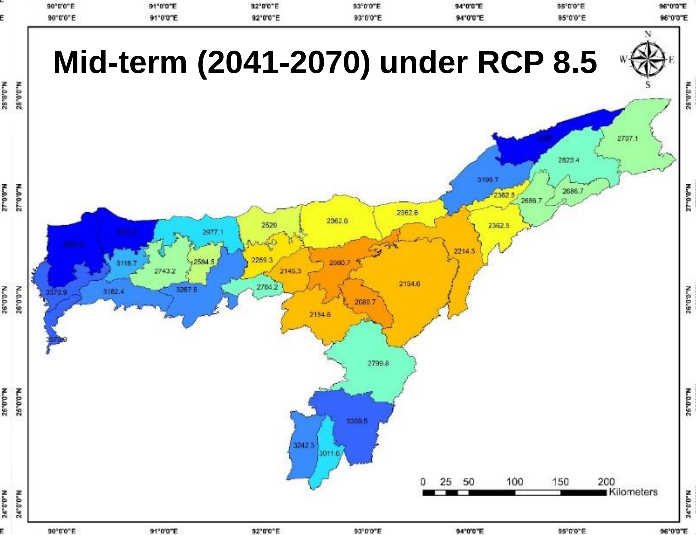


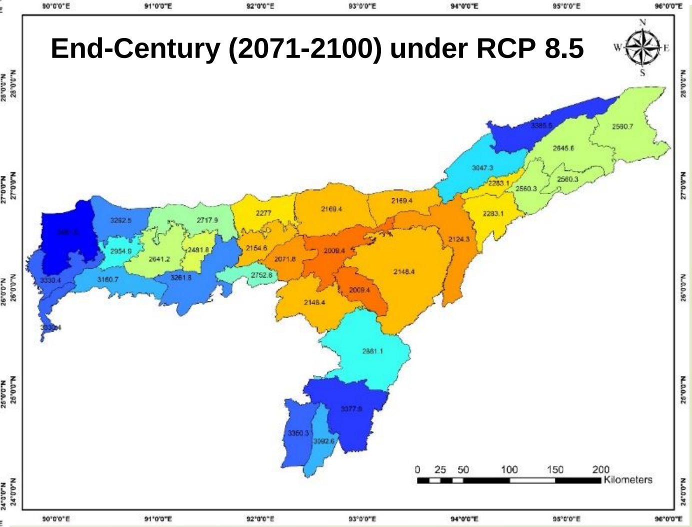






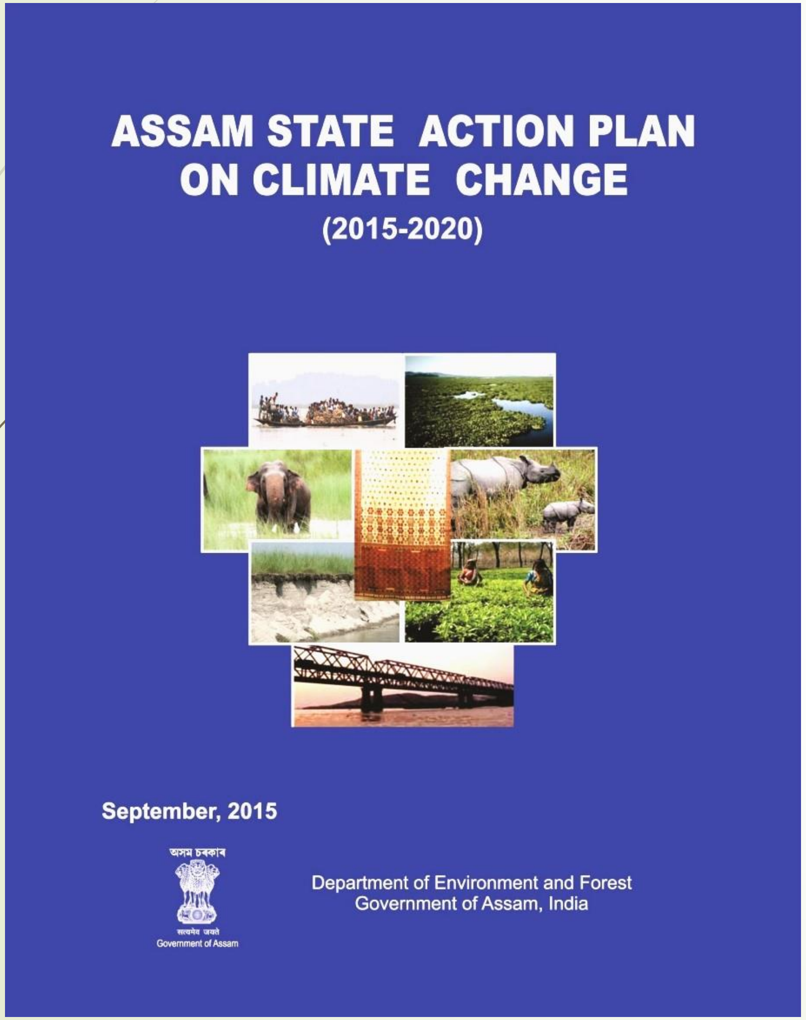




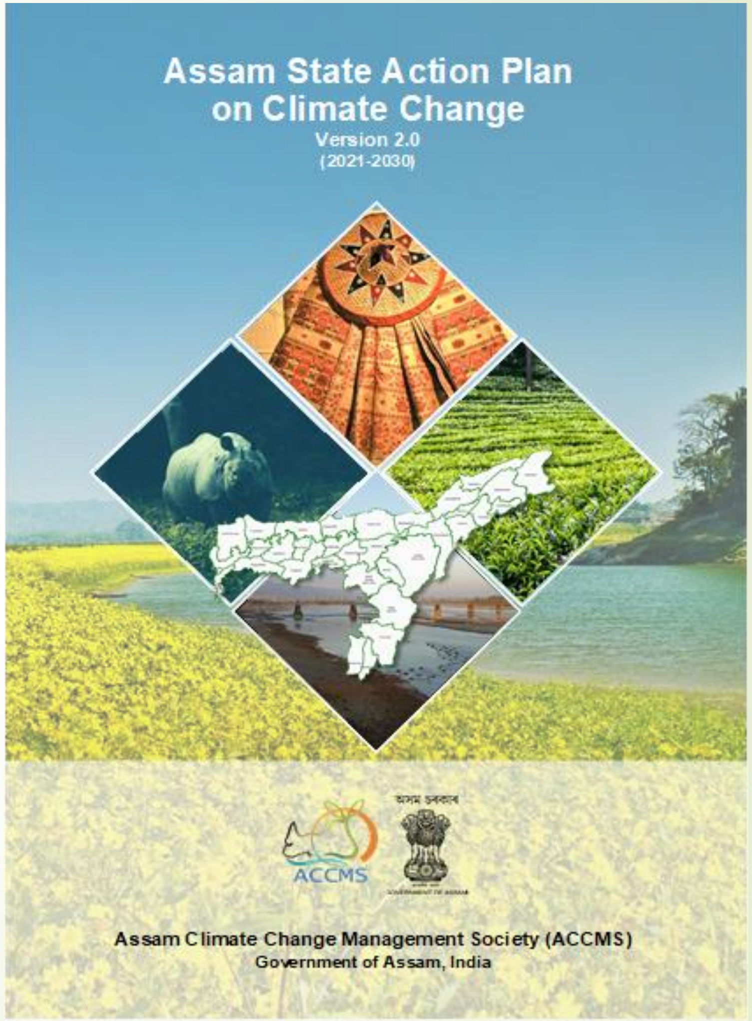


Source: ClimateVulnerability.in

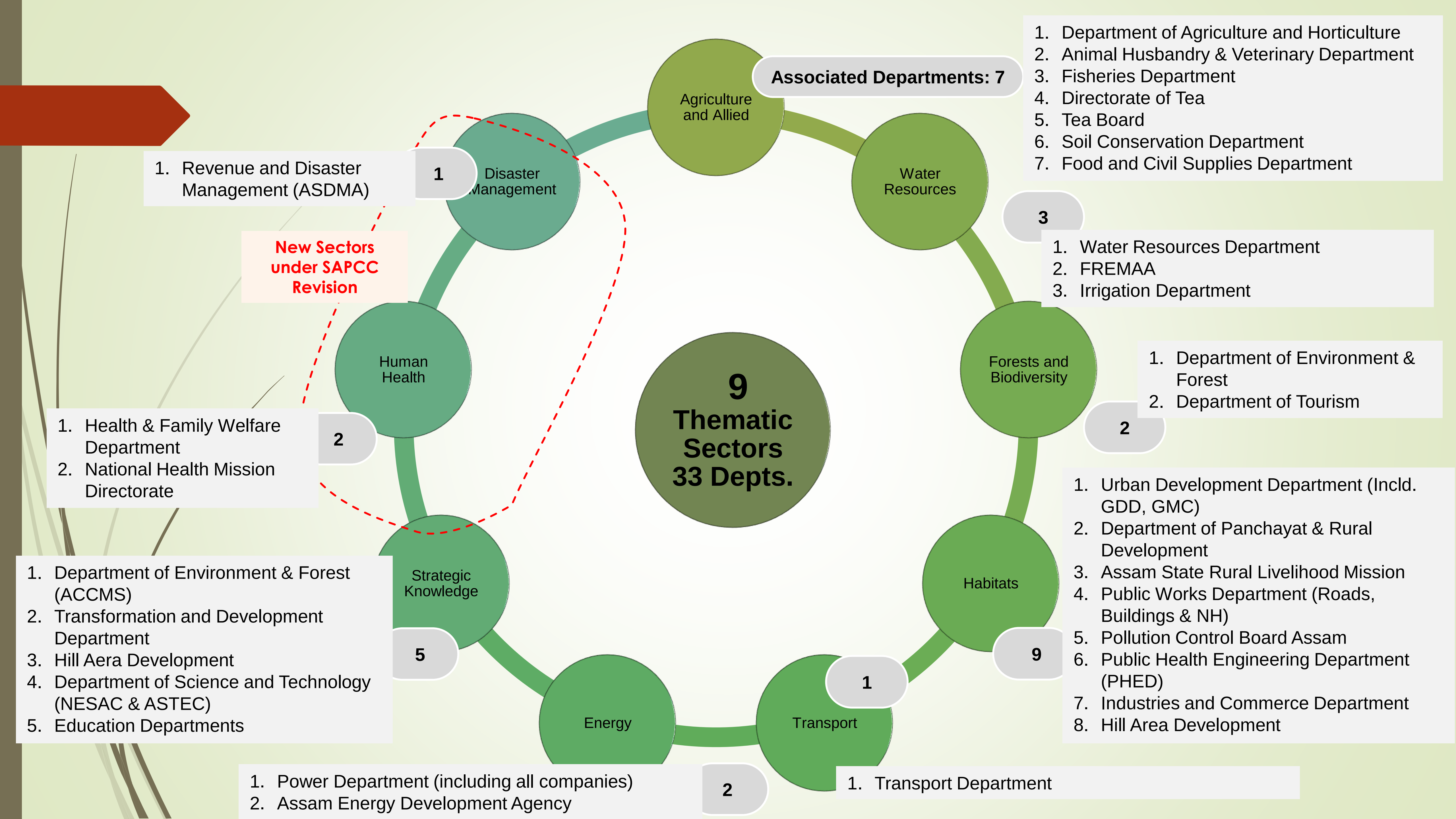
Revision of Assam State Action Plan on Climate Change



2015-2020



2021-2030



9 Thematic Sectors 33 Depts.
Agriculture and Allied
Associated Departments: 7
1. Department of Agriculture and Horticulture
2. Animal Husbandry & Veterinary Department
3. Fisheries Department
4. Directorate of Tea
5. Tea Board
6. Soil Conservation Department
7. Food and Civil Supplies Department
Water Resources
3
1. Water Resources Department
2. FREMAA
3. Irrigation Department
Forests and Biodiversity
2
1. Department of Environment & Forest
2. Department of Tourism
Habitats
9
1. Urban Development Department (Incld. GDD, GMC)
2. Department of Panchayat & Rural Development
3. Assam State Rural Livelihood Mission
4. Public Works Department (Roads, Buildings & NH)
5. Pollution Control Board Assam
6. Public Health Engineering Department (PHED)
7. Industries and Commerce Department
8. Hill Area Development
Transport
1
1. Transport Department
Energy
2
1. Power Department (including all companies)
2. Assam Energy Development Agency
Strategic Knowledge
5
1. Department of Environment & Forest (ACCMS)
2. Transformation and Development Department
3. Hill Aera Development
4. Department of Science and Technology (NESAC & ASTEC)
5. Education Departments
Human Health
2
1. Health & Family Welfare Department
2. National Health Mission Directorate
Disaster Management
1
1. Revenue and Disaster Management (ASDMA)
New Sectors under SAPCC Revision

Summary of Strategies and Actions Across Sectors

9 Sectors

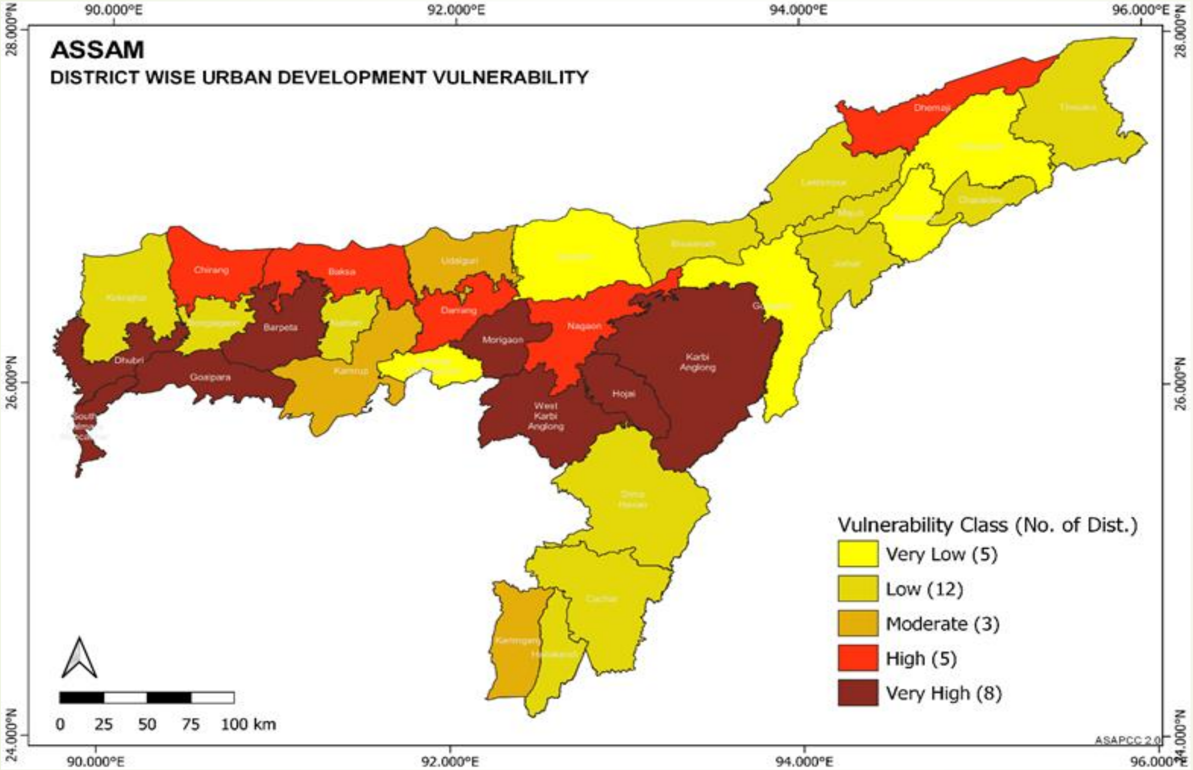
36 Strategies

211 Actions

Sector	Strategies
Agriculture and Allied	03 Strategies
Water Resources	06 Strategies
Forests and Biodiversity	05 Strategies
Energy	03 Strategies
Transport	02 Strategies
Human Habitat	06 Strategies
Human Health	02 Strategies
Disaster Management	06 Strategies
Strategic Knowledge	03 Strategies

Sectoral Vulnerability Assessment for ASAPCC 2.0

Urban Habitat

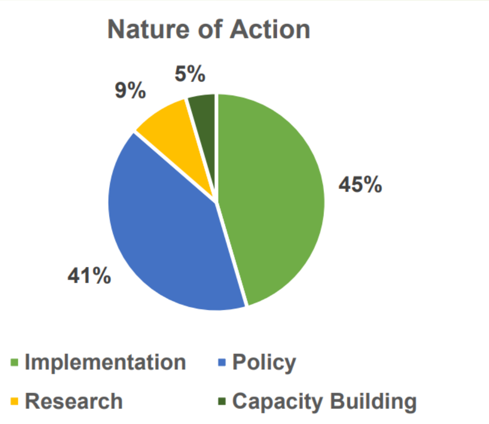


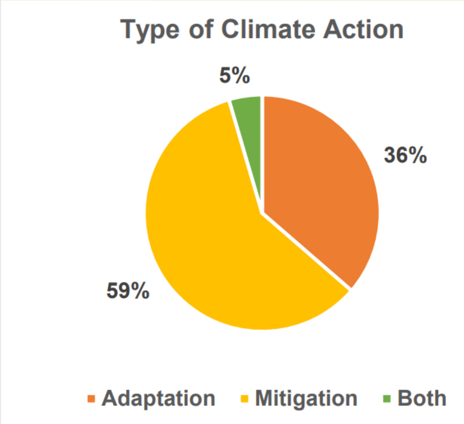
Very Highly Vulnerable Districts

- South Salmara
- Mancachar
- Dhubri
- Hojai
- Barpeta
- Morigaon
- West Karbi Anglong,
- Karbi Anglong
- Goalpara

Sustainable Habitat Sector (Urban Habitat)

Key climatic drivers impactingSustainable Habitat Sector (Urban)



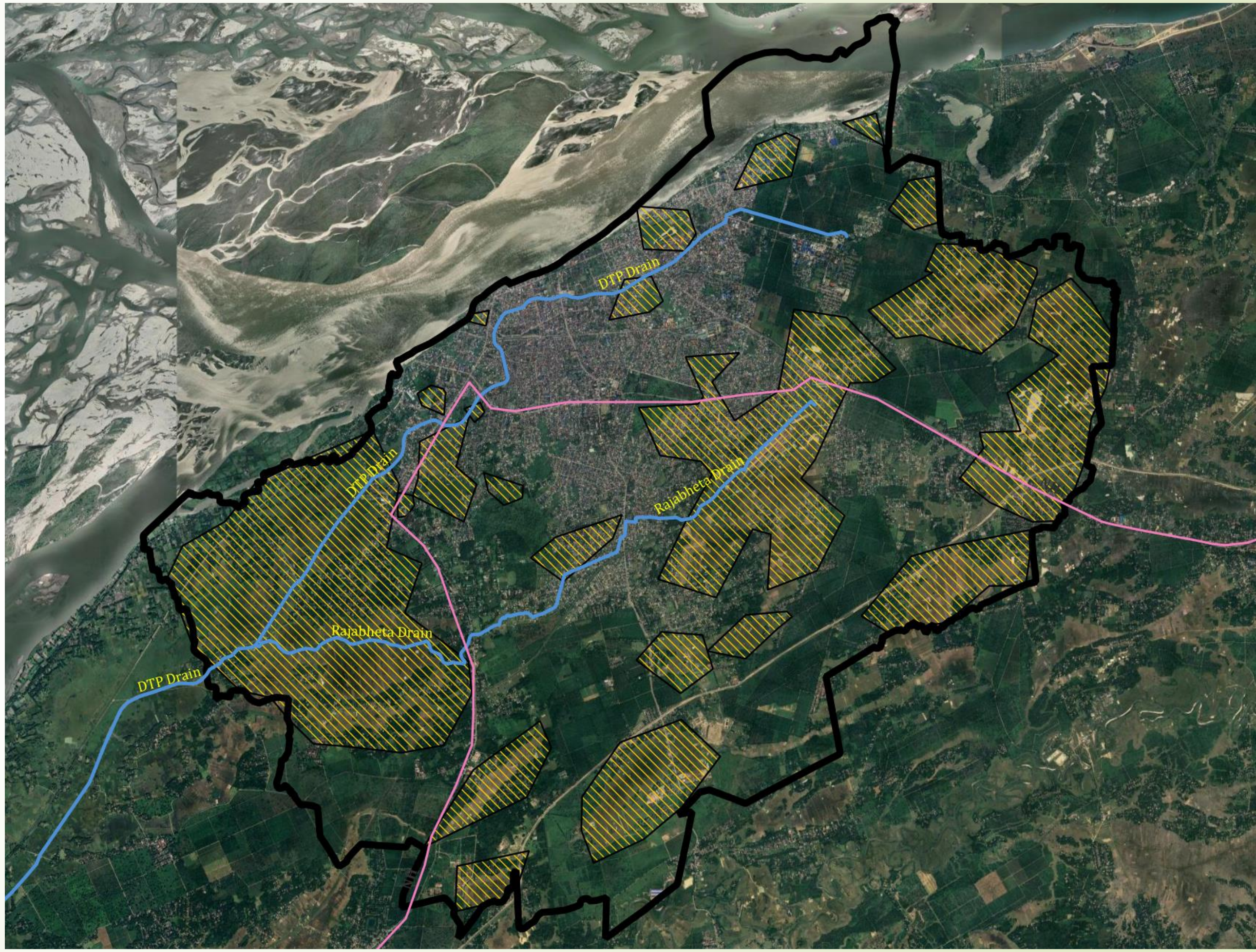


URBAN HABITAT			
ASAPCC 2.0 Strategies (2021-203)	Number of Actions	Key Nodal and Implementing Agency	SDG NDC and Mission LiFE Linkages
Strategy 1: Mainstreaming Climate action into urban governance and policy	2	DOHUA	SDG 11 SDG 13 NDC 6 SDG 9 SDG 11 SDG 13 NDC 6 SDG 6 SDG 11 SDG 13 NDC 6 Mission LiFE
Strategy 2: Building Climate resilient urban housing infrastructure	6	Assam State Housing Board, DOHUA	
Strategy 3: Developing climate smart and resilient urban waste management infrastructure	8	. DOHUA, AUWS&SB, PWD	

Source: ASAPCC 2.0

Case-study: Issue of Urban Flooding in Dibrugarh city

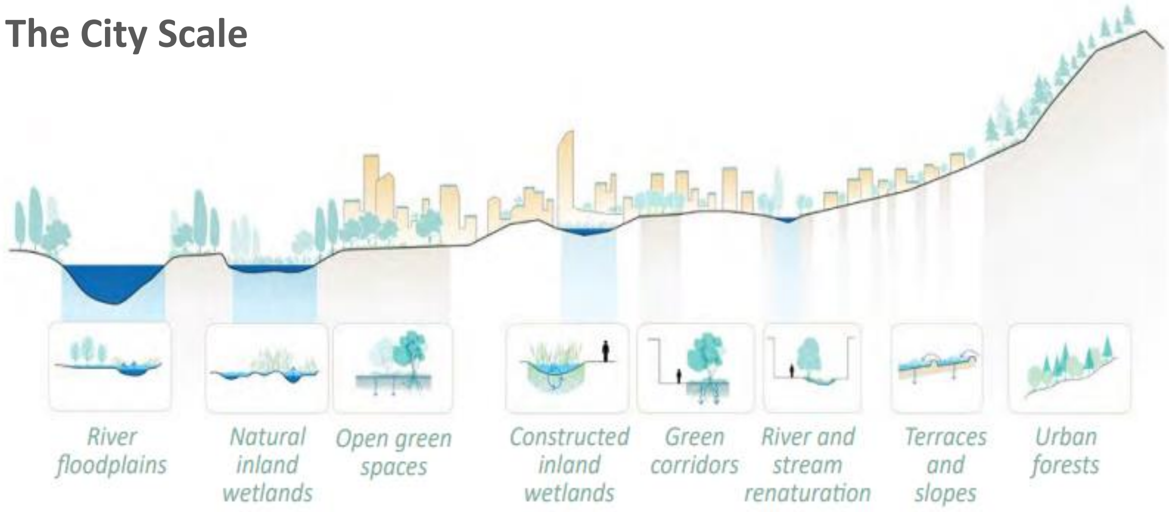
- ACCMS is conducting a *study to develop a flood management plan, prioritizing Blue-Green Interventions* for Dibrugarh Town
- Around 31 sq.km. area out of 71 sq.km. (planning area) is flood prone in Dibrugarh
- Many low-lying areas are found underwater logging within the city area.
- Due to the absence of stormwater drains, the rainwater and the flash water, in monsoon, are unable to flow downstream, and this area becomes prone to waterlogging.
- The waterlogged areas include Mancotta and NH-37 T-junction to Civil Defence Office; near the office of Divisional Forest Officer to the cross-junction of NH 37 (AT Road) to Dibrugarh Hospital (civil hospital).



Flood Prone Areas in the Master Planning Area of Dibrugarh

A few of the Proposed Blue-Green Interventions

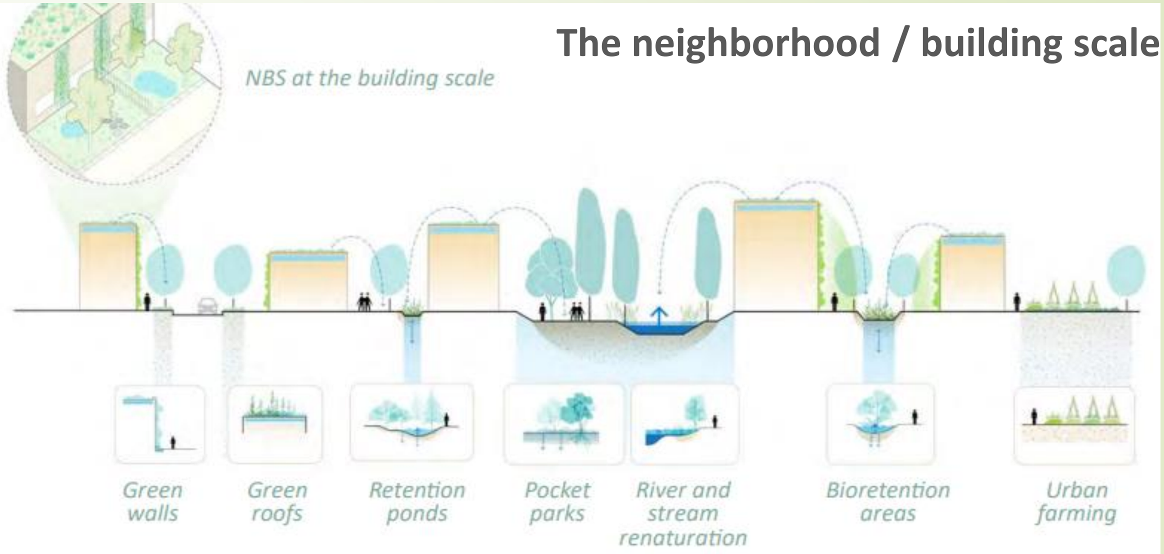
The City Scale



Nature Based Solutions at a City Scale

- Urban forests and terracing on higher elevation levels to delay runoff.
- Creation of constructed wetlands or wetland restoration in lower urban areas to collect and store water runoff.
- Renaturation of existing streams and drainage lines in the city to slow down water flows.
- Increase of open green spaces or parks throughout the city to add infiltration capacity and reduce urban heat.
- Continuity of linear tree canopies and green corridors along roads in the city.

The neighborhood / building scale



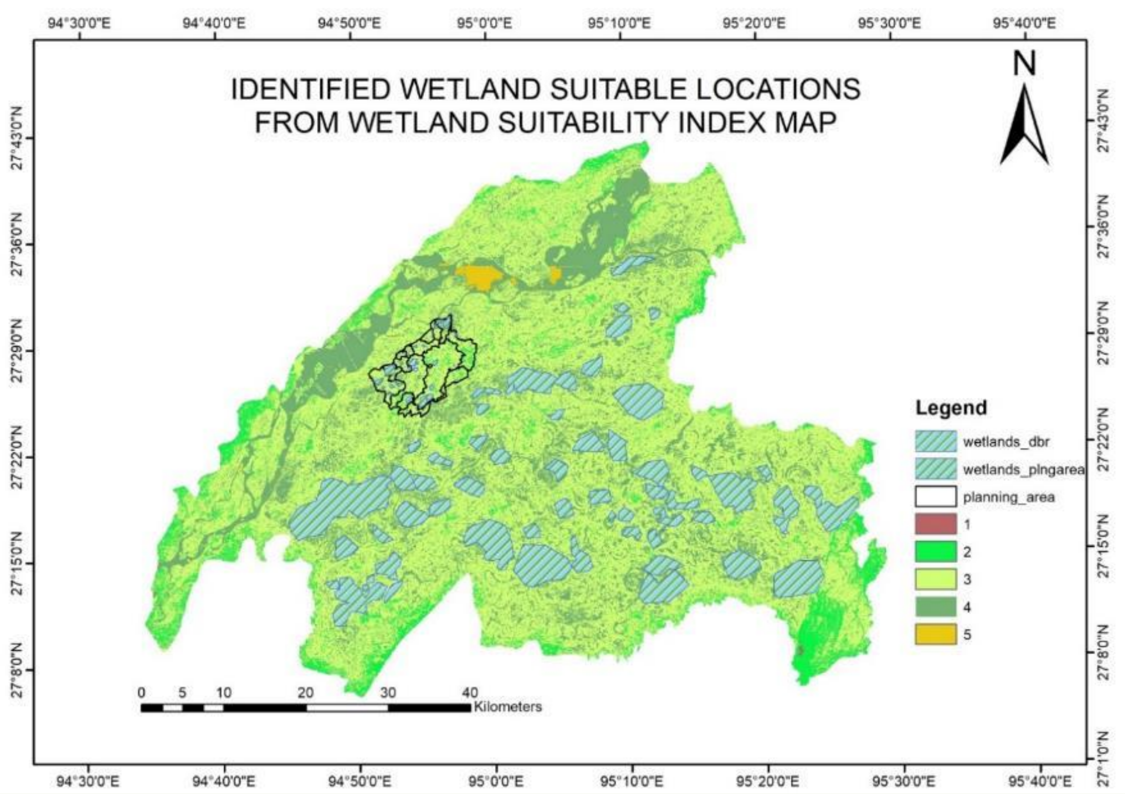
Nature Based Solutions at neighbourhood / building scale

- NBS integrated into buildings such as green roofs, green facades, private gardens in combination with green streets. Such measures can both regulate temperature and store water.
- Retention basins, rainwater retention ponds, or green water squares to store water.
- Small-scale rainwater catchment and drainage interventions such as bioswales.

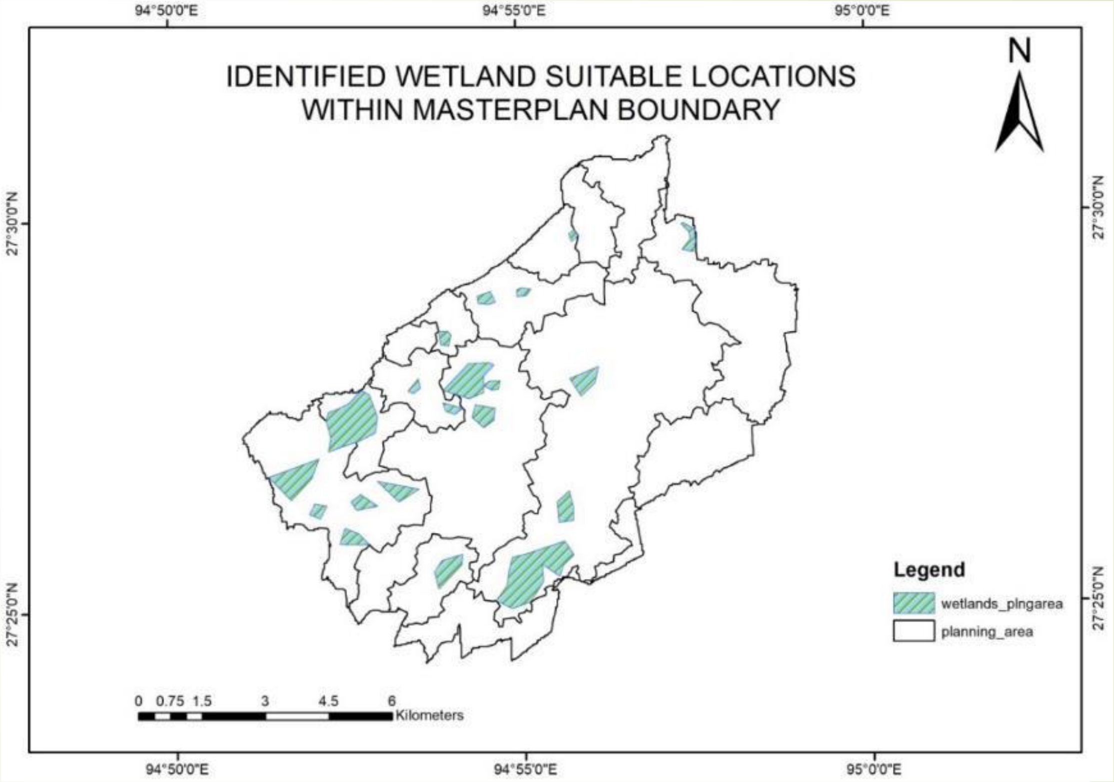
Interventions

Identification of Suitable Wetland Locations

GIS-MCA (Multi-Criteria analysis) is used to identify suitable locations for constructed wetlands. Slope, drainage density and topographic wetness index of the area are the major influencing parameters. And along with that, proximity to roads, buildings and waterways are also considered. The Suitability index map is overlaid with land use utility map of Dibrugarh, buffer map of identified infrastructural location point map and natural vegetation map to identify most suitable locations of constructed wetlands both in-stream and out-stream watersheds within the district.



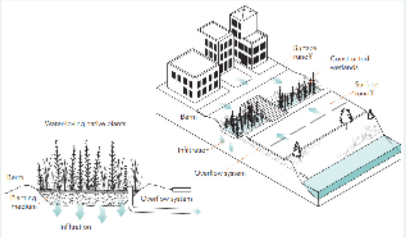
Identified wetland suitable locations in Dibrugarh



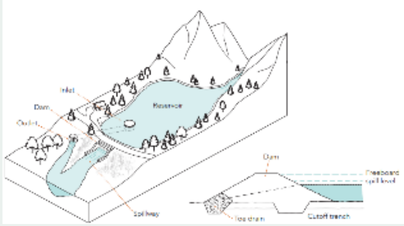
Identified wetland suitable locations in Master plan Boundary

Interventions

Potential Actions

S. No.	Intervention	Benefits
1	Constructed Wetlands	• As wetlands are generally controlled by a pit and a piped outlet, they can act under the same principle as a retarding basin by discharging flood flows at a controlled rate. With more wetlands being constructed and restored widely, flood storage capacity is increased, and the flood peak is reduced • tolerates fluctuations in water flow • facilitates wastewater reuse and recycling 
2	Natural Drainage Path Restoration	• Restoring and preserving natural drainage systems involves the promotion of vegetated and other "soft" ground covers over impervious surfaces in developed areas. These types of ground treatments provide drainage that more closely resembles the natural landscape prior to development. 
3	Sponge Gardens and Pocket Parks	• Effectively alleviate the problem of urban stormwater systems and also lay a foundation for the construction of an environmentally friendly city 
4	Retention Ponds / Rain Gardens	• Prevent rainwater run-off from entering the stormwater sewer system. • Filtering rainwater run-off before it reaches stormwater sewers and waterways. • Protecting communities from drainage problems and flooding. • Increasing groundwater flow. • Creating natural wildlife habitats. 
5	Bioswales: linear green corridors and tree canopies along roads in the city	• Bioswales are similar to rain gardens but are designed to capture much more runoff coming from larger areas of impervious surfaces like streets and parking lots • collect polluted stormwater runoff, soak it into the ground, and filter out pollution 

Potential Actions

S. No.	Intervention	Benefits	
6	Drainage corridor enhancement	• Reducing Water Build Up. • Prevents Soil Erosion.	
7	Stormwater Infiltration	• Decrease peak runoff flow rates. • Decrease the volume of stormwater runoff. • Reduce stormwater pollutant loading to surface waters. • Increase groundwater recharge.	
8	Urban Forests	• Help rainwater infiltrate into the soil, and slow down its flow over the ground. These processes reduce the risk of localized flooding.	
9	Pervious Paving	• Can reduce part of surface runoff and flood peak and can delay peak time	
10	Dams and Reservoirs (Outside Municipal Limits)	• Delay and attenuate flood peaks downstream	

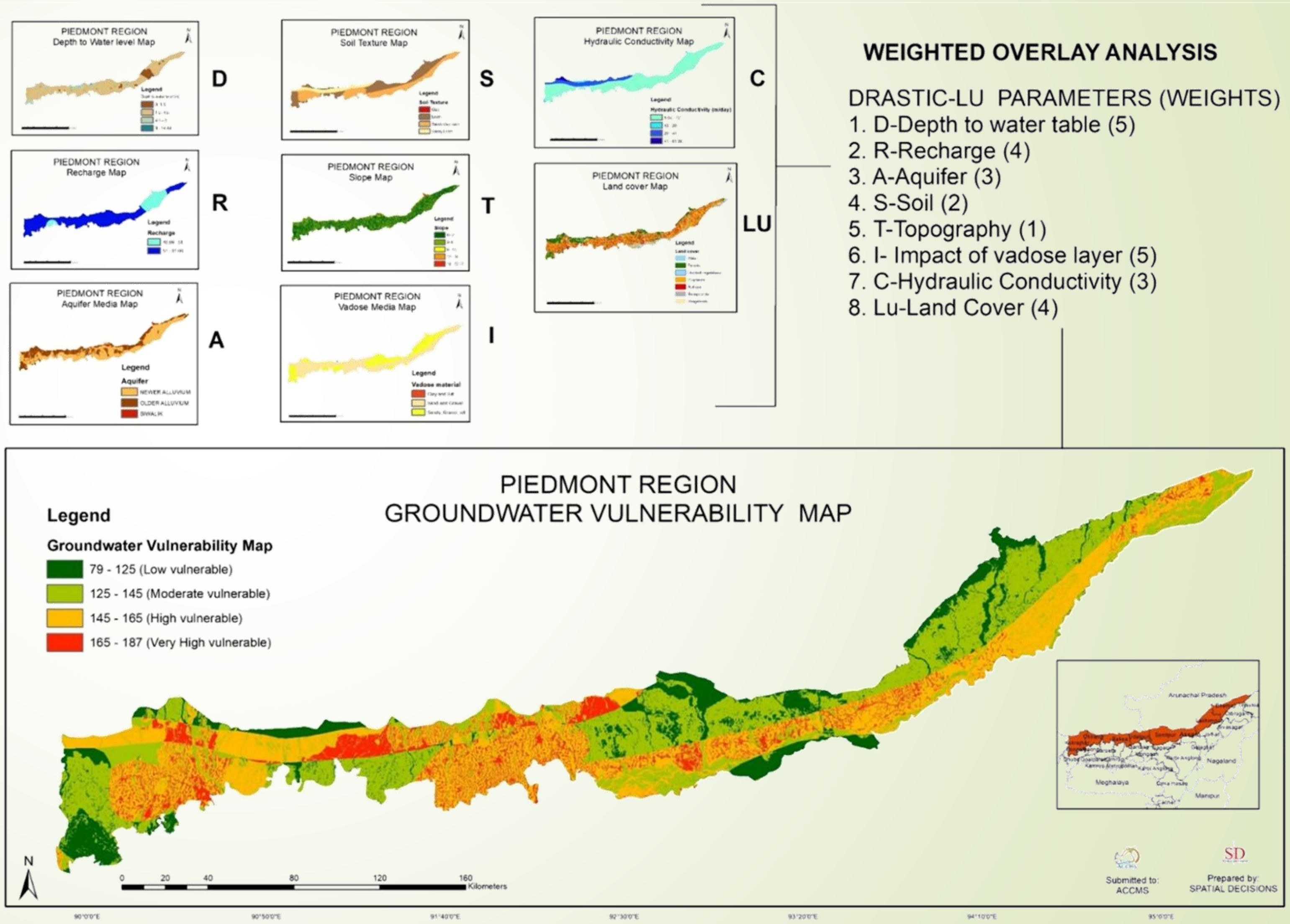
Issue of Groundwater depletion and potential BGI

- ACCMS is conducting a study to document the Groundwater Level in the Piedmont Plain of Northern Assam for Climate-resilient Water Management Planning in Dhemaji, Lakhimpur, Sonitpur, Biswanath, Kokrajhar, Chirang, Baksa, Udalguri Districts.

- Always regarded as a water-affluent state, Assam has lost 2% of its usable groundwater resource and is designated as having the “highest depletion potential” of useable groundwater storage.

- The geographical location plays key factor on climate change vulnerability, It is likely that groundwater vulnerability will increase if the change in climate continues at current trends (IPCC, 2007).

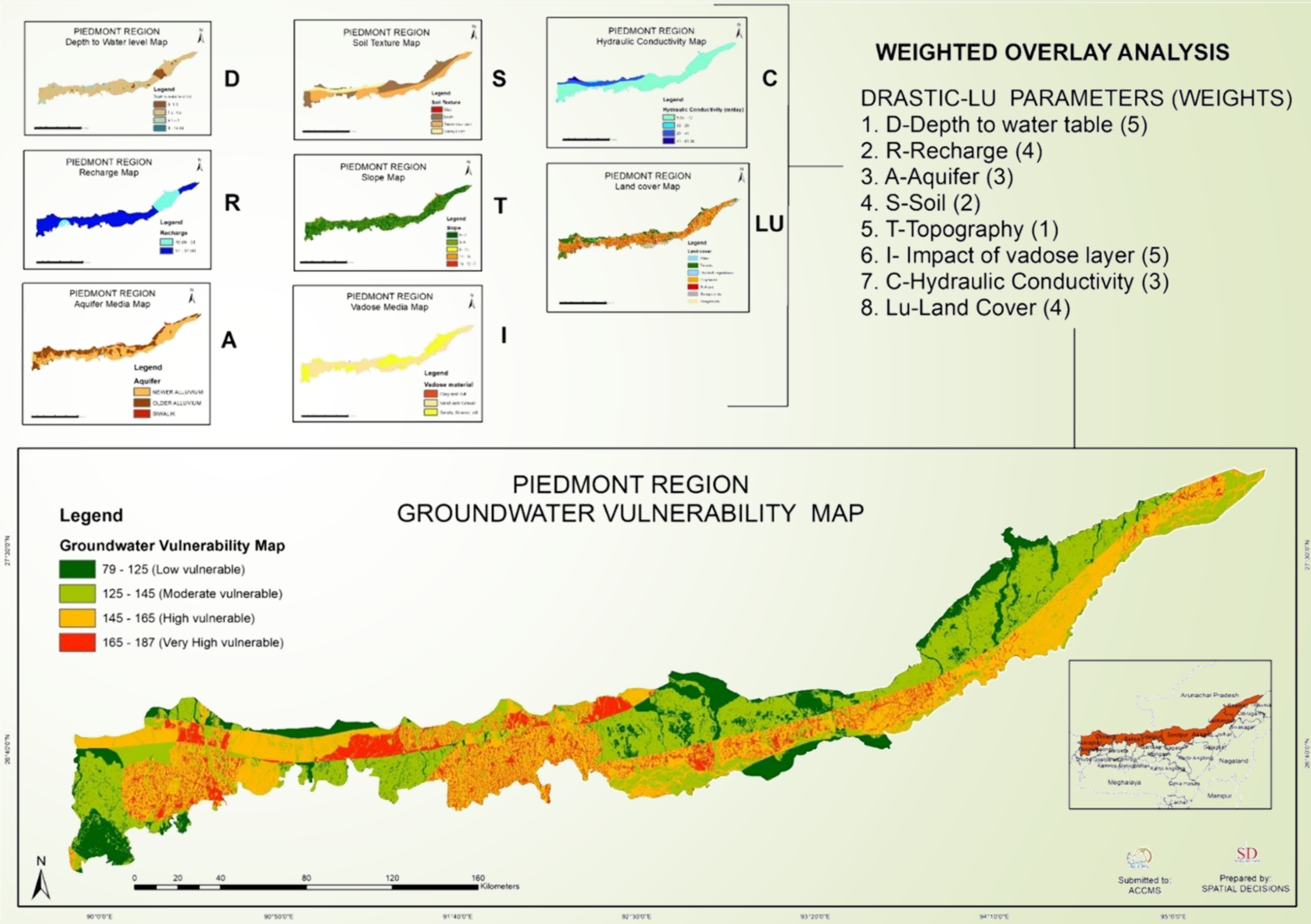
- Groundwater vulnerability could depends on various factors such as the type and thickness of the soil, water table depth, permeability of the aquifer, the distance and direction of groundwater flow due to topography, the intensity and duration of rainfall for recharge, hydraulic conductivity and land use and land cover.



Issue of Groundwater depletion and potential BGI

- As per CGWB, **Piedmont Assam has a high groundwater potential, with an annual recharge of 10.8 billion cubic meters and a net availability of 9.7 billion cubic meters.** The **stage of groundwater extraction in Piedmont Assam is only 9%,** which means that there is a lot of scope for further development of groundwater resources in the region.

- Groundwater recharge and potential are not uniform across study area in Piedmont Assam, and depend on various factors such as geology, soil, land use, rainfall, topography, and hydrogeology.



Potential Interventions

Urban	Peri-urban	Rural

SPATIAL OCCURRENCE	KEY ISSUES	INTERVENTIONS	DISTRICTS						
			Kokrajhar	Chirang	Baksa	Udalguri	Sonitpur	Lakhimpur	Dhemaji
GROUNDWATER	Uncontrolled Water Extraction	Digital-enabled monitoring system	✓	✓	✓	✓	✓	✓	✓
	Anthropogenic Water Contamination	Preventing Contamination	✓	✓	✓	✓	✓	✓	✓
		Public Awareness	✓	✓	✓	✓	✓	✓	✓
	Water Contamination	Injection Well						✓	✓
		Dong System	✓	✓	✓	✓			
SURFACE WATER	Flooding	Spong Garden/ Recharge Basin	✓	✓	✓	✓	✓	✓	✓
	Waterlogging	Rooftop Rainwater Harvesting	✓	✓	✓	✓	✓	✓	✓
	Drilling Difficulty	Ditch and Furrows	✓	✓	✓	✓			
		Retention Pond	✓	✓	✓	✓	✓	✓	✓

Conclusion

- Addressing the climate challenges in urban areas requires a holistic approach that integrates blue-green infrastructure into urban planning
- Sustainable practices and policies are essential to build resilient urban environments capable of adapting to and mitigating the impacts of climate change
- Mainstreaming of the Blue-green infrastructure will not only contribute to the broader goals of environmental sustainability and climate resilience but also promote good health, well-being, and better physical & mental development