

Climate Change Technical Note

Assam Integrated River Basin Management Program (P174593)

World Bank Task Team, January 2023

Climate and Disaster Vulnerability Context:

- **Climate Trends:** An analysis of temperature records in Assam for the period 1990-2019 indicated a rising trend in annual average maximum at the rate of 0.049°C and minimum temperature at the rate of 0.013°C annually. For the same period the annual rainfall has shown a decreasing trend by approximately 10.77 mm (annually).¹
- **Climate change projections:** 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. Considerable uncertainty characterizes projections of local long-term future precipitation trends in India. Annual average rainfall in Assam is projected (low confidence) 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. 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.¹
- **Disaster Risks:** Due to its topographic and climatic conditions, Assam is vulnerable to numerous extreme climate events, which leads to recurring disasters including floods. Almost half of Assam's landmass is prone to floods. Between 1953 and 2020, over 50 million hectares in Assam were affected by floods which represents over 10 percent of the total area affected by floods India wide. Approximately 386,476 hectares, equivalent to approximately 7% of the State's landmass in 17 riverine districts was lost due to river erosion between 1954 and 2019. An estimated 178 million people were impacted by floods in virtually all districts of the State, between 1953 and 2020. Climate modeling studies consistently project an increase in the frequency of extreme flooding events over the Indus-Ganga-Brahmaputra River Basins for the period 2020-2059 due to higher monsoon precipitation and accelerated glacial melting in the Himalayas and the Tibetan Plateau due to warmer temperatures. The Brahmaputra River basin, 36 percent of whose drainage area in India lies within Assam, is amongst the river basins with the highest projected increase in extreme flooding events.² This increase is expected to accelerate the rate of soil erosion³ and sedimentation in Assam, contribute to further wetlands degradation, and amplify adverse impacts on the State's agricultural sector. Studies also project an increase in the number of annual drought weeks in several districts of Assam, adding to the stress from the projected higher temperatures in the region. A study by Dutta et al. (2021)⁴ reported the expected 2.5 mm/year and 0.062°C/year, precipitation and temperature increases respectively in the Brahmaputra basin will result in a rise in stream flow by 13% in annual discharge. Climate change will also impact the sediment load of the river which is projected to rise by 40% annually by the end of the period 2075–2100 compared to 1986–1991 affecting the region's ecosystem and agricultural fields.

Climate Adaptation and Mitigation Context: Frequent floods and bank erosion and loss of cropland were identified as key climate risks by the Government of Assam (GoA). The GoA took actions to adopt to the

¹ Assam State Action Plan on Climate Change Version 2.0, 2021

² Assessment of Climate Change over the Indian Region, 2020, Ministry of Earth Sciences, Gol.

³ Assam State Action Plan on Climate Change, 2022.

⁴ Dutta, P., Hinge, G., Marak, J. D. K., and Sarma, A. K. (2021). Future climate and its impact on streamflow: a case study of the Brahmaputra River basin Model. *Earth Syst. Environ.* 7, 2475–2490. doi: 10.1007/s40808-020-01022-2

increased climate disasters in the past decade. These include.

- 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-erosions.
- FREMAA in collaboration with WRD have taken major initiative for Riverbank Protection work, Fortification of Embankment, Construction of new Embankment & Pro-siltation measures.

In addition, the Assam State Action Plan on Climate Change: 2021 – 2030 (SAPCC) provides the State's general approach for dealing with climate change adaptation and mitigation with a focus on eight sectors, including water and disasters. The Government of Assam's (GoA) policy document "Assam 2030: Our Dream, Our Commitment" outlines the State's strategy for meeting the Sustainable Development Goals (SDGs), including those that relate to IWRM and DRM.⁵ Assam demonstrated its commitment to make more optimal use of water resources and mitigate water-related risks to catalyze economic growth through its key involvement in the Government of India's (GoI) initiative on 'proper management of water resources in the Northeast' and the resulting Action Plan.

Intent to address the identified vulnerabilities: Given the current starting base and complexities, a consistent long-term engagement that gradually tackles the challenges and allows for adaptive learning and management is most appropriate. A critical first step is the development of an enabling institutional framework and building the capacities of relevant agencies for IWRM and DRM. These include the Assam Water Resources Department (WRD), Assam Disaster Management Authority (ASDMA), and Flood and River Erosion Management Agency of Assam (FREMAA). New and innovative governance approaches to managing flood and river erosion risks are required, which take time to evolve and consolidate.

AIRBMP is a key program for helping Assam achieve its climate adaptation goals as outlined in the Assam State Action Plan on Climate Change (2021-2030). The proposed Program is squarely aimed at reducing vulnerability and building resilience of communities to the impacts of climate variability and change. The Program would enable Assam to better adapt to the impacts of climate change by building the knowledge base and decision-support systems for climate-resilient planning and investment. Phase 1 of Program components are directly related to improving Assam's climate adaptation and enhancing disaster risk management. The investments included in the project will directly contribute to the institutional and infrastructure capacity to mitigate the impacts of climate change. In addition, the project will build the capacity of institutions managing water resources and disaster risk management in Assam to be able to include climate change mitigation measures in their activities.

The specific adaptation and mitigation activities that will be considered and discussed with the client under the Program are tabulated below:

⁵ https://transdev.assam.gov.in/sites/default/files/portlet/level_2%5Bcurrent-domainmachine-name%5D/ASSAM_2030_Our_Dream__Our_Commitment.PDF

Table 1: Adaptation and Mitigation Activities under the Program

Component	Adaptation Action	Mitigation Action
Component 1: Institutional Development and Strategic Studies. (US\$ 20 million)		
<p><i>Sub-Component 1.1: Institutional Strengthening of WRD</i></p> <p><i>Sub-Component 1.2: Institutional strengthening of ASDMA</i></p> <p><i>Sub-Component 1.3: FREMAA Project Management and Incremental Costs</i></p> <p><u>Activities:</u></p> <ul style="list-style-type: none"> - Assam Water Policy - Assam Brahmaputra State of Basin Report. - Disaster risk financing study. - Flash Flood Forecasting Study. 	<p>Vulnerability context: Refer Above</p> <p>Intent to address identified vulnerabilities: <i>Institutional capacity is one of the limitations identified in Assam State Action Plan on Climate Change: 2021 – 2030 (SAPCC) for effective implementation of climate change adaptation programs in the state.</i> This component aims at enhancing institutional capacity of WRD and ASDMA to undertake climate informed Integrated Water Resources Management (IWRM) and disaster risk management.</p> <p>The explicit link between identified climate change risks and specific project activities:</p> <p>This component includes the development of the Assam state water policy which is one of the key central and state policies linked to Climate Adaptation and Mitigation in Water</p> <p>Resources in Chapter 5.2 of the <i>draft Assam State Action Plan on Climate Change: 2021 – 2030 (SAPCC)</i>. The aim of the Assam state water policy is adjusting the objectives, functions, and structure of WRD to make the transition to a broader IWRM organization and approach river erosion and flood risk management from a climate and DRM perspective. The component also intends to improve the capacity of ASDMA by examining the best mix of financing instruments to meet Assam disaster risk profile and support mitigation, disaster response, and recovery efforts, specifically to flooding.</p> <p>Further, this component will prepare the first Assam Brahmaputra State of Basin Report which will do a stock taking of the hydrology and climatology (including climate trends) of the Brahmaputra basin to support knowledge-based decision-making including climate risk management. This component will also include a Flash Flood Forecasting Study to increase the understanding of inland flooding due to extreme rainfall events. According to the Assam State Action Plan on Climate Change: 2021 – 2030 (SAPCC), extreme rainfall events were likely to increase by 5-38% and floods by more than 25% by the mid-century.</p>	<p>The institutional capacity building activities will extend to identification of climate mitigation measures as part of water resources and disaster risk management. This includes education on nature-based solutions to reduce impacts of floods in Assam in addition to the grey infrastructure approach currently used in the state. Nature based solutions are expected to have significantly less carbon footprint than other alternatives of flood risk reduction measures.</p>

Component	Adaptation Action	Mitigation Action
Component 2: Water Resources Management (US\$ 80 million)		
<p><i>Sub-Component 2.1: River Works Investments in Beki and Buridehing River Basins</i></p> <p><i>Sub-Component 2.2: Flood Forecasting, IFRMPs, and Investment Preparation</i></p> <p><i>Sub-Component 2.3: Data Collection and Embankment Asset Management</i></p> <p><i>Sub-Component 2.4: Assam Water Center Annex</i></p> <p><i>Sub-Component 2.5: WRD Project Management and Incremental Costs</i></p> <p><u>Activities:</u></p> <ul style="list-style-type: none"> - Anti-erosion works and rehabilitation of existing embankments. - Integrated Water and Flood Management Plans. - Establishing a flood 	<p>Vulnerability context: Refer above</p> <p>Intent to address identified vulnerabilities: This component will focus on improving the climate resilience of communities in Assam by investing in both physical infrastructures like anti-erosion works and rehabilitation of existing embankments as well as develop tools and plans to minimize the damage caused by floods before and when they happen.</p> <p>Explicit link between identified climate change risks and specific project activities: The project plans to carry out new anti-erosion works, 18.55 kms in Buridehing and 13.67 kms in Beki, to reduce the loss of land due to erosion due to high flood waters. In addition, 20.10 kms of embankment strengthening will be done in Buridehing with another 4.0 kms also planned in Beki to minimize the risk of embankment breaches and overtopping as climate extremes become more frequent. A provisional sum is reserved for piloting nature-based solutions as part of the identified investments in river works. This follows the new paradigm that's emerging which also looks at how to integrate green infrastructure with traditional gray infrastructure.⁶ In addition, the preparation of Integrated Flood Risk Management Plans (IFRMPs) will minimize Assam's exposure to local impacts of climate change. As floods become more frequent and extreme, delivery of reliable and timely flood forecasts at the local level will be increasingly important. This component will establish a state-of-the-art flood forecasting (FF) system by improving upon the existing flood early warning system (FLEWS) developed by NESAC. Additional activities like river cross section surveys, flood plain surveys using LiDAR, installation of Hydro-Met Real-time Data Acquisition System (RTDAS),</p>	<p>In addition to the trainings planned in component 1 the Integrated Flood Risk Management Plans (IFRMPs) will identify nature-based solutions to reduce impacts of floods as part of the investment identification for Phase 2 and Phase 3 of the program. As stated above this will contribute towards reducing the carbon footprint during construction and maintenance of the identified interventions.</p> <p>Furthermore, the component will introduce additional mitigation measures such as the use of green building concepts for the Assam Water Center Annex and other buildings that will be constructed as part of the project. These include the use of passive cooling systems, energy efficient designs including possible use of</p>

⁶ "Browder, Greg; Nunez Sanchez, Ana; Jongman, Brenden; Engle, Nathan; van Beek, Eelco; Castera Errea, Melissa; Hodgson, Stephen. 2021. An EPIC Response : Innovative Governance for Flood and Drought Risk Management. World Bank, Washington, DC. © World Bank. <https://openknowledge.worldbank.org/handle/10986/35754> License: CC BY 3.0 IGO."

forecasting (FF) system - Installation of Hydro-Met Stations. - <i>Levee Asset Management System</i>	and development of a levee asset management system will further contribute to increasing the flood resilience of Assam by providing the required data for planning and forecasting.	renewable energy sources to reduce GHG emissions over the life of the building.
Component	Adaptation Action	Mitigation Action
Component 3: Disaster Risk Management (US\$ 35 million)		
<p><i>Sub-Component 3.1: Flood Shelters.</i></p> <p><i>Sub-Component 3.2: Early Warning and Dissemination System (EWDS).</i></p> <p><i>Sub-Component 3.3: Revenue Circle Disaster Management.</i></p> <p><i>Sub-Component 3.4: Climate Resilient Villages.</i></p> <p><i>Sub-Component 3.5: ASDMA Project Management and Incremental Costs.</i></p> <p><u>Activities:</u></p> - Upgrading of school flood relief shelters and new flood shelters.	<p>Vulnerability context: Refer above</p> <p>Intent to address identified vulnerabilities: This component will enhance disaster risk management and disaster response capabilities at state and district levels. As intensity and duration of floods are expected to increase due to climate change investments are needed in shelters and other response and relief preparations. Furthermore, this component will work towards improving the dissemination of early warnings which are critical to allow communities seek shelter or evacuate before floods occur.</p> <p>Explicit link between identified climate change risks and specific project activities:</p> <p>Through Phase 1 of this program about 25 flood shelters will be upgraded or constructed to allow users to adapt to climate change by providing a safe refuge during floods. This is in addition to upgrading the school flood relief shelters already used in Assam. Some of the activities in augmenting and retrofitting existing shelters include:</p> <ul style="list-style-type: none"> ➤ Augmentation and retrofitting to ensure that existing facilities can serve the needs of the Non-Destructive tests of existing buildings to check structural strength ➤ Designing additions based on the flood shelter needs ➤ Construction of toilets and drinking water points ➤ Site protection issues ➤ Construction of vertical evacuation structures ➤ Civil work along with interventions for energy efficiency <p>Under this component upgrading state and 15 District Emergency Op Centers (EOCs) is planned which will provide better information; supports response and</p>	<p>Through the climate resilience component, the program will finance activities with in ASDMA such as technology demonstration units for different types of resilient structures. These structures, in addition to demonstrating climate resilience, will also serve as a showcase case for renewable energy use, energy efficient designs which is expected to be upscaled in subsequent phases of the project.</p>

<ul style="list-style-type: none"> - Establishing Circle Quick Response Teams (CQRTs) - Upgrading State and District Emergency Operation Centers (EOCs) - Preparation of Village Disaster Mitigation Plans (VDMPs) 	<p>recovery to climate hazards. There's also a plan to train and equip 50 Circle Quick Response Teams (CQRT) to improve local emergency response to climate hazards.</p> <p>The local response efforts will be structured under 50 Village Disaster Mitigation Plans (VDMPs) planned to be developed under this component. VDMPs improves resilience to climate hazards through upgraded infrastructure and improved governance and coordination framework. In addition, the Climate resilient villages component will also include (i) constructing of low-cost, energy efficient resilient housing demonstration structures in some of these Villages; and (iii) providing training, equipment and capacity building to the participating Villages, including lightning arrestors, emergency response kits, alternative energy sources and emergency warning systems.</p>	
---	---	--