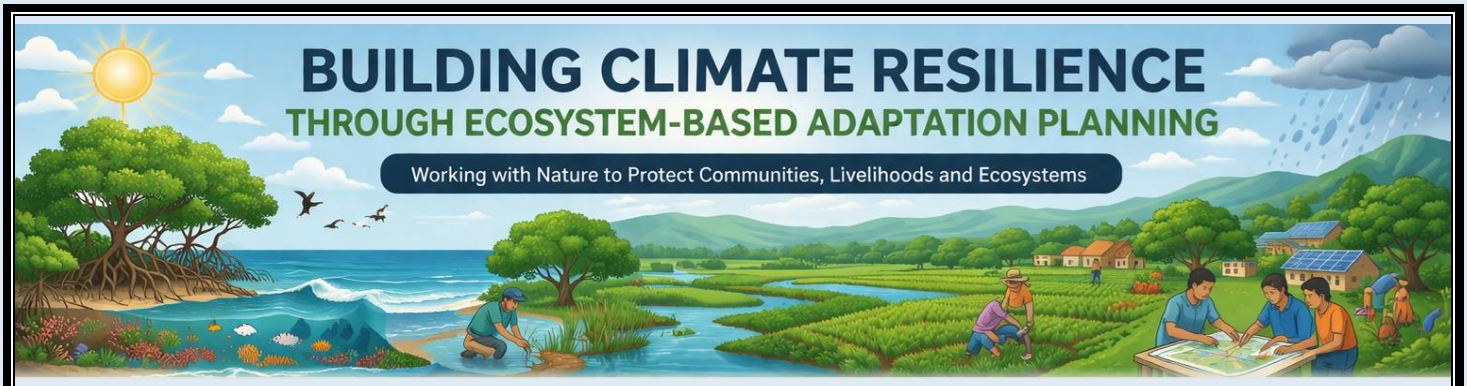
Government of Puducherry
DEPARTMENT OF SCIENCE, TECHNOLOGY AND ENVIRONMENT

Building Climate Resilience through Ecosystem-based Adaptation Planning

PUDUCHERRY CLIMATE CHANGE CELL
PUDUCHERRY

March 2026



INTRODUCTION

Climate change is one of the most critical challenges of the twenty-first century, with far-reaching impacts across natural and human systems. It is expected to significantly influence where people live, how food is produced, how cities are planned and how societies depend on ecosystems for essential services. In many regions, rising temperatures and sea-level rise are already placing ecosystems under stress, adversely affecting human livelihoods and well-being. When extreme weather events interact with vulnerable social conditions, they often lead to disasters that disrupt the normal functioning of ecosystems. Climate-induced hazards such as floods, storms, droughts, erratic precipitation and heatwaves are increasingly frequent and intense across the globe. At the same time, rising concentrations of greenhouse gases (GHGs) in the atmosphere are contributing to global warming, making climate patterns more variable and extreme.

In this context, there is a growing need to adopt approaches that emphasise the sustainable management and restoration of ecosystems. Strengthening ecosystem resilience can enhance its capacity to support human well-being while also mitigating and adapting to the impacts of climate change.

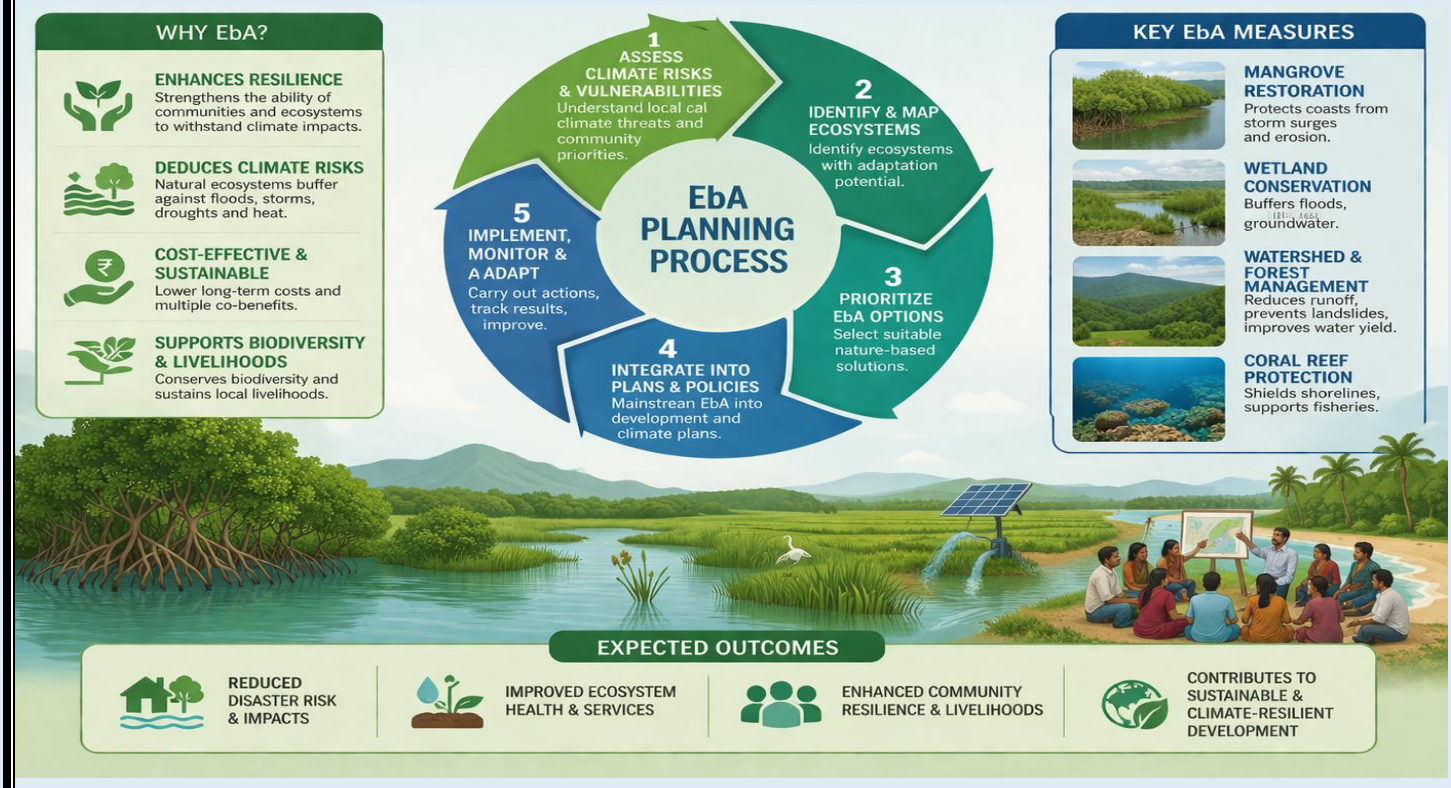
ECOSYSTEM-BASED ADAPTATION PLANNING

Ecosystem-based Adaptation (EbA) is a holistic, nature-based approach to climate change adaptation that focuses on the sustainable management, conservation and restoration of ecosystems to help people and communities cope with the adverse impacts of climate change. It is rooted in the understanding that ecosystems are not only environmental assets but also critical infrastructure that supports human survival, livelihoods and economic development.

Unlike conventional adaptation strategies that rely predominantly on engineered or "grey" infrastructure, such as seawalls, embankments, drainage systems and other hard interventions, EbA emphasises working with nature rather than against it. By leveraging the inherent capacity of ecosystems to absorb shocks and regulate environmental processes, EbA provides cost-effective, flexible and long-term solutions that evolve with changing climatic conditions. At the same time, it generates multiple co-benefits, including biodiversity conservation, carbon sequestration, improved water security and enhanced livelihood opportunities.

Natural systems such as forests, wetlands, mangroves, coral reefs, rivers and grasslands provide a wide range of ecosystem services which includes water regulation through groundwater recharge and flow moderation, soil stabilisation to prevent erosion and land degradation, flood mitigation by absorbing excess runoff, coastal protection through natural barriers like mangroves and reefs and climate regulation through carbon storage and microclimate control that are essential for climate adaptation.

EbA also integrates local knowledge, community participation and cross-sectoral planning, making it a socially inclusive approach. It supports vulnerable communities—particularly those dependent on natural resources, by strengthening their adaptive capacity while maintaining ecological integrity. EbA ensures that adaptation measures are sustainable, context-specific and scalable across different landscapes.



NATURE AS A SOLUTION: EBA PLANNING

The increasing frequency and intensity of climate-related hazards such as floods, storms, droughts and heatwaves highlight the limitations of relying solely on conventional infrastructure-based approaches. In this context, EbA emerges as a sustainable, cost-effective and long-term solution for building climate resilience. Nature-based interventions often require lower maintenance, adapt dynamically to changing climatic conditions and provide multiple environmental and socio-economic benefits.

EbA is particularly important for livelihood security and socio-economic resilience, especially for communities that depend directly on natural resources. For instance, mangrove restoration not only protects coastlines from storm surges but also supports fisheries, while watershed management enhances water availability and agricultural productivity. Furthermore, EbA contributes to biodiversity conservation, strengthens ecosystem integrity and supports broader goals such as disaster risk reduction and sustainable development. By integrating ecological health with human well-being, EbA offers a synergistic and scalable approach to address climate change impacts.

Why Ecosystem-based Adaptation (EbA)

Natural Infrastructure

- Ecosystems provide cost-effective and nature based infrastructure solutions.
- They incudes flood protection, water purification and soil conservation, that can complement or replace traditional built infrastructure.

Long-Term Sustainability

- EbA planning promotes the long-term sustainability of adaptation measures.
- EbA is very efficieant in such a way that it requires low maintenance and healthy ecosystems can naturally adapt and evolve over time.

Community Engagement

- EbA encourages the active participation of local communities.
- This ensures a sense of ownership and all measures culturally appropriate and socially accepted.

Global Climate Goals

- EbA aligns with broader global goals for climate change mitigation and adaptation.
- It contributes to national and international efforts to address climate.

Economic Viability

- Approaches of EbA are often economically viable in the long run.
- It helps to provide services without the ongoing costs associated with maintaining traditional infrastructure.

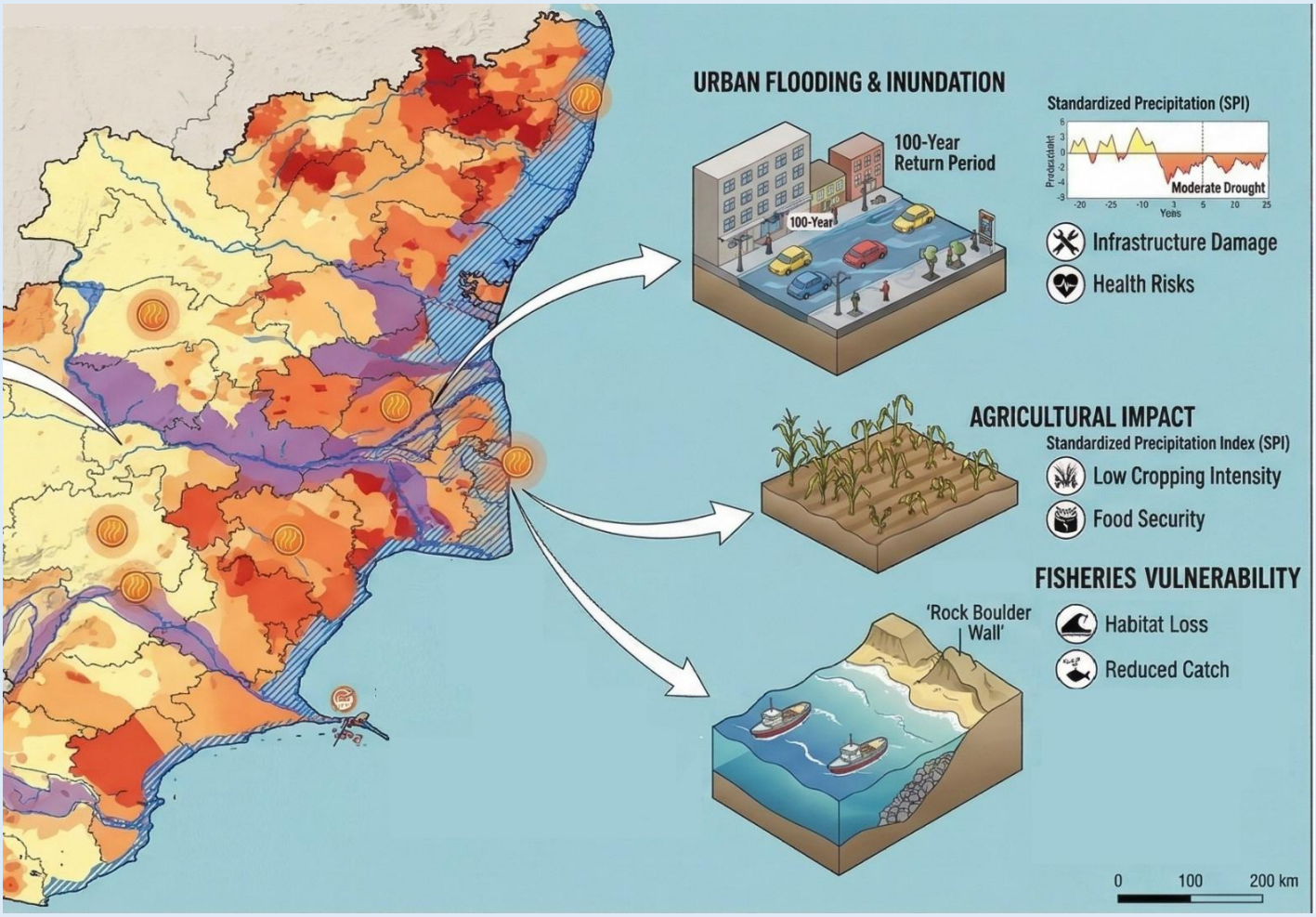
Climate Resilience

- EbA strategies will depend on diverse and adaptive ecosystems that can help communities better cope with these uncertainties.

HARNESSING NATURE FOR CLIMATE RESILIENCE IN PUDUCHERRY

Puducherry, a geographically fragmented coastal Union Territory located along the southeastern coast of India, is inherently vulnerable to the impacts of climate change due to its low elevation, dynamic coastline and high dependence on climate-sensitive sectors such as fisheries, agriculture and tourism. The region is increasingly experiencing intensified climate variability, manifested through sea-level rise, coastal erosion, cyclonic disturbances, erratic rainfall patterns, urban flooding and salinity intrusion into freshwater resources.

The physical characteristics of Puducherry comprising narrow coastal stretches, estuarine systems, backwaters and low-lying urban areas further exacerbate its sensitivity to climate risks. Coastal erosion has resulted in the loss of beaches and protective natural barriers, while unplanned urbanization and encroachment of wetlands have reduced the natural drainage capacity of the landscape, leading to frequent waterlogging and urban floods. Additionally, the over-extraction of groundwater combined with sea-level rise has accelerated salinity intrusion, posing a serious threat to drinking water security and agricultural productivity.



Traditionally, climate adaptation in Puducherry has relied on grey infrastructure approaches, such as seawalls and groynes. While these interventions provide localized and short-term protection, they often involve high capital and maintenance costs, limited flexibility under changing climate conditions and unintended environmental consequences, such as shoreline imbalance and habitat degradation. These limitations highlight the need for a more integrated, sustainable and adaptive approach to climate resilience.

In this context, EbA offers a strategic and scientifically grounded framework for addressing climate risks in Puducherry. EbA focuses on the conservation, restoration and sustainable management of mangroves, wetlands, estuaries, coastal dunes and urban green spaces, to enhance the natural capacity of these systems to buffer climate impacts. Healthy ecosystems function as natural infrastructure, providing critical services such as shoreline stabilization, flood regulation, groundwater recharge, carbon sequestration and biodiversity support, while also sustaining local livelihoods.

The relevance of EbA in Puducherry is particularly significant given the strong interlinkages between ecosystem health and socio-economic resilience. Coastal communities, especially fisherfolk and small-scale farmers, are directly dependent on ecosystem services for their livelihoods. Therefore, ecosystem degradation not only increases environmental vulnerability but also amplifies social and economic risks. EbA addresses this dual challenge by promoting cost-effective, community-driven nature-based solutions capable of delivering multiple co-benefits.

The adoption of EbA aligns with national and global policy frameworks, including the Paris Agreement and the Sustainable Development Goals, as well as India's National Action Plan on Climate Change (NAPCC) and State Action Plan on Climate Change (SAPCC). Integrating EbA into Puducherry's climate planning can therefore contribute to achieving long-term sustainability, climate resilience and inclusive development.

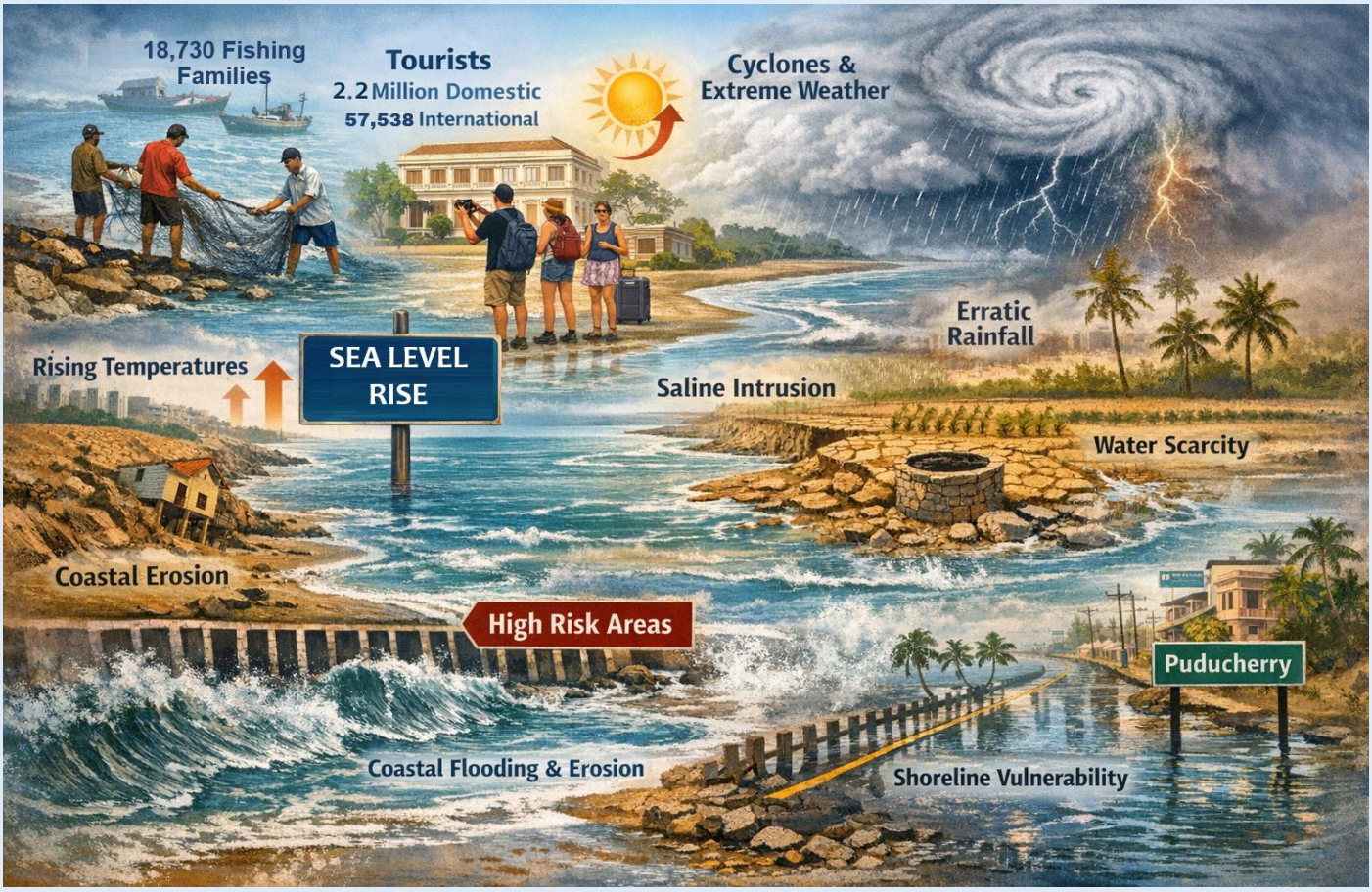
EbA is not merely an alternative approach but a necessary and foundational strategy for Puducherry. By leveraging the adaptive capacity of natural ecosystems and embedding them within planning and governance frameworks, EbA can effectively address the complex and evolving climate risks facing the region, ensuring long-term resilience for both ecosystems and communities.

UNDERSTANDING CLIMATE RISKS: CONTEXT AND SCIENTIFIC INSIGHTS

Puducherry's vulnerability to climate change is closely linked to its coastal exposure and its dependence on climate-sensitive sectors such as fisheries, agriculture, tourism and water resources. The Union Territory has a significant coastal population, including nearly 18,730 fishing families (2024) whose livelihoods depend directly on marine and coastal ecosystems. Tourism, another key economic sector, recorded over 2.27 million domestic and 57,538 international visitors in 2024, further underscoring the importance of maintaining healthy ecosystems for sustained economic resilience.

Recent studies and climate assessments indicate that the region is increasingly exposed to multiple, interacting climate risks, necessitating a structured and science-based adaptation framework such as EbA. The region is already experiencing increasing variability in rainfall, rising temperatures and frequent extreme weather events, particularly cyclones originating from the Bay of Bengal. In addition, saline intrusion into groundwater is affecting both agricultural productivity and drinking water security.

Scientific assessments indicate that sea-level rise in the region could range from approximately 7 cm to as high as 78 cm by 2100 under different climate scenarios, posing a serious threat to coastal ecosystems and infrastructure. Historical observations further show a consistent rise in sea levels in the northern Indian Ocean at about 3.3 mm/year, contributing to coastal erosion and inundation risks. Also, the shoreline changes studies indicate substantial erosion along parts of the Puducherry coast, with long-term sea-level rise and anthropogenic interventions exacerbating the problem. The physical landscape, largely at or near sea level, further increases susceptibility to flooding, storm surges and permanent inundation.



Recent analytical tools, such as the *Climate Risk Assessment Tool (CRAT) for Puducherry (2025)* developed by DSTE in collaboration with CSTEP, highlight that the Union Territory is exposed to multiple, interacting climate hazards, including droughts, floods, heatwaves, sea-level rise and coastal erosion. These risks have significant implications for key sectors such as agriculture, fisheries, health, tourism and water resources.

The interconnected nature of these hazards underscores the limitations of isolated or sector-specific adaptation measures and reinforces the need for integrated, ecosystem-based planning approaches.

EbA PLANNING FRAMEWORK FOR CLIMATE RESILIENT PUDUCHERRY

EbA Planning Framework for Puducherry provides a structured approach to systematically address climate risks by integrating ecosystem conservation with development planning. By focusing on the restoration and sustainable management of ecosystems such as mangroves, wetlands, coastal dunes and urban green spaces, EbA offers a cost-effective, sustainable and multi-benefit pathway to enhance climate resilience.

Accordingly, EbA in Puducherry is not merely a technical exercise but a strategic necessity aimed at safeguarding ecosystems, securing livelihoods and ensuring long-term resilience through a science-based and participatory approach.

The framework follows a step-wise, iterative process that integrates scientific assessments, stakeholder engagement and policy convergence, as outlined below:

Step-1: Climate Risk Assessment

- Identification of key climate hazards such as coastal erosion, cyclones, flooding and heat stress, etc,
- Use of tools such as Climate Risk Assessment Tool (CRAT), GIS mapping and historical climate data.
- Sectoral vulnerability analysis (fisheries, agriculture, water resources, urban systems).

Step-2: Ecosystem Services Mapping and Evaluation

- Mapping critical ecosystems such as mangroves, wetlands, coastal dunes, water bodies and urban green spaces.
- Assessment of ecosystem services including flood buffering, groundwater recharge, carbon sequestration and biodiversity support.
- Identification of degraded and high-priority restoration areas.

Step-3: Participatory Planning and Stakeholder Engagement

- Engagement with local communities (fisherfolk, farmers), line departments, NGOs and research institutions.
- Conduct of consultations, workshops and inter-departmental coordination meetings.
- Integration of local knowledge and traditional practices into planning.

Step-4: Identification and Design of EbA Interventions.

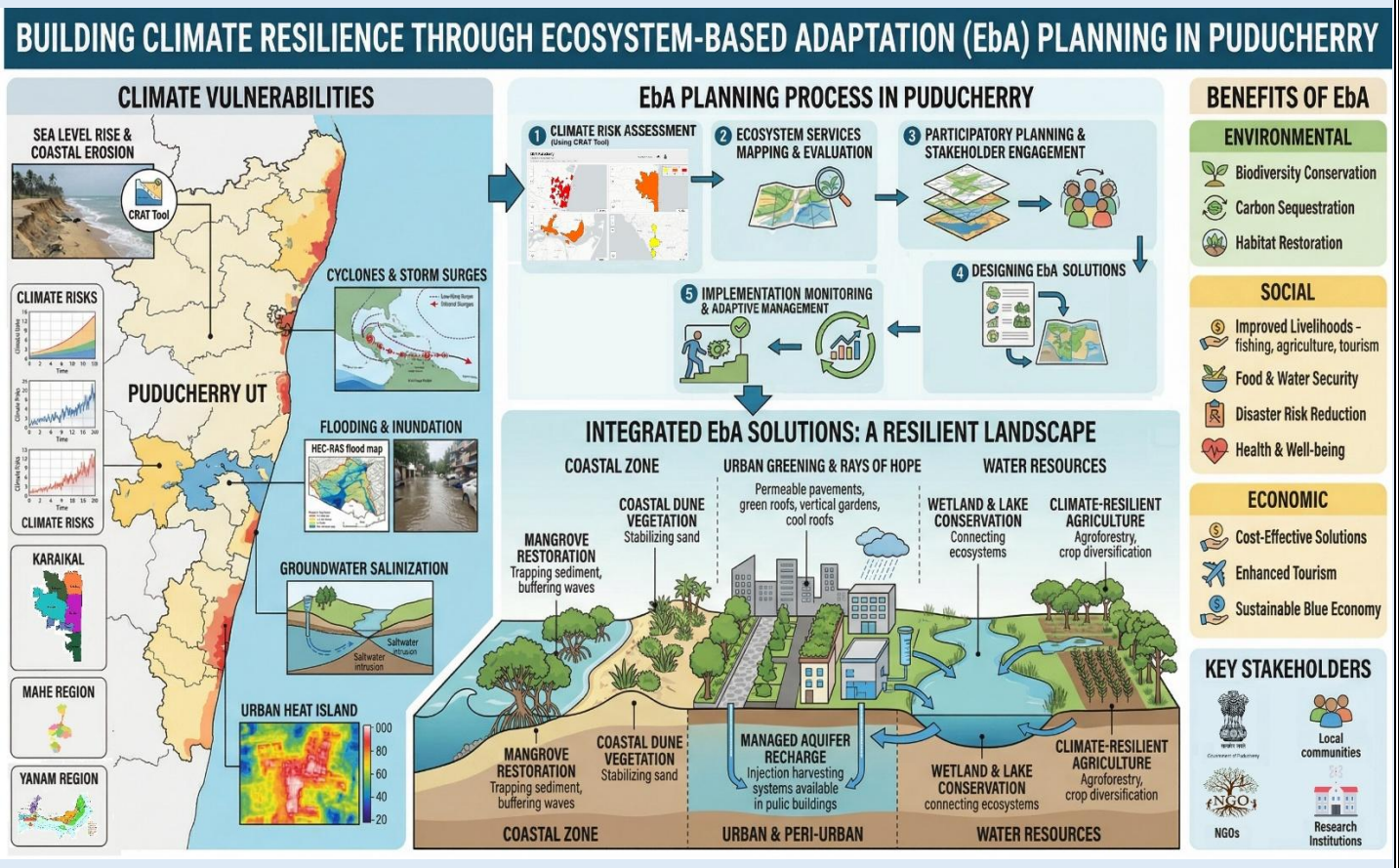
- Development of nature-based solutions tailored to local risks. Examples: Mangrove restoration for coastal protection, Wetland conservation for flood mitigation, Urban greening for heat reduction and Climate-resilient agriculture for drought adaptation.
- Technical feasibility, cost-benefit and sustainability assessment

Step-5: Monitoring, Evaluation and Adaptive Management

- Development of indicators to measure:
    - Reduction in climate risks
    - Improvement in ecosystem health
    - Livelihood benefits
- Use of remote sensing, field surveys and community feedback
- Adaptive management to refine strategies over time
- Integration into Policies and Development Plans

Step-6: Implementation of EbA Measures

- Department-wise execution with clear roles and responsibilities
- Convergence of funding sources and schemes
- Promotion of community participation and public-private partnerships



EbA represents a transformative approach for Puducherry, enabling a shift from reactive disaster management to proactive, nature-based resilience planning. By integrating ecosystem restoration with development planning, EbA provides a cost-effective, sustainable and multi-benefit pathway to address climate risks. The structured six-step planning framework ensures that adaptation strategies are scientifically robust, participatory and aligned with policy frameworks.

Mainstreaming EbA into Puducherry's climate and development policies will be critical for safeguarding ecosystems, securing livelihoods and ensuring long-term resilience in the face of increasing climate variability.

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Author

S. Pannerselvam
Senior Project Associate
Puducherry Climate Change Cell (PCCC)

Prepared under the guidance of:

Dr. R. Sagaya Alfred
Senior Scientific Officer-cum-Programme Coordinator (PCCC)
Department of Science, Technology and Environment, Government of Puducherry.
&
Er. K. Kalamegam
Environmental Engineer-cum-Co-Principal Investigator (PCCC)
Department of Science, Technology and Environment, Government of Puducherry.

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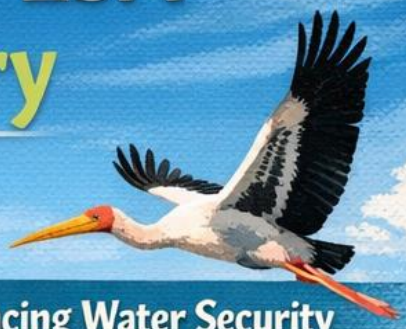
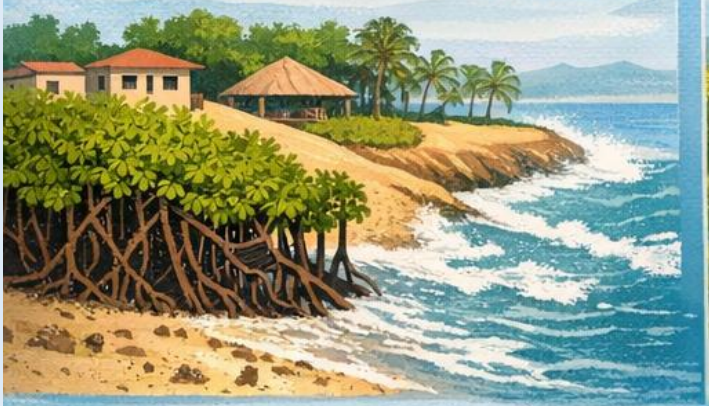
The Relevance of EbA in Puducherry



Protecting Coastal Communities

Mangroves & Sand Dunes
Reduce Storm Surges & Erosion

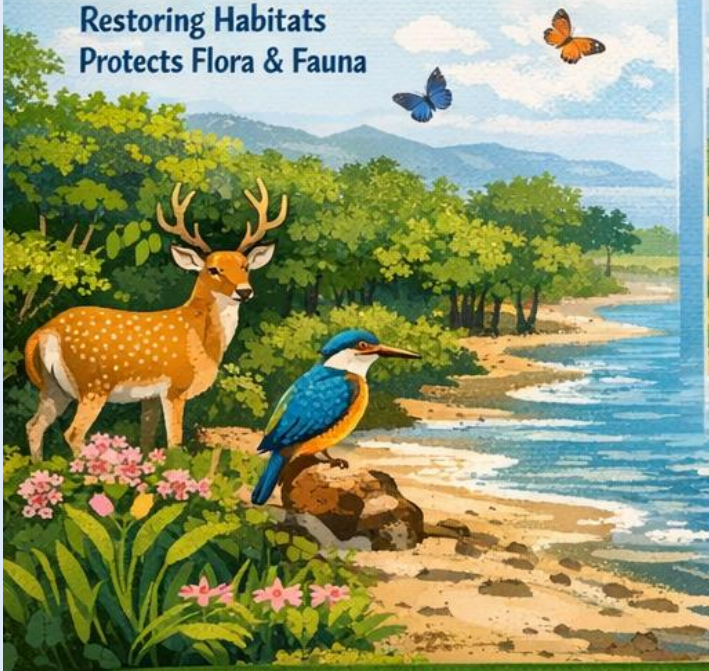


Enhancing Water Security

Wetlands & Lakes
Improve Groundwater Recharge

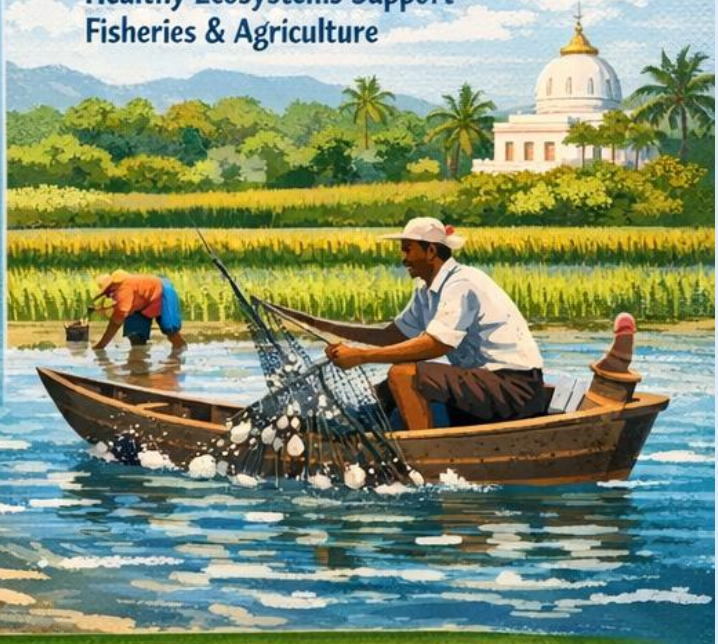
Preserving Biodiversity

Restoring Habitats
Protects Flora & Fauna



Sustaining Livelihoods

Healthy Ecosystems Support
Fisheries & Agriculture



Building Resilience to Climate Change