On behalf of:

Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

IKI INTERNATIONAL CLIMATE INITIATIVE

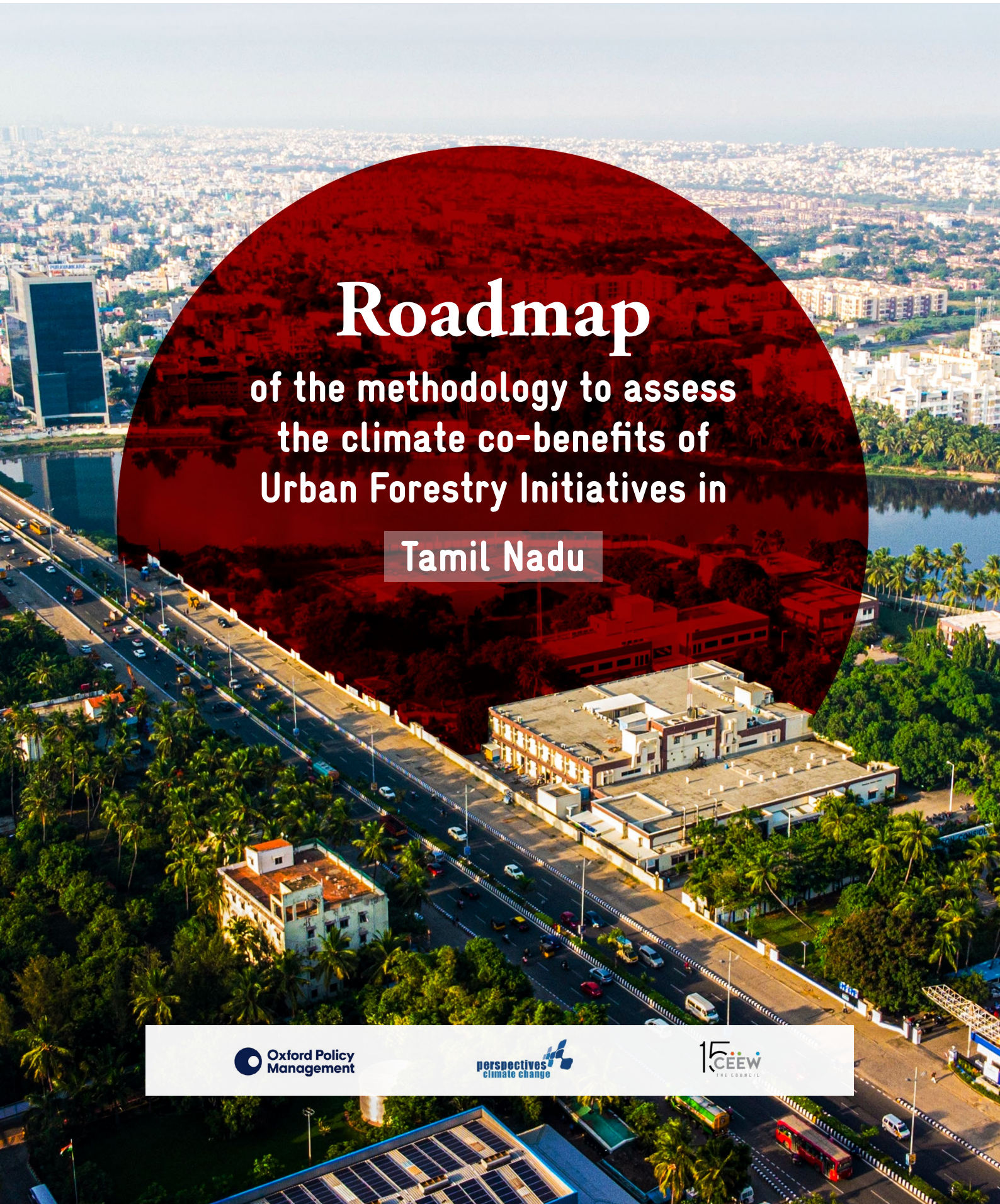
Ministry of Environment, Forest and Climate Change

TNGCC Tamil Nadu Green Climate Company

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

# Roadmap

## of the methodology to assess the climate co-benefits of Urban Forestry Initiatives in Tamil Nadu



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**Indo-German Support Project for Climate Action in India**
A2/18, Safdarjung Enclave New Delhi 110 029 India
T: +91 11 4949 5353
F: +91 11 4949 5391
E: info@giz.de
1: www.giz.de/india

**Responsible**
Vaibhav Rathi, Deputy Team Lead, Indo-German Support Project for Climate Action in India

**Contributors**
Arun Poojary, Climate Change Advisor, GIZ India | Jasprit Kaur, Climate Change Advisor, GIZ India | Soumik Biswas, Team Leader, OPM | Nitin Bassi, Circular Economy Expert, CEEW | Axel Michaelowa, Climate change mitigation expert, PCG | Nancy Okodoi, Sustainability Expert, OPM | Sushant Figueiredo, Expert Pool, OPM | Anurag Saha, Expert Pool, OPM | Gaurav Sahni, Expert Pool, CEEW | Priyanka Singh, Expert Pool, CEEW | Dr. Akanksha Tyagi, Expert Pool, CEEW | Aeshita Mukherjee, Forestry Expert, CEEW | Mousumi Kabiraj, Expert Pool, CEEW | Duska Sasa, Expert Pool, PCG | Ashwin Tomy, Expert Pool, PCG

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# List of abbreviations

| | |
|---|---|
| AMRUT | Atal Mission for Rejuvenation and Urban Transformation |
| CBO | Community-Based Organisation |
| CCoB / CCoBs | Climate Co-benefit(s) |
| CDM | Clean Development Mechanism |
| $CO_2$ | Carbon Dioxide |
| CSR | Corporate Social Responsibility |
| DBH | Diameter at Breast Height |
| ESG | Environmental, Social, and Governance |
| ONGC | Oil and Natural Gas Corporation |
| PSE | Public Sector Enterprise |
| PU | Planting Unit |
| QA/QC | Quality Assurance / Quality Control |
| RWA | Residents' Welfare Association |
| SAIL | Steel Authority of India Limited |
| SAPCC | State Action Plan on Climate Change |
| SCOPE | Standing Conference of Public Enterprises |
| SOP | Standard Operating Procedure |
| SPV | Special Purpose Vehicle |
| TNA | Training Needs Assessment |
| ToC | Theory of Change |
| TtT | Train-the-Trainer |
| UF | Urban Forestry |
| ULB | Urban Local Body |
| FSI | Forest Survey of India |

| | |
|---|---|
| GHG | Greenhouse Gas |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH |
| GTNM | Green Tamil Nadu Mission |
| ICFRE | Indian Council of Forestry Research and Education |
| IIRS | Indian Institute of Remote Sensing |
| IPCC | Intergovernmental Panel on Climate Change |
| IOCL | Indian Oil Corporation Limited |
| JSW | Jindal South West (Foundation) |
| MoEFCC | Ministry of Environment, Forest and Climate Change |
| MoHUA | Ministry of Housing and Urban Affairs |
| MoU | Memorandum of Understanding |
| MRV | Measurement, Reporting, and Verification |
| NGO | Non-Governmental Organisation |
| NDC | Nationally Determined Contribution |
| NVY | Nagar Van Yojana |
| UNEP | United Nations Environment Programme |

# Background[1]

# 1.

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[1] Disclaimer: Parts of this document have been refined using AI-based editing tools to enhance clarity and readability. All findings, interpretations, and recommendations are originally institutionalised and based on the author's research and analysis.

India's accelerated urbanisation has resulted in significant ecological pressures, underscoring the role of urban forestry (UF) as a strategic intervention for enhancing environmental quality and climate resilience. National and subnational programmes, such as the Nagar Van Yojana (NVY) (2020), Maharashtra's Majhi Vasundhara Abhiyan, and the Green Tamil Nadu Mission (GTNM), demonstrate government-led efforts to expand urban green cover, conserve biodiversity, and promote climate-resilient species suited to local agro-climatic conditions. While these interventions are not primarily framed as climate-oriented actions, they yield certain climate co-benefits (CCoBs) by contributing to greenhouse gas (GHG) mitigation and enhancing adaptive capacity through urban cooling, flood regulation, and the delivery of ecosystem services. The present project aims to develop methodologies for quantifying the co-benefits of mitigation and adaptation from urban forestry initiatives. Developed through a consortium-led, multi-stakeholder process, these methodologies aim to support the Ministry of Environment, Forests, and Climate Change (MoEF&CC) in mainstreaming CCoBs across various policies, in line with the climate co-benefit definition.

This project and the developed methodology consider climate co-benefits (CCoBs) as mitigation or adaptation benefits arising from initiatives not primarily designed with a climate-related focus but that target other areas, in this case, UF schemes. Mitigation benefits are generated through increased carbon sequestration, while adaptation benefits are seen in enhanced urban resilience, such as cooling effects, better stormwater management, and enhanced groundwater recharge that help cities cope with climate impacts. Furthermore, this methodology addresses only direct mitigation co-benefits—those that are measurable, quantifiable, and directly linked to project/programme activities.

The project "Indo-German Support for Climate Action in India and the IKI Interface Project" (CAP)" is supported by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) and implemented by GIZ India under the overall guidance of the Ministry of Environment, Forest and Climate Change (MoEFCC), through a multi-tier governance and coordination structure. Implementation follows a phased approach that encompasses methodology development, pilot testing, validation, and capacity building for two thematic streams: urban forestry and circular economy. Pilot activities are undertaken in selected states, specifically Maharashtra and Tamil Nadu, in partnership with respective State Climate Change nodal departments, Forest Departments and Urban Local Bodies (ULBs).

Tamil Nadu has emerged as a frontrunner in implementing urban forestry through a strong policy and implementation ecosystem that aligns closely with climate mitigation and adaptation objectives. Under the Nagar Van Yojana (NVY), the state has secured approval for 10 projects between 2020–21 and 2023–24, covering a sanctioned area of approximately 435 hectares, reflecting a sustained commitment to expanding urban green spaces. Complementing NVY, the Tamil Nadu State Forest Policy (2018) provides a comprehensive framework that emphasises biodiversity conservation, climate change mitigation and adaptation through enhanced tree cover, water augmentation, restoration of degraded ecosystems, and inclusive forest governance with a focus on women and tribal communities.

Building on this foundation, the Green Tamil Nadu Mission represents a flagship, mission-mode intervention aimed at increasing the state's forest and tree cover from 23.6 per cent to 33 per cent by 2030–31 through large-scale plantation of native, climate-resilient species tailored to agro-climatic zones. The mission is underpinned by robust monitoring systems, including geo-tagging of seedlings, mobile-app–

based nursery management, and regular departmental inspections, enabling scale with accountability. Given this strong institutional architecture, scale of implementation, and emphasis on data-driven monitoring, Tamil Nadu provides an enabling and mature context for piloting and mainstreaming a standardised methodology to assess climate co-benefits of urban forestry, particularly under the Green Tamil Nadu Mission and allied urban greening programmes.

1.1

## Objectives of the roadmap

The primary goal of the Roadmap is to embed a robust, standardised methodology for assessing climate co-benefits (CCoBs) within urban forestry (UF) programmes in Tamil Nadu, thereby ensuring accountability, transparency, and scalability of UF interventions in the state. It seeks to provide a structured framework through which state-level schemes, state missions, and sectoral policies can institutionalise the measurement and reporting of mitigation and adaptation cobenefits. Specifically, the roadmap will:

- Define actionable roles and responsibilities for government agencies, urban local bodies (ULBs), and private actors in Tamil Nadu;
- Establish short-, medium-, and long-term pathways for mainstreaming CCoB assessment in the state;
- Enable systematic capacity building and data-driven monitoring mechanisms.

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# Climate co-benefits assessment methodology:

# A brief overview

## 2.


Source: ©Freepik

2.1

# The methodology

A methodology to estimate mitigation and adaptation co-benefits from UF initiatives in India is designed to provide a standardised approach for estimating GHG removals (mitigation domain) and four adaptation-related parameters, i.e., urban heat island reduction, improvement in groundwater recharge, flood and stormwater management and improved biodiversity.

The process for the mitigation domain builds on international good practices (e.g. CDM, Verra, Gold Standard), adapted wherever feasible to align with India's data, institutional, and policy environment. The methodology focuses on quantifying carbon removals in above-ground and below-ground biomass. The estimation is based on a planting unit (PU) approach, with $CO_2$ removals calculated annually. Two pathways are offered, dependent on data availability:

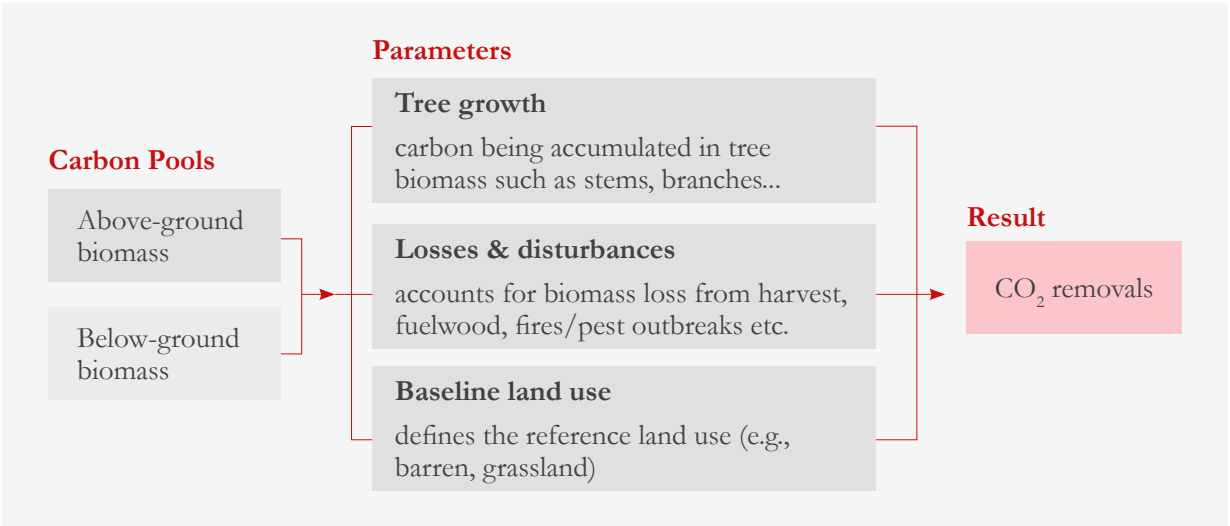
- Pathway I relies on field measurements of tree diameter at breast height (DBH) and species-specific volumetric equations (as provided by FSI and ICFRE), while

- Pathway II applies default sequestration factors from the literature, requiring minimal field data (e.g., area planted, species mix, planting date and area affected with natural disturbance, if any).

Both approaches account for carbon sequestration as well as carbon losses due to harvest, fuelwood collection, and natural disturbances. It is essential to emphasise that the two pathways were designed to accommodate different data availability levels without placing an additional burden on stakeholders. However, the application of the methodology requires a certain minimum of data inputs (light MRV is necessary).

Baseline conditions—whether grassland, barren land, or shrubland—are conservatively defined, and leakage risks are considered negligible. For stakeholders, the methodology enables transparent, data-driven estimates of mitigation co-benefits, thereby strengthening the integration of urban forestry into planning, financing, and reporting systems.

*Figure 1: Flow of Mitigation Elements in Urban Forestry*



The adaptation assessment framework for UF initiatives is designed to evaluate how increased tree and vegetation cover contributes to enhanced climate resilience in urban systems. Drawing on international best practices (e.g., the UNEP and IPCC AR6 frameworks, as well as urban resilience assessment tools) and aligned with India's national and state climate priorities, the methodology identifies and quantifies adaptation co-benefits through measurable physical and socio-environmental indicators. After conducting a comprehensive literature review which is (U.S. Department of Agriculture, 2020), (Behera, et al., 2022), (Saha, 2017) (Cheung and Jim 2018) and (Safford, Larry, McPherson, Nowak, & Westphal, 2023), it was determined that four distinct parameters would be evaluated to gauge the climate co-benefits of urban forestry.

These parameters include Urban heat island reduction (cooling effect around the plantation site); improvement in groundwater recharge and quality (redirecting water across the land surface or injecting it directly into the subsurface); flood and stormwater management (the practice of managing the quality and quantity of water to prevent flooding, protect the environment, and preserve infrastructure); and Improved biodiversity of the region (establish green corridors to connect green areas and build an ecological network that connects two or more green spaces, creating a continuous network of habitat while providing benefits to locale), all viewed from the climate change adaptation perspective.

For stakeholders, the framework provides a structured means to integrate adaptation benefits into urban planning, climate risk assessments, and monitoring systems, thereby strengthening evidence-based decision-making. Table 1, presented below, summarises the parameters selected and the reasoning for their inclusion in assessing the climate co-benefits associated with promoting urban forestry.

**Table 1: List of parameters considered to measure adaptation-related climate co-benefits of Urban Forestry**

| Parameter | Justification/Rationale for selection |
|---|---|
| 1. Urban heat island reduction (cooling effect around the plantation site) | Planting trees and increasing urban green spaces significantly mitigates the urban heat island effect by providing shade, reducing heat absorption, and increasing evaporation, ultimately lowering temperatures and creating Albedo effect where Vegetation has a higher reflectivity than urban surfaces, meaning it reflects more sunlight and absorbs less heat (Saha, 2017), (Safford, Larry, McPherson, Nowak, & Westphal, 2023). |
| 2. Improvement in groundwater recharge | Tree cover is known to have a favourable impact on local water availability, especially groundwater recharge, which in turn is important for improving resilience to the adverse impacts of climate change on hydrology (U.S. Department of Agriculture, 2020). |
| 3. Flood and stormwater management | It is a well-established fact that tree cover plays a crucial role in stormwater management by reducing runoff and soil loss, increasing infiltration, and thereby mitigating the risk of flooding (U.S. Department of Agriculture, 2020; Safford, Larry, McPherson, Nowak, & Westphal, 2023). |
| 4. Improved biodiversity of the region | Urban forests contribute to biodiversity by providing habitats for a wide range of species, thereby fostering ecological balance. Creating habitats for a variety of plants and animals, and by improving the connectivity between different forest patches (Behera, et al., 2022). |

Source: Authors' compilation

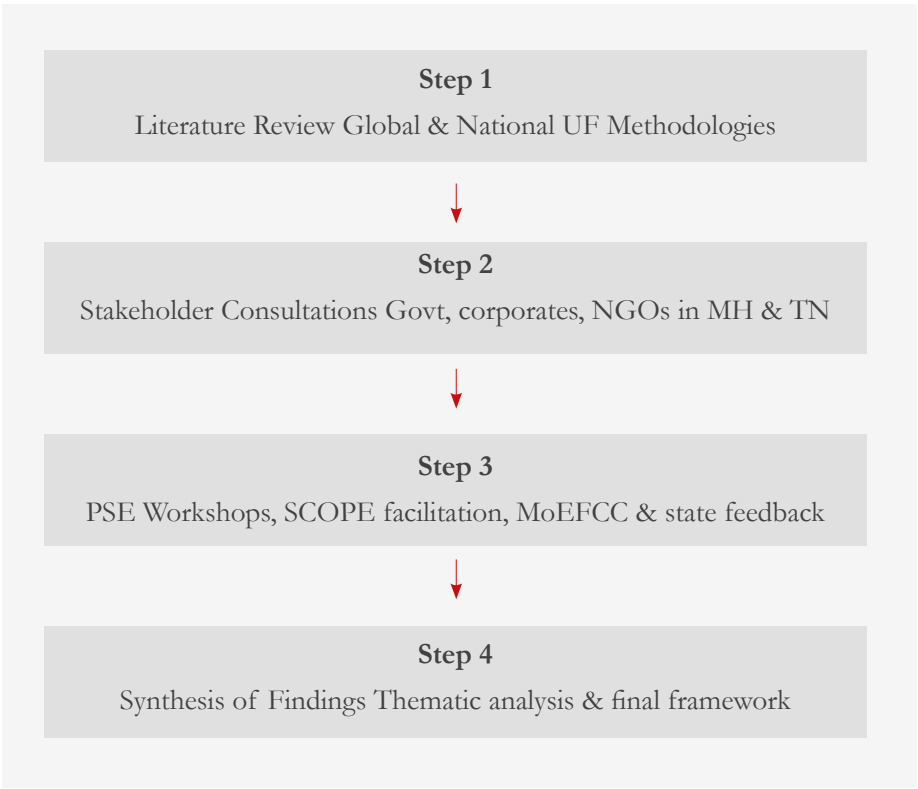
Overall, by aligning with India's NDC and state climate missions, the methodology serves as a credible framework for quantifying the contribution of urban forestry to national/ sub-national climate actions. The data metrics to measure each parameter are added in Annexure 1.

2.2

## Approach to the development of the methodology

The methodology was developed through a systematic step-by-step process combining evidence, practice, and stakeholder validation. First, an extensive literature review of global and national approaches helped identify relevant frameworks and data parameters for assessing the co-benefits of mitigation and adaptation. This was followed by targeted stakeholder consultations in Maharashtra and Tamil Nadu with government agencies, research institutions, corporates, and non-government organisations (NGOs) to contextualise and refine the framework. Semi-structured interviews and field visits enriched the contextual understanding and practical relevance of the methodology. Next, regional workshops with Public Sector Enterprises (PSEs), across Goa, New Delhi, Kolkata, and Bengaluru, and facilitated by SCOPE, gathered practical feedback. The methodology was also presented to MoEFCC to seek their feedback and insights. Subsequently, state-level validation workshops were conducted with forest officials, municipal authorities, and other key stakeholders, including representatives of PSEs, to present the final methodology and assessment tool. Finally, insights were synthesised through thematic analysis, ensuring that the methodology is scientifically robust, operationally feasible, and consistent with national and state-level climate policy objectives.

*Figure 2: Approach to the development of the Methodology*



2.3

# Need for assessing climate-cobenefits of UF in Tamil Nadu

It is crucial to evaluate the CCoB of UF for climate change mitigation and adaptation in order to shape effective policies and attract financial support. Impacts such as carbon sequestration, urban heat reduction, flood and stormwater management, groundwater recharge, and biodiversity enhancement, when quantified, not only aid in ensuring that the climate-positive outcomes of the UF do not go unrecorded, are accounted, and reported but also enable policymakers to make informed decisions and justify investments in UF initiatives. Climate co-benefits measurement of ongoing urban afforestation projects and programmes help in strengthening implementation as well as reporting within the State Climate Action Plans and national climate missions. Thus, the methodology can be used by the state to build capacity of relevant stakeholders to undertake such assessment and data required for the same. Governments can also consider climate co-benefits accounting to contribute to reporting under the nationally determined contributions (NDCs). This also helps attract funding from multiple sources, including government schemes, philanthropic organisations, corporate social responsibility (CSR) programmes, and carbon markets.

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# Stakeholder engagements

# 3.

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Multiple stakeholder engagements were conducted in Tamil Nadu, followed by focused group discussions with key stakeholders, including Public Sector Enterprises (PSEs), to review the methodology, data metrics, and understand their existing monitoring systems. Additionally, field visits were conducted to selected sites, providing additional insights and thus strengthening the methodology.

3.1

# Stakeholders involved

The diverse set of stakeholders consulted to achieve a comprehensive understanding of UF/plantation initiatives in the region/s were:

## Government departments

- Involved in site selection for UF projects and data collection to support the piloting and validation of the methodology such as Green Tamil Nadu Mission; State Forest Research Institute; National Biodiversity Authority; Institute of Forest Genetics and Tree Breeding, Coimbatore; Forest Departments from Chennai and Coimbatore; Forest Genetics Division, Coimbatore; TN Green Climate Company; State Ground and Surface Water Resources, Chennai and others.

## Non-government organisations (NGOs)

- Two NGOs engaged in plantation activities, either as CSR partners or individual organisations advocating for urban parks/forests and environmental conservation.

## Public Sector Enterprises (PSEs)

- Any commercial or industrial undertaking owned and managed by the government that implements UF projects under various central and state government programmes.

Through engagement with over 25 stakeholders, it provided insights into existing monitoring and data collection practices, gaps, and opportunities for embedding the CCoB of UF initiatives. The consultations also provided insights into the diverse approaches and challenges faced by both private sector organisations and government departments in UF initiatives. Participants emphasised the need for context-specific solutions, considering geographic, ecological, and socio-economic factors as well, in the methodology section. Issues such as land availability, maintenance, and monitoring challenges were consistently mentioned by multiple stakeholders, along with the importance of developing tailored methodologies for assessing co-benefits, including carbon sequestration, groundwater recharge, biodiversity enhancement, and others.

In addition, Training Needs Assessment (TNA) was also conducted with officials from over 50 Public Sector Enterprises (PSEs), such as Indian Oil Corporation Ltd. (IOCL), Oil and Natural Gas Corporation (ONGC), Steel Authority of India Limited (SAIL), etc. The assessment aimed at evaluating the capacities of PSEs to effectively monitor plantation-related projects and assess the CCoB impacts of these activities. Furthermore, TNA was also helpful in identifying existing knowledge gaps among stakeholders regarding the integration of monitoring methodologies into their existing projects and reporting. It was also realised

that CCoBs—such as temperature gradation, improved biodiversity, carbon sequestration, and improved groundwater recharge—are crucial but often not well understood at various levels by officials and stakeholders involved in these initiatives.

3.2

## Existing challenges in assessing CCoBs and integrating the methodology

Based on several consultations, the key barriers observed towards implementing the CCoB methodology for urban forestry and plantation initiatives were:

- **Limited Awareness and Knowledge Gaps:** Staff often lack understanding of the full spectrum of climate co-benefits, particularly for less visible impacts such as carbon sequestration, flood mitigation, groundwater recharge, and soil conservation. Limited familiarity with climate adaptation concepts further restricts effective assessment.

- **Inadequate Training and Capacity-Building:** Many organisations have not conducted regular training on climate project implementation or impact assessment. It is clearly evident that the Staff require structured, practical training to enhance their skills in data collection, monitoring, and the interpretation of CCoBs.

- **Data Limitations:** Existing monitoring primarily focuses on basic indicators such as tree survival rates and species diversity only during the initial 2-3 years of plantation survival monitoring period. Additionally, tree growth parameters for post-survival monitoring period are not captured in the current plantation monitoring system, which is necessary for mitigation impact calculations. There is a significant lack of baseline data, inconsistent collection frequencies, and standardised approaches to measure comprehensive climate impacts.

- **Limited Use of Tools and Technology:** Only a few organisations leverage tools, software, or technological solutions such as remote sensing, sensors, piezometers, or perception-based surveys to track climate co-benefits. Many frameworks and tools remain underutilised.

- **Financial and Resource Constraints:** Organisations often lack dedicated budgets for monitoring, capacity-building, and data analysis. Additionally, they often face staffing shortages or lack dedicated personnel to implement climate-related initiatives and systematically monitor outcomes. This constrains both the quantity and quality of data that can be collected.

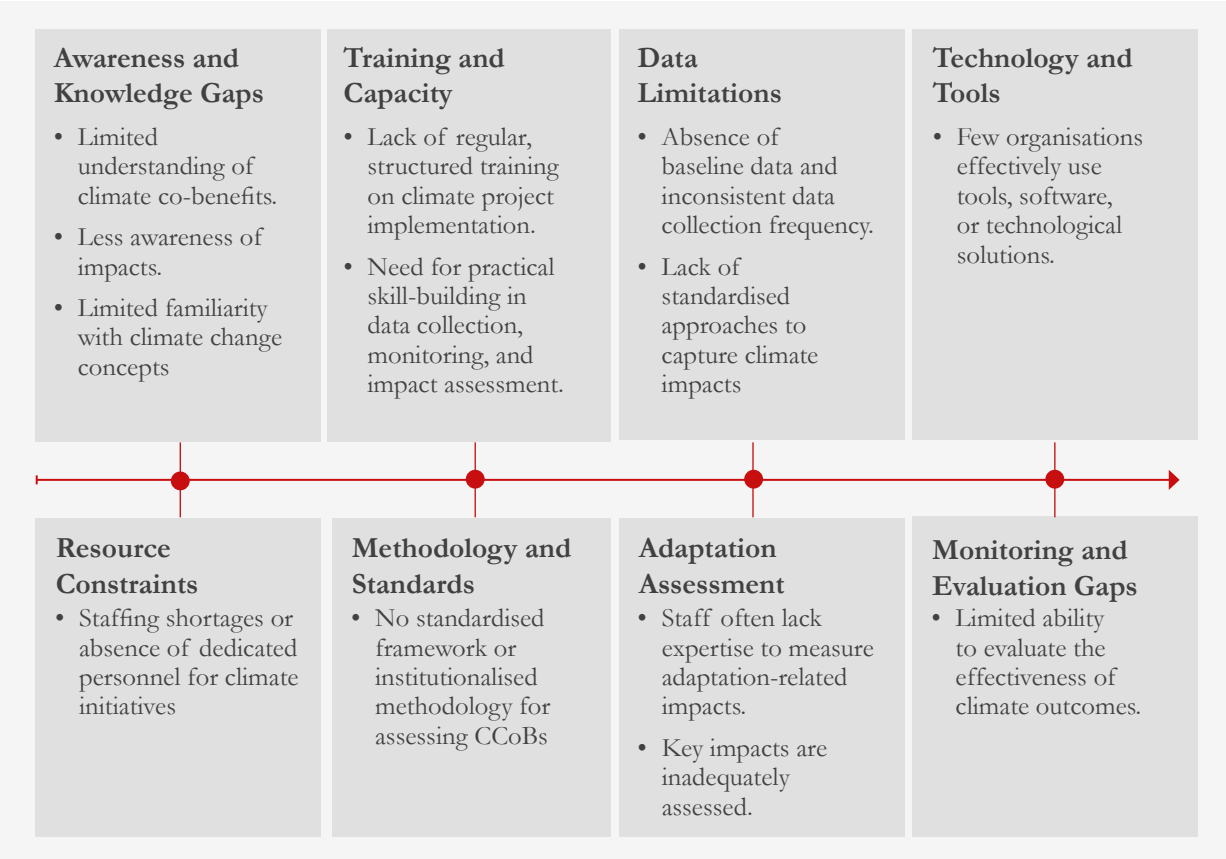
- **Inconsistent Methodologies and Standards:** There is no standardised framework or institutionalised methodology for assessing CCoBs, which makes it difficult to compare results across sites or scale practices across regions.

- **Challenges in Adaptation Assessment:** Staff often lack expertise in measuring adaptation-related impacts such as stormwater management, urban heat mitigation, and biodiversity enhancement, which are critical components of CCoBs.

- **Monitoring and Evaluation Gaps:** Even where monitoring exists, it often focuses on quantity metrics rather than quality or impact metrics due to limited monitoring mandate and scope, thereby limiting the ability to effectively evaluate climate outcomes.

Addressing these challenges will require dedicated capacity-building, resource allocation, standardised tools, and clear guidance to ensure the methodology can be effectively applied and sustained across organisations.

*Figure 3: Existing challenges in assessing CCoBs and integrating the methodology*




## 3.3

# Opportunities for implementation and scaling

Stakeholder consultations in Tamil Nadu indicated significant interest by TN Green Climate Company and Green Tamil Nadu Mission in enhancing organisational capacity to implement the CCoB methodology. Participants during the state validation workshops such National Highway Authority of India emphasised the need for structured and regular training, favouring a combination of in-person workshops, on-site

sessions, and practical demonstrations to deepen understanding of climate change concepts, data collection protocols, and impact assessment of plantation activities. There was also recognition of the value of online courses and periodic webinars to support ongoing skill development.

Furthermore, it is worth noting that the stakeholders expressed a willingness to integrate the methodology into existing urban forestry and plantation initiatives, perceiving it as a mechanism to strengthen monitoring, reporting, and evidence-based decision-making. Illustrative examples from organisations already undertaking impact-tracking practices demonstrated the potential for broader adoption and institutionalisation of the methodology across diverse projects. These observations highlight the readiness of organisations to adopt systematic approaches for assessing climate co-benefits, contingent upon targeted capacity-building and training support.

3.4

## Learnings from the stakeholder engagement

The consultations underscored the need for strengthened inter-agency coordination to ensure coherence in data collection, monitoring, and reporting processes. They also highlighted the importance of maintaining contextual flexibility to accommodate regional ecological and institutional variations during implementation. Furthermore, the establishment of standardised reporting templates and clearly defined institutional mandates was identified as essential for ensuring consistency, comparability, and accountability in assessing and documenting climate co-benefits across urban forestry initiatives.

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# Proposed roadmap

# 4.

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# Theory of Change (ToC)

A Theory of Change (ToC) articulates the causal pathway through which an intervention is expected to achieve its objectives. It links what is put in place to what is done, what is produced, how behaviour or systems change, and the longer-term effects, while making explicit the assumptions and risks that must hold for the pathway to work. ToC starts from the problem statement and evolves further into these elements:

- **Inputs** – resources and enablers secured at the outset (e.g., policies, partnerships, tools, roles, budget codes).
- **Activities** – actions undertaken using those inputs (e.g., deployment, training, piloting, dissemination).
- **Outputs** – immediate, tangible products of the activities (e.g., operational tools, signed MoUs, issued guidance, published rosters).
- **Outcomes** – short- to medium-term changes in behaviour, practice, or system performance (e.g., routine, on-time reporting; improved data quality; method referenced in guidance).
- **Impact** – the durable, higher-level results attributable to the intervention (e.g., consistent, auditable estimates that inform planning, budgeting, and public reporting).

The particular ToC for UF is described in more detail below and presented with a diagram.

## Problem Statement

Urban forestry (UF) schemes in Tamil Nadu—such as NVY and state missions—generate real mitigation and adaptation co-benefits, but these programmes were not designed around climate accounting. As a result, co-benefits are not measured consistently or comparably across owners and years, limiting their use in planning, budgeting, and national aggregation. Implementers face data and capacity gaps (e.g., missing baselines, uneven collection frequency, limited QA/QC), and most programmes have no dedicated MRV resources, which nudges practice toward ad-hoc or purely narrative reporting. At the same time, there is demand for a simple, standard method and tool that can work with light inputs (including defaults) and scale across diverse UF typologies (NVY blocks, avenues, campuses/CSR). The roadmap, therefore, addresses a clear "missing middle": a robust yet practical methodology, versioned calculator, and operating model (roles, SOPs, helpdesk, training) that enable routine, auditable estimates of mitigation and adaptation CCoBs and their integration into sectoral policies.

## Theory of Change for mainstreaming UF methodology

### Inputs

The approach is anchored by MoEFCC and the state government designated departments for state climate action plans as the beneficiary and custodian of the methodology and the web-based tool/calculator (with an Excel equivalent). The methodology already defines parameters for mitigation and adaptation.

Around these technical assets sit the enabling conditions:

- Recognition of the method via Tamil Nadu state nodal climate department (Tamil Nadu Green Climate Company/Green Tamil Nadu Mission) circular and hosting of the tool;
- Programme owners across sectors (e.g., NVY, highways/roads, utilities/CSR, campuses/industrial estates) willing to participate;
- Light legal/data-sharing instruments (MoUs/letters) that authorise minimum-dataset sharing and routine submission;
- A one-page SOP template that names roles, timing and quality checks;
- A helpdesk contact and a compact knowledge base;
- Training assets—a MOOC for everyone and a small Train-the-Trainer (TtT) kit to seed local trainers; and
- Existing M&E/Admin heads in programmes to host the small, recurring effort needed for light MRV (defaults), without seeking new funds.

## Activities

Based on the challenges and barriers for adopting the proposed climate co-benefit methodology, identified through stakeholder consultations conducted within this project, the following activities are proposed to facilitate its successful integration and should serve as a guiding framework. These interventions will require financial and infrastructure resources, as well as political will and coordination among various stakeholders. Some interventions can be implemented in the short term, while others may require a medium- to long-term commitment. Please note that the list of proposed activities is not exhaustive and can be further refined based on the local context.

- **Tamil Nadu Green Climate Company, the state nodal climate department, issues a circular (recognition and hosting).** TNGCC issues a formal circular recognising the methodology and identifying the Government-hosted calculator as the reference platform for reporting mitigation and adaptation co-benefits. The circular announces the reporting window, provides the tool URL, and references the methodology document, relevant MOOC, and support channels, establishing a common standard and predictable cadence.
- **The state executes MoUs/letters for data sharing.** The state and programme owners/data providers execute MoUs or letters that authorise the sharing of the minimum dataset, define its purpose and permitted use, specify roles and contacts, and set its validity/renewal—enabling routine annual submissions.
- **State nodal department activates the help desk.** A state-level helpdesk (internal or contracted), that can provide relevant information on the submissions, tool, MOOC, etc, is being established and set up by the state nodal department.
- **Programme owners nominate Programme Administrators.** Each participating programme nominates a Programme Administrator responsible for preparing files, conducting internal checks,

submitting them within the reporting window, and retaining receipts. The state nodal department provides accounts, provides a brief onboarding note, and publishes a roster to ensure accountability.

- **State (TN Green Climate Company) operates and maintains the tool/ methodology/MOOC.** State accepts the main role in operating, maintaining and promoting the methodology and the accompanying tool, as well as related MOOC.

- **The state nodal department and partners conduct operational piloting (readiness checks.)** Operational piloting serves as a readiness check and aids in acceptance and scaling up the methodology for wider implementation across states. It entails short, end-to-end pilots in representative contexts (e.g., NVY blocks, roadside avenues, campuses/CSR) conducted by MoEFCC in collaboration with their partners. Lessons learned feed into SOPs.

- **Programme owners establish standard operating procedures (SOPs).**Developing a Standard Operating Procedure (SOP) that outlines roles and responsibilities, quality control measures, and coordination protocols with all relevant bodies for measuring, monitoring, and reporting data according to the proposed methodology is a crucial activity. The latter will ensure consistent implementation, quality checks, and effective reporting.

- There are some existing manuals or protocols developed by FSI/ICFRE comprising guidelines and instructions for data collection/ monitoring post plantation period including suggestive frequency, sampling guidelines for sample size and stratification, data collection methods. Implementing agency/ department can refer to existing data collection guidelines for collecting tree growth parameters for mitigation calculation. Sample Resource: Measurement of Forest Carbon Stocks for Capacity Building of State Forest Departments[2]

- **Embed MOOC in onboarding.** The existing MOOC is included in onboarding for Programme Administrators and relevant staff. A short assessment/certificate is provided to evidence completion.

- **States and UF programmes run Train-the-Trainer (TtT) and clinics.** States/UF programmes nominate 1–2 trainers to complete a focused Train-the-Trainer (TtT) session. Certified trainers provide brief hands-on clinics and advice, resolving routine issues locally and reducing helpdesk load. The latter also ensures long-term sustainability of the methodology/tool/MOOC.

- **Programme owners leverage policy/programme synergies for resourcing.** The methodology is flexible, considering various data availability levels, and enables its use with minimal data input, relying on default factors in such cases. The minimum data input requires light MRV activities, and financial resources for the latter could potentially sit under existing programme budget provisions. The current budgets are hence reviewed to confirm the status of the available resources.

- **Programme owners identify new budget heads.**In case existing UF programmes' budgets do not entail financial resources for obtaining the minimum data input, or the decision is to apply a more reliable, field-based approach as per the methodology, Programme owners search for additional funding outside of the existing budgets.



[2] ICFRE (2020). Resource Manual: Measurement of Forest Carbon Stocks for Capacity Building of State Forest Departments. Indian Council of Forestry Research and Education, Dehradun (INDIA). https://moef.gov.in/uploads/2019/06/05-Forest-Carbon-Stocks-Measurement-RESOURCE-MANUAL-in-English.pdf

## Outputs

The near-term products are concrete and ready to use. The circular has been published; MoUs/letters for data sharing have been signed, and the helpdesk has been activated. A Programme Admin roster is published per participating owner, with access enabled. The methodology and the accompanying tool are live and stable. Pilot briefs, per programme type, document readiness are fed into the final SOP. Developed MOOC is embedded in onboarding processes, and TtT is performed, resulting in 1-2 skilled trainers per programme to support future submissions with a trainer roster published. Financial resources are allocated and secured, either for the light MRV serving minimum data requirements as per the methodology or for the field-based methodological approach.

## Outcomes

With these outputs in place, programme owners submit on schedule during the submission window using a common, conservative method. Because the inputs are small (defaults-friendly) and support is available, first-pass validation improves, and routine issues are solved locally by trainers, reducing dependency on central support. The method and tool are referenced in sector/state guidance and SOP, with named roles and cadence becoming part of the way programmes operate. Over successive cycles, reporting becomes predictable and comparable across owners, and managers begin to use the numbers—however conservative—to shape siting/species choices, maintenance priorities, and disclosures. For adaptation, regular parameter tracking (kept to a minimum) is displayed alongside mitigation results, allowing portfolios to communicate both climate values simultaneously.

## Impact

Practice is institutionalised. Despite staff turnover, the combination of SOP, local trainers, and MOOC provides reliable, auditable, and comparable annual estimates of co-benefits from mitigation and adaptation. The state roll-up under state nodal agencies such as TNGCC becomes timely and defensible, improving public reporting and planning credibility and making it easier to align UF investments with climate-relevant goals and finance. Over time, the steady visibility of co-benefits supports more evidence-informed budgets and protects essential maintenance and survival—without turning every UF programme into a climate project.

The ToC also includes 13 accompanying indicators, as shown in the diagram. Associated assumptions and risks are further elaborated in the next subchapter.

*Figure 4: Theory of Change (ToC)*

**Problem Statement**

- UF programmes generate real co-benefits but don't measure them consistently, so results aren't comparable or usable for planning and national roll-up
- Teams have limited capacity and no dedicated MRV funds-a simple, standard method + web tool (with defaults) is needed for routine, auditable estimates

| Inputs | Activities | Outputs | Outcomes | Indicators | Impacts |
|---|---|---|---|---|---|
| Peer reviewed methodology with defined parameters and measurement approach. accompanied with a simple data dictionary all publicly available | MH-SCAC Issuing a cirzular as recognition of the methodology and hosting the accompanying tool | Circular published and circulated | Programmes share data | % programmes acknowledging the circular | Practice is institutionalised |
| Tool/calculator for estimating mitigation and adaptation CCoBs developed and hosted by the Government and GIZ India | Drafting Memorandum of Understading/Letters for Data fiharing between MOEFCE programme owners and data providers | MoUs/ Letters signed | Users receive timely, reliable support, leading to valid submissions with fewer basic errors and higher first-pass data quality | No. of MoUs/ Letters signed | Stable support that keeps MRV consistent and scalable across programmes |
| Digitized, self-paced Massive Open Online Courses (MOOCs) developed with accompanying certificates of completion | Procure and onboard helpdesk provider | Helpdesk contract in place | Clear accountability for reporting | % of vald submissions | Sustained reporting across programmes |
| MOOCs hosted by the Government and GIZ India | Programmes nominating one Programme Admin responsible for submission | Published roster of Programme Admins (per programme) with contacts | Programmes submit using a standard method | % programmes with a named, active Programme Admin | Consistent CCoBs estimations provided across programmes |
| Methodology includes default values' database enabling its overall usage with even minimum monitoring inputs | Operating, maintaining updating and promoting the web tool and the accompanying methodologies | Live and stable tool/ calculator and continuously updated methodologies | The methodologies and the tool/ calculator usage becomes routine in sector guidance | No. of Programmes using the methodology and the tool | Planning and public reporting for UF programmes strengthened |
| | Operational piloting of representative projects & different UF programme types for stress testing hands- off | Pilot briefs per programme prepared | Routine, high-quality submissions with training institutionalised | No. of submissions, per Programme and State | Sustained capability and credible, scalable mitigation and adaptation CCoBs reporting |
| | Developing Standard Operating Procedures (SOPs) with roles and responsibilities for monitoring and reporting as per methodology | Established SOPS | Both ministry and state-level trainer network is operationalized, providing targeted clinics and support | ≥1 pilot per programme type completed | Both centralized and decentralised capability is sustained |
| | Embedding the MOOCs in onboarding for Progrumme Administrators, field staff contractors etc | MOOCs embedded and operationalised | Implementing teams submit on time with higher first-pass quality, routine issues are resolved locally, and onboarding of new staff is faster and more consistent | % programmes with an approved SOP in force | MRV becomes routine and sustainable across UF portfolios, producing consistent and comparable time-series of mitigation/ artaptation CCoB estimates that credibly inform planning. budgeting, and public reporting |
| | MH-SCAC issuing the request to nominate 1-2 trainer candidates per State and within MUEFCC | Trainer nominees identified | Dedicated MRV resources are in place across participating programmes, enabling MRV delivery | No. of persons with completed MOOC | |
| | State runs Train the Trainers (TtT) sessions | Trainer roster published in all States and within MoEFCC | | % active submitters certified | |
| | Leveraging synergies with other policies and programmes to secure funding for MRV | Funding secured | | % of States with 21 certified trainer active | |
| | Assessing available and prospective budget heads for MRV financing in each participating programme | | | % of clinics held per year | |
| | | | | % of participating programmes that submit | |

4.2

# Assumptions

In implementing the proposed ToC, certain assumptions have been made to reflect the external conditions and internal factors that are expected to support the adoption and implementation of the ToC.

- It is assumed that the political will to support the initiative will remain strong throughout the implementation process. This political backing is critical for the continued uptake of the methodology across states and at the national level.

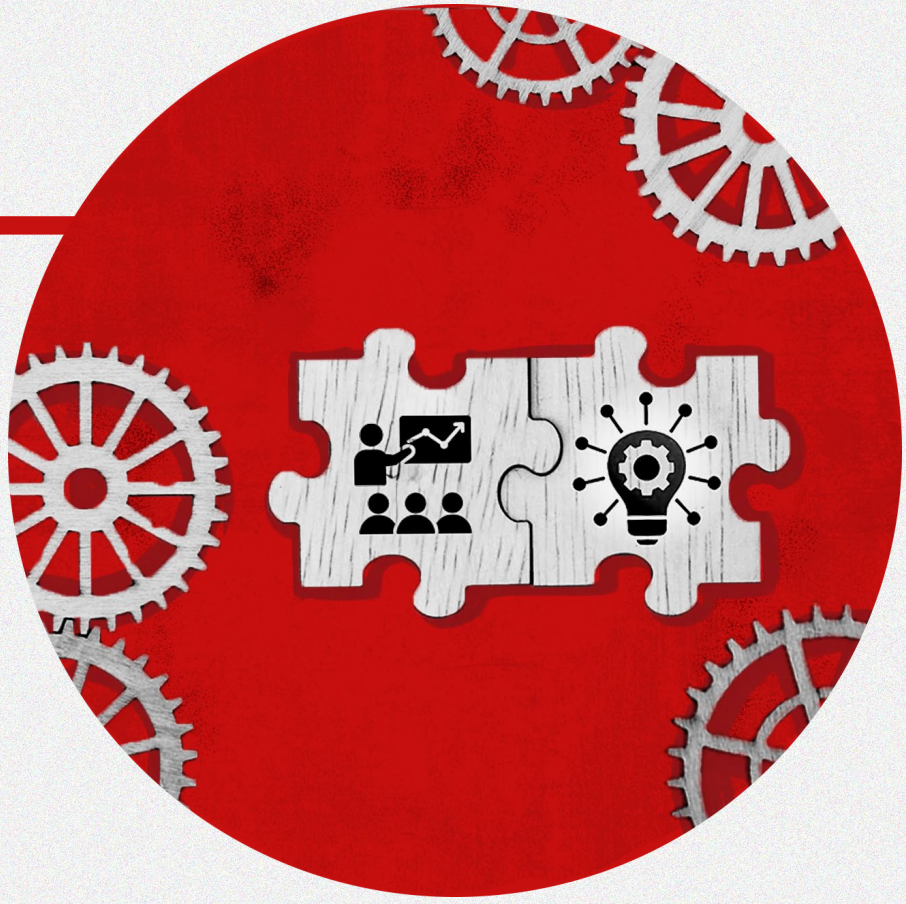
- Synergies between different entities (e.g. ULBs, state forest departments, ministries, private companies), both horizontal and vertical, will be crucial for securing necessary funds and fostering cross-governmental collaboration. This coordination will ensure that both financial and personnel resources are available for the effective implementation of the methodology.

- Continuous cooperation between the government, donors, public sector enterprises (PSEs) and the private sector will play an important role in ensuring the methodology's successful adoption. Public and private sector involvement will be particularly important in scaling the methodology, disseminating its results, and ensuring its widespread use.

Source: ©Shutterstock, Pranavan Shoots

# Stakeholder mapping and their roles

# 5.



Source: ©Freepik, fmuda4166

The effective integration and scaling of the CCoB methodology for UF and plantation initiatives requires coordinated action among a diverse range of stakeholders. Each group plays a distinct but complementary role in institutionalising the methodology, strengthening monitoring mechanisms, and ensuring the sustainability of outcomes.

**Table 2: List of potential stakeholders and their roles**

| Stakeholder | Role | Potential Organisations |
|---|---|---|
| Policy and Regulatory Institutions | • Institutionalise the methodology into national and subnational frameworks, such as the Nagar Van Yojana, AMRUT, Smart Cities Mission, etc.<br>• Develop enabling policies, allocate dedicated targets and budgets for monitoring, and issue guidelines mandating the use of standardised data protocols. | Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Housing and Urban Affairs (MoHUA), Tamil Nadu Environment Departments, municipal corporations, TNGCC, GTNM, Tamil Nadu Forest Department, etc. |
| Private Sector and CSR Entities | • Integrate methodology within their Environmental, Social, and Governance (ESG) frameworks.<br>• Leverage and promote remote sensing technologies, automate impact monitoring, and report performance through integrated CSR dashboards. | Corporate and Public Sector Enterprises (PSEs) engaged in plantation and sustainability programmes such as SAIL, NTPC, JSW Foundation, etc. |
| Community-Based Organisations (CBOs) and Civil Society | • Ensures long-term stewardship of plantation sites, supports data collection, and integrate behavioural change.<br>• CBOs can also facilitate participatory mapping exercises and awareness drives to encourage community-led greening efforts. | Local NGOs, residents' welfare associations (RWAs), youth groups, environmental collectives, etc. |
| Donors and Development Partners | • Strengthen institutional capacity by supporting pilot projects, facilitating peer-learning networks, and encouraging harmonisation of CCoB indicators across regions. | Multilateral and bilateral agencies such as the World Bank, GIZ, UNDP, and philanthropic foundations, etc. |
| Implementing Agencies | • Adopt the standard operating procedures (SOPs) for CCoB assessment, ensuring systematic data collection and facilitating cross-departmental coordination. | Urban Local Bodies (ULBs), Smart City Special Purpose Vehicles (SPVs), State Forest Departments, others such as Say Trees, Nizhal, etc. |

| Stakeholder | Role | Potential Organisations |
|---|---|---|
| Technical and Research Institutions | • Provide technical assistance to refine data/ parameters, pilot advanced monitoring tools, and validate results through independent assessments.<br>• Develop training curricula and certification programmes to enhance institutional capacity in monitoring climate co-benefits. | Indian Council of Forestry Research and Education (ICFRE), National Institute of Urban Affairs (NIUA), Indian Institute of Remote Sensing (IIRS), Anna University, Institute of Forest Genetics and Tree Breeding, Coimbatore; Forest Genetics Division, Coimbatore, Tamil Nadu Agricultural University (TNAU), etc. |

Source: Authors' compilation

5.1

# Interventions by stakeholders (Action Pathways)

For meaningful integration of the methodology, a phased approach is suggested for multiple stakeholders over short, medium and long-term time periods. Each phase aims to build the capacities of involved stakeholders, strengthen collaboration among departments and embed the methodology into practice.

Table 3: **Proposed actionable pathways for each stakeholder type**

| Stakeholder | Short-term (0–2 years) | Medium-term (2–5 years) | Long-term (5+ years) |
|---|---|---|---|
| Policy and Regulatory Bodies | • Issue policy advisories integrating CCoB parameters within urban forestry and climate action schemes.<br>• Initiate pilot projects in selected cities or states to demonstrate feasibility.<br>• Develop inter-departmental task forces to ensure coordination among the environment, urban development, and forest departments. | • Institutionalise standardised templates for data collection, reporting, and verification across states.<br>• Establish dedicated budget lines for climate co-benefit monitoring and allocate resources for capacity-building initiatives.<br>• Integrate CCoB assessment into city development plans and State Action Plans on Climate Change (SAPCCs). | • Embed the methodology within policies such as the State of Environment Reports, State Adaptation Frameworks, and State Action Plan on Climate Change .<br>• Mandate periodic impact assessments and third-party audits to ensure data integrity and transparency. |

| Stakeholder | Short-term (0–2 years) | Medium-term (2–5 years) | Long-term (5+ years) |
|---|---|---|---|
| Private Sector and CSR Entities | • Align ongoing plantation and ESG initiatives with the CCoB framework.<br>• Collaborate with government bodies to co-fund pilot sites demonstrating measurable co-benefits. | • Adopt standardised monitoring tools and report CCoB outcomes as part of ESG disclosures.<br>• Support technology-enabled monitoring through remote sensing or IoT solutions. | • Institutionalise partnerships with research and government institutions for large-scale deployment.<br>• Promote adoption of CCoB-aligned sustainability benchmarks across industrial sectors. |
| Community-Based Organisations (CBOs) and Civil Society | • Mobilise citizen volunteers for plantation drives and awareness campaigns.<br>• Use mobile-based applications for participatory data collection and feedback. | • Institutionalise citizen science networks in collaboration with local bodies.<br>• Partner with schools and educational institutions to embed climate education. | • Strengthen local ownership through community-led monitoring systems.<br>• Establish long-term partnerships with ULBs to maintain and sustain plantation sites. |
| Donors and Development Partners | • Provide seed funding and technical assistance to pilot the methodology in select geographic areas.<br>• Support baseline assessments and training programmes for implementing agencies. | • Facilitate the development of a national CCoB data and monitoring portal.<br>• Encourage regional learning exchanges and promote harmonised data standards. | • Embed CCoB frameworks in funding criteria for urban forestry and climate resilience projects.<br>• Support India's global leadership through partnerships in South–South cooperation networks. |
| Implementing Agencies | • Conduct baseline mapping of plantation sites and establish data repositories.<br>• Train field staff and project managers on CCoB methodology and standard operating procedures. | • Adopt digital platforms for centralised data entry, tracking, and analytics.<br>• Introduce monitoring committees comprising officials, NGOs, and citizens to oversee implementation. | • Institutionalise a dedicated Environmental Monitoring Cell within each implementing agency.<br>• Link monitoring outcomes with performance evaluation frameworks and annual work plans. |

| Stakeholder | Short-term (0–2 years) | Medium-term (2–5 years) | Long-term (5+ years) |
|---|---|---|---|
| Technical and Research Institutions | • Develop detailed training modules and conduct ToT (Training of Trainers) programmes.<br>• Pilot the use of GIS-based and remote sensing tools for data validation. | • Create a National repository of research on CCoBs in urban forestry to guide future projects.<br>• Provide ongoing technical support and independent evaluations to validate impact data. | • Design accredited certificate courses on climate co-benefit assessment and GIS-based monitoring.<br>• Facilitate global research collaborations and cross-country knowledge exchange platforms. |

Source: Authors' compilation

## 5.3

# Risks and mitigation strategies

| Potential Risks | Level of Risk | Mitigation strategies | Responsible Stakeholders |
|---|---|---|---|
| Organisations may be reluctant to embed the methodology into their existing reporting and monitoring frameworks despite training sessions. | Medium | A formal mandate/circular to be shared from the nodal department or ministry for the integration of methodology and ensuring institutional adoption. | Policy-makers; Nodal Implementing Agencies |
| Limited administrative capacities, differing local priorities, and expertise lead to limited adoption or poor data quality. | High | Integrate standardised protocols and formats with continuous technical handholding via local trainers and MOOC availability. | Policy-makers; State-level Nodal Agencies; Technical & Research Institutions |
| Limited coordination among various departments could lead to delays in implementation and effective reporting. | High | Formation of inter-agency working groups headed by the nodal department; conduct frequent meetings and alignment on objectives and timelines. | Policy-makers; State Departments; Implementing Agencies |
| Limited accountability leading to inconsistent tracking of progress across departments/ agencies. | Medium | Creating dedicated roles for monitoring, reporting, etc., within existing review systems. | Policy-makers; State Nodal Departments; Implementing Agencies. |

Source: Authors' compilation

# Conclusion and way forward

The methodology developed to assess the co-benefits of UF activities provides a framework for quantifying several benefits of UF initiatives, including carbon sequestration, cooling effects, and others in Tamil Nadu. To this end, stakeholder consultations were a crucial phase, providing insights into both existing challenges, such as limited capacities, inadequate monitoring mechanisms, and limited application of tools, as well as opportunities to scale the adoption of the methodology through dedicated training and embedding it into existing schemes.

To meaningfully integrate the methodology and bring this into action, the immediate next steps must focus on building the capacities of the organisations and relevant stakeholders through workshops and online courses. It is also crucial to develop standard monitoring mechanisms and data collection protocols, as well as to conduct a pilot study at multiple sites. While in the medium term, it is crucial to integrate the methodology into city and state-level planning and reporting. Additionally, strengthen the inter-departmental coordination. However, to operationalise the methodology and scale its application in the long term in the state, it is necessary to institutionalise it into organisational and government policies that cater to climate change, and to develop and leverage partnerships for its dissemination and nationwide adoption.

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# Annexure

## Annexure 1: List of data metrics to measure the parameters in the methodology

### Mitigation

| Parameter | Unit | Time period | Data Source | Frequency of monitoring |
|---|---|---|---|---|
| Clearing of vegetation prior to afforestation/reforestation | Yes/No | Number of years for which climate co-benefits in mitigation want to be estimated | field records | |
| If yes: Type of vegetation cleared (e.g. shrub) | Explanation | | field records | |
| If yes: Clearing method (e.g. controlled fire) | Explanation | | field records | |
| Pathway I | | | | |
| Area planted, per species | ha | | field measurements / remote sensing | annual |
| Diameter at breast height (DBH), 1.37m above ground level, per specie | cm | | field measurements | annual |
| Pathway II | | | | |
| **Minimum data inputs for Pathway II** | | | | |
| Area planted, per species | ha | | field measurements/ remote sensing | semi-annual |
| Date of planting | DD/MM/YY | | field records | |
| Area affected by disturbance (e.g. fire, pests) | ha | | field survey/ remote sensing | after natural disturbance |
| Additional data inputs for Pathway II | | | | |
| Wood harvest of roundwood | m3 | | field survey | after tree cutting |
| Volume of fuelwood harvest of whole trees | m3 | | field survey | after tree cutting |
| Volume of fuelwood harvest as tree parts | m3 | | field survey | after tree cutting |

| Parameter | Unit | Time period | Data Source | Frequency of monitoring |
|---|---|---|---|---|
| Additional data inputs for Pathway II - general parameters | | | | |
| Biomass conversion and expansion factor, for conversion of net annual increment volume to aboveground biomass (BCEFI) | Tonnes of aboveground biomass / m3 growing stock volume | Number of years for which climate co-benefits in mitigation want to be estimated | field survey or literature | |
| Biomass conversion and expansion factor, for conversion of wood and fuelwood removal volume to aboveground biomass (BCEFR) | Tonnes of aboveground biomass / m3 volume | | | |
| Ratio of below ground biomass to above ground biomass (Root to shoot ratio) | dimensionless | | | |
| Basic wood density, per species (or vegetation type/climatic zone) | t.d.m/m3 | | | |
| Carbon fraction of dry matter, per specie (or vegetation type/ climatic zone) | t C/ t.d.m | | | |
| CO2 removal from shrubland | tCO2/ha of shrubland | | | |

## Adaptation

| Parameter | Data needed | Unit | Time Period | Data sources |
|---|---|---|---|---|
| **1. Urban heat island reduction (cooling effect around the plantation site)** | Temperature data (via thermometer) at three different spots within the selected region (~10-15 m. apart) in a concrete area (such as a residential building or road) located at least 0.5-1 km away from the plantation site.<br><br>Three times a day (Morning: 8-9 AM; Afternoon: 1-2 PM; Evening: 5-6 PM) for three consecutive days in the months for three summer months (mid of May, June, July). | Degree Celsius (°C) | Annually, starting from the fourth year after the plantation | On-ground data to be collected manually |
| | Temperature data using thermometers placed inside the plantation region at three times of the day (Morning: 8-9 AM; Afternoon: 1-2 PM; Evening: 5-6 PM).<br><br>Three times a day (Morning: 8-9 AM; Afternoon: 1-2 PM; Evening: 5-6 PM) for three consecutive days in the months for three summer months (mid of May, June, July). | Degree Celsius (°C) | Annually, starting from the fourth year after the plantation | Data observations from the installed thermometer in the plantation site |
| For example, a tree that is 30 feet tall can provide a cooling effect over a distance of up to 120 feet. | | | | |
| Trees cool the land surface temperature of cities by up to 12°C | | | | |
| **2. Change in Groundwater Recharge** | Depth to groundwater level in the selected site during the pre-monsoon (usually by the end of May) and post-monsoon (usually at the start of October) season | Meter (m) | Collection of five years' historical water level fluctuation data before plantation and annual water level fluctuation data post-plantation | India Water Resources Information System (I-WRIS) data source (Data Download (Time Series Data - tab) for existing groundwater monitored well. |

| Parameter | Data needed | Unit | Time Period | Data sources |
|---|---|---|---|---|
| | Specific Yield (Y) of the principal aquifer of the selected plantation site from CGWB | NA | Once, while doing the calculations | Central Ground Water Board (CGWB) |
| | Catchment Area (A) | in m square | Once, during the initiation of the project | To be provided by the programme manager |
| **3. Flood and stormwater management** | Runoff Coefficient (C) of the selected land type | NA | Assess land cover at the time of evaluation and use the relevant runoff coefficient | US Curve Number Method |
| | Catchment Area (A) | in m square | Once, during the initiation of the project | To be provided by the programme manager |
| | Highest single daily rainfall (P24) | in mm | At the start of the project, for baseline and then annually, beginning five years after the plantation | Refer to the India Water Resources Information System (I-WRIS) data source (Data Download (Time Series Data) tab) for rainfall data. |
| **4. Change in Biodiversity of the region** | Number of different species observed in the site (Flora and Fauna) Species Diversity | Number | Conduct surveys during early morning or late afternoon on 10th, 20th, and 30th of every month, once during baseline and monthly after five years of plantation | Observational data (conduct plot-based measurement) |

Source: Authors' compilation

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

A-2/18, Safdarjung Enclave
New Delhi, 110029, India

T: +91 11 49495353
E: info@giz.de
W: www.giz.de/India