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

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Roadmap

for the implementation of the methodology to assess the climate co-benefits of the Single Use Plastics Ban in Maharashtra

Oxford Policy Management

perspectives climate change

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Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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Bonn and Eschborn

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As of
February 2026

New Delhi, India

GIZ is responsible for the content of this publication

On behalf of the
German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN)

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List of abbreviations

BHEL	Bharat Heavy Electricals Limited
CCoB	Climate co-benefit
CE	Circular Economy
CO_2	Carbon Dioxide
CPCB	Central Pollution Control Board
CSO	Civil Society Organisations
ESG	Environmental, Social, and Governance
GAIL	Gas Authority of India Limited
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
IOCL	Indian Oil Corporation Limited
MoEFCC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MPCB	Maharashtra Pollution Control Board
MRV	Monitoring, Reporting, and Verification
MSME	Micro, Small, and Medium Enterprises
NGO	Non-Governmental Organisation
NMC	Nagpur Municipal Corporation
NMMC	Navi Mumbai Municipal Corporation
PSE	Public Sector Enterprise
SCAC	State Climate Action Cell
SPCB	State Pollution Control Board
SOPs	Standard Operating Procedure
SUP	Single Use Plastic

TNA	Training Needs Assessment
ToC	Theory of Change
UDD	Urban Development Department, Maharashtra
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VMC	Vengurle Municipal Council

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 introduced a "Single-Use Plastic (SUP) ban" under the Plastic Waste Management (PWM) Rules, 2016 and its amendments (Ministry of Environment, Forest and Climate Change MoEFCC 2018, MoEFCC 2021) at the central level, and many states are at different stages of implementing it. The PWM regulation prohibits the manufacture, import, stocking, distribution, sale and use of plastic sheet (<50u) and plastic bag (<50u) from 27th March 2018 onwards (MoEFCC 2018). The subsequent amendment banned manufacture, import, stocking, distribution, sale and use of other SUP items including ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene (Thermocol) for decoration; plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 microns, stirrers from 1st July 2022 (MoEFCC 2021). The manufacture, import, stocking, distribution, sale and use of plastic carry bags (<75u) and plastic carry bags (<120u) are also prohibited from 30th September 2021 and 31st December 2022 respectively (MoEFCC 2021). Apart from the direct benefits of reducing plastic litter and lowering plastic production and consumption, the "SUP ban" has potential climate co-benefits. These include greenhouse gas mitigation co-benefits of switching from plastics to low-emission, non-plastic alternatives, and climate adaptation co-benefits such as prevention of water logging and flooding caused due to the choking of water bodies by plastics.

Climate co-benefits are benefits (mitigation or adaptation) that are generated from project/schemes/policies that do not have a primary focus on the climate impacts. Climate mitigation co-benefit is defined as a benefit for mitigation or adaptation that are generated from project/schemes/policies that do not have a primary focus on addressing climate change.

The project "Development of climate co-benefit methodologies of Indian circular economy and forest programmes" is implemented under the overall guidance of the MoEFCC in collaboration with GIZ India, through a multi-tier governance and coordination structure. The primary objective of the project is to establish methodologies to assess the climate change mitigation and adaptation co-benefits derived from Circular Economy (CE) and forestry policies of India. The project 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 Forest Departments and Urban Local Bodies (ULBs).

The state of Maharashtra has been a front runner in curbing plastic led pollution. Even before the national SUP ban, in 2018, the state had banned specific plastic products under the Maharashtra Plastic and Thermocol Products (Manufacture, Uses, Sale, Transport, Handling, and Storage) Notification, 2018. Further, Maharashtra Pollution Control Board (MPCB) launched the Plastic Bandi application to raise awareness of the plastic ban, alternate modes of plastic, penal provisions, citizen contribution, etc.

The Maharashtra government also set up a toll-free helpline for queries and informing regarding the plastic collection centres (NDTV, 2018). It has constituted a District-level Task Force under the chairmanship of the Municipal Commissioner in ten cities with a million-plus population to design strategies and monitor the effective implementation of the SUP ban (Environment and Climate Change Department, 2022). Building on its early successes, the state is uniquely positioned to quantify its efforts on implementation of the national SUP ban.

Under the context of the project, a methodology was developed to estimate the mitigation and climate adaptation co-benefits from the SUP ban that prohibits the manufacture, import, stocking, distribution, sale, and use of SUP items and promote switching to SUP substitutes that have a potentially lower environmental impact.

1.1
Objectives of the roadmap

The primary goal of the roadmap is to embed a robust, standardised methodology for assessing climate co-benefits) within CE programmes in India, thereby ensuring accountability, transparency, and scalability of interventions in this sector. It seeks to provide a structured framework through which national schemes, state missions, and sectoral policies can institutionalise the measurement and reporting of mitigation and adaptation co-benefits. The roadmap is relevant agencies like MoEFCC and Central Pollution Control Board (CPCB) at national level and agencies like the Maharashtra Pollution Control Board, Maharashtra State Climate Action Cell, among other state departments and urban local bodies at the state and local level, public or private sector enterprises, manufacturers and importers. Specifically, the roadmap will:

- Illustrate a theory of change and define actionable roles and responsibilities for government agencies, ULBs, and private actors in alignment with it.
- Establish short, medium, and long-term pathways for mainstreaming climate co-benefit assessment.
- Enable systematic capacity building and data-driven monitoring mechanisms.

Source: ©Freepik

Climate co-benefits assessment methodology:

A brief overview

2.

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The scope of the methodology is limited to specific SUP banned by the Indian government under PWM Rules amended till date (MoEFCC 2018 and MoEFCC 2021). The entire life cycle of SUPs and its alternatives (i.e., such as extraction, refining, processing of petroleum products for producing plastic raw material, production of SUPs, production of alternative raw materials, production of alternatives, transport and end-of-life emissions) is considered for estimating the climate co-benefits. The specific SUPs and the alternatives considered in the methodology are illustrated in Figure 1. These alternatives should be comparable to SUPs in terms of quality and intended function, and like SUPs, should be designed for single use. The methodology shall not be used for calculation of carbon credits under domestic or international markets.

Figure 1: SUPs and alternatives covered under the methodology

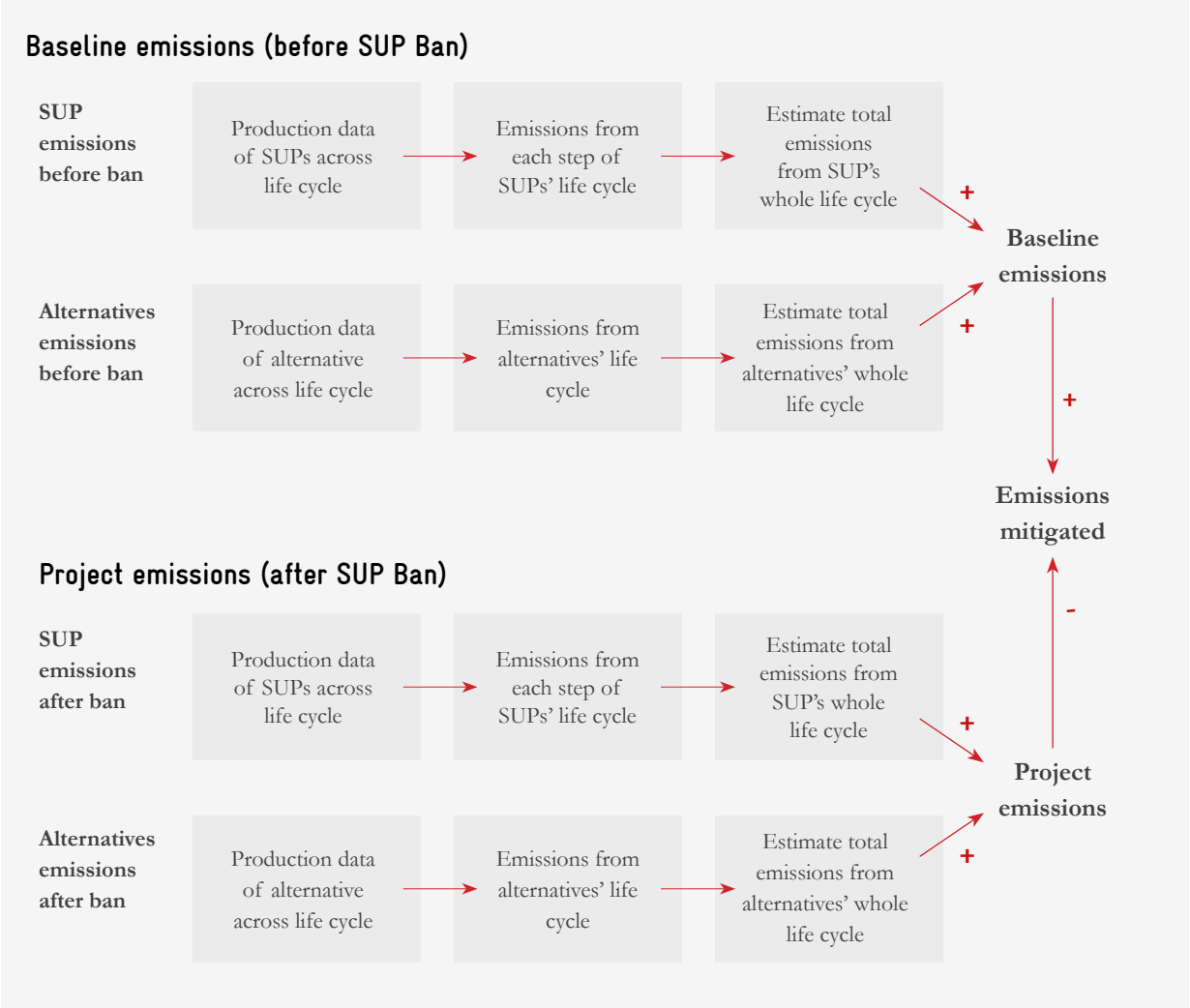
Source: Authors

2.1

Climate mitigation co-benefits assessment

The methodology defines a baseline scenario and then an alternative scenario. Afterwards, by using the production quantity for SUPs and alternatives and their corresponding emission factors, the mitigation co-benefits can be determined. The entire process is outlined below in Figure 2

Figure 2: Overview of the methodological approach



Source: Authors

For the effective estimation of mitigation co-benefits from the transition to alternatives following the SUP ban, it is essential that certain parameters are consistently monitored and reported. Monitoring is fundamental to applying the methodology in practice and requires sufficient resources, technical capacity, and financial support. The methodology has been designed to strike a balance between obtaining accurate estimates of mitigation benefits and ensuring that monitoring remains practical and feasible for stakeholders. In this context, two categories of parameters are defined: parameters to be monitored (refer Annexure A), which involve data directly reported by manufacturers, importers, and regulatory bodies; and default parameters, which are derived from established scientific databases.

To streamline monitoring, the methodology applies a materiality threshold of 5%, meaning emission sources that collectively account for less than 5% of total estimated emissions may be excluded from calculations without affecting overall accuracy.

The default factors are emission factors derived from secondary literature review, with priority first given to state specific literature, then national (Indian), regional (Asian), and finally international literature. Emission or default factors include the production of raw material, the manufacture of the product (SUP or alternative), and end-of-life for the identified SUPs and their alternatives. A tiered approach has been developed for

assessing production emissions of SUPs to account for varying data availability at the ground level. The approach comprises three tiers: if the total weight of banned SUPs is available, Tier 1 emission factors are applied; if data on the weights of different polymer materials used for SUP production are available, Tier 2 emission factors are used; and if weight data for each specific banned SUP are available, Tier 3 emission factors are applied. For more details, refer to the SUP co-benefit methodology.

The proposed methodology offers a flexible and robust framework for measuring climate co-benefits based on the data available on the ground. The accuracy of mitigation benefit estimations improves with the degree of data segregation and granularity. Conversely, when only limited datasets are available, the accuracy of the mitigation benefits calculated is reduced. The table below provides an overview of the various options available under this methodology. It also outlines the minimum parameters that need to be monitored and the corresponding approach to be followed for calculating climate co-benefits under each option.

Table 1: Overview of various options available within methodology

Options	Parameters available/ Parameters to be monitored[2]	Approach to calculate mitigation co-benefits
Option 1	Segregated weight of SUP and alternatives in project and baseline scenario	Use the available parameters along with default emission factors (apply Tier 3 for SUP) to calculate mitigation co-benefits.
Option 2	Segregated weight of polymer material (e.g., Low-Density Polyethylene (LDPE), Polystyrene (PS)) used to produce SUPs; and the segregated weight of alternatives in both project and baseline scenarios	Use the available parameters along with default emission factors (apply Tier 2 for SUPs) to calculate mitigation co-benefits.
Option 3	Total weight of SUPs and segregated weight of alternatives in both project and baseline scenarios	Use the available parameters along with default emission factors (apply Tier 1 for SUPs) to calculate mitigation co-benefits.
Option 4	Total Municipal Solid Waste (MSW) and percentage share of SUPs in MSW; segregated weight of alternatives in both project and baseline scenarios	Use the available parameters along with default emission factors to calculate mitigation co-benefits.
Option 5	Total MSW for baseline and project scenarios; percentage share of SUPs in the project scenario; and segregated weight of alternatives in both scenarios	Use the available parameters, take city-specific default factor for SUP share in MSW in baseline and default emission factors to calculate mitigation co-benefits.
Option 6	Segregated weight of alternatives in baseline[3] and project scenario	Assume that the difference of alternatives in the both scenarios is the corresponding SUPs replaced due to the ban. Based on the default factors for the unit weight of each SUP and its alternative and using the default emission factor (apply Tier 3 for SUPs), the mitigation benefits are estimated.

Source: Authors

[2] All values must be measured in tonnes/year

[3] If no data is available for alternatives in the baseline scenario, then the value can be assumed to be zero.

Based on the above analysis in Table 1 , it is clear that the prerequisite for applying the co-benefit methodology is that the weight of alternatives in both the baseline[3] and project scenarios must be monitored. Building upon this foundation, the accuracy of the methodology can be progressively enhanced by incorporating additional parameters such as the annual MSW, the percentage share of SUPs in the MSW, and the weight of total SUPs, polymer materials, and segregated SUPs, depending on the financial resources and monitoring budget available.

2.2

Climate adaptation co-benefits assessment

Banning SUP can lead to various types of adaptation and resilience benefits such as reduced impacts from flooding, higher resilience of agricultural production due to improved soil quality, reduced impacts from lack of precipitation due to contamination of clouds by microplastics, etc. However, estimating these benefits is complex as they span a wide range of physical, social, environmental, and economic aspects across variable timescales. One approach to estimating adaptation benefits is calculating the avoided losses, which is the difference between the avoided direct and indirect damage to various systems (human, infrastructure, and nature) (EEA, 2023). This approach can also be applied to quantify the adaptation and resilience benefits of the SUP ban.

The following three parameters are identified to assess adaptation co-benefits, reflecting the increased climate resilience of urban ecosystems resulting from the SUP ban. These parameters were selected based on their direct linkage to urban resilience, data availability, and relevance to both local and national climate objectives. The methodology will compare the baseline year data and against the succeeding project year to assess the climate co-benefits.

Parameter 1: Reduced blockage in storm drains

Plastic waste scattered in the environment blocks storm drains and increases the risk of flooding. The ban's reduction in the SUP will reduce this blockage, thereby increasing the climate resilience of urban infrastructure.

Parameter 2: Prevention of plastic from water bodies

SUP/plastic waste is disposed off in water bodies directly or indirectly. This contaminates the marine environment and its ecosystem and also enters the food chain and drinking water sources (Woods et. al). Reduction in the SUP due to the ban will prevent it from entering the water bodies.

Parameter 3: Contribution to climate resilience of vulnerable communities

The SUP ban would reduce the consumption of unnecessary and avoidable use of plastic. These can be substituted by sustainable alternatives, which would lead to employment in this sector. In this context, an assessment of employment will be undertaken along with the number of workers affected by the SUP ban to understand the sector's adaptability.

Each parameter is linked with measurable indicators, data requirements and suggested data sources in the Annexure B, forming the basis for periodic monitoring and aggregation at city, state, and national levels.

2.3

Existing regulatory monitoring requirements and gaps

This section outlines the existing monitoring requirements and processes stipulated by government bodies for various stakeholders. To integrate the methodology within the policy framework, it is essential to first assess the existing monitoring, reporting, and verification (MRV) requirements and processes mandated by the government for SUPs. By conducting a comprehensive assessment of the current local MRV requirements and processes, a roadmap can be developed to integrate the climate co-benefit MRV requirements within the existing structures and align it with the prevailing reporting processes.

Following monitoring requirements are stated for different stakeholders from SUP producers to recyclers in PWM regulation amended till date (MoEFCC 2018, and MoEFCC 2021).

- Archived data from the earlier registrations by plastic raw material manufacturers which included details of supply of raw materials to SUP producers (Form - III); and by SUP producers, brand owners, and importers' (Form I) on type and capacity of SUP manufactured can be used, if its available. This reporting is no longer valid owing to the SUP ban.

- Recyclers must apply for registration or renewal through Form II, reporting waste generation, collection, transportation, and disposal, along with characterization reports and sources of waste acquired, and submit an annual report (Form IV) by April 30 each year detailing technologies used, quantities of plastic waste received, processed, recycled, and sent to landfill.

- Urban local bodies (ULBs) must submit an annual report (Form V) to the Maharashtra Pollution Control Board (MPCB) by June 30, summarizing plastic waste generated, collected, recycled, reused, and disposed of within their jurisdiction.

- ULBs must also follow the CPCB's Standard Operating Procedure for Assessment & Characterization of Plastic Waste (CPCB SOP) for data collection (CPCB 2024).

- MPCB would compile this data and submit a consolidated report (Form VI) to the Central Pollution Control Board (CPCB) by July 31, including total plastic waste generated, quantities processed, and actions taken on non-compliance.

For a detailed list of data requirements under each Form (I, II, III, IV, V and VI), please refer to Annexure C.

A summary of all parameters currently being reported as per PWM regulation amended till date (MoEFCC 2018, and MoEFCC 2021), with respect to mitigation co-benefit methodology, is illustrated below in the Table 2.

Table 2: Summary of all reporting parameters

What parameter?	Who reports?	Reported to whom?	Which form is used?	Reporting frequency
Archived data from earlier registrations, if available: • on raw material supplied to SUP producers; and • type and capacity of SUP manufactured	Plastic producer Importer, producer, and brand owner	SPCB	Form III Form I	Once while seeking facility registration and while renewal of registration
Waste disposed type, and quantity, waste characterization certificate	Plastic waste recyclers and processors	SPCB	Form II	Once while seeking facility registration and while renewal of registration
Quantity of plastic waste received, Quantity of plastic waste used, Quantity of plastic waste processed, Quantity of plastic waste recycled, Quantity of inert or rejects sent for final disposal to landfill sites.	Plastic waste recyclers and processors	SPCB	Form IV	Annual before April 30th of each year
Quantity of plastic waste generated in ULB's jurisdiction, Quantity of plastic waste collected in ULB's jurisdiction, Quantity of plastic waste channelized for recycling, Quantity of plastic waste channelized for use[4], Quantity of inert or rejects sent to landfill sites.	ULB	SPCB	Form V	Annual before June 30th of each year
Quantity of plastic waste generated	SPCB	CPCB	Form VI	Annual before 31st July of each year

Source: Authors

Based on Table 1 and Table 2 it is evident that there are certain gaps within the existing monitoring framework established by the PWM regulation regarding the parameters to be monitored and the frequency of monitoring. As discussed earlier, the minimum parameter that must be monitored for applying the climate co-benefit methodology is the quantity of alternatives used in both the baseline and project scenarios. Building upon this foundation, the accuracy of the estimated benefits can be enhanced by incorporating additional parameters such as the percentage share of SUPs in the annual generation of municipal solid weight, and the weight of total SUPs, polymer materials, and segregated SUPs, depending on the financial resources and monitoring budget available.

To effectively utilise the climate co-benefit methodology, it is therefore recommended that at least the annual weight of alternatives be monitored as a prerequisite for estimating climate co-benefits, while the additional parameters mentioned above is recommended to be measured progressively to enhance the accuracy and reliability of the estimations depending on the available budget and data.

[4] Use means recycled plastic used as raw material, instead of virgin plastic, in the manufacturing process.

2.4

Approach to develop the methodology

The methodology to assess the climate co-benefits, namely, mitigation and adaptation, was developed through a multi-stage process focused on ease of implementation while allowing for scientific rigour where needed. A comprehensive review of international and Indian studies on SUP bans was undertaken to identify the parameters and the methods with which the climate co-benefits can be assessed. This was followed by relevant stakeholder consultations, including pollution control boards, climate change cells, urban local bodies, and alternative manufacturers and plastic recyclers in Maharashtra and Tamil Nadu to gather practical insights and refine the methodology. Further, four regional workshops were also conducted with Public Sector Enterprises (PSEs) in New Delhi, Kolkata, Bangalore and Goa to evaluate the parameters, the data availability to estimate them and for training needs assessment (the "TNA workshops"). The approach also prioritised interoperability with existing waste management and climate reporting systems to ensure consistency, comparability, and scalability across regions.

2.5

Need for methodology to assess climate co-benefits of SUP ban

The methodology aims to quantify the climate co-benefits from the SUP ban. As a result, the methodology should be leveraged for targeted capacity building, equipping personnel with the technical expertise on how and what data metrics should be collected. By standardising this, the methodology can provide high quality output that directly links the SUP ban or the plastic reduction to 'climate avoidance'. As this data collection process matures and achieves greater accuracy, the resulting outputs can be integrated into the Maharashtra State Action Plan on Climate Change (SAPCC), or any other state reporting framework.

Stakeholder engagements & implementation challenges

3.

Source: ©Freepik, user850788

Multiple consultations were conducted in Maharashtra with public and private stakeholders to discuss and refine the proposed methodology. These were followed by four regional workshops with Public Sector Enterprises (PSEs) to present the methodology, outline data requirements, explain estimation processes, and understand existing monitoring systems. A state level climate co-benefits assessment methodology validation workshop was organised as well. The consultations offered valuable insights to simplify parameter assessment and highlighted key challenges faced by different stakeholders in implementing the methodology.

3.1

Stakeholders consulted

The following stakeholders were consulted to understand the supply chain of the banned SUP items from manufacturing to disposal, the major issues caused by them, their contribution to overall plastic manufacturing and waste generation, and the specific data availability in relation to it.

State departments such as MPCB, State Climate Action Cell (SCAC), and Urban Development Department, Maharashtra (UDD)

- They were integral in validating the methodology, selecting urban local bodies to pilot it, and collecting data from them.

Urban local bodies

- Three cities including two pilot cities, Navi Mumbai Municipal Corporation (NMMC), Vengurle Municipal Council (VMC) and Nagpur Municipal Corporation (NMC) were consulted to understand the current data availability and obtain sample data focused on SUP and its alternatives.

Private sector

- Over 25 alternative manufacturers, recyclers and non-governmental organisations (NGOs) were consulted, including 6 in Maharashtra, to understand data availability with respect to SUP and their alternatives within the ecosystem and validate the methodology.

Public Sector Enterprises (PSEs)

- Four regional training needs assessment (TNA) workshops were conducted with over 30 PSEs, including Bharat Heavy Electricals Limited (BHEL), Indian Oil Corporation Limited (IOCL), and Gas Authority of India Limited (GAIL). The workshops were to assess the capacities of the PSEs for implementing the methodology within their organisation (the "TNA workshops"). This was to understand existing data monitoring mechanisms with respect to SUP and their alternatives, since it is banned effectively within the PSE townships and institutions.

3.2

Existing challenges in assessing CCoBs and integrating the methodology

The methodology's operationalisation will depend on addressing several systemic, institutional, and technical challenges. Based on the consultations mentioned in the earlier section, the following key barriers were identified to implement the methodology to assess climate co-benefits from the SUP ban:

- **Knowledge gaps:** There is a non-uniform understanding of the items banned under the SUP ban. Further, there is limited knowledge on climate co-benefits from the SUP ban and their impact, particularly with respect to adaptation parameters such as increased urban resilience due to the lesser flow of SUP into stormwater drains and water bodies.

- **Institutional and enforcement gaps:** There is an absence of formal mandate to collect data on SUP and its alternatives, through its supply chain and disposal. Additionally, implementation of the SUP ban for a few items remains a challenge at different levels.

- **Data challenges:** Data is currently available only for plastic manufacturing and consumption at a sub-national level, and its disposal in solid waste generation locally. This data is not available for SUP-banned items. Additionally, aggregated data is not available for the production and disposal of alternatives locally. In this context, baseline data on SUP and alternatives, including quantum, categories, and energy used required for the methodology, are not available.

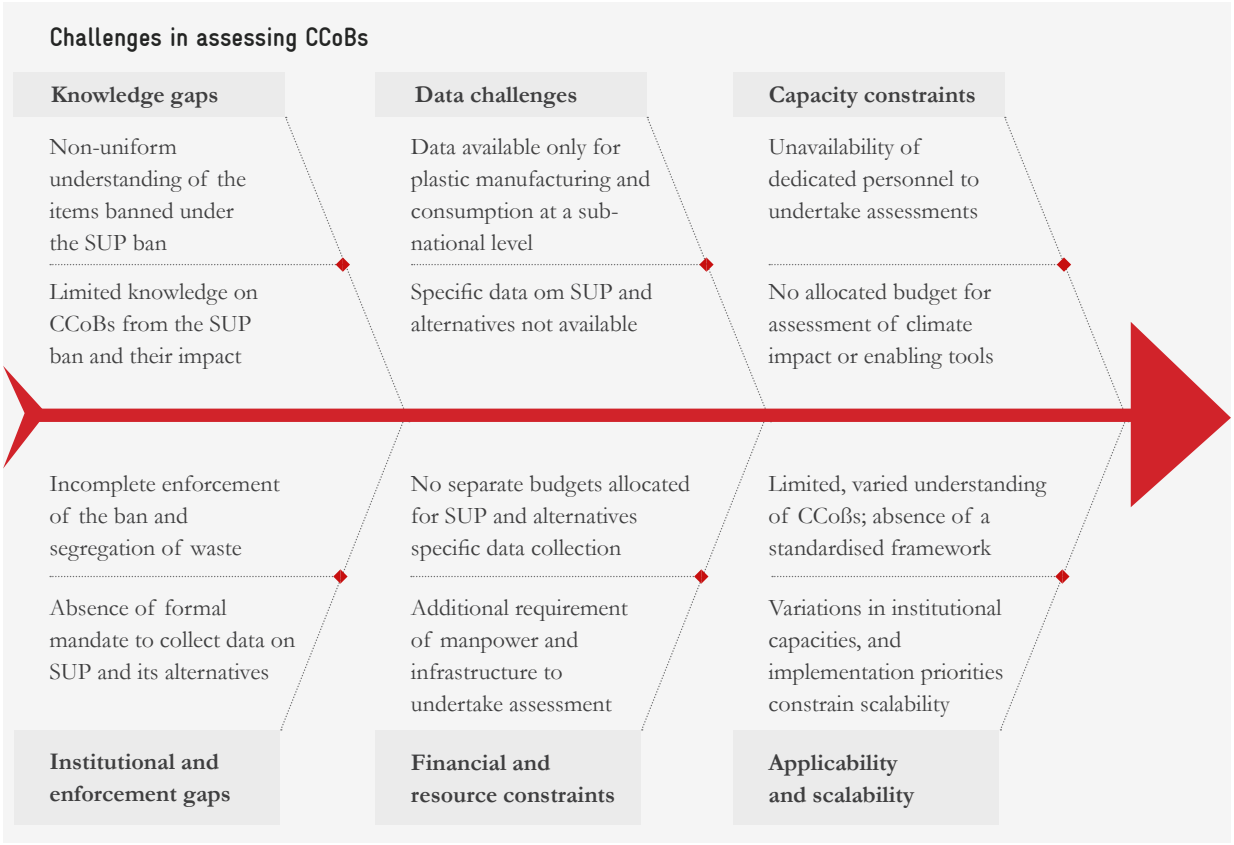
- **Financial and resource constraints:** The ULBs suggested that separate budgets would be required to facilitate separate SUP waste data collection from stormwater drains and water bodies through contractors, and infrastructure required, and for capacity building.

- **Capacity constraints:** The TNA workshops[5] suggested organisations often do not have dedicated staff to assess the climate co-benefits or budgets for monitoring and data analysis. Further, inadequate training and insufficient tools hinder reliable monitoring.

- **Applicability and scalability:** Limited and varied understanding of climate co-benefits across institutions, combined with the absence of a standardised framework, particularly for assessing adaptation, restricts consistent application of the methodology. Variations in local data systems, institutional capacities, and implementation priorities across states further constrain scalability.

[5] Four regional training needs assessment (TNA) workshops were conducted with over 30 PSEs. The workshops were to assess the capacities of the PSEs for implementing the methodology within their organisation.

Figure 3: Fish bone diagram representing the existing challenges in assessing the CCOB



Source: Author's compilation

3.3

Opportunities for implementation and scaling

Despite existing challenges, the MPCB, UDD and SCAC along with NMMC and VMC expressed a strong interest in adopting the methodology within their operations. Findings from the TNA workshops and consultations with NMMC and VMC indicate that standardising data collection frameworks, ensuring adequate resource allocation, building staff capacity, enhancing technical skills, and establishing clear implementation procedures can enable CCoB assessment for the SUP ban at scale.

The stakeholders were willing to integrate the CCoB methodology into their existing initiatives on SUP ban and waste management, and increasing the use of alternatives to banned items, recognising its potential to improve monitoring and reporting. They also underscored the importance of institutionalising the methodology, periodic data collection and assessment. Further, in order to address the gaps in the capacities of personnel, training sessions for staff in sustainability and administrative departments focusing on methodologies for assessment are recommended. These should be in different formats, including in-person workshops, online sessions, and mentorship programmes, among others, at different frequencies depending on the requirements for continuous learning.

Additionally, linking the methodology with ongoing national digital initiatives, such as Swachh Bharat Mission dashboards and ESG disclosures of enterprises, could provide ready platforms for integration and visibility.

Proposed roadmap

4.

Source: ©Freepik

This section of the report outlines the roadmap for integrating the proposed climate co-benefit methodology into Maharashtra's state initiatives and India's existing policy and institutional framework. Based on the assessments carried out in the earlier sections; evaluation of the current MRV framework, findings from stakeholder consultations, a Theory of Change (ToC) was developed with the goal for incorporating the methodology into existing framework.

A TOC is a comprehensive framework for planning, participation, and evaluation, which defines the logical steps needed to achieve a long-term goal (integrating methodology in this case). It involves analysing the problem statement, identifying the key barriers to change, and outlining the specific activities that need to be implemented. These activities are mapped to create a causal chain of outputs and outcomes that lead to the ultimate impact—integrating the co-benefits methodology into existing policy and decision-making processes. Based on this TOC, actionable recommendations will be provided for stakeholders at various levels—short-term, medium-term, and long-term.

Additionally, the section will also highlight the assumptions underlying the TOC, acknowledging the potential risks, uncertainties involved and propose strategies for mitigating these risks, ensuring that the integration process is both robust and adaptable to changing circumstances.

4.1
Theory of Change

As outlined earlier, the TOC provides a comprehensive framework for addressing the identified problems. TOC begins by clearly defining the problem statement and the barriers that hinder progress. The ToC will then outline the proposed interventions, followed by a mapping of the anticipated outputs, outcomes, and eventual impacts of these interventions. Additionally, the ToC will include the key performance indicators necessary for monitoring and evaluating the success of the roadmap.

4.2
Problem statement

India has launched policies aimed at promoting a circular economy, such as the single-use plastic ban. However, there is a lack of a structured framework for reporting climate co-benefits (mitigation and adaptation) achieved through such policies, resulting in missed opportunities to fully capture and report these benefits. Through the current project, a methodology has been developed to estimate the mitigation and adaptation co-benefits arising from the single-use plastic ban that needs to be integrated into the existing policy and institutional framework, complementing current MRV arrangements and roles to enable consistent reporting of climate co-benefits. Integrating it in this way would strengthen alignment across programmes and improve the usability of results for planning and disclosure. Without such integration, the potential for achieving broader, more sustainable development outcomes is being overlooked. Additionally, barriers such as a lack of coordination among stakeholders, policy gaps, data gaps, and infrastructural limitations, as well as limited understanding of proposed methodology, hinder progress.

Therefore, there is a critical need for an approach or roadmap that embeds such a methodology, complementing and aligning with the existing frameworks and infrastructure. This approach should identify existing barriers to the adoption of the methodology, align it with existing frameworks, and leverage synergies from current stakeholders and resources to incorporate the proposed climate co-benefit methodology, thereby enabling effective reporting of the climate co-benefits from single-use plastic ban policy.

4.3

Barriers identified

Several critical barriers were identified in Section 3.2 at different levels during stakeholder consultations. For developing the TOC, the identified barriers are grouped as follow:

Institutional and policy barriers: oblem Statement

- Complete enforcement of waste segregation into wet and dry waste, as well as between SUPs and their alternatives is required, which is essential for measuring the climate co-benefits.
- While the CPCB SOP has set out the process of monitoring SUP and their alternatives during usage and end of life, the ULBs must periodically track and report it, else it can lead to gaps in data and reporting.
- Lack of financial resources, and manpower, to undertake regular monitoring and reporting of the data required as per the methodology.
- Additional space and tools for measuring the SUPs and alternatives particularly at waste disposal sites.

Capacity barriers

- Lack of understanding of climate co-benefits, particularly related emission mitigation and adaptation benefits from SUP ban amongst producers, importers, staff and officials.
- Lack of regular training and upskilling on impact assessment to enhance the skills of personnel in data collection, monitoring, reporting and the interpretation of climate co-benefits

4.4

Proposed interventions (activities)

Based on the identified barriers for adopting the proposed climate co-benefit methodology, the following interventions are proposed to facilitate its successful integration. These interventions will require financial and infrastructure resources, political will, and coordination among producers, state and central governments, urban local bodies, and staff at waste disposal sites. Some interventions can be implemented in the short term, while others may require a medium or longer-term commitment, which will be outlined in a later section of the report. Please note that the list of proposed interventions is not exhaustive and can

be further refined based on the local context and policy framework. These interventions are based on the general challenges and barriers identified through stakeholder consultations conducted within this project and should serve as a guiding framework.

Secure official endorsement

- Obtain formal endorsement or recognition from national and state level (in the form of official notifications or orders) for the proposed methodology. This recognition is crucial for ensuring the legitimacy and smooth integration of the methodology.

Directions to producers, importers, waste collection and disposal centres

- Based on the official notification, direct producers' importers, waste collection and disposal centres provide data points annually as required by the methodology to relevant government agencies. This will help in building a robust database for monitoring and reporting climate co-benefits.

Financial and resource allocation

- Investigate any opportunity to secure a dedicated budget for monitoring and reporting as per the climate co-benefits methodology within the existing SUP ban framework. Additionally, leverage synergies with complementary policies and programs such as the Swachh Bharat Mission and CE initiatives. These collaborations can help secure the necessary budget to strengthen infrastructure and ensure adequate manpower for effective monitoring, while also supporting capacity-building and training programs for staff.

- Consider also leveraging public-private partnerships to support the scaling of required infrastructure and training programs. Secure financial support to address infrastructure gap, for segregating, sampling, measuring and reporting SUPs and alternatives.

Regular training and capacity building

- Conduct regular training programs for importers, producers (both SUP and alternatives), Public Sector Enterprises, townships, officials, including those at the MPCB, CPCB, ULBs, particularly in the solid waste management and storm water drain departments, and staff involved in waste disposal and management. These programs should focus on the importance of measuring climate co-benefits, data monitoring and reporting and on using the proposed methodology.

- Upskill officials and waste management staff to ensure proper segregation of waste, with a focus on SUPs and alternatives. Provide training on the appropriate methodology for measuring and sampling waste as per the CPCB SOP.

Establish SOPs

- Develop a Standard Operating Procedure (SOP) with roles and responsibilities, quality control measures, and coordination protocols with ULBs, MPCB, and other relevant bodies for measuring, monitoring and reporting data as per the proposed methodology. The latter will ensure consistent implementation, quality checks, and effective reporting.

4.5

Narrative for TOC

This section will provide a narrative on how the roadmap will work in practice and include a visual description of the TOC. Based on the barriers discussed earlier, a pathway will be outlined to explain how the proposed interventions (activities)—through their outputs and outcomes—will overcome these barriers and ultimately achieve the objective of demonstrating the broader climate benefits resulting from India's single-use plastic ban. Additionally, the key indicators to be measured for evaluating the progress of the roadmap's implementation will also be highlighted.

TOC for overcoming capacity barriers

Figure 4 illustrates the TOC for overcoming the capacity barriers. The TOC starts with the identification of awareness barriers related to methodology. These include, low awareness about climate co-benefits; need for capacity building in monitoring; reporting aspects and using climate co-benefit methodology; and robust compliance with the requirement under the SUP Compliance Monitoring Module to monitor and report SUP use. To overcome these barriers, the inputs required are financial resources, manpower, and skill development. The proposed interventions are designed to feed these desired inputs so as to circumvent the barriers discussed.

Three interventions are proposed to overcome the awareness barriers. The first intervention focuses on addressing financial and resource allocation. A financial budget is required to design and conduct training programs aimed at building the capacity of personnel in waste segregation, sampling as per CPCB guidelines, and measuring, monitoring the parameters for climate co-benefit methodology. These training programs will help ensure that the expected co-benefits are properly reported. In addition to the budget, resources in terms of manpower and infrastructure are also required (discussed in subsequent TOC) to carry out monitoring, reporting, and verification according to the climate co-benefits methodology. This budget can be leveraged from state, central governments or ULBs by aligning with other policies, such as the Swachh Bharat Mission or circular economy initiatives, or by seeking funding from international donors. Further scaling of both the budget and manpower can be achieved through potential partnerships with public or private agencies (such as universities, think tanks, and public sector enterprises) in the form of Public-Private Partnerships (PPP).

The second intervention involves developing training programs, Training of Trainers (ToT), workshops, or MOOCs on waste segregation and waste sampling, in line with CPCB SOP. Additionally, capacity building should focus on measuring and monitoring the necessary parameters as per the climate co-benefits methodology. Finally, personnel should be trained on using the climate co-benefits methodology and tool/calculator for measuring and reporting these co-benefits, utilizing the MOOC already developed within this project.

The third intervention involves the development of Standard Operating Procedures (SOPs) with clear roles and responsibilities for stakeholders, including importers, producers of alternatives and SUPs, personnel at waste collection, waste disposal, recycling centres, ULBs, MPCB, and CPCB officials. These SOPs will outline the process for data reporting, specifying what data needs to be monitored, data collection

templates, who monitors the data, who reports the data, whom to report to, and frequency of monitoring and reporting. Additionally, quality assurance (QA) and quality control (QC) guidelines will be established for CPCB and MPCB officials to ensure the accuracy of the data reported. This process could be complemented by third-party checks to verify that the data reporting is indeed correct.

The immediate outputs expected from these interventions include securing the necessary budget and manpower to conduct proper monitoring and implement training programs. The long-term outcomes would involve a trained cadre of officials, from grassroots to ministry levels, skilled in waste segregation, measuring, sampling, monitoring, and reporting, and capable of using the climate co-benefits methodology. Additionally, the SOPs would be established. Building on these outcomes, the ultimate impact is that the methodology to be formally adopted and used by the Government of Maharashtra in its existing framework for reporting climate co-benefits resulting from the single-use plastic ban policy.

To effectively monitor that the envisioned TOC is implemented in practice, it is important to evaluate the progress through key performance indicators. The indicators for monitoring the progress of these proposed interventions include; overall budget and manpower allocated, the number of training workshops conducted, the number of personnel trained in various aspects of waste segregation, monitoring, reporting and using co-benefit methodology, and the number of ULBs, departments and organisations, that adopted the SOPs.

Figure 4: TOC for overcoming capacity barriers

Capacity barriers	Inputs required	Proposed interventions	Outputs	Outcomes	Impact	Indicators
Low awareness about climate co-benefits Limited understanding of methodology Lack of training programs for upskilling personnel in measuring, monitroing and reporting Lack of monitoring and reporting systems to track SUPs and alternatives	Financial resources Manpower Skill development	**Financial and resource allocation** • Leverage synergies with other policies to secure funding and manpower. • Leverage public private partnerships for scaling of training programs **Capacity building** Upskill personnel through MOOCs or training workshops on: • Waste segregation. • Measuring, sampling and monitoring SUPs and alternatives • Using climate co-benefit methodology **Develop SOPs** With roles and responsibilities for monitoring and reporting as per methodology	Funding secured for designing training module and manpower	Trained cadre of personnel SOPs established	Integration of methodology into CPCB/ MOEFCC reporting	Number of training workshops conducted Number of personnel trained in waste segregation, monitoring and using climate co-benefit methodology through physical workshops. Number of personnel completed training MOOC Number of ULBs, cities, townships, states, adopted the SOPS Overall budget and manpower allocated for implementing the monitoring framework

Source: Authors

TOC for overcoming institutional and policy barriers

Figure 5 illustrates how institutional and policy barriers related to the adoption of climate co-benefits methodology are addressed. The TOC begins by identifying the key institutional and policy barriers. These include, lack of recognition of climate co-benefits methodology and their importance in robust monitoring and reporting of SUPs as required under the SUP Compliance Monitoring Module and their alternatives (from production to end-of-life); limited enforcement of waste segregation, and monitoring; and finally, limited infrastructure for undertaking monitoring and reporting at waste processing facilities in line with the co-benefits methodology. To overcome these barriers, the required inputs include government recognition of the climate co-benefits methodology and mandate to measure and monitor SUPs and alternatives. The proposed interventions are designed to address these barriers by ensuring the necessary inputs are in place.

Three key interventions are proposed to address institutional and policy barriers. The first focuses on obtaining official recognition of the climate co-benefit methodology to ensure wider acceptance and mandate data collection on SUPs and their alternatives across their lifecycle. As highlighted earlier, the minimum parameter to be monitored is the quantity of alternatives in both baseline and project scenarios. The methodology's flexibility allows reporting of mitigation benefits based on available data and budget, with accuracy improving as more parameters—such as annual MSW generation, SUP share in MSW, and weights of total and segregated SUPs—are included. The second intervention emphasizes allocating budget to strengthen the infrastructure (space and equipment for waste segregation, sampling, etc) needed for effective monitoring and reporting. In addition to this, the budget will be required for manpower for conducting monitoring, and capacity building the personnel in monitoring and reporting (already highlighted in previous TOC). The third intervention involves piloting the methodology in cities. The results of these piloting exercises can then be analysed, disseminated, and promoted to encourage broader adoption across the state.

The immediate outputs expected from these interventions include the methodology being endorsed at national and state level, and the methodology operationally piloted in cities. The long-term outcome would involve the allocation of budget for the required infrastructure needed for the monitoring and reporting framework (budget for capacity building covered in previous TOC). The main outcome would include a larger uptake among cities, and other states. Building on the latter, the ultimate impact would be the formal adoption and usage of the methodology by the Government of Maharashtra as part of their existing framework for reporting climate co-benefits resulting from the single-use plastic ban policy.

To ensure effective monitoring and implementation of the envisioned TOC, it is important to evaluate progress through KPIs. The indicators for monitoring the progress of these proposed interventions include the overall budget allocated for strengthening infrastructure, and the number of cities and states that have endorsed the climate co-benefits methodology.

Figure 5: TOC for overcoming institutional and policy barrier

Institutional and policy barriers	Inputs required	Proposed interventions	Outputs	Outcomes	Impact	Indicators
Lack of government regulation mandating measuring of SUPs and alternatives	Government mandate/ recognition of methodology	Secure endorsement of methodology	Methodology endorsed at national and state level	Waste processing facilities equipped with necessary infrastructure	Integration of methodology into CPCB/ MoEFCC reporting	Number of states endorsed the methodology
Limited enforcement of waste segregation, limited monitoring and reporting of data	Budget	Obtain endorsement of methodology at national and state level	Budget allocated for strengthening infrastructure at waste processing facilities	Methodology piloted in selected townships		Number of townships that operationally exercised the methodology
Limited infrastructure for monitoring and reporting at waste processing facilities	Infrastructure	Financial allocation				Overall budget allocated for strengthening infrastructure
		Leverage synergies with other policies to secure funding for strengthening infrastructure				
		Select townships for piloting				
		Establish partnerships with selected townships for piloting the methodology				

Source: Authors

Assumptions

In the implementation of 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 cities, states and national level.
- Regular characterisation and value chain mapping of SUPs and alternatives would be undertaken by the ULBs, MPCB, SCAC, UDD, and other state agencies. Third party expert agencies may also be involved to ensure its robustness.
- Continuous cooperation between government, donors, PSEs and private sector will play an essential role in ensuring the methodology's successful adoption.
- It is anticipated that, over time, government initiatives such as the Lifestyle for the Environment (LiFE) initiative, the Swachh Bharat Mission, and other climate change awareness campaigns will enhance consumer understanding of sustainability, motivating them to adopt more environmentally friendly lifestyle choices. This increased awareness is expected to drive a conscious shift towards alternatives, thereby facilitating the broader adoption of this methodology for estimating the co-benefits of the SUP ban.

Risks and mitigation strategies

At the same time, there are certain risks that could hinder the successful integration of methodology into the existing monitoring framework. Identifying and addressing these risks is essential for the successful execution of the initiative. The table below outlines the key assumptions, risks, the corresponding mitigation strategies and responsible stakeholders. The following risks have been identified in Table 3, along with their corresponding mitigation strategies to ensure the methodology's effective implementation:

Table 3: Overview of potential risks and corresponding mitigation strategies

Potential Risks	Level of Risk	Mitigation strategies	Responsible Stakeholders
Low enforcement of the SUP ban As observed during stakeholder consultations, for a few items SUP ban is not completely enforced.	Medium	Promote stronger coordination between government agencies, local authorities (ULBs), NGOs, and communities to increase awareness of banned SUPs and ensure stronger compliance.	ULBs, MPCB, CPCB, MoEFCC
Low enforcement of waste segregation Complete enforcement of waste segregation in wet and dry waste is required. For effective implementation of the climate co-benefit methodology, it is essential that alternatives are at least segregated and measured in both the baseline and project scenarios. Where budgets allow, higher accuracy in estimating mitigation benefits can be achieved by monitoring annual MSW generation and the percentage share of SUPs in MSW. Additionally, personnel on ground may not be fully aware of alternatives and banned SUPs, making identification difficult.	Medium	To address this, sufficient budget, manpower, and equipment for waste segregation, sampling, and weighing must be provided. In addition to strengthening the enforcement of waste segregation, efforts should also focus on raising awareness about the banned SUPs, and benefits of the using the methodology to ensure its effective implementation.	Training institutes, CPCB, MoEFCC, MPCB, ULBs (particularly the Solid Waste and Storm Water Drain Departments), Personnel at waste collection, processing facilities
Lack of accurate data Due to the above reasons there is limited availability of accurate data	High	Enforce waste segregation and SUP ban regionally. Implementing the methodology using the standardised sampling strategies.	Implementing agencies such as ULBs (particularly the Solid Waste and Storm Water Drain Departments), contractors, and Smart City Mission SPVs

Potential Risks	Level of Risk	Mitigation strategies	Responsible Stakeholders
Lack of recognition for the methodology by state and national government and PSEs Official recognition of the methodology at national level and by government of Maharashtra.	High	Engaging stakeholders at both the national and regional levels will be essential to promote the methodology's benefits and demonstrate its necessity for effective implementation.	MoEFCC, CPCB, MPCB
Limited capacity building and coordination between agencies Limited technical capacity among staff and lack of coordination between relevant departments could affect the proper implementation and interpretation of the methodology.	High	Integrate standardised curricula and formats with technical handholding via trainers and MOOC, ensuring it goes beyond box-ticking, with periodic evaluations of its effectiveness. Further, designate an agency responsible for spearheading the assessment with support from other departments.	Implementing agencies such as ULBs, MPCB Technical institutes and universities
Lack of a dedicated budget for monitoring and reporting from government funds: Securing a dedicated budget for the monitoring and reporting framework aligned with the methodology is critical to its successful implementation.	Medium	Efforts should be to investigate existing funding sources within SUP ban and other CE schemes, alongside exploring potential funding from international donors and public-private partnerships for piloting methodology in townships.	MoEFCC, Ministry of Finance, CPCB, international donors

Source: Authors' compilation

By proactively addressing these risks and implementing appropriate mitigation strategies, the adoption and effectiveness of the methodology can be significantly enhanced.

Stakeholder mapping and their roles

5.

Source: ©Freepik, user850788

An ecosystem approach is necessary to implement the CCoB methodology effectively and at scale. Stakeholders from public and private sectors, along with community and research-based organisations have diverse roles to play for long-term assessment and sustainable impact of the methodology.

Table 4: Role of different stakeholders in implementing the methodology

Stakeholder	Role	Potential Organisations
Central and state agencies (policymakers)	• Institutionalise the methodology into national and subnational reporting frameworks under the Plastic Waste Management Rules, 2016, Swachh Bharat Mission, Smart Cities Mission, among others. • Integrate the methodology with central and state policies. Provide dedicated budgets for data collection, training personnel and assessment with standard operating procedures (SOPs).	Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Housing and Urban Affairs (MoHUA), Central Pollution Control Board, Environment and Climate Change Department, UDD, SCAC, MPCB, etc.
Implementing government bodies	• Enforce the SUP ban and encourage the use of alternatives • Collect periodic data as required under the methodology, following the SOPs. • Facilitate and support the training of the personnel and staff engaged in implementing the methodology. • Maintain records on a regular basis for long-term assessment of climate impact.	ULBs, particularly the Solid Waste and Storm Water Drain Departments, Smart City SPV, MPCB, SCAC, UDD and Industries Department, etc.
Private organisations	• Facilitate and support the training of the personnel and staff engaged in implementing the methodology. • Create reporting mechanisms to showcase the CCoBs, and integrate the methodology with sustainability and Environmental, Social, and Governance (ESG) frameworks.	Corporate and Public Sector Enterprises (PSEs) engaged in manufacturing alternatives and taking initiatives such as SUP ban and use of alternatives.
Civil Society Organisations (CSOs) or NGOs	• Integrate the methodology in their initiatives to clean water bodies, map waste flows into the water bodies, and clean stormwater drains. • Encourage behavioural change in citizens for the effective implementation of the SUP ban and more use of reusables and alternatives.	Regional water bodies-cleaning foundations such as Bharat Clean Rivers Foundation, and Afroz Shah Foundation, plastic waste management organisations such as. SWaCH Pune
Technical and research institutions	• Develop training modules and certification programmes on climate co-benefits and its methodologies, including proper monitoring, analysis and reporting, to enhance institutional capacity. • Technically support in implementing the methodology and validating results through independent assessments.	National Institute of Urban Affairs (NIUA), institutes on climate change, universities, etc.

Stakeholder	Role	Potential Organisations
Donors and development partners	• Technically and financially support pilot projects, encouraging uniform CCoB indicators across regions. • Facilitating training and learning networks.	Multilateral and bilateral agencies such as the World Bank, GIZ, UNDP, and philanthropic foundations etc.

Source: Authors' compilation

5.1

Interventions by stakeholders (Action Pathways)

Table 5: **Proposed interventions by different stakeholders in short, medium and long term**

Stakeholder	Short-term (0–2 years)	Medium-term (2–5 years)	Long-term (5+ years)
Central and state agencies (policymakers)	• Introduce the methodology in a phase wise manner and pilot them to assess feasibility and gain learnings. • Issue advisory under the national frameworks to initiate the collection of baseline data.	• Pilot the methodology across more sites or cities and apply lessons learned to improve effectiveness. • Develop training modules and sector-specific guidelines on monitoring, data frequency, and assessment requirements. • Allocate budgets, organise capacity-building efforts, for implementing the methodology.	• Integrate the methodology within national policies such as the Swachh Bharat Mission, and National Adaptation Frameworks • Mandate periodic impact assessments and reporting. • Periodic third-party audits to ensure data authenticity.
Implementing government bodies	• Engage with relevant departments to begin baseline data collection using existing records and datasets. • Direct local contractors to initiate on-ground baseline data gathering. • Initiate training for field staff and project managers on the CCoB methodology and SOPs to ensure uniform and effective implementation.	• Standardise data collection by introducing templates and formalising SOPs for consistent quality and process adherence. • Create a periodic training plan and secure alliances with relevant institutional partners for the training and hand-holding.	• Integrate monitoring outcomes directly with the performance evaluation frameworks and key milestones defined within annual contracts. • Maximise the digitisation of data collection processes to the extent feasible, and prioritise solutions that automate assessment and reporting functions.

Stakeholder	Short-term (0–2 years)	Medium-term (2–5 years)	Long-term (5+ years)
Private organisations, CSOs or NGOs.	• Identify organisational interventions that are relevant to the methodology, such as effective SUP bans and more use of alternatives. • Introduce the methodology to the identified personnel for baseline data collection. • Select and depute staff for training and hands-on familiarisation with the implementation of the methodology.	• Link the assessments with sustainability and ESG reporting. • Adopt standardised monitoring tools for relevant departments. • Create a periodic training plan with in-house modules or secure alliances with relevant institutions.	• Institutionalise partnerships with research and government institutions for large-scale deployment. • Promote adoption of CCoB-aligned sustainability benchmarks across industrial sectors.
Technical and research institutions	• Develop comprehensive training modules and offer them in different formats. • Customise these for different stakeholders to build effective institutional capacity. • Conduct Training of Trainers (ToT) programmes to build institutional capacity.	• Establish a central repository of research on CCoBs from SUP bans to inform and guide future initiatives. • Introduce tools and technology to include automation. • Provide technical assistance and independent evaluations to validate impact data.	• Foster global research partnerships and facilitate cross-country knowledge exchange platforms.
Donors and development partners	• Offer funding to pilot the methodology and train the staff with capacity-building initiatives. • Assist implementing agencies with technical expertise.	• Assist policymakers with foresight on replicating climate impact assessment. • Enable the creation of a national portal for CCoB data collection and monitoring. • Enable regional knowledge exchanges on climate impact and co-benefits assessments.	• Provide a platform at international forums to present success stories, which can facilitate more investments into climate efforts in India. • Strengthen India's global leadership through partnerships within cooperation networks. • Integrate CCoB frameworks into funding criteria for plastic/SUP bans and climate resilience projects.

Source: Authors' compilation

Conclusion and way forward

The successful implementation of the climate co-benefits assessment methodology will depend on a shared commitment from all stakeholders to institutionalise a consistent and transparent process in Maharashtra. The roadmap outlines a clear approach supported by actionable steps, identifies key challenges, and defines roles to ensure accountability and coordination. The methodology can evolve from a pilot exercise into a robust state and national framework by addressing the highlighted risks through targeted capacity building, data harmonisation, and continuous evaluation. Embedding CCoB assessments into decision-making will not only strengthen evidence-based climate action and Maharashtra's reporting on climate but also enhance India's leadership in integrating environmental and developmental goals. In the long term, scaling this framework across sectors beyond plastics—such as waste management, circular economy, and sustainable production—can establish a unified approach to assessing climate co-benefits across India's environmental programmes.

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Annex A List of annexures

The below equations from the climate co-benefit methodology should be used to estimate the mitigation co-benefits from SUP ban.

$$ER_Z = \Delta Q_{SUP,z} * (EF_{SUP,raw} + EF_{SUP,item} + EF_{SUP,dis}) + \Delta Q_{AI,z} * (EF_{AI,raw} + EF_{AI,item} + EF_{AI,dis})$$

$$\Delta Q_{SUP,z} = Q_{SUP,BL} - Q_{SUP,PJ}$$

$$\Delta Q_{AI,Z} = Q_{AI,BL} - Q_{AI,PJ}$$

Where:

ER_Z refers to emission reduction for one SUP and its corresponding identified (single/multiple) alternative(s) during the selected year, z. A positive emission reduction value indicates that mitigation has been achieved, while a negative value indicates that GHG emissions have increased due to the SUP ban.

$EF_{SUP,raw}$ is the emission factor covering the petroleum extraction, refining, polymerisation and processing into plastic pellets (HDPE, LDPE, PVC, etc.), which is subsequently serving as feedstock for producing the particular SUP, in tCO_2e/tonne of the SUP.

$EF_{SUP,item}$ is the emission factor for producing the particular SUP from the pellets, in tCO_2e/tonne of the SUP.

$EF_{SUP,dis}$ represents the emission factor for the end-of-life treatment (such as landfill, incineration or other treatment) that accounts for the largest share of the final disposal of the particular SUP item, in tCO_2e/tonne of the SUP.

EF_{AIraw} is the emission factor covering production of the alternative raw material (including upstream emissions) which is subsequently used for producing the particular alternative, in tCO_2e/tonne of the alternative.

$EF_{AI,item}$ is the emission factor for producing the particular alternative from the raw material, in tCO_2e/tonne of the alternative.

$EF_{AI,dis}$ represents the emission factor for the end-of-life treatment (such as landfill, incineration or other treatment) that accounts for the largest share of the final disposal of the particular alternative, in tCO_2e/tonne of the alternative.

$\Delta Q_{SUP,z}$ refers to the difference in weight (in tonnes) of the identified SUP between project and baseline scenario.

$\Delta Q_{Al,z}$ refers to the difference in weight (in tonnes) of the corresponding alternative between project and baseline scenario.

The parameters to be monitored as per climate co-benefit methodology are listed below:

Table 6: Parameters to be monitored

Data/ Parameter	Unit	Description	Frequency of monitoring
$Q_{SUP,y-5}$ $Q_{SUP,y-4}$ $Q_{SUP,y-3}$ $Q_{SUP,y-2}$ $Q_{SUP,y-1}$	Weight (in tonnes)	Weight of identified SUP produced before the SUP ban	Once, at the start of the project
$Q_{,Al,y-5}$ $Q_{,Al,y-4}$ $Q_{,Al,y-3}$ $Q_{,Al,y-2}$ $Q_{,Al,y-1}$	Weight (in tonnes)	Weight of corresponding alternative produced before the SUP ban	Once, at the start of the project
$Q_{SUP,z}$	Weight (in tonnes)	Weight of the identified SUP in the year "z".	Annual
$Q_{Al,z}$	Weight (in tonnes)	Weight of the corresponding alternative in the year "z".	Annual

Where,

y refers to the year in which the "SUP ban" was first implemented.

z is the accounting year

Annexure B

Data requirements to assess adaptation co-benefits

Parameter	Data needed	Unit	Time Period	Data sources
Reduced blockage in storm drains (Chen et al 2021)	Total quantity of waste removed from stormwater drains. The waste collected annually (for any number of cleanings undertaken in a year) from cleaning the stormwater drains will be weighed and recorded. It is important to note that only the dry weight of the waste is recorded.	kg	Annually	Urban local bodies conducting the stormwater drain cleaning
	Sampling quantity of SUP of the waste removed from the stormwater drain. • During cleaning of drains, a sample of at least 10% of the total dry weight is taken of the waste collected from stormwater drains. • Segregate the plastic carry bags and plastic cutlery and measure the weight of this SUP.	kg	Annually (for every cleaning undertaken in a year)	Urban local bodies conducting the stormwater drain cleaning
Prevention of plastic from water bodies	Weighing and recording the quantity of waste removed from each cleaning drive for each type of water body separately. Dry the total waste collected in each drive for each water body and record the readings in kg.	kg	Annually (for each drive)	CSOs, NGOs, ULBs conducting cleaning drives
	Proportion of SUP from the sample waste from each cleaning drive for each type of water body. Take a sample of minimum 10% of the waste by weight in each cleaning drive from every water body. Segregate the plastic carry bags and plastic cutlery, measure the weight	kg	Annually (for each drive)	CSOs, NGOs, ULBs conducting cleaning drives
Employment creation in SUP alternatives industry, thus contributing to climate resilience of vulnerable communities	Number of jobs created from manufacturing the alternatives to banned SUP items (plastic carry bags and cutlery)	Number	Annual	MSME department or pollution control board
	Number of jobs otherwise generated from manufacturing banned SUP items (plastic carry bags and cutlery) of the same quantum	Number	Annual	Older data from MSME or Industries or Labour departments

Annexure C

Figure 6: Data to be submitted by producer, brand owner and importers for seeking registration (Form-I)

FORM - I

[See rules 13 (2)]

APPLICATION FOR REGISTRATION FOR PRODUCERS or BRAND OWNERS

From: .....

.....

..... (Name and full address of the occupier)

To

The Member Secretary,

.....Pollution Control Board or Pollution Control Committee

....

Sir,

I /We hereby apply for registration under rule 9 of the Plastic Waste Management Rules, 2016, as amended 2018.

I-PRODUCERS

S. No	PART – A (GENERAL)	
1	a. Name and location of the unit	
	b. Address and Contact number	
	c. Registration required for manufacturing of:	
	(i) Carry bags; (a) petro- based, (b) Compostable (ii) Multi-layered plastics	
	d. Manufacturing capacity	
	e. In case of renewal, previous registration number and date of registration	
2	Is the unit registered with the District Industries Centre of the State Government or Union territory? If yes, attach a copy.	
3(a)	Total capital invested on the project	
(b)	Year of commencement of production	
4(a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
5	Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and water.	
6	Status of compliance with these rules- Thickness – fifty microns (Yes/No)	
PART – B (PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS)		
7	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974? If yes, attach a copy.	
8	Does the unit have a valid consent under the Air (Prevention and control of Pollution) Act, 1981? If yes, attach a copy.	
PART – C (PERTAINING TO WASTE)		
9	Solid Wastes or rejects: a) Total quantum of waste generated b) Mode of storage within the plant c) Provision made for disposal of wastes	
10	Attach or Provide list of person supplying plastic to be used as raw material to manufacture carry bags or plastic sheet of like or multi-layered packaging	
11	Attach or provide list of personnel or Brand Owners to whom the products will be supplied	
12	Action plan on collecting back the plastic wastes	
Date: Place:		Name and Signature Designation

II - BRAND OWNERS

S. No	PART – A (GENERAL)	
1	Name, Address and Contact number	
2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union territory? If yes, attach a copy	
4(a)	Total capital invested on the project.	
(b)	Year of commencement of production	
5(a)	List and quantum of products by-products	
(b)	List and quantum of raw materials used	
	PART – B (PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS)	
6	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974? If yes, attach a copy.	
7	Does the unit have a valid consent under the Air (Prevention and control of Pollution) Act, 1981? If yes, attach a copy.	
	PART – C (PERTAINING TO WASTE)	
8	Solid Wastes or rejects: a) Total quantum of waste generated b) Mode of storage within the plant c) Provision made for disposal of wastes	
9	Attach or Provide list of person supplying plastic material	
10	Action plan on collecting back the plastic wastes	

Date:
Place:

Name and Signature
Designation

PART – A **GENERAL**		
1.	Name, Address and Contact number	
2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union Territory? If yes, attach a copy.	
4.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
5. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
6 (a)	Quantity of plastic sheet or like used for packaging of imported or to be imported products	
(b)	Quantity of plastic sheet or like used for packaging for further supply or self-use	
(c)	Quantity of multilayered packaging for further supply or self-use	
PART – B **PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS**		
7.	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
8.	Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
PART – C **PERTAINING TO WASTE**		
9.	Solid Wastes or rejects: (a)Total quantum of waste generated (b)Mode of storage within the plant (c) Provision made for disposal of wastes	
10. (a)	Attach or provide list of person supplying imported (i) plastic sheet or like used for packaging, (ii) multilayered packaging	
(b)	Quantity of imported (i) plastic sheet or like used for packaging along with the quantity used for further supply or self use, (ii) multilayered packaging along with the quantity used for further supply or self use	
11.	Action Plan in line with Guidelines specified in Schedule - II	
		Name and Signature Designation
Date : Place :".		

Source: MoEFCC 2018 and MoEFCC 2021

Figure 7: Data to be submitted by plastic waste recycling or processing units (Form -II)

FORM – II

[SEE RULE 13 (3)]

Application Form for Registration of Units Engaged in Processing or Recycling of Plastic Waste

1	Name and Address of the unit				
2	Contact person with designation, Tel./Fax /email				
3	Date of commencement				
4	No. of workers (including contract labour)				
5	Consent Validity	a. Water (Prevention & Control of Pollution) Act, 1974; Valid up to _____ b. Air (Prevention & Control of Pollution) Act, 1981; Valid up to _____ c. Authorization; valid up to ….			
6	Manufacturing Process	Please attach a flow diagram of the manufacturing process flow diagram for each product.			
7	Products and installed capacity of production (MTA)	Products		Installed capacity	
8	Waste Management:	S. No.	Type	Category	Qty.
	a. Waste generation in processing plastic-waste	i			
		ii			
	b. Waste Collection and transportation (attach details)				
	c. Waste Disposal details	S. No.	Type	Category	Qty.
		i			
	d. Provide details of the disposal facility, whether the facility is authorized by SPCB or PCC				
	e. Please attach analysis report of characterization of waste generated (including leachate test if applicable)				
9	Details of plastic waste proposed to be acquired through sale, auction, contract or import, as the case may be, for use as raw material	i. Name ii. Quantity required /year			
10	Occupational safety and health aspects	Please provide details of facilities			
11	Pollution Control Measures				
	Whether the unit has adequate pollution control systems or equipment to meet the standards of emission or effluents.	If Yes, please furnish details			
	Whether unit is in compliance with conditions laid down in the said rules.	Yes/No			
	Whether conditions exist or are likely to exist of the material being handled or processed posing adverse immediate or delayed impacts on the environment.	Yes/No			
	Whether conditions exist (or are likely to exist) of the material being handled or processed by any means capable of yielding another material (e.g. leachate) which may possess eco-toxicity.	Yes/No			
12	Any other relevant information including fire or accident mitigative measures				
13	List of enclosures as per rule				
Date: Place:		Name and Signature Designation			

Source: MoEFCC 2018 and MoEFCC 2021

Figure 8: Data to be submitted by plastic raw material manufacturers for seeking registration (Form-III)

FORM - III

[SEE RULES 13(4)]

APPLICATION FOR REGISTRATION FOR MANUFACTURERS OF PLASTIC RAW MATERIALS

From: .....

……

…….(Name and full address of the occupier)

To

The Member Secretary,

.....……. Pollution Control Board or Pollution Control Committee

……

……

Sir,

I/We hereby apply for registration under the Plastic Waste Management Rules, 2011

PART – A GENERAL		
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the DIC or DCSSI of the State Government or Union Territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
(c)	List of producers and quantum of raw materials supplied to producers	
Date: Place:		Name and Signature Designation

Source: MoEFCC 2018 and MoEFCC 2021

Figure 9: Annual report submission template for plastic waste processing units (Form-IV)

Form - IV

[SEE RULES 17 (1)]

FORMAT OF ANNUAL REPORT BY OPERATOR OF PLASTIC WASTE PROCESSING OR

RECYCLING FACILITY TO THE LOCAL BODY

Period of Reporting:

(1)	Name and Address of operator of the facility	
(2)	Name of officer in-charge of the facility (Telephone/Fax/Mobile/ E-mail)	
(3)	Capacity:	
(4)	Technologies used for management of plastic waste:	
(5)	Quantity of plastic waste received during the year being reported upon along with the source	
(6)	Quantity of plastic waste processed (in tons): - Plastic waste recycled(in tons) - Plastic waste processed (in tons) - Used (in tons)	
(7)	Quantity of inert or rejects sent for final disposal to landfill sites:	
(8)	Details of land fill facility to which inert or rejects were sent for final disposal: - Address – Telephone	
(9)	Attach status of compliance to environmental conditions, if any specified during grant of Consent or registration	
Dated: Place:		Signature of Operator

Source: MoEFCC 2018 and 2021

Figure 10: Annual report submission template by urban local bodies (Form-V)

Form - V

[See rules 17(2)]

FORMAT FOR ANNUAL REPORT ON PLASTIC WASTE MANAGEMENT TO BE SUBMITTED BY THE LOCAL BODY

Period of Reporting:

(1)	Name of the City or Town and State:	
(2)	Population	
(3)	Area in sq. kilometres	
(4)	Name & Address of Local body Telephone No. Fax No. E-mail:	
(5)	Total Numbers of the wards in the area under jurisdiction	
(6)	Total Numbers of Households in the area under jurisdiction	
(7)	Number of households covered by door to door collection	
(8)	Total number of commercial establishments and Institutions in the area under jurisdiction -Commercial establishments - Institutions	
(9)	Number of commercial establishments and Institutions covered by door to door collection -Commercial establishments - Institutions	
(10)	Summary of the mechanisms put in place for management of plastic waste in the area under jurisdiction along with the details of agencies involved in door to door collection	
(11)	Attach details of infrastructure put in place for management of plastic waste generated in the area under jurisdiction	
(12)	Attach details of infrastructure required, if any along with justification	
(13)	Quantity of Plastic Waste generated during the year from area under jurisdiction (in tons)	
(14)	Quantity of Plastic Waste collected during the year from area under jurisdiction (in tons)	
(15)	Quantity of plastic waste channelized for recycling during the year (in tons)	
(16)	Quantity of plastic waste channelized for use during the year (in tons)	
(17)	Quantity of inert or rejects sent to landfill sites during the year (in tons)	
(18)	Details of each of facilities used for processing and disposal of plastic waste **Facility-I** i) Name of operator ii) Address with Telephone Number or Mobile iii) Capacity iv) Technology Used v) Registration Number vi) Validity of Registration (up to)	

	Facility-II i) Name of operator ii) Address with Telephone Number or Mobile iii) Capacity iv) Technology Used v) Registration Number Validity of Registration (up to)	
(19)	Give details of: Local body's own manpower deployed for collection including street sweeping, secondary storage, transportation, processing and disposal of waste.	
(20)	Give details of: Contractor or concessionaire's manpower deployed for collection including street sweeping, secondary storage, transportation, processing and disposal of waste.	
(21)	Mention briefly, the difficulties being experienced by the local body in complying with provisions of these rules including the financial constraints, if any	
(22)	Whether an Action Plan has been prepared for improving solid waste management practices in the city? If yes (attach copy) Date of revision:	

Date:

Place:

Signature of CEO/Municipal Commissioner or Executive Officer/Chief Officer

Source: MoEFCC 2018 and MoEFCC 2021

Figure 11: Annual report template submission by Pollution Control Board

FORM-VI

STATE-WISE STATUS OF IMPLEMENTATION OF PLASTIC WASTE MANAGEMENT RULES, 2016, AS AMENDED 2018, FOR THE YEAR… ANNUAL REPORT FORMAT

Name of the SPCB/ PCC	Estimated Plastic Waste generation. Tons per annum (TPA)	Implementation of thickness of less than 50 microns carry bags (virgin/ recycled). (Rule 4c)	Details of Plastic Waste Management (PWM) e.g. Collection, Segregation, Disposal (Co-Processing, Road construction, etc.) Rules (5 & 6). **(Attach Action Plan)**	Partial/complete ban on usage of Plastic carry bags (through Executive Order) Attach copy of notification or Executive Order	No. of registered Manufacturing/Recycling Units (Rule 13)			No. of unregistered Manufacturing or Recycling Units (in residential or unapproved areas). (Rule 13)	Status of Marking, Labelling on carry bags (Rule 11) Specify No. of units not complied	No. of violations & action taken on non-compliance of provisions of PWM Rules, 2016, as amended, 2018 (Rule 12)	Explicitly pricing of carry bags from producers, brand owners and importers (Rule 15)	Status of submission of Annual Report by ULBs to SPCB/PCCs (Rule 16)	Submission of Annual Report to CPCB (Rule 17)
					Plastic Units	Compostable Plastic Units	Multilayer Plastic Units						
1	2	3	4	5	6			7	8	9	10	11	12

Source: MoEFCC 2018 and MoEFCC 2021

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