



# THE CLIMATE COMPASS

## THE CELESTIAL EARTH DIGEST



**The Celestial Earth Annual Digest, Issue 4, March 2026.**



# 2026



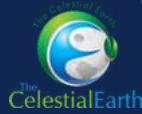
## OUR MISSION

To support global public and private sector initiatives in aligning development trajectories with green economic pathways, fostering a clean, sustainable, and inclusive approach to growth that benefits both present and future generations.



## OUR VISION

To create a sustainable, green environment worldwide by ensuring equitable access to resources while bridging knowledge and development gaps between nations using efficient, cost-effective tools to support global sustainable growth.



## THE CELESTIAL EARTH



**The Climate Compass:** Annual Digest of The Celestial Earth (TCE)  
March 2026, Issue 4

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## Highlights of The Company

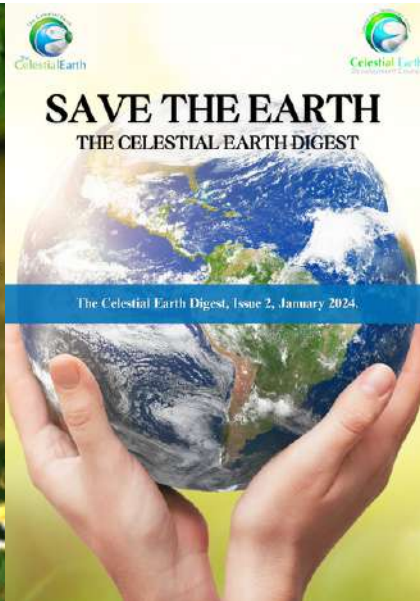


# ABOUT CLIMATE COMPASS

Previous Issues of “The Climate Compass”, as it was formerly named as- “Save the Earth”



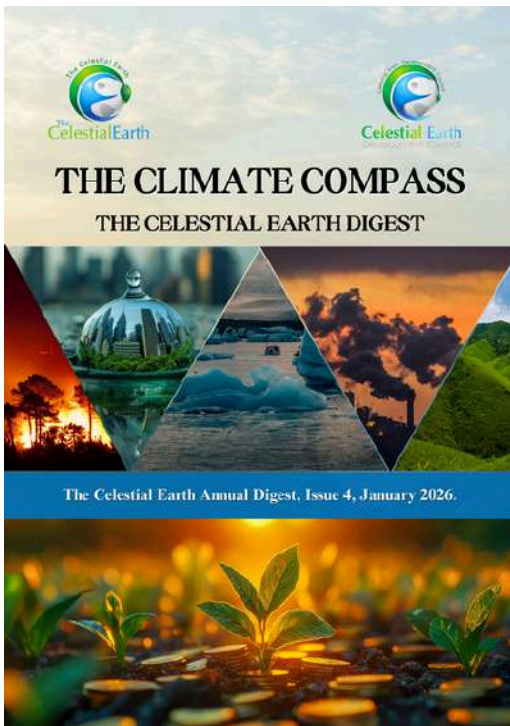
**1st Issue: Jan 2023**



**2nd Issue: Jan 2024**



**3rd Issue: Jan 2025**



**Present Issue: Mar 2026**

Greetings from The Celestial Earth. We are delighted to unveil the 4th Issue of our Digest, Climate Compass, which was previously known as “Save the Earth”. This current publication carries the ISBN No. 978-81-985773-3-7.

This informative and visually vibrant digest offers insights into our organization and our work, while featuring impactful articles across multiple sustainable development domains. This issue also presents compelling photographs of nature and wildlife. We hope this edition informs, inspires, and leaves a lasting impression on all who read it.

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# EDITORIAL

Dear Readers,

Warm greetings from The Celestial Earth and the Celestial Earth Development Council.

It gives us great pleasure to present the 4th issue of our annual digest, The Climate Compass. In this edition, you will find a collection of thoughtful articles on some of the most pressing issues of our time—climate change, energy and environment, nature-based solutions, and green technologies. These contributions come from experts associated with eminent organizations as well as members of our own dedicated team.

Following the positive response to our previous issue, we are delighted to once again include a special Photography Section, featuring beautiful moments of nature and wildlife captured by passionate photographers and nature lovers. Alongside these, the digest also highlights our success stories, publications, major projects, contributions to local communities, and the national and international events we have been part of throughout the year.

The Celestial Earth began 14 years ago with a passionate vision—to help make our planet more livable for human beings, plants, and animals alike. This vision continues to inspire and guide our work today. Through our research and consulting initiatives, we strive to translate this vision into meaningful action,



Editor

**Dr. Tania Ray  
Bhattacharya**

Founder CEO: The Celestial  
Earth

Director: Celestial Earth  
Development Council



# EDITORIAL

supporting both government and private sector-stakeholders in policy development as well as on-ground implementation in areas such as climate change mitigation and adaptation, nature-based solutions, ecosystem conservation, ESG and compliance services, auditing, and impact assessment.

At this moment, I would like to sincerely thank all our clients, partners, funding supporters, and collaborators whose trust and cooperation have been invaluable to our journey.

I would also like to extend my heartfelt appreciation to the writers and photographers who have enriched the 4th issue of *The Climate Compass* with their inspiring contributions. My special thanks go to our publication and design team, whose dedication, creativity, and tireless efforts have helped shape this digest so beautifully.

We hope that you will enjoy reading this issue of *The Climate Compass* and that it will inspire deeper reflection and collective action toward a more sustainable future.

Sincerely,

Dr. Tania Ray Bhattacharya

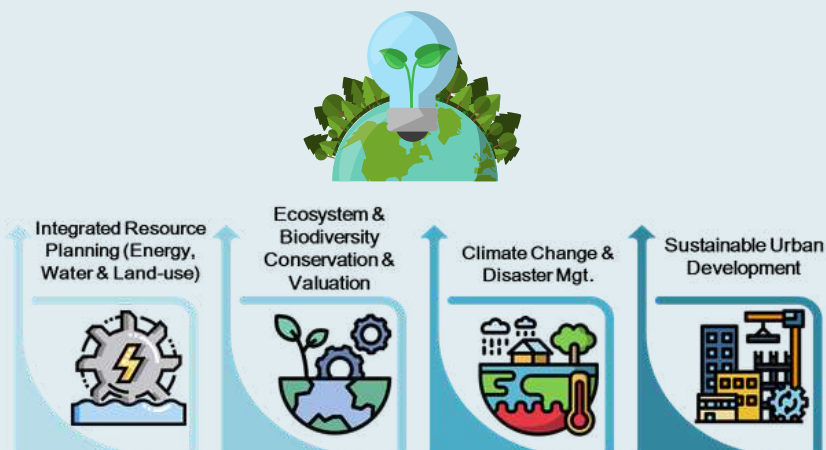
Founder CEO: The Celestial Earth

Director: Celestial Earth Development Council



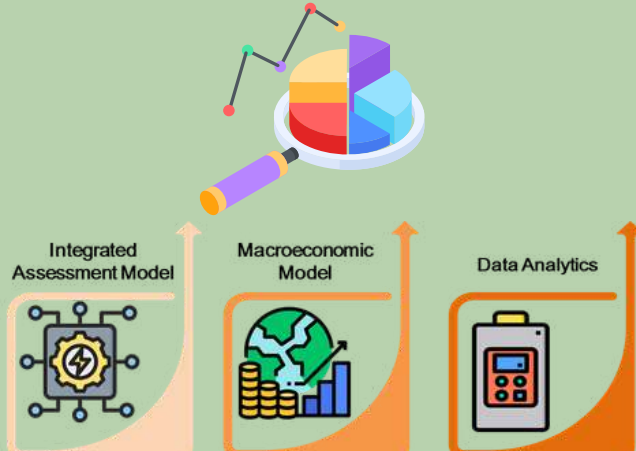
# OUR MAJOR SERVICES

## Policy Research on Natural Resource Conservation and Management (For Governments)



Policy research focuses on the optimal use of natural resources such as energy and water to support sustainable economic and social development. The Celestial Earth (TCE) contributes through evidence-based research that supports responsible resource management, climate resilience, and sustainable policy planning.

## Modelling and Data Analytics in the fields of Sustainable Development



The Celestial Earth is working on developing comprehensive modeling systems to systematically quantify policy impacts on the economy, environment, and society, ensuring effective and successful implementation of sustainable development policies, with AI/ML forming a key component of the modelling and analysis process.

## Compliance Services to Private Sectors



We deliver science-driven private sector solutions by leveraging machine learning, advanced technologies, and in-house tools such as SPIBEAT, enabling scalable and measurable impact through strong domain knowledge, technical expertise, and innovative analytical approaches.



The Celestial Earth



Celestial Earth Development Council

We are thankful to our valued clients



“From Earth to Ether — A Journey of Sustainability”  
-hand in hand, with our stakeholders





# OBJECTIVES & THEMATIC FOCUS OF (2025-26)



## Climate Finance and Sustainable Urban Development

Climate finance and sustainable development align environmental, social, and economic goals, mobilizing capital to support low-carbon, resilient growth, inclusive progress, resource use, reduced emissions, and livelihoods.



Sustainable urban development focuses on creating cities that balance environmental, economic, and social needs while minimizing pressure on natural resources and climate risks. It integrates climate finance to enable efficient land use, low-carbon transitions, resilient infrastructure, enhanced public transport, green spaces, and long-term adaptation to climate change. The Celestial Earth (TCE) advances sustainable urban development by linking data-driven planning with climate finance strategies for urban resilience. Using tools such as GIS, InVEST, and CEA, TCE supports sustainable city design, energy optimization, and green infrastructure while enabling governments and non-government bodies to access and align climate finance for low-carbon planning, resource efficiency, and climate adaptation, ensuring long-term urban sustainability.



## Transformative Cooling Solutions

Transformative cooling solutions involve innovative, sustainable methods to reduce heat in urban areas, using energy-efficient technologies, passive cooling, and nature-based strategies for climate resilience.



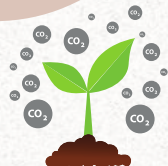
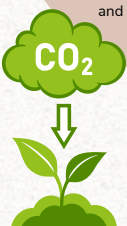
As global temperatures rise and urban heat intensifies, cities face challenges in managing cooling demands. Sub-National Cooling Action Plans (SCAPs) provide localized, data-driven strategies aligned with global climate goals like net-zero emissions, the Kigali Amendment, and the Paris Agreement. SCAPs focus on energy-efficient cooling systems, passive cooling techniques, and innovative urban design to enhance climate resilience and public health.

TCE addresses these challenges by offering data-driven solutions through the Spatially Integrated Building Energy Assessment Tool (SPIBEAT) for modeling cooling demands. TCE helps optimize cooling infrastructure, reduce emissions, and identify sustainable technologies like energy-efficient HVAC, cool roofs, and district cooling systems. Through capacity-building, policy guidance, and technical consultations, TCE supports sub-national governments in advancing smart cooling policies, contributing to global net-zero efforts and promoting resilient, climate-adaptive cities.



## Low Carbon Climate Resilient Development Pathway (LCRDP)

LCRDP integrates emission reduction and climate adaptation strategies to promote sustainable development, enhance resilience, and reduce carbon impacts in vulnerable regions.



As climate impacts intensify, the Low Carbon Climate Resilient Development Pathway (LCRDP) approach becomes vital for achieving sustainable development. It integrates both mitigation (reducing emissions) and adaptation (enhancing resilience to climate impacts) in a holistic manner. TCE has emerged as a key player in LCRDP, leading projects in regions like Goa and Kerala. Our approach focuses on reducing emissions, assessing carbon sequestration, identifying climate vulnerabilities, and exploring nature-based solutions for adaptation. We also estimate the costs of mitigation and adaptation activities, ensuring that solutions are both practical and cost-effective. TCE employs advanced tools like Message-ix, InVEST, ArcGIS, and CGE to conduct these assessments. Our work emphasizes energy security, disaster resilience, and economic growth, particularly in high-income sectors that require sustainable interventions. Through this comprehensive and integrated approach, TCE is committed to fostering low-carbon, climate-resilient development for a sustainable future.

# OBJECTIVES & THEMATIC FOCUS OF (2025-26)



## Ecosystem Services & Carbon Sequestration

Ecosystem services refer to nature's benefits to humanity, while carbon sequestration involves capturing and storing carbon dioxide, mitigating climate change by reducing atmospheric CO2 levels.



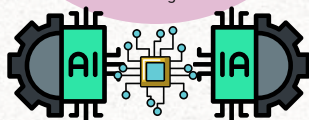
Ecosystem services have been classified into four different categories: provisioning, regulating, cultural, and supporting services, as per the Millennium Ecosystem Assessment (2005). These services underpin human well-being by forming the foundation of climate resilience, biodiversity conservation and sustainable livelihoods by regulating carbon cycles, water flows and local microclimates.

TCE & CEDC has been actively working on assessing, documenting, and communicating ecosystem services across wetlands, riverine systems and culturally protected landscapes like sacred groves, considering their vulnerability and importance towards climate change and their role in mitigation strategies while focusing on the key ecosystem services like carbon sequestration, water conservation, etc., along with multiple stakeholder's coordination and support for implementing the policy and strategies accordingly.



## AI/ ML Applications for Power Sector Reform and RE Integration

AI/ML applications for power sector reform and renewable energy integration involve using data-driven algorithms to enhance grid efficiency, optimize resources, and enable smarter, more resilient and sustainable energy system decision-making.



The Celestial Earth (TCE) has developed an in-house, Python-based spatial intelligence tool called SPIBEAT Pro to support data-driven distribution network planning and capacity expansion. SPIBEAT Pro integrates consumer demand profiling, geo-location insights, network infrastructure analysis, and renewable energy potential assessment into a single framework. The tool provides granular, location-specific insights—such as building-level energy demand, rooftop solar potential, EV charging suitability, and grid constraints—enabling utilities and planners to optimize renewable integration, manage grid challenges, and improve system performance cost-effectively.



## Conserving Local Sustainability & Heritage

Conserving local sustainability and heritage ensures balanced growth by preserving cultural identities, promoting eco-friendly practices, safeguarding biodiversity, and fostering community-driven solutions for resilient and inclusive development.



The Celestial Earth (TCE), along with its NGO wing and sister organization Celestial Earth Development Council (CEDC), works towards conserving local sustainability and cultural-ecological heritage by documenting and communicating on-ground environmental restoration initiatives. Through the scientific documentation of the rejuvenation of 75 ponds in Gurugram and the production of a documentary on water conservation and spring rejuvenation efforts in the Haryana Aravallis, particularly in Khod and Kotla villages of Nuh district, TCE and CEDC highlight the revival of traditional water systems and contemporary conservation practices implemented by GMDA and the Haryana Forest Department. These documentation efforts strengthen public awareness, institutional learning, and long-term stewardship of local natural heritage.

# CELESTIAL EARTH DEVELOPMENT COUNCIL (CEDC)- OUR NGO OBJECTIVES & THEMATIC FOCUS (2025-26)

## Not-For-Profit Organization



### Training & Capacity Building

To provide training on various areas, such as- clean energy, renewable energy, wetland and biodiversity conservation etc. CEDC also provide sponsorship to govt. officials for training & capacity building initiatives, all across India & abroad.

## Celestial Earth Development Council



Celestial Earth  
Development Council



### Workshops & Awareness Campaigns

Various workshops on the domains of environment & energy are conducted by The Celestial Earth Development Council (CEDC).



### Research

The Celestial Earth Development Council (CEDC) conducts research activities and research based projects on the various domains of sustainable development and climate change.



Celestial Earth Development Council (CEDC), the sister organization of The Celestial Earth (TCE) is a not-for-profit organization established in June 2021 in Gurugram, Haryana, by the Directors of TCE with the objectives of training, capacity building and skill development. The aim was an initiative of giving back to the society after a decade of being a for-profit org.



## Research in Sustainable Development

Thermal adaptation and sustainable cooling are critical for India's urban landscapes to address rising heat stress, increasing energy demand, and climate resilience. Rapid urbanization has intensified heat island effects, making region-specific cooling strategies essential. Assessments of commercial buildings in cities such as Delhi, Mumbai, Hyderabad, and Bangalore—representing diverse climatic zones—provide insights into localized cooling needs, urban form, and the effectiveness of passive design, energy-efficient technologies, and green infrastructure, helping inform national sustainable cooling policies.

In addition, related work includes creating awareness-driven video documentaries on local sustainability initiatives, including Mangar Bani—an age-old sacred grove in the Haryana Aravalli—and water conservation and spring rejuvenation efforts across the region. These documentaries highlight links between ecosystems, community stewardship, and climate resilience, supporting conservation practices and promoting nature-based solutions for local sustainability.

## Initiatives of Summer and Winter Training Programs in Collaboration with Govt. & Other Training Bodies

The Winter and Summer training programs by the Celestial Earth Development Council (CEDC), in collaboration with notable government and other training bodies, will offer transformative benefits for students and professionals by addressing key sustainability and climate challenges through specialized modules. Programs on Adaptation Planning, Net Zero Assessment, Power Systems Modeling, Macro-economic Modeling, and Climate Change Systems Modeling empower postgraduate students with advanced skills and practical knowledge, enhancing their academic and professional competitiveness. Industry professionals gain cutting-edge knowledge and tools to implement adaptation strategies, optimize power systems, analyze macroeconomic trends, and model land, water, and energy systems. These interdisciplinary training programs foster innovation, informed decision-making, and strategic planning, contributing to sustainable development and policy effectiveness across diverse sectors.

# RECENT PROJECTS (2025)



## Assessment of Cooling and Electrical Demand in Commercial Buildings of 4 cities (Delhi, Mumbai, Bangalore, Hyderabad)

Support to BEE's initiatives by assessing the cooling and electrical demand in commercial buildings within Indian cities. This contract focuses on four cities – Delhi, Mumbai, Bangalore and Hyderabad – each representing a different climatic zone in India

Client: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ India).

## Capacity Enhancement Planning for Renewable Energy for Goa

The project analyzes power distribution networks, capacity, and load demand, focusing on solar, wind, bio-gas, and small hydro. It identifies adoption barriers, explores renewable technologies, and develops policies and mechanisms for network augmentation to enhance renewable energy integration and sector-coupling.

Client: International Sustainable Energy Foundation (ISEF)



## Developing Cooling Action Plan at Sub-national Level

The project involves creating a standardized methodology for assessing cooling demand at the city level, developing a sub-national cooling action plan, introducing energy-efficient cooling technologies like district cooling systems, and developing a financial model for implementing Cooling as a Service (CaaS) at the sub-national level.

Client: International Sustainable Energy Foundation (ISEF)

## Developing Climate Finance Facility Roadmap for the State of West Bengal

The project evaluates integrating renewable energy and electric vehicles into the energy system, identifying challenges, opportunities, and requirements to enhance resilience, reliability, and sustainability, providing recommendations to meet future demands while mitigating environmental impacts.

Client: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ India).



## Climate Resilient Sustainable Development: Lessons to Learn from Harappan Civilization by the Modern Cities of India

This study compares the ancient Indus-Saraswati (Harappan) civilization with modern Delhi-NCR cities, focusing on Harappan civilization's climate adaptability, disaster-resilient architecture, and agriculture. It examines Delhi-NCR's climate risks, such as groundwater depletion and temperature fluctuations, using GIS techniques and archaeological insights. The research integrates ancient resilience practices into modern planning for sustainable and climate-resilient urban development.

# REPORTS & WHITE PAPER PUBLISHED (2025)

## Gurugram City Cooling Action Plan

### Developing Cooling Action Plan at Subnational Level

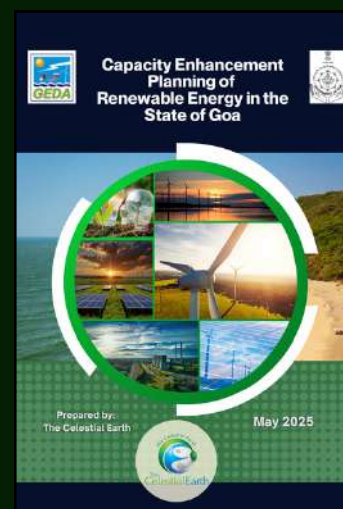


The Celestial Earth (TCE) has developed the Gurugram Cooling Action Plan, a roadmap to manage rising cooling demand, reduce energy usage, and cut GHG emissions in line with Gurugram's Climate Action Plan and India's 2070 net-zero goal. Using SPIBEAT, the study assesses cooling needs, evaluates sustainable scenarios, and recommends passive design, efficient technologies, district cooling, and policy measures. Developed through stakeholder collaboration, the plan supports planners and policymakers in advancing resilient, low-carbon cooling solutions.

## Capacity Enhancement Planning of Renewable Energy in the State of Goa

Goa's Clean Energy Roadmap 2050 targets net-zero emissions and 100% renewable power, yet its RE share remains low despite strong solar potential. This study analyzes Goa's distribution network to identify cost-effective RE integration pathways.

Facing land constraints, intermittency, grid limits, and rising RPO obligations, Goa must strengthen procurement, regulation, and infrastructure. Using power system modelling, the study outlines required investments in grid upgrades, storage, and smart technologies for a reliable clean energy transition.



## TCE's White Paper: India's Adaptation Planning, Policy & Financing



Climate resilience is critical for India amid rising climate risks. This white paper from The Celestial Earth's Jan 2025 conference- "Pathways to Resilience: Climate Adaptation and Nature-Based Solutions", outlines the need for stronger adaptation finance, policy innovation, and multi-stakeholder collaboration. It identifies key challenges and actionable pathways to mobilize resources and supports India's National Adaptation Plan and long-term resilience goals.

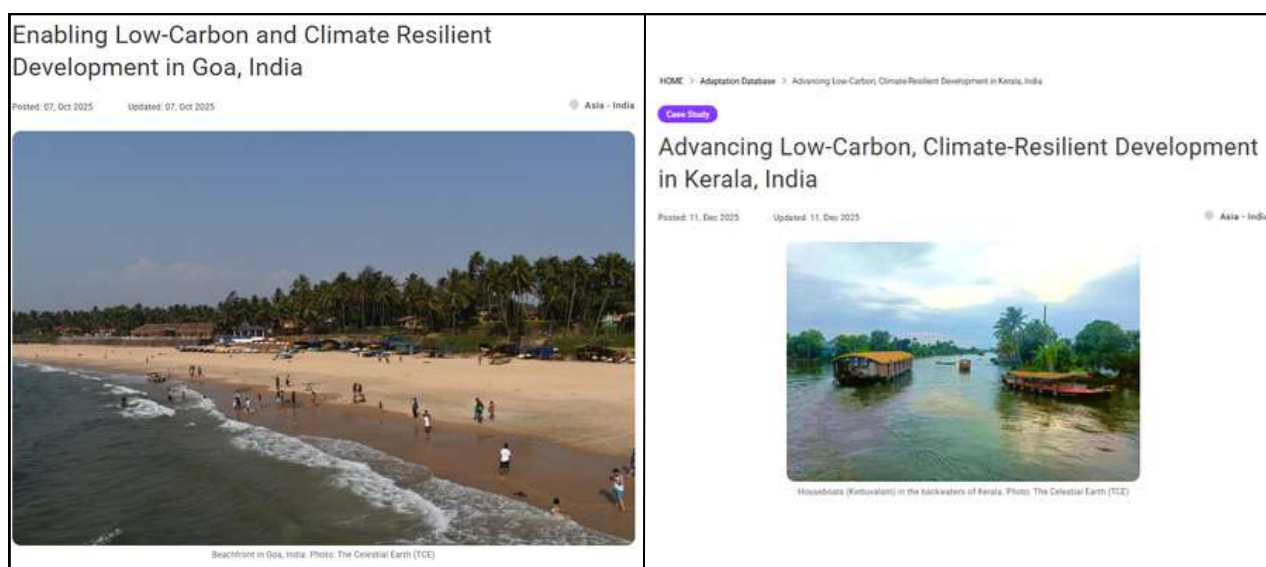
# RECENT PUBLICATIONS

The Celestial Earth is proud to share that its research on Low-Carbon and Climate-Resilient Development has been featured on the Asia-Pacific Climate Change Adaptation Information Platform (AP-PLAT), hosted by the National Institute for Environmental Studies (NIES), Japan. The recognition highlights TCE's work in advancing sustainable growth and climate adaptation finance through state-level pathways. Alongside Goa, the platform also features TCE's Kerala Low-Carbon, Climate-Resilient Development (LCRD) framework, which addresses rising climate risks and emissions through an integrated approach covering mitigation, adaptation, and disaster risk management across energy, transport, land use, ecosystems, and infrastructure. Using advanced modelling and district-level prioritisation, the study demonstrates how high-risk regions can reduce emissions while strengthening resilience to floods, heat, and coastal hazards.

Read the full case studies:

Goa: <https://ap-plat.nies.go.jp/adaptation-database/list/case-study/db1422.html>

Kerala: <https://ap-plat.nies.go.jp/adaptation-database/list/case-study/db1422.html>



# UPCOMING PUBLICATIONS

**Our upcoming publication is Titled "Reclaiming Indigenous Ecologies: Sacred Groves in Climate Strategy and Environmental Governance."**

**Publisher: Taylor & Francis  
Journal: Journal of Sustainable Forestry.**

## Reclaiming Indigenous Ecologies: Sacred Groves in Climate Strategy and Environmental Governance

*Tania Ray Bhattacharya<sup>1</sup>, Ishita Rathore<sup>2</sup>, Sakshi Bish<sup>3</sup>, Subhash Chander Yadav<sup>4</sup>*

<sup>1</sup>Founder, CEO; The Celestial Earth, 316, Vipul Trade Centre, Sector 48, Gurugram-122018, HR, India

<sup>2</sup>Research associate; The Celestial Earth, 316, Vipul Trade Centre, Sector 48, Gurugram-122018, HR, India

<sup>3</sup>Senior research associate; The Celestial Earth, 316, Vipul Trade Centre, Sector 48, Gurugram-122018, HR, India

<sup>4</sup>Conservator of Forest, Forest & Wildlife Department, Haryana

\*Corresponding author. E-mail: [tania.b@thecelestialearth.org](mailto:tania.b@thecelestialearth.org)

Exploring sacred groves' contribution to climate strategy, their significance in ecological and environmental governance, and their continuity within traditional knowledge systems. Investigating sacred groves as indigenous ecological systems that integrate biodiversity conservation, cultural heritage, and climate resilience.

# UPCOMING PUBLICATIONS

Celestial Earth's upcoming publication will also feature book chapters (Chapters 5 and 19) in the book "Wetland Management for Biodiversity Conservation and Climate Change Mitigation", published by Apple Academic Press.

## CHAPTER 5

### ASSESSMENT OF BIODIVERSITY AND ECOSYSTEM SERVICES OF WETLANDS SAKSHI BISHT\*, TANIA RAY BHATTACHARYA

<sup>1</sup>The Celestial Earth, 316, Vipul Trade Centre, Sector 48, Gurugram-122018, HR, India

\* E-mail: bishtsakshi867@gmail.com

#### ABSTRACT

Wetland ecosystems are home to a wide variety of plants and animals. They provide habitat for aquatic animals and plants, including fish, birds, insects, and algae. Wetlands are significant for human survival as they provide several ecosystem services, categorized into four groups: provisioning, regulating, cultural, and supporting services. However, these services are increasingly affected by anthropogenic activities, leading to wetland loss and degradation. This chapter discusses the importance of understanding the status and value of wetlands through biodiversity and ecosystem services assessment using different parameters. Baseline information is essential for assessments, as each parameter includes specific indicators for systematic evaluation of biodiversity and ecosystem services. The study also illustrates the importance of such assessments for Ramsar designation and for promoting conservation and sustainable use of wetlands. A case study of Ramsar wetlands in Goa and Kerala is presented, focusing on biodiversity and ecosystem service assessment. Nanda Lake in Goa and Vembanad, Ashtamudi, and Sasthamkotta Lakes in Kerala are Ramsar wetlands located in the coastal western region of India. These wetlands are well known for their unique ecosystems and the services they provide. The study showcases that comprehensive assessment supports effective management, policy implementation, and long-term conservation of wetland ecosystems.

Wetlands support diverse plant and animal life and provide vital ecosystem services—provisioning, regulating, cultural, and supporting—that are essential for human well-being but increasingly threatened by human activities. This chapter highlights the need for biodiversity and ecosystem service assessments, emphasizing the role of baseline data and indicators in evaluating wetland health. Through case studies of Ramsar wetlands in Goa and Kerala, it shows how comprehensive assessments aid Ramsar designation, inform policy, and support effective management and long-term wetland conservation.

## Chapter 19

### Wetlands: Source or Sinks? The Role of Wetlands in Carbon Sequestration and Storage

Tania Ray Bhattacharya\* and Sakshi Bisht

*The Celestial Earth, 316 Vipul Trade Centre, Sector 48, Gurugram-122018 HR, India*

\*Corresponding author: [tania.b@thecelestialearth.org](mailto:tania.b@thecelestialearth.org)

#### Abstract

Wetlands possess a high capacity for carbon sequestration and long-term storage, exceeding that of many other terrestrial ecosystems. They encompass diverse systems, including marshes, swamps, mangroves, peatlands, and estuarine, riverine, and marine wetlands. However, inadequate management and unsustainable land-use practices can transform wetlands from carbon sinks into significant carbon sources. Seasonal assessments of air–water CO<sub>2</sub> fluxes indicate that wetlands may function alternately as sinks or sources, depending on ecological condition and climatic factors. Peatlands and moors, which store approximately 30% of global terrestrial carbon, are particularly vulnerable; their degradation or conversion for agricultural or urban use can result in substantial carbon release, exacerbating climate change. Conversely, wetland restoration, sustainable use, maintenance of ecological health, and integrated management practices—such as effective sewage treatment and eutrophication control—can significantly reduce CO<sub>2</sub> emissions and enhance sequestration potential. Globally, the annual loss of coastal wetlands contributes an estimated 0.15–1.02 billion metric tons of CO<sub>2</sub>-equivalent emissions. Accurate carbon stock assessment, supported by modelling tools such as InVEST and robust wetland inventory and monitoring frameworks, is essential for prioritizing conservation actions. Strengthening wetland management policies is critical for enhancing their role in achieving net-zero emission targets.

Wetlands have high carbon sequestration capacity, often exceeding many terrestrial ecosystems, and include marshes, swamps, mangroves, peatlands, and estuarine, riverine, and marine systems. Poor management and unsustainable land use can shift wetlands from carbon sinks to sources, while seasonal CO<sub>2</sub> fluxes indicate they may function as either depending on ecological and climatic conditions. Peatlands, storing nearly 30% of global terrestrial carbon, are especially vulnerable, and their degradation releases significant emissions. Conversely, wetland restoration, sustainable management, and measures such as sewage treatment and eutrophication control can reduce emissions and enhance sequestration. Accurate carbon stock assessments using tools like InVEST and effective monitoring frameworks implemented in this study are essential for strengthening wetland policies and supporting net-zero emission targets.

# TCE IN NEWS (2025)

## Tracks to Green Cover: Gurgaon breathes fresh life into 75 ponds- Times Of India, Feb 24, 2025

The article highlights rising urban heat challenges in Indian cities and the need for science-based cooling solutions beyond conventional approaches. In response, The Celestial Earth (TCE) has developed the Gurugram Cooling Action Plan, providing a structured, climate-responsive framework to help cities address heat risks through integrated design and planning. The coffee table book was formally launched by Shri Bhupender Yadav Ji (Union Environment Minister) and Shri Rao Narbir Singh Ji (Haryana Environment Minister) at the Aravalli Green Wall Partnership Summit 2025.

Article Link:

<https://timesofindia.indiatimes.com/city/gurgaon/tracks-to-green-cover-gurgaon-breathes-fresh-life-into-75-ponds/articleshow/118512166.cms>



## Feeling the heat: IITM's Shaastra: Vol 04 Issue 03 : Apr 2025



The article highlights rising urban heat challenges in Indian cities and the need for science-based cooling solutions beyond conventional approaches. In response, The Celestial Earth (TCE) has developed the Gurugram Cooling Action Plan, providing a structured, climate-responsive framework to help cities address heat risks through integrated design and planning.

Article Link: <https://shaastramag.iitm.ac.in/special-feature/feeling-heat>

## Glass Towers to Green Roof: New Plan Redraws how Gurgaon must Build: Times Of India, Dec 22, 2025

As reported by The Times of India, Gurugram has introduced its first Cooling Action Plan to tackle rising urban heat and energy demand. Developed by The Celestial Earth (TCE), the plan provides a structured, climate-responsive framework promoting passive design, green roofs, better insulation, and efficient cooling systems to reduce heat stress, lower emissions, and guide sustainable, future-ready urban development.

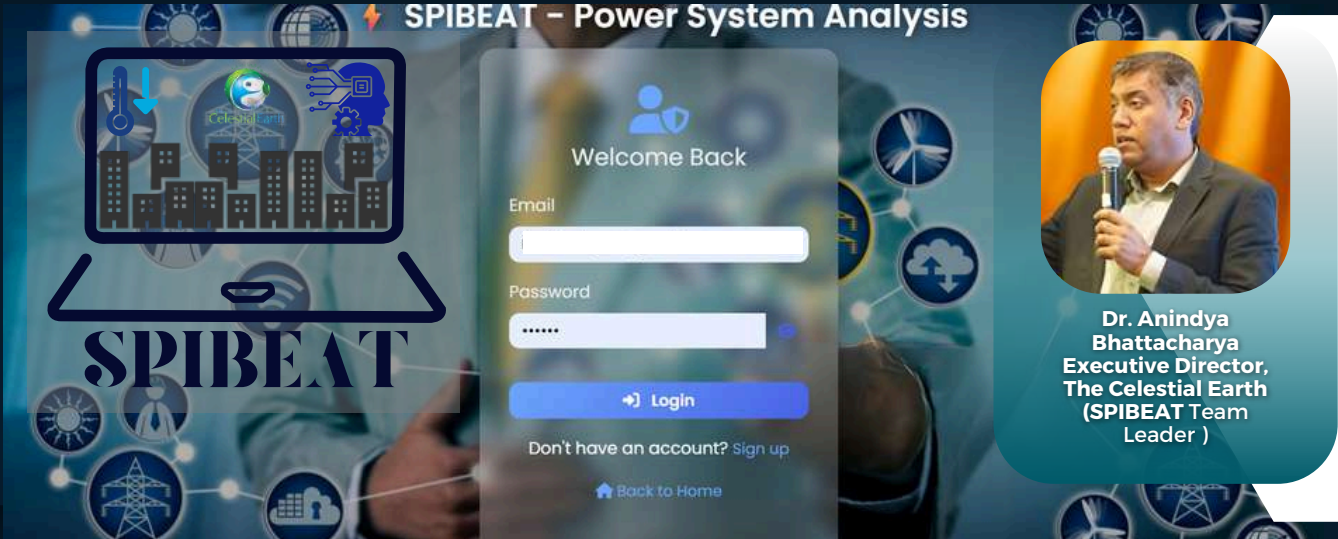
Article Link:

<https://timesofindia.indiatimes.com/city/gurgaon/glass-tower-to-green-roof-new-plan-redraws-how-gurgaon-must-build/articleshow/126108936.cms>



# AI/ML APPLICATION

## SPIBEAT – Power System Analysis



**Dr. Anindya Bhattacharya**  
Executive Director,  
The Celestial Earth  
(SPIBEAT Team Leader)

## SPIBEAT IS TCE'S IN-HOUSE TOOL

\*1



SPIBEAT Pro is an AI/ML powered advanced spatial intelligence-driven planning tool that supports distribution network planning, capacity expansion, and renewable energy integration. It unifies four key decision-making pillars such as consumer demand profiling, geo-location insights, network infrastructure analysis, and renewable energy potential assessment within a single integrated framework.

As this concept is unique and TCE is the proprietor of it, an **IPR** application has been filed for this tool.

### HIGHLIGHTS

#### GEO-SPATIAL POWER PLANNING TOOL

SPIBEAT Pro covers key features, like computing consumer demand profiling by use type, analyzing the distribution network, and identifying RE, EV, and BESS potential to support users in planning future buildings and power distribution networks.

#### LOCATION-SPECIFIC INFORMATION

The tool identifies the geographical locations of buildings and distribution network components, enabling site-specific analysis of RE and EV integration within the network. This supports utilities and planners in making targeted, area-based interventions.

#### DISTRIBUTION NETWORK PLANNING TOOL

SPIBEAT Pro serves as a planning tool that enables the strategic integration of RE and EV, along with demand-side flexibility, also supporting the digitalization of distribution power networks. It helps utilities and planners design future-ready systems and achieve national mandates related to energy transition and sustainability.

# COP30 BRASIL AMAZÔNIA

-By Ishita  
Rathore  
(Research  
Associate),  
The Celestial  
Earth

## COP 30- A Way Forward to Implementation



**From ambition to action:** COP30 in Belém marked a shift toward implementation, with strong emphasis on climate finance, adaptation, nature-based solutions, and people-centred climate action, though gaps remain on fossil fuel transition commitments.



**India's leadership for the Global South:** India emerged as a key voice advocating climate justice, adaptation, just transition, renewable energy, resilient infrastructure, and women-led climate action, aligning ambition with development priorities.

In the centre of the Amazon, Belém, Brazil hosted the 30th Conference of the Parties (COP30) of the United Nations Framework Convention on Climate Change from November 10–21, 2025. COP30 was positioned as an opportunity to move decisively from ambition to implementation at a time when the effects of climate change are worsening across ecosystems and societies. The conference emphasised how urgent it is to take collective, equitable, and people-centered climate action, especially for nations and communities that already face irreversible climate risks.

### Key highlights of Cop 30:

**Climate finance-** Climate finance was a central focus at COP30, with countries reaffirming a political negotiation to mobilise USD 1.3 trillion annually by 2035 and to triple adaptation finance for developing nations. However, concerns remained over who will provide the funds and how predictable, transparent, and grant-based support, especially for adaptation

and loss and damage will be ensured.

**Adaptation and resilience-** COP30 highlighted adaptation as an urgent priority, acknowledging that climate impacts are already being experienced across regions. It worked upon the Baku Adaptation Roadmap by promoting adaptation tracking, supporting National Adaptation Plans, and recognising the value of indigenous and locally led resilience practices.

**Just Transition Mechanism-** The adoption of a Just Transition Mechanism, which supports nations and communities through fair low-carbon transitions, was a noteworthy institutional result. The mechanism focusses on reskilling workers, protecting livelihoods, and addressing the social aspects of climate action. However, future clarification regarding funding and operational assistance will determine its efficacy.

**Forests, Nature and Ecosystems-** COP30 pushed forests and nature-based solutions to the forefront of climate negotiations. Projects like the Tropical Forests Forever Facility (TFF)

were emphasised as performance-based strategies for preserving forests and boosting regional economies through this payment-for-performance model. Developing nations with vast forests demanded that ecosystem management be acknowledged as a global climate service.

**Health, Gender and People-Centred Climate Action-**

COP30 placed people at the centre of climate action by linking climate resilience with public health through the health-focused initiatives launched in Belém. It also advanced gender equity and social justice by strengthening women’s leadership in climate governance through Belém Gender Action Plan, and recognising the links between climate change, poverty, hunger, and inequality.

**Fossil Fuel Transition-** Despite intense negotiations, COP30 did not arrive at a binding agreement on fossil fuel phase-out or phase-down. Divergent national circumstances and development priorities continued to shape positions, leaving this issue to future COPs.

**India’s Role in COP30:**

India played an active and consistent role at COP30, grounding its interventions in the principles of equity, climate justice, and Common but Differentiated Responsibilities (CBDR-RC).

**Climate Finance Advocacy-** India played an active and consistent role at COP30, grounding its interventions in the principles of equity, climate justice, and Common but Differentiated Responsibilities (CBDR-RC).

**Adaptation and Resilience Leadership-** India highlighted its climate-resilient agriculture, water management, disaster risk reduction, and heat action initiatives as scalable models for developing countries, contingent on adequate international support.

**Just Transition Pathways for the Global South-**

India emphasised just transition frameworks that link clean energy expansion with job

creation, reskilling, and social protection, ensuring that climate action supports livelihoods and development priorities in the Global South.

**Resilient Infrastructure and Disaster Risk**

**Reduction-** India highlighted the need to mainstream climate-resilient infrastructure into national development planning, showcasing its leadership in disaster risk reduction and adaptive infrastructure as essential for climate-vulnerable countries.

**Industrial Decarbonisation and Green**

**Hydrogen-** India positioned green hydrogen and low-carbon technologies as key enablers of industrial decarbonisation, presenting itself as an emerging hub for affordable and scalable solutions for hard-to-abate sectors.

**Solar and Renewable Energy Cooperation-**

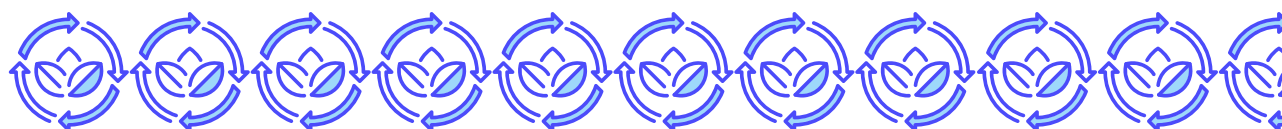
India reinforced its commitment to global renewable energy cooperation by advocating the rapid scaling of solar and other clean energy solutions to improve energy access and accelerate low-carbon transitions across developing regions.

**Women-Led Climate Action-**

COP30 platforms were used by India to underline the critical role of women in climate solutions, highlighting women-led community renewable energy and adaptation initiatives as drivers of inclusive, resilient, and locally grounded climate action.

**Conclusion**

COP30 in Belém marked a critical shift in the global climate process from negotiating new promises to delivering on existing ones. While gaps remain, particularly on finance and fossil fuel transitions, the conference strengthened the global focus on adaptation, equity, and people-centred climate action. India’s engagement reflected a balance between ambition and realism, reinforcing its role as a key voice for the Global South and a proactive contributor to a more just, inclusive, and climate-resilient future.



A landscape photograph featuring a wind turbine on a hill in the background, a house with solar panels in the middle ground, and a field in the foreground. The text is overlaid on the image.

# **Climate Adaptation & Finance and Sustainable Development**

**Insights and Innovations**

# From Principles to Practice: Foundations of Climate Finance



**Translating SAPCCs into Bankable Climate Action:** Climate finance is essential to convert State Action Plans into implementable, scalable mitigation and adaptation projects by assessing bankability, financing gaps, and appropriate financial instruments beyond government budgets.



**Blended Finance with MDB Catalysis:** Effective climate portfolios require mobilizing public, private, philanthropic, and multilateral resources, where MDB participation helps reduce risk, finance public goods, and crowd in private capital for long-term climate resilience.

Climate financing refers to the mobilization, allocation, and management of financial resources to support climate change mitigation and adaptation initiatives. Effective climate finance is essential for the implementation of State Action Plans on Climate Change (SAPCCs), as it enables the translation of policy objectives into actionable and scalable projects.

## Objective of Climate Finance Assessment

The primary objective of this activity is to examine how SAPCC activities can be translated into implementable projects and programs capable of achieving defined climate goals and targets. A key component of this assessment is the evaluation of project bankability, with the aim of identifying suitable financing mechanisms beyond direct state government budgetary allocations.

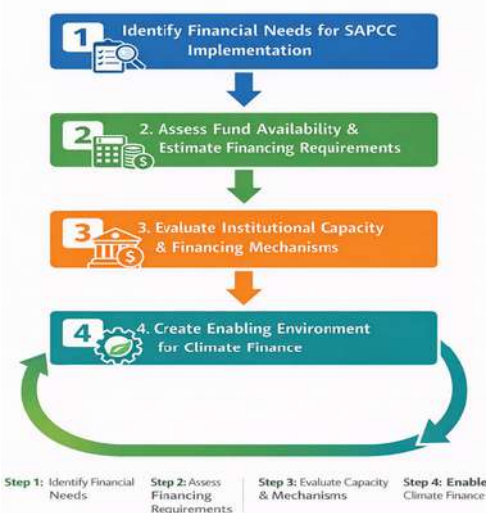
## Sources of Climate Finance and Resource Mobilization:

Climate finance can be mobilized from a diverse range of public, private, and philanthropic sources, each guided by distinct investment principles and risk-return



-By Dr. Tania Ray  
Bhattacharya  
(Founder CEO),  
The Celestial Earth

## Key Steps in Climate Finance Mobilization



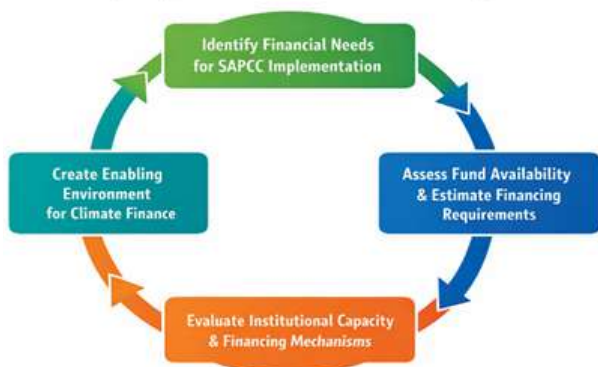
expectations:

- *Multilateral Development Banks (MDBs) and Development Finance Institutions (DFIs):* These institutions provide financing aligned with their investment mandates, focusing on development impact, climate resilience, and sustainability.
- *Central Government:* Public financing is extended in the form of equity, debt, or subsidies to projects and sectors deemed strategically significant at the state or national level.

- *Philanthropic Foundations*: Funding is mobilized from domestic and international donors, including foreign and domestic foundations, corporate social responsibility (CSR) arms, and high-net-worth individuals or family offices. Investments are guided by defined social and environmental objectives.
- *Private Sector*: Private capital is directed toward commercially viable and bankable projects with expectations of market-based returns. This includes financial investors, strategic investors, and retail investors.

## Methods for Estimating State Level Climate Finance Requirements

### Key Steps in Climate Finance Planning



Determining climate finance requirements involves a systematic and evidence-based approach which includes:

1. Assessment of climate vulnerabilities and hazard exposure at the district level;
2. Mapping and costing of SAPCC interventions across climate-vulnerable geographies;
3. Classification of adaptation and mitigation interventions based on their bankability to guide financing strategies;
4. Identification of financing gaps through a comparison of estimated adaptation and mitigation costs with current expenditure levels;
5. Development of a climate finance project matrix that aligns each intervention with the most appropriate financial instrument;
6. Designing an institutional structure and operational framework for climate finance delivery.

**Cost of Capital:** This determines the overall cost of externally sourced finance for SAPCC

implementation, with variations across funding sources in terms of interest rates, tenors, and conditionalities.

- *Return on Investment (ROI)*: Analysis of project cash flows, risk profiles, and expected returns is critical to determine suitable financing instruments and investor participation. Without the possibility of high ROI, it is bit difficult to motivate private sectors to invest in climate financing.
- *Financing Prioritization*: Not all SAPCC interventions are amenable to external financing due to the non-monetizable nature of their benefits. In such cases, government funding and public finance remain indispensable.

### **MDB participation is essential to address market failures and scale climate action:**

1. *Addressing Market Gaps*: MDBs finance projects unattractive to private investors due to low or uncertain returns.

2. *Enhancing Community Resilience*: Concessional financing supports flood control, ecosystem restoration, and other projects benefiting vulnerable communities.

3. *Provision of Public Goods*: Investments generate shared benefits such as water security, biodiversity conservation, and reduced disaster risk.

4. *Advancing Long-Term Objectives*: Adaptation and mitigation require significant upfront investments with long-term returns.

5. *Catalyzing Co-Financing*: MDB and public funds reduce risk and crowd in private capital.

### **Financing Bottlenecks in Climate Projects**

Climate adaptation and mitigation projects often face significant financing challenges, including:

1. Limited or absent direct revenue streams;
  2. Extended payback periods that deter private investment;
  3. Predominance of public good benefits (e.g., resilience, ecosystem services, public health) rather than private financial returns;
- High perceived risk relative to conventional investment opportunities.

# Urban Green Spaces as Natural Coolants for Sustainable and Climate-Resilient Gurugram



## Green Spaces as Natural Coolants

Expanding urban greenery—parks, trees, and green roofs—offers Gurugram an effective, low-cost solution to combat rising urban heat and reduce dependence on energy-intensive cooling.



## Strengthening Climate Resilience

Urban green cover improves air quality, lowers temperatures, and supports vulnerable communities through natural, accessible cooling and enhanced well-being.

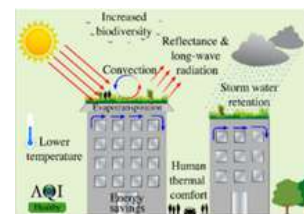


## Towards a Greener Gurugram

By integrating blue-green corridors, nature-based infrastructure, and community initiatives, Gurugram can lead India's path to sustainable, climate-resilient urban growth.



-By Jigyasa Gambhir  
(Sr. Research Associate),  
The Celestial Earth



Cities across India are heating up rapidly due to expanding concrete landscapes, dense urbanization, and rising cooling demands, intensifying the urban heat island effect. Gurugram—one of India's fastest-growing cities and the financial hub of the National Capital Region—faces a complex and urgent cooling challenge. As outlined in the Gurugram Cooling Action Plan and the Climate Action Plan for Net Zero Gurugram 2050, expanding urban green spaces offers one of the most effective and low-cost solutions.

Green spaces—parks, roadside trees, urban forests, and green roofs—serve as natural coolants, lowering temperatures through shading and evapotranspiration. Remote sensing studies show a clear link between vegetation cover (NDVI) and reduced land surface temperature (LST), while highly built-up areas (NDBI) experience higher heat levels. This reinforces the vital role of green cover as a natural buffer against rising urban heat.

Covering nearly 673 km<sup>2</sup> and home to 1.9 million residents (projected to reach 4.25 million by 2031), Gurugram has evolved from a small village into a dense urban hub of high-rises and corporate offices. While this growth has brought economic gains, it has also led to widespread concrete development and heat-retaining infrastructure. The Net Zero Climate Action Plan highlights uneven green distribution—sectors near the Aravallis still retain vegetation, while central and eastern zones are highly built-up, with elevated LST and poor air quality. Expanding and evenly distributing urban greenery is thus critical for heat mitigation and resilience.

Beyond cooling, green spaces improve air quality by filtering pollutants, sequestering carbon, and mitigating emissions from vehicles, construction, and industry. The Cooling Action Plan warns that under a business-as-usual scenario, Gurugram's cooling demand could soar by 2050, stressing power

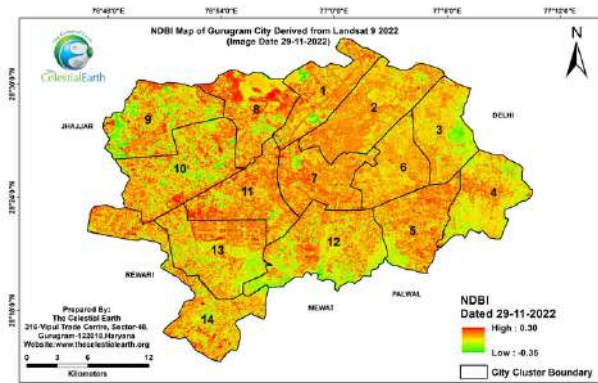
systems and increasing greenhouse gases. Integrating greenery—via shaded streets, pocket parks, and green roofs—can lower ambient temperatures, reduce air-conditioning dependence, and cut emissions.

Urban greenery also enhances public health and social well-being, especially for vulnerable groups such as the elderly, children, and low-income communities. Parks and shaded spaces provide affordable heat relief and improve mental health and social cohesion. Thus, green cover serves as both climate infrastructure and social infrastructure, promoting inclusivity and resilience.

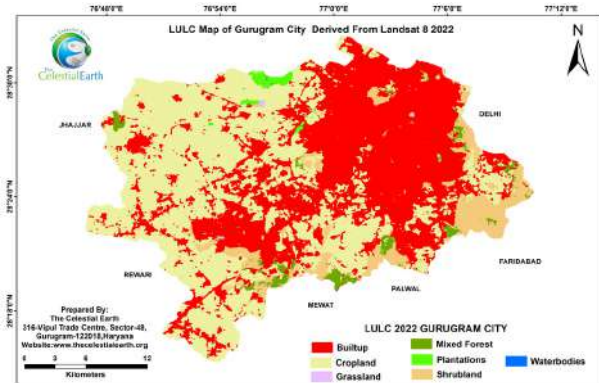
To move forward, Gurugram must expand both the quantity and quality of green spaces. Urban planning should mandate minimum green cover, establish blue-green corridors connecting water bodies and vegetation, and encourage nature-based infrastructure like green roofs and vertical gardens. Community

participation through resident groups, local stewardship, and tree-planting initiatives can sustain these efforts, while financing tools like green bonds and public-private partnerships can scale them up. Green infrastructure is not an add-on—it is essential for sustainable development. When combined with other cooling solutions such as energy-efficient buildings and district cooling, it can significantly lower energy use and emissions by 2050. Expanding urban greenery aligns with India’s Paris Agreement, India Cooling Action Plan, and net-zero 2070 targets.

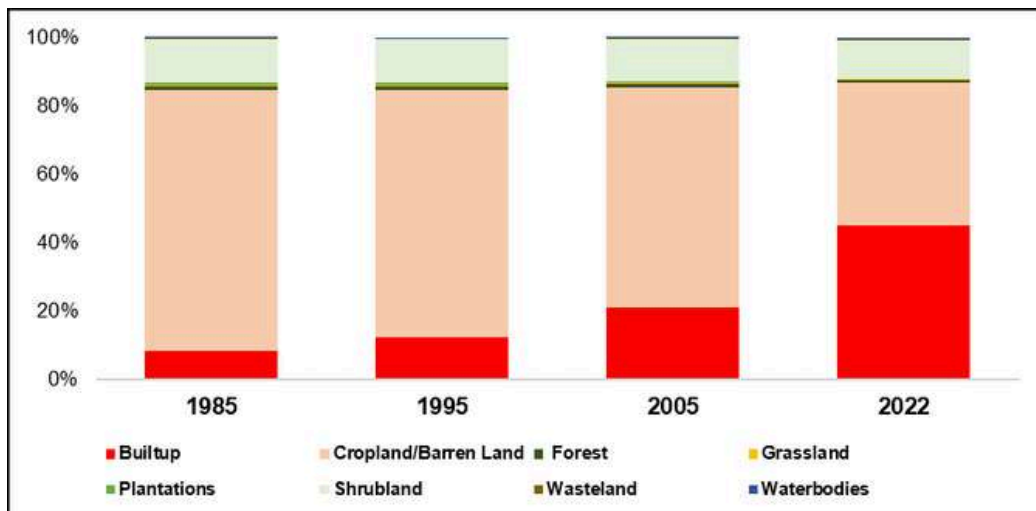
Gurugram’s growth presents both a challenge and an opportunity: to balance economic progress with environmental sustainability. By embedding nature within its urban design, the city can lead India’s path in sustainable cooling—demonstrating how local, science-driven, and community-based action can create cooler, greener, and more resilient cities.



Cluster-wise NDBI Map of Gurugram City for 2022



LULC Map of Gurugram City: 2022



% Change in LULC of Gurugram City between 1985-2022

# Building Future-Ready Skills: Why Climate Risk and Sustainability Training Matters



**Essential Skills for a Changing World** – Courses on climate risk assessment and sustainability build the technical and analytical expertise needed by both students preparing for careers and professionals adapting to new regulatory and market realities.



**Expanding Career Opportunities** – Whether entering the job market or advancing within it, participants gain pathways into high-demand fields like green finance, energy transition, policy, and corporate sustainability.



**Driving Climate-Resilient Growth** – By equipping learners and practitioners alike with tools for risk management, compliance, and innovation, such programs nurture future leaders capable of shaping resilient, low-carbon economies.



By Sayanee Das  
(Sr. Env. Project  
Coordinator),  
Celestial Earth  
Development Council

**Note:** TCE's sister organization and NGO wing- Celestial Earth Development Council has an aim of providing training and capacity building on the above mentioned domain.

The world is undergoing an unprecedented transformation driven by the realities of climate change, resource depletion, and sustainability imperatives. Rising global temperatures, extreme weather events, shifting rainfall patterns, and sea level rise are no longer distant concerns — they are immediate challenges affecting financial systems, infrastructure, supply chains, and everyday lives. In this evolving landscape, the ability to assess, anticipate, and respond to climate risks has become a critical skill across sectors. This is why courses and training programs focused on climate risk assessment, energy transition, climate compliance, and sustainable development are gaining importance worldwide.

## Responding to Growing Risks and Regulations

Climate-related risks are now recognized as systemic risks that can disrupt economies and financial markets. Financial institutions, for

instance, are increasingly required by central banks and regulators to conduct climate risk assessments to evaluate the exposure of assets and investments. Similarly, infrastructure projects are subject to safety audits and compliance measures to ensure resilience against climate-induced disasters such as floods, cyclones, and heatwaves. Corporate entities are also under growing scrutiny to measure and disclose their carbon footprint, including indirect Scope 3 emissions across supply chains.

Therefore, relevant courses in this space not only provide knowledge of methodologies and frameworks used in risk assessment but also ensure alignment with regulatory requirements. This equips professionals with the ability to integrate climate considerations into decision-making, thereby reducing vulnerabilities and avoiding compliance risks.

## Bridging Science, Policy, and Business

One of the biggest challenges in climate

governance is translating scientific findings into actionable strategies for businesses, governments, and institutions. Courses on climate risk assessment and sustainability help bridge this gap by offering interdisciplinary insights — combining climate science, financial risk modeling, policy frameworks, and corporate sustainability practices.

Participants gain exposure to real-world case studies, scenario analysis, and practical applications that help them connect policy requirements (such as carbon markets, green credits, or ESG disclosures) with operational strategies that organizations can implement. In doing so, these programs create professionals capable of working at the intersection of science, policy, and practice.

### **Building Competence for the Energy Transition**

The global shift toward renewable energy and low-carbon technologies requires a workforce that is well-versed in energy transition pathways, sustainable resource management, and carbon market mechanisms. Courses focusing on these themes provide learners with a solid understanding of energy modeling, compliance with evolving climate laws, and strategies to integrate sustainability into development planning.

By emphasizing green finance, resource efficiency, and carbon credit markets, such courses prepare participants for the emerging realities of a carbon-constrained world. As economies transition, professionals trained in these areas will be essential for shaping strategies that balance growth with environmental responsibility.

### **Empowering Careers in the Green Economy**

The rise of the green economy has created a strong demand for skilled professionals who can navigate complex sustainability challenges. Careers in climate risk consulting, environmental finance, carbon trading, sustainability governance, and policy research are expanding rapidly. Universities, businesses, and governments are seeking individuals equipped with specialized

knowledge in risk assessment, emissions management, compliance frameworks, and energy transition planning.

Courses in climate risk and sustainability not only enhance professional competencies but also open doors to impactful careers in financial institutions, corporate sustainability departments, environmental consultancies, government agencies, and international organizations. They prepare individuals to thrive in sectors that are increasingly shaped by climate priorities.

### **Enabling Resilient and Sustainable Futures**

At their core, these programs are not just about meeting regulatory obligations or unlocking career opportunities. They are about building the capacity to safeguard communities, economies, and ecosystems from the escalating impacts of climate change. By training professionals in climate risk assessment, energy efficiency, sustainable development strategies, and carbon management, these courses empower societies to:

- Anticipate and mitigate climate shocks
- Ensure resilience of critical infrastructure
- Drive innovation in sustainable technologies
- Align with global commitments such as the Paris Agreement and the Sustainable Development Goals (SDGs)

### **Conclusion**

In today's world, where climate change poses both risks and opportunities, education and training in climate risk assessment and sustainability are no longer optional — they are essential. They prepare individuals and organizations to move beyond reactive measures, toward proactive, strategic, and science-based responses. By fostering expertise in regulatory compliance, risk management, energy transition, and sustainability governance, such courses contribute to building a new generation of professionals who can lead the way in creating resilient economies and a sustainable future.

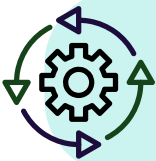


# Workplace Sustainability: How Administration Can Reduce Carbon Footprints



## Administration as a Driver of Sustainability

Beyond managing daily operations, office administration can lead meaningful climate action by integrating sustainability into energy use, procurement, and workplace policies.



## Greening Everyday Operations

Simple steps like using LED lighting, efficient equipment, waste segregation, and promoting eco-friendly commuting can significantly cut a workplace's carbon footprint.



## Building a Sustainable Work Culture

Engaging employees through awareness drives and green initiatives turns sustainability from a policy into a shared habit—creating long-term environmental and social impact.



-By Dipti Agarwal  
(Sr. HR & Admin)  
The Celestial Earth

Climate change is one of the biggest challenges of our time, and while we often think of industries, factories, or transport systems as the main contributors, the truth is that even our workplaces play a role in adding to carbon emissions. The way offices are run, the resources they consume, and the habits they encourage all leave an impact. This is where administration, often considered a behind-the-scenes function, can step in as a real driver of sustainability.

### Energy efficiency in daily operations

One of the simplest yet most effective ways to reduce a workplace's carbon footprint is through better energy management. Something as basic as switching to LED lights, maximizing natural daylight, or setting office air conditioners at optimal temperatures makes a noticeable difference. Administration teams can also ensure that computers, printers, and other equipment are switched off after hours

instead of being left on standby. Regular maintenance of electrical systems prevents energy wastage and even reduces costs—proving that sustainability and savings can go hand in hand.

### Sustainable procurement choices

Another area where administrative decisions count is procurement. Every purchase, no matter how small, leaves a footprint. Choosing recycled paper, promoting digital documents over printing, and buying eco-friendly stationery and cleaning supplies are easy steps. When it comes to office equipment, opting for energy-efficient models not only reduces emissions but also lowers electricity bills over time. By embedding sustainability into purchasing policies, administration can influence change in every corner of the workplace.

### Waste reduction and recycling

Waste is a visible problem in most offices, but

it can also be one of the easiest to tackle with the right systems. Setting up separate bins for paper, plastics, and organic waste is a simple start. Encouraging employees to bring reusable water bottles and coffee mugs can drastically cut down on single-use plastic. Food waste from office canteens or pantries can be composted, and recycled materials can be sent to certified waste handlers. These small steps create a workplace culture where reducing waste becomes second nature.

### **Greener commuting practices**

The carbon footprint of a workplace isn't limited to what happens inside the office—it also includes how employees travel to and from work. Encouraging carpooling, supporting the use of public transportation, and providing facilities such as bicycle stands can help reduce commuting-related emissions. In today's world, even allowing flexible or hybrid work arrangements helps lower travel footprints while also supporting employee well-being.

### **Creating awareness and engagement**

Policies alone cannot bring change unless

people are involved. HR and administration together can play a big role in raising awareness about sustainability. This could mean organizing workshops, setting up "green office challenges," or simply recognizing employees who take initiative in reducing waste or saving energy. When staff feel engaged and rewarded, sustainable practices become an integral part of the office culture, rather than just rules to follow.

### **Conclusion**

Workplace sustainability doesn't require massive investments or dramatic changes. It begins with small, practical steps led by the administration, and grows stronger when employees are brought on board. By making conscious choices in energy, procurement, waste, commuting, and awareness, administration can significantly reduce an organization's carbon footprint. More importantly, it sets the tone for a culture of responsibility—where sustainability becomes a way of life both inside and outside the office.





# Fast Fashion: An Environmental Disaster



**Fast fashion drives massive environmental damage**, contributing nearly 10% of global carbon emissions, expanding waste, and accelerating water and resource depletion.



**Synthetic fibres, toxic dyes and a culture of disposability fuel pollution**—microplastics, chemical runoff, and 92 million tonnes of textile waste annually, much of which ends up in landfills or low-income countries.



**Global policy action enrisng**, with the EU and UN pushing for circularity, waste reduction, and extended producer responsibility, while the slow-fashion movement promotes durability, repair, and mindful consumption.



-By Ishita Rathore  
(Research Associate),  
The Celestial Earth

Over the last two decades, fashion has shifted from slow, seasonal cycles to a relentless stream of new styles, discounts and micro-trends. What once represented craftsmanship is now driven by rapid production and excessive consumption, making garments cheaper, shorter-lived and more disposable than ever. Behind the glamour is a hidden ecological crisis one where rivers turn toxic, carbon emissions rise, and millions of tonnes of waste pile up across the world. Fast fashion's impact extends far beyond overflowing wardrobes; it affects the climate, ecosystems, and communities that bear the environmental costs. Understanding this crisis requires looking closely at the industry's resource and energy demands, its mounting pollution and waste, and the global policy movement attempting to slow the damage.

## **Carbon, Energy and Resource Intensity**

Much of fast fashion's environmental burden begins long before a garment reaches a store.

The global textile sector produces nearly 10 per cent of all carbon emissions, exceeding the combined emissions of international flights and shipping. This footprint is fuelled by energy-intensive processes at every stage of production. Cotton cultivation requires enormous quantities of water and relies on fertilisers and pesticides that are energy-heavy to manufacture. A single cotton t-shirt can consume more than 2,700 litres of water, revealing the scale of resource extraction behind everyday purchases.

Synthetic fibres, especially polyester, add another layer of impact. Produced from fossil fuels, polyester requires high heat, chemical processing, and large amounts of electricity, much of it generated from coal, in major manufacturing regions. Polyester production emits significantly more CO<sub>2</sub> than cotton and continues to pollute long after production through microfibres shed during washing. The dyeing and finishing stages further amplify the

energy footprint, as factories consume vast amounts of heat, steam and electricity. In countries where renewable energy is limited, these processes remain heavily dependent on fossil fuels, embedding carbon into the lifecycle of every garment.

### **Waste, Pollution and the Culture of Disposability**

Fast fashion's business model depends on speed, quantity, and constant newness. As a result, clothing is discarded more quickly than ever. Globally, an estimated 92 million tonnes of textile waste is generated each year, with the majority burned or dumped in landfills. In the European Union alone, citizens discard about 12 kilograms of clothing annually, but only around 1 per cent is recycled into new textiles. The rest sits in landfills where synthetic fibres can take centuries to break down or is incinerated, releasing additional greenhouse gases and toxic fumes.

Pollution is woven into every stage of the textile lifecycle. Toxic chemicals used in dyeing and finishing frequently enter rivers and groundwater, harming aquatic life and contaminating water sources for communities living near production hubs. Synthetic garments release microplastics during washing, adding to the growing crisis in marine ecosystems. Many low-income countries have become destinations for exported textile waste, resulting in vast dumpsites where mountains of discarded garments degrade local soils and waterways. These environmental inequalities show that the global South often shoulders the heaviest burden of the global North's fast-fashion consumption.

### **Policy Momentum and Paths to Change**

As the scale of damage becomes increasingly

visible, governments and international bodies are pushing for stronger oversight. The European Union has recognised textiles as one of the most environmentally harmful consumption categories and is now implementing measures to shift the sector towards circularity. These include mandatory textile-waste collection, bans on destroying unsold garments, and extended producer responsibility schemes requiring brands to finance recycling and waste-management systems. Together, these reforms aim to reduce resource use and close the loop on textile production.

The United Nations has also placed fashion at the centre of discussions on climate change, pollution and biodiversity loss the "triple planetary crisis." Growing consumer awareness has given rise to the slow-fashion movement, which emphasises durability, repair, mindful consumption and reduced waste. However, meaningful change will also require cleaner energy in manufacturing hubs, transparent supply chains and a shift in how brands design, market and value clothing.

### **Conclusion**

Fast fashion may appear affordable and attractive, but its true cost is borne by the planet. High energy use, carbon emissions, water depletion, toxic pollution and mounting waste make it one of the most environmentally damaging industries of our time. Yet with strong policies, responsible production and conscious consumer choices, the sector can move toward a more sustainable and circular future. Transforming fashion is not just a trend it is a climate and ecological necessity.



# From Vulnerability to Resilience, A Navigation of Sustainable Development in the Climate Crisis Era



**Rising climate risks demand urgent action:** Record emissions, extreme weather, and economic losses highlight the narrowing window to meet global climate and development goals.



**Renewables and equity enable resilience:** Accelerating clean energy transitions, supported by inclusive finance and adaptation measures, is key to achieving sustainable and resilient development.



-By Kajal Barman  
Global Sustainability,  
Carbon Professional,  
UAE & PhD Scholar at  
SPPU, India

## 1. Introduction:

The defining challenge of the 21st century is balancing human development needs with the planet's ecological limits. The intersection of sustainable development, climate change, biodiversity loss, and social equity presents a complex global crisis that requires integrated, urgent, and science-driven responses. Development pathways must now address economic growth while ensuring environmental protection and social inclusion, making sustainability central to long-term resilience.

### 1.1. The Current Climate Crisis:

The evidence of accelerating climate change is unequivocal. Global greenhouse gas emissions reached a record 57.1 gigatons of CO<sub>2</sub> equivalent in 2023, reflecting a 1.3% rise from 2022. Even more concerning, 2024 was confirmed as the hottest year on record, with global temperatures approximately 1.55°C above pre-industrial levels, indicating that the 1.5°C Paris Agreement threshold is close to being breached.

Between 2011 and 2020, Earth's average temperature increased by 1.09°C compared to 1850–1900 levels. Extreme weather events that once occurred once a decade in the late

19th century now occur nearly three times per decade. These changes translate into real human suffering, economic damage, and ecosystem degradation, disproportionately affecting developing countries and vulnerable communities.

## 2. Interconnections Between Climate and Sustainable Development:

Climate change and sustainable development are deeply interconnected challenges. Research shows a shift from general climate discourse toward specialized themes such as mitigation, adaptation, and the Sustainable Development Goals (SDGs). Bibliometric studies identify 19 research clusters linking climate change with SDGs, particularly agriculture, water, energy, ecosystems, and sustainable management.

Without adaptation, climate impacts could reduce global GDP by up to 4.4% annually, with developing economies facing the highest risks. This highlights that climate action is not only an environmental necessity but also an economic imperative, as the cost of inaction far exceeds the investment required for sustainable solutions.

### 3. Renewable Energy as The Engine of Transition:

Renewable energy is a cornerstone of climate mitigation and sustainable development. Global renewable capacity grew by a record 15.1% in 2024, reaching 4,448 GW, driven largely by solar and wind expansion. Solar power alone doubled over the past three years, exceeding 2,000 TWh and becoming the largest source of new electricity generation globally.

Low-carbon power sources accounted for over 40% of global electricity in 2024 for the first time since the 1940s. Despite this progress, current growth rates remain insufficient to meet the goal of tripling renewable capacity by 2030, which requires sustained annual growth of 16.6%.

### 4. Pathways to Sustainable Development:

Research highlights multiple pathways to achieve climate and sustainability goals through sustainable lifestyles, green innovation, and government-led transformation. These pathways challenge the notion that sustainable development is unattainable, showing instead that coordinated action can redirect unsustainable trajectories.

#### 4.1. Mitigation Strategies:

Deep, rapid, and sustained reductions in greenhouse gas emissions across all sectors are essential. The IPCC stresses that global emissions must be nearly halved by 2030, with

a decisive shift from fossil fuels to renewable energy systems.

#### 4.2. Adaptation Measures:

Strengthening resilience through disaster risk reduction, water management, climate-smart agriculture, and urban planning is critical. Effective adaptation reduces economic and human losses, particularly in developing nations.

#### 4.3. Finance and Investment:

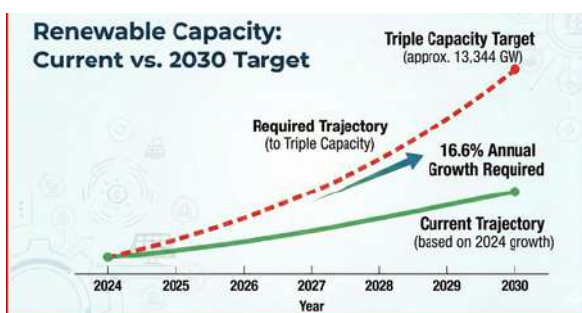
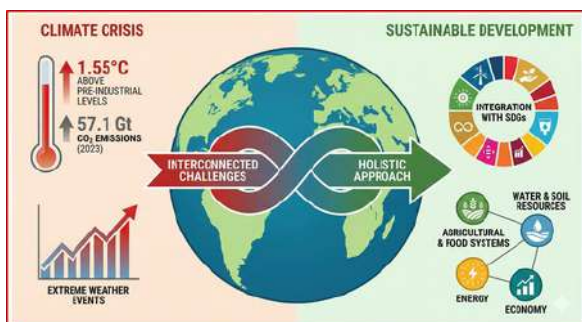
At COP29 in 2024, governments agreed to a new climate finance goal of at least \$300 billion annually by 2035, with ambitions to scale financing to \$1.3 trillion per year.

### 5. Regional Disparities and Equity Considerations:

Climate impacts are unevenly distributed, with low-income and high-inequality countries facing greater risks. Research output is also geographically concentrated, underscoring the need for inclusive participation in knowledge generation and implementation.

### 6. Conclusion:

The convergence of climate change and sustainable development requires systemic transformation across energy, resource management, and governance. With coordinated global action, adequate financing, and a strong commitment to equity, resilient and sustainable development remains achievable, though the window for action is rapidly narrowing.



A futuristic digital head with glowing blue lines and nodes, symbolizing AI and technology. The head is composed of a network of interconnected points and lines, with a central face that has closed eyes. The overall aesthetic is clean, modern, and high-tech, with a cool blue color palette.

# **AI/ML Tools & Other Technologies**

## **Insights and Innovations**

# Digitalization of Distribution Network:

## An Essential Step towards 500 GW+ RE Capacity Augmentation in India



### Digitalization is critical to achieving India's 500 GW

**renewable target**, as legacy distribution networks designed for one-way power flow are ill-equipped to manage variable, decentralized, and bidirectional renewable energy.



### An integrated digital stack—

smart sensing, robust communications, and AI-driven intelligence—combined with ADMS platforms can significantly enhance grid stability, reduce curtailment, and manage safely.



### SPIBEAT enables data-driven solar-grid planning by linking high-resolution resource data with feeder-level grid

**constraints** and techno-economic analysis, helping DISCOMs optimize siting, defer upgrades, and improve renewable integration outcomes. (\*1)



-By Dr. Anindya  
Bhattacharya  
(Exec. Director),  
The Celestial Earth

India has set an ambitious target of achieving 500 GW of renewable energy (RE) capacity by 2030, a cornerstone of its pathway to net-zero emissions by 2070. While policy and investment attention have largely focused on expanding solar parks, wind farms, and hybrid projects, a critical enabler remains underemphasized: the digitalization of India's distribution network. Without a modern, intelligent distribution backbone, integrating 500 GW+ of variable renewable capacity will be increasingly difficult, leading to grid instability, curtailment losses, and under-utilized assets. Strengthening the distribution layer is therefore not a parallel reform—it is foundational to the success of India's clean energy transition.

### The Distribution Challenge in RE Integration

India's distribution system, primarily operated by state DISCOMs, was historically designed for unidirectional power flow—from centralized generation to passive consumers. Renewable

energy disrupts this architecture. Solar and wind are variable, geographically dispersed, and increasingly bidirectional due to rooftop solar and prosumer participation. Much of the current infrastructure still relies on manual monitoring, reactive fault response, and limited real-time visibility, making it ill-suited for high RE penetration.

The scale of the challenge is significant. A large share of the planned 500 GW will come from distributed generation connected at the distribution level. Without digital visibility and control, DISCOMs risk voltage excursions, frequency deviations, reverse power flow stress on transformers, and localized outages during rapid weather-driven fluctuations. The issue is therefore not merely capacity addition but system intelligence and flexibility.

### What Digitalization Entails

Digitalization of the distribution network rests on three interconnected layers: sensing,

communication, and intelligence. The sensing layer deploys smart meters, IoT devices, and phasor measurement units (PMUs) to capture real-time data on voltage, current, frequency, and power quality. The communication layer—leveraging fiber, 4G/5G, and LPWAN—ensures reliable data transfer to control centers. The intelligence layer uses AI-enabled analytics, digital twins, and automation to optimize load balancing, forecast faults, and trigger demand response or storage dispatch in near real time.

At the system level, Advanced Distribution Management Systems (ADMS) act as the operational brain by integrating SCADA, outage management, GIS, and forecasting tools into a unified control environment. Together, these components enable DISCOMs to transition from reactive operations to predictive, data-driven grid management.

### **SPIBEAT: Pioneering Solar-Grid Integration Tools**

A major gap in India's RE journey is the lack of localized, spatially aware planning tools that simultaneously consider solar resource potential and grid constraints. SPIBEAT (Solar Power Integration and Business Evaluation Analysis Tool), developed by The Celestial Earth, addresses this need by combining high-resolution satellite-derived solar data with detailed grid topology and techno-economic modeling.

Unlike generic planning approaches, SPIBEAT incorporates feeder capacity, transformer loading, voltage drop behavior, and fault indices to identify where solar additions can be absorbed and where they may trigger network stress. Its spatial analytics help DISCOMs distinguish between areas requiring infrastructure upgrades and those with available hosting capacity. The business evaluation module further models tariff impacts, avoided losses, and grid stability costs, enabling more informed investment decisions. Early pilot applications have demonstrated measurable reductions in curtailment and the deferral of costly network upgrades through optimized solar siting.

### **Unlocking RE Integration Benefits**

Digitalization—supported by platforms such as SPIBEAT and ADMS—directly addresses three core bottlenecks in large-scale RE integration.

First, grid stability improves through AI-based forecasting of solar and wind variability, allowing operators to proactively manage voltage and reactive power. Hyper-local forecasting at sub-feeder level enables pre-emptive deployment of voltage regulation and compensation devices.

Second, curtailment can be reduced through dynamic congestion management and better spatial planning of new RE assets, improving overall system efficiency and financial returns.

Third, two-way power flow becomes manageable as smart inverters with volt-var capabilities, coordinated through digital platforms, regulate reverse power injection and protect distribution assets.

### **The Path Forward**

The Revamped Distribution Sector Scheme (RDSS) has committed substantial resources for DISCOM modernization, including smart metering and network strengthening. However, progress remains uneven, with smart meter penetration still limited and ADMS adoption confined to a handful of states. Accelerated implementation is essential. Priorities should include mandating digital-ready infrastructure for new RE projects, establishing interoperable data standards, and advancing a coordinated National Digital Grid Mission.

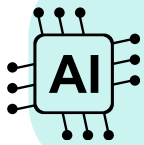
DISCOMs must also adopt advanced planning platforms such as SPIBEAT to move from reactive grid management toward predictive, optimization-driven operations. Integrating spatial planning with real-time grid operations will create the closed-loop intelligence required for high renewable penetration.

Digitalization is no longer an optional efficiency upgrade—it is a prerequisite for India's 500 GW renewable ambition. Without intelligent distribution networks, generation growth risks outpacing deliverability. The strategic choice is clear: digitalize the distribution grid to secure a reliable, flexible, and economically efficient clean energy future.

# Artificial Intelligence and Environment: A Friend or a Foe ?



-By Sanghamitra Das  
(Program Coordinator:  
Europe),  
The Celestial Earth



**AI is both a climate enabler and a climate burden**—driving smarter energy, agriculture, wildlife and waste systems while also increasing data-centre energy use, water demand and e-waste—making global standards and renewable-powered, greener AI essential.

AI presents a classic paradox to the climate crisis in front of us: it offers powerful tools to identify & mitigate environmental damage while simultaneously consuming vast amounts of energy and water and generating significant electronic waste. Understanding this dual impact is essential for guiding the sustainable development and deployment of AI technologies.

## **AI's approach to deal with the challenges**

AI is excellent at processing massive, complex datasets, making it an indispensable tool in tackling global environmental challenges.

Energy optimization and integration of renewable sources. AI is crucial to optimise energy use in buildings and power grids and improve the forecasting and management of renewable energy sources like solar and wind.

Environmental monitoring and conservation. AI-powered analysis of satellite imagery can detect illegal deforestation and wildfires, monitor changes in sea ice, and track the health of coral reefs far faster than human analysts. In wildlife conservation, AI analyzes sensor data and images to track animal populations, detect wildlife diseases in early stages, and combat poaching.

Resource efficiency and circular economy. In manufacturing and transportation AI optimizes supply chains, creating efficient delivery routes to reduce carbon emissions. Boston-based

Geminus AI uses deep learning and advanced reasoning to help oil and gas companies reduce methane flaring and venting, and reduce the energy they use in extracting and refining.

In waste management, AI-guided robotics identify and sort recyclables with greater speed and accuracy, improving recovery rates and helping materials stay in circulation longer. For precision agriculture, AI analyzes soil conditions and weather to minimize water usage and optimize fertilizer application, reducing runoff pollution. US based startup Zanskar has built AI models to understand the Earth's subsurface and locate overlooked geothermal hot spots and target drilling.

## **AI's Environmental Footprint is lethal and the game has only started**

The infrastructure required to develop and run advanced AI models creates a substantial environmental cost, primarily centered on energy, water, and waste.

Energy: Training a single, state-of-the-art LLM (Large Language Model) can consume as much electricity as multiple homes do in a year, equivalent to the lifetime carbon emissions of several cars. Deploying these models in real-world applications, enabling millions to use generative AI in their daily lives, and fine-tuning the models to improve their performance

draws large amounts of energy long after a model has been developed. Because a majority of the world's electricity still comes from fossil fuels, this surge in computational power demand directly increases greenhouse gas emissions.

The International Energy Agency (IEA) predicts global data centres may consume up to 1,000 TWh of electricity in 2026 – an increase of 400% from 2022. Reports from major tech giants support these projections with Google and Microsoft recently disclosing y-o-y increase in emissions challenging their climate commitments.

**Water:** These data centers require enormous volumes of water for cooling their servers especially in warmer climates. GPT-3 is estimated to utilize about one 16-ounce for every 10-50 responses it prepares and this quickly adds up when factoring in billions of queries – with AI’s projected annual water withdrawal to reach 6.6 billion cubic metres by 2027.

The rapid development cycle of AI also contributes to the growing e-waste problem. AI hardware, particularly the high-performance GPUs and specialized chips used in training, quickly become obsolete. This short lifespan leads to a surge in electronic waste, which contains hazardous substances and requires the unsustainable mining of critical minerals for their manufacture, further exacerbating resource depletion and pollution.

This pie chart shows the results of the first multi-criteria Life Cycle Assessment (LCA) study done in 2025 evaluating all the environmental and health impacts of AI worldwide, conducted by

Green IT (non profit association, France). According to this study, the current environmental impacts of AI are as follows:

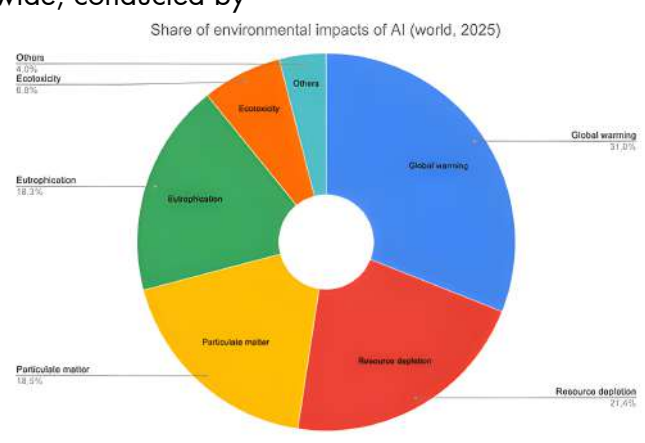
- Global warming: 41 million tonnes of CO2 equivalent;
- Resource depletion: 376 tonnes of antimony equivalent (SB);
- Particulate matter (air pollution): 5 deaths per day;
- Eutrophication: 19,123 tonnes of phosphorus equivalent (P)

By 2030, these impacts will have increased sevenfold, to reach up to 62% of the European Union’s sustainable annual budget. This is, by definition, unsustainable.

In conclusion, while AI offers transformative potential in the fight against climate change—from smart energy grids to precision conservation—its growth must be carefully managed. As currently it is supply that is creating the impacts, there is an urgent need to regulate AI players and raise awareness among users. Achieving a truly "Green AI" requires a global commitment to establish standardized procedures and bring appropriate regulations demanding the AI industry to develop more energy-efficient models, transitioning data centers to 100% renewable energy, and establishing circular design principles for AI hardware to mitigate its severe resource footprint.

**Sources:**

- UNRIC, AI and the Environment: Risks and Potentials, 2025.
- International Energy Agency, Electricity 2024: Executive Summary
- "What are the environmental and health impacts of AI?," Green IT



# Smart Climate Monitoring: Using IoT and Drones to Enhance Satellite-based Early Warning Systems



**Integrating satellites with IoT sensors and drones creates a powerful, real-time climate early warning system,** overcoming the spatial and temporal gaps of traditional satellite monitoring.



**IoT devices and drones provide hyper-local, high-resolution data**—from river levels and soil moisture to landslide risks and methane leaks—enabling faster, more accurate alerts and community-level climate insights.



**India's disaster management systems can become more predictive and resilient** by adopting fused satellite–IoT–drone platforms, supported by AI analytics, edge computing, and autonomous drone networks for future climate adaptation.

Climate change is intensifying the frequency and severity of extreme events such as floods, droughts, heatwaves, and storms. Traditional monitoring systems—although highly advanced—often face limitations in spatial detail, temporal resolution, and real-time responsiveness. In this context, integrating IoT sensors and drone-based observations with satellite data is emerging as a powerful solution to build modern, data-driven, smart climate early warning systems.

Satellites have long served as the backbone of environmental monitoring. Systems such as INSAT, MODIS, Sentinel, and Landsat continuously observe atmospheric processes, land surface changes, sea-level trends, and forest conditions. However, they operate at fixed revisit intervals and may struggle with cloud cover, low spatial resolution for micro-scale events, and limited ground validation. This is where IoT and drones add exceptional

value by providing high-resolution, localized, and real-time environmental insights.

## Role of IoT in Climate Monitoring

IoT (Internet of Things) systems consist of interconnected sensors deployed on land, water, and infrastructure. These devices collect climate-critical parameters such as:

- Temperature, humidity, wind speed, and rainfall
- Soil moisture and evapotranspiration
- River water level and discharge
- Gas concentrations such as CO<sub>2</sub>, CH<sub>4</sub>, and NO<sub>2</sub>
- Air quality indicators (PM<sub>2.5</sub>, PM<sub>10</sub>, ozone)

IoT weather stations and sensor networks transmit data continuously using LoRaWAN, 4G/5G, or satellite IoT networks. This real-time data helps fill spatial gaps left by satellite sensors and provides accurate ground truth for model calibration.



-By Bhartendra Kumar  
(GIS Engineer),  
The Celestial Earth

For example, during heavy rainfall events, river-level sensors can instantly detect rising water and send alerts to emergency authorities far before riverbanks overflow. Similarly, IoT-enabled soil moisture sensors can warn of drought stress in agriculture, helping farmers and decision-makers plan irrigation and water resource management more effectively.

### Role of Drones in Climate Monitoring

Drones, or unmanned aerial vehicles (UAVs), are revolutionizing climate data collection through their flexibility, high-resolution cameras, multispectral sensors, and thermal imaging capabilities. Unlike satellites, drones can fly during cloudy conditions, hover over specific locations, and provide centimeter-level detail.

Drones support climate monitoring in multiple ways:

- Mapping flood-affected areas in real time
- Detecting landslides and slope instability
- Monitoring forest health and fire risk
- Measuring methane leaks in industrial zones
- Creating 3D models of glaciers, rivers, and coastlines

During emergencies, drones enable rapid damage assessment and support rescue operations when roads are inaccessible.

### Integration with Satellite-based Early Warning Systems

The true strength of smart climate monitoring emerges when satellite data, drone imagery, and IoT sensor streams are combined on a

single analytical platform. This fusion of multi-scale data improves accuracy, reduces uncertainty, and enhances predictive capabilities.

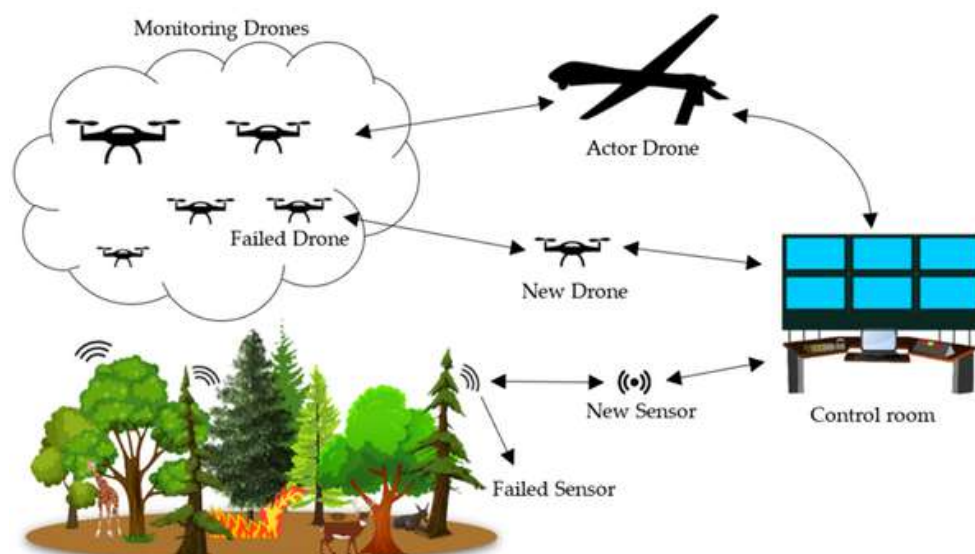
### Key integration benefits include:

- Improved early warning accuracy: Ground sensors validate satellite observations, reducing false alarms.
- Real-time monitoring: Drones and IoT provide continuous updates between satellite passes.
- Micro-level detail: High-resolution drone data helps identify community-level risks.
- Rapid response: Authorities receive instant alerts and can mobilize resources quickly.
- Better climate modelling: Fused datasets improve the reliability of numerical weather prediction and risk forecasting models.

### Applications in India and Future Potential

India is rapidly adopting digital technologies for disaster preparedness under initiatives such as the Integrated Flood Warning System (I-FLOWS), IMD's Agromet Advisory, and ISRO's satellite-based monitoring. Integrating IoT and drones into these systems can transform them into more proactive, localized, and community-centric tools.

In the future, AI-driven analytics, edge computing, and autonomous drone fleets will further strengthen climate resilience. Smart climate monitoring will not only improve disaster preparedness but also support renewable energy planning, agriculture, water management, and urban climate adaptation.



# Geo-AI for a Better Tomorrow: Merging Space, Data, and Intelligence



## Geo-AI as a Game-Changer for Environmental Intelligence

Geo-AI merges satellite data, GIS, and AI to deliver real-time, automated insights—replacing slow manual mapping with fast, scalable intelligence for environmental monitoring and climate resilience.



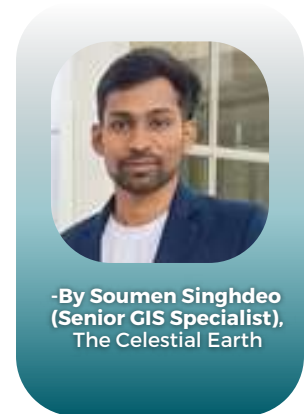
## TCE's Geo-AI Adoption Through SPIBEAT <sup>(\*)</sup>

TCE's SPIBEAT tool uses satellite imagery and AI to extract building details and estimate cooling and energy demand, supporting smarter urban planning and climate-responsive infrastructure design.



## Geo-AI in Action: Renewable Energy Planning in Goa

Geo-AI-driven modelling in Goa identified optimal solar sites, grid stress points, and transformer-level integration limits, helping plan safe, efficient, and future-ready renewable energy expansion.



-By Soumen Singhdeo  
(Senior GIS Specialist),  
The Celestial Earth

Geo-AI is the powerful fusion of satellite data, remote sensing, GIS, and artificial intelligence—that redefining of our observation, analyse, and manage our planet to support sustainable development and climate resilience. Now a day's environmental challenges demand a shift from static maps to dynamic intelligence, where traditional GIS is enhanced by real-time insights, automated analysis, and predictive AI models. This evolution also marks a transition from manual analysis to full automation, where tasks that once required weeks of intensive GIS processing can now be completed within minutes through AI-driven workflows, minimizing human error and maximizing accuracy. Similarly, Geo-AI enables scaling from local projects to global coverage, allowing organizations to move from village level studies to worldwide monitoring using the

same integrated platform.

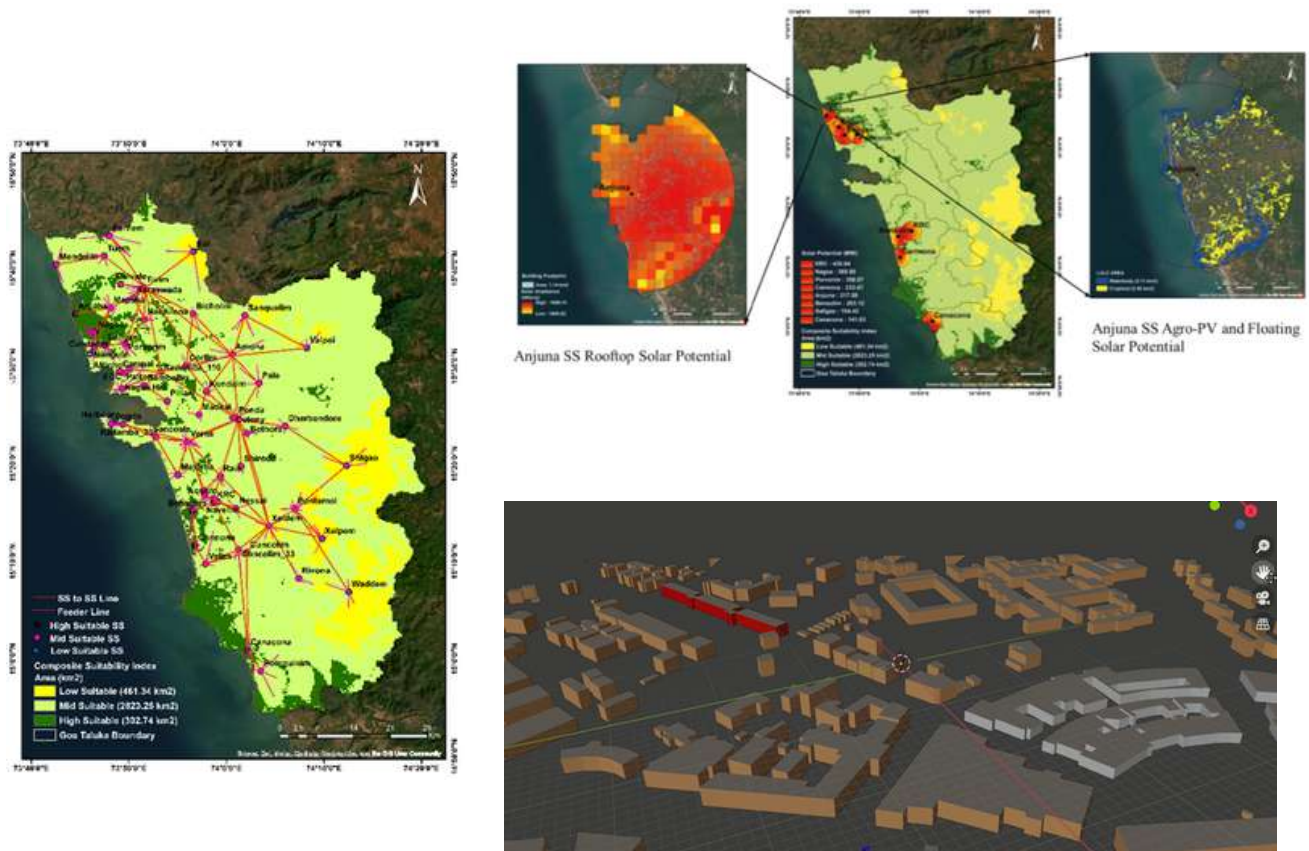
The Celestial Earth (TCE) has already adopted this new technological revolution, embedding Geo-AI across its projects to enhance modelling, ecosystem assessment, energy modelling and environmental policy research. TCE's innovative SPIBEAT tool is the example of this adoption. The tool leverages Geo-AI to automatically derive building height, structure type, and physical characteristics directly from satellite imagery, eliminating the need for ground surveys. SPIBEAT can estimate cooling demand, electrical consumption, and energy requirements for each structure enabling smarter energy planning, climate-resilient urban design, and sustainable infrastructure development with these accurate, building-level insights and their true spatial location.

### Case Study (Capacity Enhancement Planning of Renewable Energy in the State of Goa):

In this project a composite renewable energy assessment framework follows a structured approach focused on combining spatial intelligence with energy modelling to guide sustainable infrastructure planning. The study integrates satellite data processing, GIS mapping, load assessment, and AI-driven simulations to ensure accurate, location-specific outputs. Grid capability, stress points, and the amount of renewable energy that can be safely integrated without causing instability was evaluated through Power Flow Analysis. Additionally, the Identification of suitable sites for solar installation uses MCDA techniques that integrate, load flow data, digital elevation models, building footprint, land-use classification, and solar irradiance modelling to select optimal solar locations with maximum energy yield and minimal environmental impact.

The analysis shows that the existing distribution network especially 33 kV and 11 kV lines is already operating at over 60% capacity, indicating a strong need for grid reinforcement

penetration. Power transformers currently and expansion for higher renewable energy operate at an average of 32% loading, reaching up to 77% at peak, highlighting uneven load distribution. Additionally, evening peak loads exceed daytime loads, indicating that increasing solar generation will require battery storage to avoid curtailment and ensure stable grid operation. In the Porvorim Bazar 11 kV feeder, focusing on the DT25 transformer showed that it could accommodate up to 44% solar penetration, of installed rooftop capacity. Beyond this level, reverse power flow began to occur, indicating the need for power flow control or energy storage. The analysis demonstrated how granular, transformer-level modeling can support safe renewable integration while avoiding grid instability. This example demonstrates how Geo-AI empowers TCE to deliver data-rich, scalable, and future-ready environmental solutions, strengthening its mission to create a greener, smarter, and more sustainable tomorrow by combining space-based intelligence with AI-driven analytics.



# Eyes in the Sky: The Geospatial Revolution against Climate Change



Satellites have revolutionized climate monitoring, replacing slow, ground-based methods with real-time global insights.



Geospatial data reveals alarming climate trends—rising temperatures, shrinking ice, and massive forest loss—accessible to all via digital platforms.



India is spearheading geospatial climate action through its expanding Earth observation satellite fleet and open-access platforms like Bhuvan.



-By Lipsa Pradhan  
(Research Associate,  
GIS)  
The Celestial Earth

Understanding climate change is essential in this day and age, which is characterized by rising sea levels, melting glaciers, unpredictable weather, and a major loss of biodiversity. Thankfully, satellites orbiting thousands of kilometers above us are our strongest allies in this battle, not just scientists on the ground. These “eyes in the sky” have subtly sparked a geospatial revolution that is altering how we track, simulate, and respond to climate change globally.

## From Manual to Orbital: A Paradigm Shift

Historically, ground-based instruments like weather stations, rain gauges, and ecological surveys were used for climate monitoring. During sporadic visits, scientists and field officers took notes on temperature, rainfall, soil moisture, and crop or forest health. This approach had limited coverage, was slow, and required a lot of work, even though it produced detailed information. Coastal regions, deep forests, and mountainous regions frequently lacked adequate data. Furthermore, it took weeks or months to gather, digitize, and analyze climate data, delaying reactions to important occurrences like droughts. India’s

drought monitoring, for instance, used to rely on rainfall variations from dispersed stations, which caused delays in identification. These difficulties demonstrated that conventional approaches were insufficient. The growing need for timely, consistent, and large-scale data led to the development of satellite-based Earth observation systems.

The alternative provided by today’s satellite-based Earth observation systems is revolutionary. The United Nations Office for Outer Space Affairs (UNOOSA) reports that there are currently over 11,000 operational Earth observation satellites, many of which are devoted to monitoring environmental factors. Global coverage, real-time monitoring, and high-resolution data on critical climate variables, including vegetation health, land surface temperature, snow cover, and ocean dynamics, are provided by instruments like MODIS, Sentinel-2, and Landsat. In just a few minutes, these satellites can cover vast and isolated regions. This capacity makes it possible for researchers and decision-makers to identify, monitor, and address climate change far more effectively than in the past.

## Monitoring a warming planet

Satellite data has helped us visualize climate trends like never before.

- Global surface temperature has increased by 1.28°C since the late 19th century (NASA, 2024).
- Arctic sea ice is shrinking at a rate of 12.2% per decade since 1980 (NSIDC, 2024).
- Between 2000 and 2024, Earth lost over 488 million hectares of tree cover. This loss is equivalent to 12% of the planet's forests (Global Forest Watch, 2024).

These are not just numbers; they are mapped realities. With tools like Google Earth Engine, Global Forest Watch, and Bhuvan (India's geoportal by ISRO), anyone, from researchers to citizens, can track these changes.

## Precision tools for Climate Action

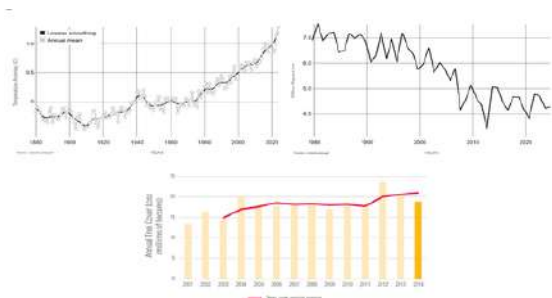
Beyond simple observation, geospatial technology is crucial for planning and climate response. As evidenced by the 2023 Assam floods, satellites such as ISRO's CARTOSAT offer real-time data for mapping floods in disaster management. Satellite imagery is used in agriculture by programs like FASAL and CHAMAN to track crops and predict yields. In order to support climate finance and REDD+ initiatives, carbon monitoring tools like InVEST and Co\$ting Nature calculate the amount of carbon stored in forests and wetlands. Satellite data such as the LST and NDVI are used to identify Urban Heat Islands in urban areas. The creation of green infrastructure to increase resilience is guided by this data.

## India's Role in Geospatial Climate Space

By employing space technology to monitor and address climate change, India is contributing

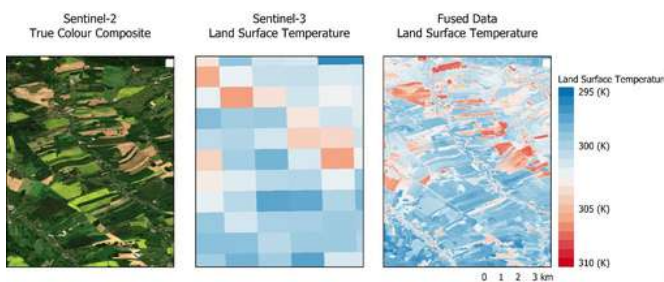
significantly to the geospatial climate revolution. The nation gathers vital information on weather, vegetation, soil, water, and land use through an expanding fleet of Earth observation satellites, including INSAT, Resourcesat, RISAT, Cartosat, and the recently launched NASA-ISRO NISAR. Platforms like Bhuvan, VEDAS, and MOSDAC provide user-friendly tools for environmental analysis and climate data visualization. These aid in agriculture, forest monitoring, and disaster management. Through programs like the NRSC Climate Data Services Portal, local organizations, NGOs, and students can now access satellite data, enhancing climate resilience at the grassroots level. India's dedication to a climate-smart future is demonstrated by its emphasis on digital public goods, such as FASAL and CHAMAN.

**Conclusion:** A Future Mapped from above The shift from ground-based observation to satellite-powered geospatial intelligence marks a transformative moment in how we understand and respond to climate change. As the climate crisis intensifies, the ability to monitor, predict, and act in near real-time has never been more crucial. Satellites don't just give us data—they give us foresight, equity in access, and the ability to craft science-driven, scalable solutions. With countries like India stepping forward through ambitious satellite programs and digital public platforms, geospatial technology is no longer a niche tool—it's becoming the backbone of climate resilience. By embracing this revolution from above, we are not only mapping the impacts of climate change but also charting a smarter, more sustainable path forward for generations to come.



Long-Term Trends in Temperature Rise, Arctic Sea Ice Decline, and Global Tree Cover Loss

Source: NASA Climate Change ([climate.nasa.gov](https://climate.nasa.gov)), NSIDC ([nsidc.org](https://nsidc.org)), Global Forest Watch ([www.globalforestwatch.org](https://www.globalforestwatch.org))



# How Python, Programming, and Automation Are Advancing Sustainability and Climate Action



**Python and automation are powering climate action** by enabling advanced climate data analysis, smarter renewable energy systems, efficient buildings, resilient agriculture, and cleaner industrial operations.



**Accessible digital tools like Python are democratizing sustainability**—supporting carbon accounting, ESG reporting, education, and citizen engagement while driving a more climate-resilient, data-driven future.



-By Ravikant Namdev  
(Java Developer),  
The Celestial Earth

Climate change has become one of the defining challenges of our time, affecting ecosystems, human health, economies, and global stability. As countries pursue carbon neutrality and sustainable development goals, digital technologies have emerged as powerful enablers. Among these, Python, programming, and automation stand out for their versatility, accessibility, and growing integration across climate-focused sectors. These tools support data-driven decision-making, optimize renewable energy, enable smart infrastructure, improve resource management, and boost climate resilience.

## 1. Transforming Climate Science Through Data and Programming

Climate research relies on massive datasets from satellites, sensors, and weather stations. Python's scientific ecosystem—NumPy, Pandas, SciPy, xarray, Matplotlib, and netCDF4—helps scientists clean, analyze, and visualize this data with efficiency. These tools reveal long-term temperature shifts, rainfall variability, sea-level rise, and pollution trends.

Machine learning frameworks such as TensorFlow, PyTorch, and scikit-learn further

enhance predictive capabilities. By training models on historical data, researchers can forecast extreme events like heatwaves, storms, and droughts. These insights strengthen disaster preparedness and policy planning, reducing risks to communities and infrastructure. Python's ease of use ensures that environmental scientists and planners can perform advanced analysis without deep programming expertise.

## 2. Enabling Renewable Energy Optimization and Energy Transition

The shift to renewable energy is essential for a sustainable future. Python plays a crucial role in planning and optimizing solar, wind, hydro, and hybrid systems. Tools like PyPSA, HOMER, pvlib, and SAM APIs allow engineers to model energy generation, storage efficiency, load patterns, and grid behavior.

Python helps energy planners:

- Estimate solar output based on irradiance data
- Calculate wind turbine performance
- Optimize battery storage and dispatch
- Design district heating and cooling systems
- Identify cost-effective renewable mixes



# CAPTURING THE WILD-LIVES & NATURE



Long legged Buzzard



**PHOTOGRAHER: MR. MANOJ KADUNGANATIL**

(HEAD OF MARKET & ENTERPRISE RISK- AHILBANK QATAR)

**Location:** Doha; Qatar. **Gears Used:** Nikon z8. **Lens:** Nikon Z8 & 180 - 600 mm lens

# CAPTURING THE WILD-LIVES & NATURE



Marsh Harrier, catching fish at Doha

**PHOTOGRAHER: MR. MANOJ KADUNGANATIL**

(HEAD OF MARKET & ENTERPRISE RISK- AHILBANK QATAR)

**Location:** Doha; Qatar. **Gears Used:** Nikon z8. **Lens:** Nikon Z8 & 180 - 600 mm lens

# CAPTURING THE WILD-LIVES & NATURE



Smog of Delhi NCR during winter, showing extreme pollution level from 48<sup>th</sup> floor where it shows that surface level pollution is higher than top level

**PHOTOGRAPHER:** MS. AUDRIJA BHATTACHARYA (LONDON SCHOOL OF ECONOMICS),

**LOCATION:** HIGH-RISE HOUSING SOCIETY OF GURUGRAM, HARYANA, INDIA

**PHOTO SPECIFICATIONS:** SHOT BY- NIKON D3500, LENS: 700-300 MM

# CAPTURING THE WILD-LIVES & NATURE

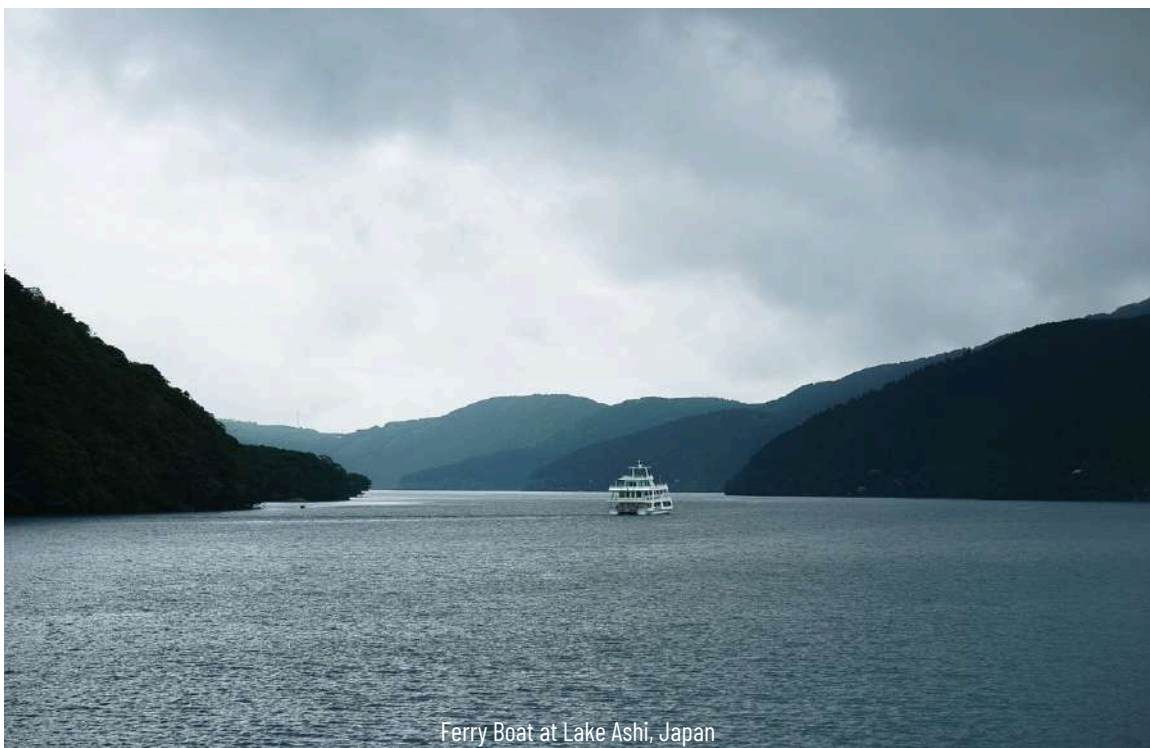


Arabian Fox, at Doha, Qatar

**PHOTOGRAPHER: MR. MANOJ KADUNGANATIL**

(HEAD OF MARKET & ENTERPRISE RISK- AHILBANK QATAR)

**Location:** Doha; Qatar. **Gears Used:** Nikon Z8 & 180 - 600 mm lens



Ferry Boat at Lake Ashi, Japan

**PHOTOGRAPHER: MS. AUDRIJA BHATTACHARYA** (LONDON SCHOOL OF ECONOMICS),

**LOCATION:** LAKE ASHI, HAKONE, JAPAN

**PHOTO SPECIFICATIONS:** SHOT BY- NIKON D3500, LENS: 700-300 MM

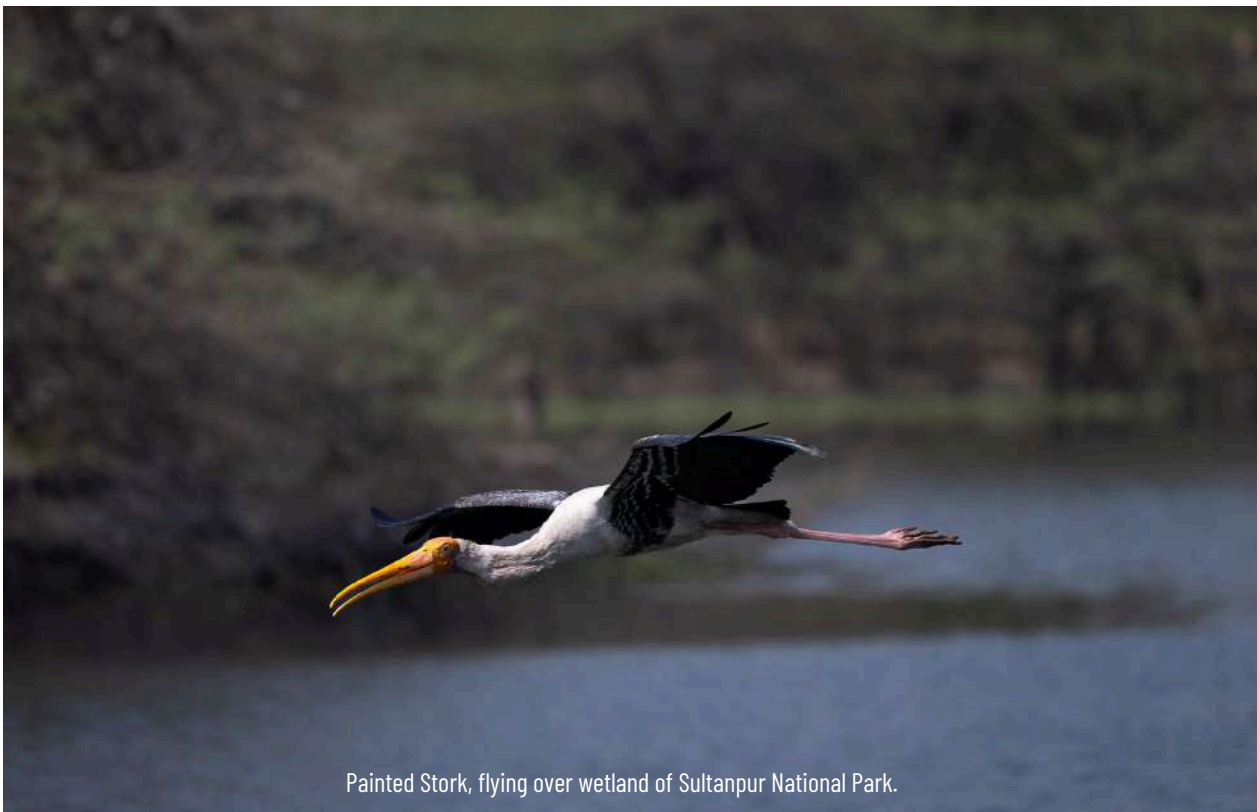
# CAPTURING THE WILD-LIVES & NATURE



Trees and shadows at Regent Park, London.

**PHOTOGRAPHER: DR. ANINDYA BHATTACHARYA** (EXECUTIVE DIRECTOR- THE CELESTIAL EARTH)

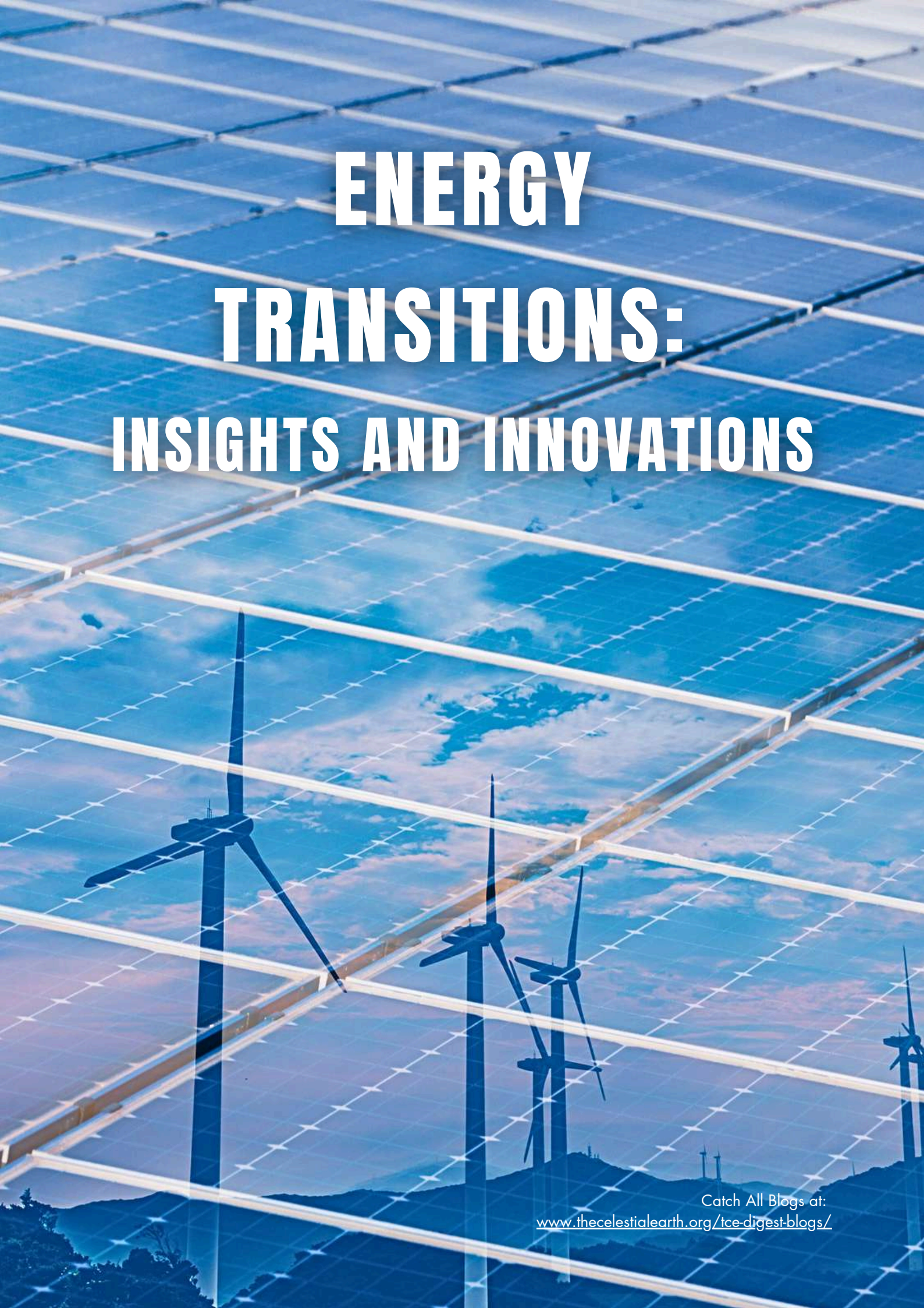
**Location:** Regent Park, London, United Kingdom



Painted Stork, flying over wetland of Sultanpur National Park.

**PHOTOGRAPHER: MR. CHIRAG TANDON, LOCATION: SULTANPUR NATIONAL PARK**

**PHOTO SPECIFICATIONS:** SHOT BY- CANON R5

An aerial photograph of a large-scale renewable energy project. The foreground and middle ground are dominated by rows of solar panels, which are semi-transparent, allowing a view of the landscape below. In the lower portion of the image, several wind turbines are visible, their silhouettes and towers standing against the ground. The background shows rolling hills under a clear blue sky with some light clouds. The overall color palette is a mix of blues, greens, and greys, with a semi-transparent grid overlaying the entire scene.

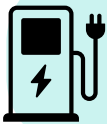
# **ENERGY TRANSITIONS: INSIGHTS AND INNOVATIONS**

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# Unlocking Nari Shakti: Women and the Future of EV Manufacturing in India



**Empowering Women in Clean Mobility** – The shift to electric vehicles is redefining industrial roles, opening new opportunities for women in manufacturing through lighter, tech-driven, and digitally enabled work environments.



**Bridging Gender Gaps through Inclusion** – By integrating gender-responsive design, skilling, and workplace safety, India can embed inclusivity into the DNA of its emerging EV sector.



**Nari Shakti for a Viksit Bharat** – Women's participation in clean mobility is essential for building an equitable, innovative, and resilient manufacturing ecosystem aligned with India's 2047 vision.



-By Dr. Nandini Biswas  
(Behavioural Science  
Specialist )  
Solutions for  
Sustainable Living  
(SoSuL) LLP

As India advances toward the vision of a Viksit Bharat by 2047, a key pillar of national transformation is the transition to clean mobility. Electric vehicles (EVs) are central to this transition—not just from an environmental or energy security perspective, but as an opportunity to create more inclusive, equitable and future-ready industries. Nowhere is this truer than in EV manufacturing and assembly, where technological shifts are altering job profiles and opening the door for enhanced female workforce participation.

According to Social Role Theory, occupational roles and gender expectations are shaped by societal norms around what men and women are "supposed" to do. In traditional automobile manufacturing—dominated by heavy, mechanical tasks—men have historically filled most roles, reinforcing the stereotype that industrial work is "male work." But clean mobility is changing that narrative.

**Technological Shifts: Redefining Gender Roles**

## **in Auto Manufacturing:**

The pivot to EVs represents more than a change in drivetrain. EV manufacturing involves lighter, electronic components, such as battery packs, power electronics, and thermal management systems—replacing the bulky, combustion-centric machinery of ICE vehicles. This shift reduces the emphasis on brute physical strength and increases the importance of dexterity, precision, digital literacy, and modular assembly line operations.

Women are inherently well-suited for these roles. With minor ergonomic adjustments to assembly lines—such as lowering workstation heights or introducing foot-operated controls—women can be deployed just as effectively as men in these manufacturing roles. By designing inclusive shopfloors, companies are beginning to challenge the structural and psychological barriers that have long excluded women from core automotive jobs.

**The Indian Context: From Low Participation to** 53

## High Potential:

Overcoming a history of low female labour force participation, India has made notable progress in recent years, increasing participation from 23.3% in 2017–18 to 41.7% in 2023–24. Yet, the transport and automobile sectors—long dominated by men—continue to mirror deep-rooted gender disparities. Data from the e-Shram Portal illustrates this gap clearly: of the 8.4 million unorganised workers registered in the automobile and transportation industries, only 0.2 million are women.<sup>1</sup> This means that women account for just 2.6% of the workforce in these sectors.

In the context of EV manufacturing, however, there is a real opportunity to reverse this trend. New factories are being designed from scratch. Fresh job roles are being created. Unlike legacy ICE roles that are deeply male-coded, many EV roles are neutral or yet-to-be gendered. This is a golden window for India to design gender inclusivity into the DNA of its clean manufacturing sector. Although subnational experience shows promising trends, there exists widespread variations across states. Tamil Nadu, Karnataka, and Maharashtra are emerging as leaders in gender-inclusive EV manufacturing. These states demonstrate that policy intent, skilling infrastructure, and industry commitment can converge to unlock women's participation—setting a precedent for others to follow.

## Enablers of Inclusion: From Skill to Safety

For women to thrive in EV manufacturing, a holistic set of enablers is essential:

- **Education and Skilling:** There is a growing need for gender-targeted technical skilling programmes—in manufacturing technologies, battery systems, electronics assembly, and automation. Partnerships between industry, ITIs, and skilling agencies must ensure that women not only enter training programmes but also receive placement support.
- **Mentorship and Role Models:** Mentorship plays a crucial role in building confidence and navigating workplace norms.

Creating communities of practice, peer-support networks, and highlighting women leaders in manufacturing helps shift internalised gender expectations.

- **Safe and Enabling Infrastructure:** Infrastructure is not gender-neutral. Well-lit pathways, safe transport options, clean and accessible toilets, changing areas, and women-friendly housing options can be the difference between attrition and retention. Companies must see these not as add-ons but as business imperatives.
- **Workplace Safety and Dignity:** Women must feel safe and respected. Strong inclusive culture, POSH (Prevention of Sexual Harassment) mechanisms, gender-sensitisation training for employees, grievance redressal cells, and zero-tolerance policies help build a culture of inclusion.
- **Awareness and Norm Shifting:** For real inclusion, community-level awareness is essential. Families must see outdoor work as respectable and viable for daughters. Women must be aware of job opportunities and their own capabilities. Media, campaigns, and local champions can play a powerful role in shifting perceptions.

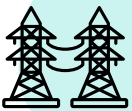
## Inclusive Development as a Cornerstone of Viksit Bharat

As we move towards a Viksit Bharat, it is increasingly evident that a sustainable future must be rooted in inclusive development. If half the population is left behind, no development goal—whether net-zero, industrial competitiveness, or employment—can truly be achieved.

By integrating Nari Shakti into India's clean mobility transition, we not only create a just and equitable pathway, but also enhance productivity, innovation, and resilience in our manufacturing ecosystem. The EV revolution provides India with a rare opportunity: to rewrite the gender script in manufacturing—not just retrofit old hierarchies into new technologies.

Let us ensure that this opportunity is not missed.

# Grid Flexibility and Renewable Energy Integration: Pathways for a Sustainable Power Transition



**Essential Role of Grid Flexibility** – The article stresses that as solar and wind expand rapidly, grid flexibility is vital to maintain stability, reliability, and efficiency in renewable-based power systems.



**Technological and Policy Enablers** – It highlights key solutions such as energy storage, demand response, smart grids, and supportive market and regulatory reforms as critical pathways to enhance flexibility.



**Global Practices and Future Outlook** – Examples from Europe, India, and the USA show how flexibility is being integrated into energy systems, underscoring the need to make it a core feature of future-ready, sustainable grids.



-By Dr. Trina Som  
(Sr. Research Fellow),  
Celestial Earth  
Development Council

## 1. Introduction

With the explosive expansion of renewable energy (RE), especially solar and wind, the world's power landscape has changed. Although they are clean and becoming more affordable, their unpredictability puts grid stability, dependability, and efficiency at risk. Grid flexibility is the ability of the power system to adapt to supply and demand fluctuations, which has become crucial for a resilient and sustainable energy transition [1,2].

## 2. Understanding Grid Flexibility

Grid flexibility refers to the capability of power systems to maintain operational stability while balancing supply and demand across all time scales.

Key aspects include:

- Temporal flexibility: Adjusting generation and demand across daily and seasonal cycles.
- Spatial flexibility: Transfers of power

between areas.

- Resource flexibility: Managing dispatchable plants, storage, and flexible loads.

Flexibility enables high renewable integration without compromising reliability or causing excessive curtailment. Understanding its dimensions helps identify the factors driving the growing need for flexibility in renewable-rich systems.

## 3. Drivers for Flexibility in Renewable-Dominated Grids

The main factors necessitating enhanced flexibility include [3]:

- Variable Generation: Wind and solar power rely on time and weather, necessitating quick response balancing.
- Demand Uncertainty: Electrification of transport and heating increases consumption volatility.
- Congestion & Voltage Issues: Reverse

power flows and localized congestion are caused by high RE penetration [4].

- Decentralization: Expanding distributed energy resources (DERs) necessitate advanced digital coordination and control.

#### 4. Flexibility Pathways and Technologies

To enhance flexibility, several technological and operational pathways have emerged [5,6]:

- Energy Storage Systems: Surplus RE is managed via flow batteries, pumped hydro, and battery storage, which relieves congestion, supports ramping, and controls frequency.
- Demand-Side Flexibility: Consumers can modify loads in response to price signals through Demand Response (DR) programs; flexibility is increased by industrial shifts, EV charging control, and smart appliances.
- Flexible Generation and Infrastructure: Interregional balancing is made easier and curtailment is decreased by dispatchable sources (bioenergy, hydropower, gas turbines) and grid enhancements.
- Digitalization and Smart Grids: IoT sensors, real-time monitoring, and AI-based forecasting improve operational and predictive flexibility at all network levels.

#### 5. Policy, Market, and Regulatory Enablers

Large-scale flexibility cannot be achieved just through technology [7]. It is crucial to have supportive markets and policies:

- Market Reforms: Ancillary service markets and time-of-use tariffs convey the need of flexibility.
- Regulatory Support: Grid-interactive standards and DER participation frameworks.
- Integrated Planning: Coordinated transmission–distribution operations and investment incentives for storage and digital assets.

#### 6. Emerging Global Practices

Global examples demonstrate successful flexibility integration [8,9]:

- Europe: The Netherlands, Germany, and the UK are advancing flexibility markets for

local grid services.

- India: The National Flexibility Scheme promotes RE integration, battery pilots, and dynamic pricing.
- USA: FERC Order 2222 enables aggregated DER participation in wholesale markets.

#### 7. Path Forward

Future-ready grids must embed flexibility as a system attribute. Increasing energy storage, empowering customers with digital tools and dynamic pricing, enhancing connectivity, and incorporating flexibility into planning and regulatory frameworks are some of the top priorities.

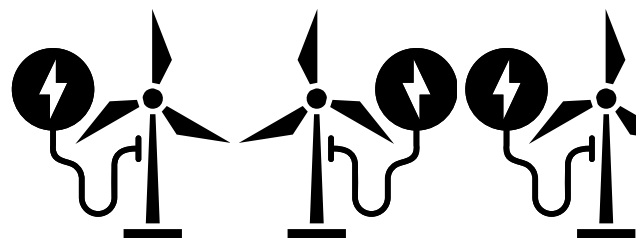
#### 8. Conclusion

Grid flexibility underpins the clean energy transition, ensuring reliability, affordability, and sustainability. Achieving it requires coordinated technological, institutional, and behavioral efforts across all levels of the power system.

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# Flooded Ghats of Varanasi, and the Rise of the Electric Vehicles



## Flooded Ghats Reveal the Urgency of Climate Adaptation

Varanasi's iconic ghats were submerged, silted, or destroyed—showcasing climate change not as theory but as a lived crisis threatening heritage, livelihoods, and urban resilience.



## A Journey That Exposed the Limits of Mitigation Alone

Despite the rise of electric mobility—seen in Varanasi's green autorickshaws—the experience underscored that mitigation is not enough; adaptation and loss-and-damage financing are now critical.



## A City at a Crossroads: Survival vs. Resilience

Temples underwater, havelis collapsing, and the Ganga aarti relocated to rooftops highlight an urgent need for stronger planning, funding, and community-based climate solutions to protect Varanasi's future.



-By Shubhashis Dey  
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Sustainable Living  
(SoSuL) LLP

As Durga Puja 2024 unfolded across India with all its colour, sound, and nostalgia, we finally decided to tick off a long-pending dream: a road trip to Kolkata during the Pujos season. This trip had been on our bucket list forever, but life kept throwing a few speed bumps our way. First, there were my “driving skills,” which, just two years ago, meant I could barely back out of the driveway without risking a minor demolition. Then there was the small matter of carving out enough time for a 3,000-km adventure. But this Pujos, with a break from work and the long-overdue confidence of finally nailing the art of driving, the stars aligned. Nandini and I were raring to go from the start; our friend, the co-traveller, however, still had to charm his way into getting leave.

First stop: Varanasi. The 850-kilometre journey from Gurgaon—through the Mumbai, Yamuna, and Agra-Lucknow expressways and finally NH 371—was uncannily smooth. Twelve hours

later, we checked into the Four Elements hotel. After a quick nightcap, we headed to the Kashi Vishwanath temple at dawn for a swift “darshan” and “rudrabhishek”. The fun twist? We hopped into an electric autorickshaw, Varanasi's eco-friendly experiment trying to coexist with its fleet of petrol and CNG three-wheelers.

But the real purpose of our halt in Varanasi was to visit the famed ghats and witness the Ganga aarti. The catch? Varanasi had been swallowed whole by floodwaters. We knew eastern India had been battered by floods in 2024, but the scale of devastation was far beyond anything we had imagined. Let's just say that no amount of climate talks can prepare you for the Ganges treating city ghats like its own backyard.

Our plan was simple: stroll from Assi Ghat to Manikarnika Ghat, like we did on our last visit in 2018. But this time? Most ghats were missing in action, buried under an insatiable river. Those still above water were smothered

in silt. Temples were underwater, sandbanks vanished, and century-old havelis slid away in mud. Even the Dashashwamedh Ghat aarti had been “evacuated”—now conducted on a building’s terrace, at a safe distance from the river’s unforgiving reach.

As we drifted along the waterlogged remains of Varanasi on a boat, my wife Nandini asked a question that landed with the weight of a sledgehammer: “Will Varanasi be the next Dwarka?” Here it was, climate change, right in front of us—not as abstract “data,” but as a drowned city slowly losing its history. Sure, more electric autorickshaws can trim down air pollution, and, as our power grid eventually turns green, they’ll make a dent on climate change. But here, on the banks of the Ganges, the pressing issue isn’t just cleaner air; it’s

adaptation—hard questions about funding loss and damage, about protecting heritage, infrastructure, and, frankly, the livelihoods of the locals whose lives are built around these ghats.

We left Varanasi with more questions than answers, having witnessed a subdued Ganga aarti that echoed the sombre mood of the city. Climate change is rewriting landscapes everywhere. Sometimes, its presence is overwhelming—like a flood swallowing ancient steps. Other times, it’s the empty absence—of a ghat, a temple, a piece of history. As we continued our Durga Puja 2024 journey toward Kolkata, we promised ourselves we’d return, hopefully to a city that’s found ways to adapt, rather than merely survive.



# The Dual Crisis: Navigating between Renewable Energy and Biodiversity



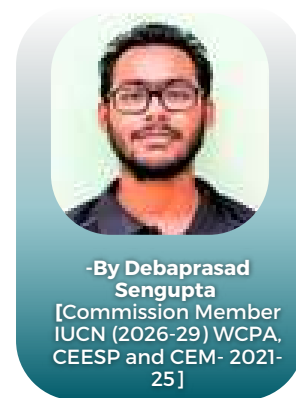
**Climate–biodiversity trade-off:** Renewable energy is essential for decarbonization but large-scale infrastructure can fragment habitats and harm wildlife, creating a potential conflict between climate mitigation and biodiversity protection.



**Impacts concentrated in few sites:** Less than 1% of renewable projects account for nearly 70% of biodiversity impacts, highlighting the importance of careful site selection.



**Strategic planning can reduce impacts:** Low-risk siting, agrivoltaics, technological mitigation, and strong policy frameworks can align renewable expansion with nature conservation.



-By Debaprasad Sengupta  
[Commission Member IUCN (2026-29) WCPA, CEESP and CEM- 2021-25]

The global transition to renewable energy (RE) is the central pillar of climate mitigation, requiring annual investments to more than double from the current \$1.4 trillion baseline by 2030. However, this expansion creates a "dual crisis": while fossil fuels drive biodiversity loss through climate change, RE infrastructure requires extensive land, threatening ecosystems through habitat fragmentation and displacement. These cumulative and often transboundary impacts risk undermining the Kunming-Montreal Global Biodiversity Framework, forcing policymakers to balance rapid decarbonization with the mandate to halt nature loss.

## Quantifying the Global Impact: The START Metric

A global audit of nearly 41,000 RE sites reveals a paradox: infrastructure intended to mitigate climate change is now generating biodiversity pressures comparable to those of entire nations. To quantify this impact,

researchers introduced the Threat-Abatement STAR (START) score, which measures how much species extinction risk could be reduced if biodiversity threats were removed within a given 5x5 km area.

Current operational RE sites collectively generate a biodiversity impact equivalent to the value of the entire forested area of Austria. With RE capacity projected to grow by 5,500 GW by 2030, the sector's biodiversity footprint could reach a scale comparable to the total land biodiversity of Canada.

## Technology-Specific Trade-offs

Evaluating climate–biodiversity trade-offs requires distinguishing between energy technologies, as their ecological footprints vary significantly.

- **Solar Power:** Solar energy contributes 46.9% of the renewable sector's biodiversity impact, largely due to its land intensity and the creation of ecological traps. Insects are often attracted to

- polarized light reflected by panels, drawing birds and bats that risk collisions or, in the case of Concentrated Solar Power (CSP), fatal exposure to solar flux.
- **Wind Power:** Wind energy accounts for only 7.6% of the sector’s terrestrial footprint, yet it creates a lethal ‘vertical gauntlet’ for aerial wildlife. In the United States alone, turbines are estimated to kill between 140,000 and 679,000 birds annually. Beyond collisions, turbines create “zones of fear” where raptors avoid airspace within 600–1000 meters, fragmenting migration corridors.
- **Hydropower:** Hydropower represents 43.9% of the renewable sector’s biodiversity impact because dams are often located in ecological hotspots. Their construction causes extensive inundation and permanent habitat fragmentation, transforming landscapes into isolated ecological islands that trap wildlife populations and accelerate local extinctions through genetic bottlenecks.

### **Species at Risk and the "Top 1%" Problem**

Renewable energy expansion increasingly intersects with conservation priorities: 17% of global facilities overlap with protected areas, contributing to habitat loss for threatened species. However, the damage is highly concentrated. Audits reveal that fewer than 1% of energy sites account for nearly 70% of the sector’s total biodiversity footprint. This concentration suggests that most renewable capacity is environmentally efficient, and avoiding high-risk locations could largely prevent the “dual crisis” of climate and nature loss.

### **The Role of Corporate Finance and Ownership**

Corporate ownership and financing models significantly influence environmental outcomes. Studies show that publicly listed companies select renewable sites with two-thirds higher biodiversity impacts than private firms, largely due to dispersed accountability structures. Private ownership tends to encourage long-term stewardship and reputational accountability. Similarly, projects involving financial

stakeholders perform better environmentally, achieving 10% lower biodiversity impacts due to stronger ESG oversight. Renewable projects funded through project finance (SPVs) also outperform those built directly on corporate balance sheets, as rigorous due diligence by lenders discourages environmentally risky siting.

### **Strategic Siting and Policy Solutions**

Reconciling renewable expansion with biodiversity conservation requires Integrated Power Sector Planning, prioritizing low-conflict zones and mitigation technologies.

#### 1. Low-Risk Siting:

Shifting development toward built environments—such as rooftops, brownfields, and degraded lands—significantly reduces ecological conflict. Expanding rooftop solar alone could reduce the need for land-intensive solar farms by 3–6%.

#### 2. Multi-Use Spaces:

‘Agrivoltaics’ integrates solar panels with agriculture, allowing land to serve dual functions. Panels reduce drought stress on crops while crop transpiration cools panels, improving energy efficiency.

#### 3. Technological Mitigation:

Simple operational changes can significantly reduce wildlife mortality. Painting one wind turbine blade black has been shown to reduce bird collisions by 70%, while raising turbine cut-in speeds can reduce bat fatalities by 33–79%.

#### 4. The Mitigation Hierarchy:

Policies must enforce the sequence of Avoidance, Minimization, Restoration, and Offsetting. Where impacts remain unavoidable, biodiversity offsets—such as retrofitting power lines to prevent electrocution—can help achieve no net biodiversity loss.

### **Conclusion**

A Green Economy must ensure renewable expansion avoids biodiversity loss. Through strategic spatial planning, development on degraded lands, and nature-positive finance, the energy transition can deliver a carbon-neutral and ecologically regenerative future.

# Beyond the Number: What India's 500 GW Non-Fossil Target Really Means for the Power Sector



**500 GW as a system transformation:** India's 500 GW non-fossil target represents a shift toward a cleaner, more resilient power system, integrating renewables, digital grids, storage, and stronger institutional coordination—not just capacity addition.



**Strong progress, persistent bottlenecks:** While nearly half the target has been achieved through solar and wind growth, execution is constrained by DISCOM financial stress, transmission gaps, land and permitting challenges, and insufficient energy storage.



**Coordination is key to success:** Achieving 500 GW will depend on integrated planning, grid readiness, DISCOM reforms, storage deployment, and effective centre–state coordination to translate ambition into a stable, future-ready energy system.



-By Rajib Deb  
(Technical  
Consultant),  
Energy Transition

India's target of achieving 500 GW of non-fossil fuel capacity by 2030 is often viewed as a large numerical milestone. In reality, it represents a far more fundamental transformation of the country's power sector. The ambition is not only about adding renewable energy capacity; it signals India's intent to redesign its electricity system to be cleaner, more resilient, and better aligned with long-term economic growth and development priorities. At its core, the 500 GW target reflects a transition away from a fossil-fuel-centric model toward a system driven by variable renewable energy, digitalized grids, flexible resources, and stronger institutional coordination.

Over the last decade, India has demonstrated strong momentum in renewable energy deployment. Today, the country has already achieved close to 48% of its 500 GW non-fossil capacity target, reflecting steady progress across solar, wind, hydro, and

nuclear energy. Solar and wind have been the primary drivers of this growth, supported by competitive bidding mechanisms, sharp declines in technology costs, and consistent central government policy support. Large-scale solar parks, wind–solar hybrid tenders, Round-The-Clock (RTC) and Firm & Dispatchable Renewable Energy (FDRE) projects, along with expanding domestic manufacturing under the Production Linked Incentive (PLI) scheme, indicate that the foundational building blocks for scale are firmly in place. This progress has reinforced investor confidence and positioned India as one of the world's fastest-growing clean energy markets.

Beyond commissioned capacity, India has also developed a substantial pipeline of renewable energy projects at various stages of bidding, allocation, and construction. Central agencies such as SECI and NTPC continue to drive volumes through innovative tender designs, while several states have announced ambitious

renewable energy targets aligned with national goals. However, the conversion of this pipeline into commissioned assets has been uneven. Importantly, this gap is not driven by a lack of demand or developer interest, but rather by a set of systemic and structural constraints that continue to slow execution.

One of the most persistent challenges is the financial stress of distribution companies (DISCOMs). Weak payment discipline, delayed dues, and concerns around long-term offtake security increase risk premiums and limit the ability of developers to raise affordable finance. At the same time, grid and transmission constraints have emerged as binding limitations. Renewable capacity additions are outpacing the development of both interstate and intrastate transmission networks, leading to congestion in renewable-rich states, curtailment risks, and reduced system flexibility. These issues are likely to intensify as renewable penetration increases further.

Land availability and permitting challenges add another layer of complexity. Right-of-way issues, delays in forest and environmental clearances, and fragmented land acquisition processes introduce uncertainty and extend project timelines. In parallel, the gap in energy storage and system flexibility is widening. Battery energy storage, pumped hydro, and demand-side response mechanisms are not yet scaling at the pace required to balance higher shares of variable renewable energy. Compounding these challenges is fragmented institutional planning, where generation, transmission, and distribution decisions are often taken in silos across ministries, regulators, and state agencies.

Recognizing the importance of grid readiness, the Government of India has launched major transmission-focused initiatives such as the Green Energy Corridor (GEC) Phase I and Phase II. GEC-I laid the groundwork for integrating large-scale renewable energy by strengthening evacuation infrastructure in renewable-rich states and enabling greater

interstate power flows. Building on this foundation, GEC-II aims to further expand transmission capacity, enhance grid stability, and support the next phase of renewable growth aligned with 2030 targets. However, the effectiveness of these initiatives will depend on timely execution and close coordination with state transmission utilities and DISCOMs.

Addressing the remaining gaps will require a shift from project-level interventions to system-level solutions. Integrated planning that aligns renewable capacity addition with transmission development, storage deployment, and demand growth is essential. DISCOM reforms must move beyond periodic financial bailouts and focus on structural improvements in governance, operational efficiency, loss reduction, and tariff rationalization. Energy storage should be treated as core power-sector infrastructure, supported by clear policy signals, appropriate market mechanisms, and enabling regulatory frameworks. Land and permitting processes also need to become more predictable, transparent, and time-bound to reduce execution risk.

Ultimately, achieving 500 GW will depend on effective convergence across policies, institutions, and stakeholders. Renewable generation, grid expansion, storage, domestic manufacturing, financing, and market design must advance in a coordinated manner rather than in isolation. Mission-mode implementation platforms, strong centre–state coordination, data-driven planning, and clear accountability mechanisms will be critical to ensuring that individual initiatives reinforce each other.

Viewed through this lens, India's 500 GW target is not merely about capacity addition. It is about building a power system capable of reliably integrating clean energy at scale. Success will be measured not only in megawatts installed, but in grid strength and flexibility, DISCOM financial health, availability of balancing resources, and institutional effectiveness. In this sense, 500 GW is not just a number—it is a test of India's ability to translate ambition into a stable, sustainable, and future-ready energy system.

A photograph of three birds perched on a tree branch. The birds have long, yellow beaks and are looking towards the right. The tree has sparse green leaves and many bare branches. The background is a clear blue sky.

# OUR CONTRIBUTION TO LOCAL SUSTAINABILITY

@CHIRAG TANDON,  
LOCATION: SULTANPUR NATIONAL PARK, NEW DELHI, INDIA



RESEARCH PAPER ON-

**"CLIMATE RESILIENT SUSTAINABLE DEVELOPMENT: LESSONS TO LEARN FROM HARAPPAN CIVILIZATION BY THE MODERN CITIES OF INDIA"** - WILL BE COMING OUT SOON

Source: Peepul Tree

**GLIMPSES OF THE SITE**

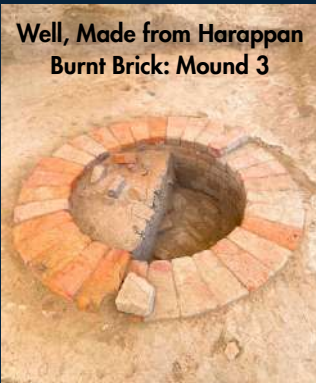
**Overview of Rakhigarhi Excavation Site: Mound 1**

This was assumed to be an industrial sector

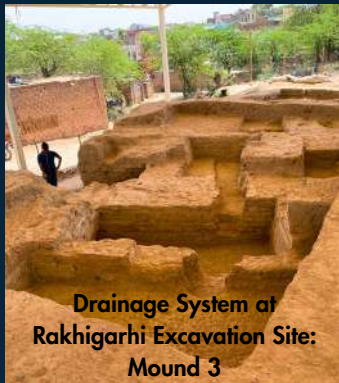


Parrot Wall at Rakhigarhi Excavation Site: Mound 4

Well, Made from Harappan Burnt Brick: Mound 3



Drainage System at Rakhigarhi Excavation Site: Mound 3



**HIGHLIGHTS**

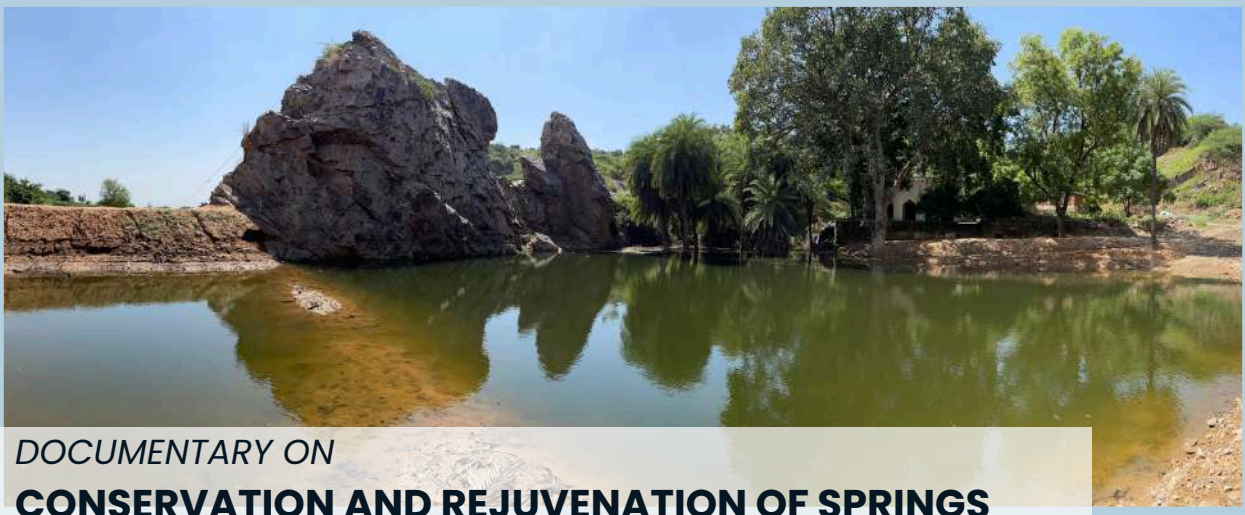
**HARAPPAN WATER WISDOM AND CLIMATE-RESPONSIVE URBAN DESIGN**

Harappan settlements along the Saraswati-Drisadvati River in today's NCR region reveal advanced water harvesting, drainage, and urban planning adapted to monsoon variability. These systems reduced flood risks, conserved water, and sustained agriculture for centuries. Learning from climate-responsive designs can guide modern cities in addressing heat stress, water scarcity, and urbanisation.

**LESSONS FROM HARAPPAN DECLINE FOR MODERN CLIMATE RESILIENCE**

The decline of the Harappan-Saraswati civilisation shows how monsoon shifts and river changes shaped vulnerability and adaptation. For modern NCR, it highlights the importance of ecosystem protection, groundwater recharge, and landscape-based planning to balance growth with ecological limits and resilience in rapidly urbanising regions.

## OUR CONTRIBUTION TO LOCAL SUSTAINABILITY~



DOCUMENTARY ON  
**CONSERVATION AND REJUVENATION OF SPRINGS  
AND SPRING-FED WATERBODIES IN HARYANA'S  
ARAVALLIS -BY THE HARYANA FOREST DEPARTMENT**

### GLIMPSES OF THE SITES



Khod Village Water Conservation Site



Khod Village Water Conservation Site



Kotla Village Water Conservation Site



Kotla Village Water Conservation Site

### HIGHLIGHTS

#### IMPORTANCE OF CATCHMENT AREA WATER CONSERVATION IN HARYANA

Catchment area water conservation projects play a vital role in recharging groundwater, reducing soil erosion, and restoring the Aravalli ecosystem, which forms a natural barrier against desertification. In Haryana, especially around the Aravalli foothills, where numerous natural springs feed local water systems, such initiatives support both biodiversity revival and water security for agriculture and rural communities facing growing water stress.

#### WATER CONSERVATION EFFORTS IN NUH, HARYANA

In Khod Basai village, Nuh district, the Haryana Forest Department has developed a catchment pond system to harness natural runoff from the Aravalli hills. Water from seasonal springs is collected in a main pond for preservation and later use, with overflow channelled into adjoining ponds through an exhaust outlet. This initiative not only conserves natural water but also enhances groundwater recharge and benefits local villagers by ensuring year-round availability of drinking water for wildlife and livestock. Similar projects, such as those in Kotla village and other Aravalli sites, are also in the pipeline.

# List of Publications by TCE

## Reports

- Capacity Enhancement Planning of Renewable Energy in the State of Goa.
- Gurugram City Cooling Action Plan.
- “Waterbodies of Gurugram City”- Coffee Table Book
- The Celestial Earth’s White Paper: India’s Adaptation Planning, Policy and Financing.
- An Indian Perspective of MRV: Way towards meeting the national target. IGES Research Report 2012/03.
- Impact of integrated watershed projects on sustainable development in India: A quantitative approach.
- Optimal Cooling Pathways: An Implementation Framework for the India Cooling Action Plan. Report

## Publications on Peer Review Journals/ Books etc.

- *Achieving Economic and Environmental Goals through Standardization of Carbon Markets: Exploring the Potential of Blue Carbon Ecosystems.* Bhattacharya, Tania, Bisht, Sakshi, Contribution on PHDCCI’s Carbon Edge: Leading the Market for a Sustainable Future, Volume 101 (2025).
- *Blockchain for Food Security Restraining Illegal Fishing and Ensuring Sustainability.* Varma, N., Bhattacharya, T., Helgheim, B.I. (2024).
- *Comparative Analysis of Potential Ramsar Wetlands in Coastal India Based on Biodiversity and Ecological Parameters.* Bisht, Sakshi., Bhattacharya, Tania. (2024)
- *Achieving Global Biodiversity Framework Targets in G20 Countries by 2030.* Bhattacharya, T., Managi, S., Dasgupta, R. (2023).
- *Inclusive Wealth Index: A Comprehensive Measure of LiFE Towards ‘Net Zero’.* Managi, S., Bhattacharya, A., Bhattacharya, T., (2023).
- *The Highest Elevation Record of River Tern (Sterna aurantia) in the Indus River Basin.* Sengupta, D., Upadhyay, Y., Bhattacharya, T., (2023).
- *A New Distributional Record and Morphometry of the Kashmir Rock Agama, Laudakia tuberculata (Gray 1827), from the Trans-Himalayan Region of Ladakh, India.* Sengupta, D., Upadhyay, Y., Preetam, K., Bhattacharya, T. (2023)
- *New distributional record of Kaniska canace (Linnaeus, 1763) (Lepidoptera: Nymphalidae), from the Trans-Himalaya region of UT Ladakh, India.* Sengupta, D., Upadhyay, Y., Bhattacharya, T. (2022).
- *The Asian Openbill Anastomus oscitans from the Union Territory of Ladakh, India.* Sengupta, D., Bhattacharya, T. (2022).
- *Impact of Expanding Coal Industry on the Regional Environment in an Indian Coal-Belt – A Case Study from Jharkhand, India.* Upadhyay, Y., Bhattacharya, T., (2022).
- *Pollution and Potential – Najafgarh Jheel seeking immediate revival.* Upadhyay, Y., Sengupta, D., Bhattacharya, T. (2022).
- *The Crested Kingfisher Megaceryle lugubris from Kargil, in the Union Territory of Ladakh.* Sengupta, D., Upadhyay, Y., Bhattacharya, T., Bhattacharya, A., Sinha, P. (2022).
- *Current Water Crisis Issues and Impacts of Decreasing Forest Cover in Indian Highlands: Case Study from a Himalayan State of India.* Bhattacharya, T.R, Bhattacharya, A (2020).

# List of Publications by TCE

## Publications on Peer Review Journals/ Books etc.

- *Limits to Urbanization: Application of Integrated Assessment for Smart City Development in India.* McLellan B., Bhattacharya T., Bhattacharya A., Tezuka T. (2018).
- *Financing biodiversity action plan using state appropriation account analysis: A case study of an Indian state.* Bhattacharya, Tania., Bhattacharya, A. (2019).
- *Sustainable smart city development framework for developing countries.* Bhattacharya Tania, Bhattacharya Anindya, McLellan Benjamin, Tezuko Tetsuo. ( 2018).
- *An Econometric Approach Of Assessment Of Water Energy Nexus In Indian Smart Cities: Case Study For Pune, Raipur And Faridabad.* Bhattacharya Tania, Bhattacharya Anindya, Tezuka Tetsuyo. (Working Paper).
- *Assessment of low carbon transport for sustainable development in Bhutan: a general equilibrium approach.* Bhattacharya, Anindya, Ghosh, J., Tezuka, T., Bhattacharya (2018).
- *Urban wetlands – co2 sink or source? A case study on the aquaculture ponds of East Kolkata Wetlands.* Biswas, Protusha., Bhattacharya, T., Chanda, A., Hazra, S. (2018).
- *From Smart Cities to Sustainable, Liveable Cities: A Capabilities Based Framework for Traversing Urban Mobility.* Mathai, Manu. Bhattacharya, T., Tezuka, T (forthcoming).
- *Comparative Assessment of Ecosystem and Biodiversity Conservation Measures in Indian Smart Cities: A City Biodiversity Index Approach.* Bhattacharya, Tania. (2017).
- *An Assessment Of Biodiversity offsets and Mitigation actions: case studies on mining, energy and paper and pulp sectors in India (Book Chapter).* Bhattacharya, Tania, Editor: Managi, S (2015).
- *Contributions of the Private Sector to Global Biodiversity Protection: Case Study of Fortune 500 Companies.* Bhattacharya, Tania (2012).
- *ASEAN-India Gas Cooperation: Redefining India's "Look East" Policy with Myanmar.* Bhattacharya, Anindya., Bhattacharya, Tania. (2014).
- *Nationally Appropriate Mitigation Actions (NAMAs) in the Electricity Sector: The Case of Thailand.* Bhattacharya, Anindya and Moinuddin, M. (2014).
- *Toward an Integrated Renewable Energy Market in the EAS Region: Renewable Energy Equipment Trade, Market Barriers and Drivers.* Mustafa Moinuddin and Anindya Bhattacharya (2013).
- *An Indian Perspective of MRV: Way towards meeting the national target.* IGES Research Report 2012/03. Bhattacharya, Anindya. Kanudia, Amit and Sethi, P. Sethi. (2012).
- *Convention on Biological Diversity and Other Initiatives to worldwide protection of Biological Diversity and Ecosystem Services. The Economics of Biodiversity and Ecosystem Services.* Bhattacharya, Tania. Managi, S (2012).
- *Power Sector Investment Risk & Renewable Energy: A Japanese case study using portfolio risk optimization method.* Bhattacharya, Anindya., Kojima, S. (2012).
- *Is Japan Prepared to Accept Post-3.11 Energy Policy Change? Future of Renewable Energy.* Japan Spotlight. Jan 2012 Special Issue: Post Fukushima Outlook. Bhattacharya, Anindya., (2012).
- *"Contributions of the Private Sector to Global Biodiversity Protection: Case Study of Fortune 500 Companies"* Bhattacharya Tania, (2012). MPRA Paper No. 39949.

Refer to the website for all publication details: <https://www.thecelestialearth.org/publications>

# Projects Undertaken by TCE



## Projects Under

Ongoing & Completed

## Ecosystem & Biodiversity Conservation & Valuation



Biodiversity Strategy & Action Plan for the UT-Jammu & Kashmir

Client: UNDP, India



Economic Valuation of Ecosystem and Biodiversity-Methodology and Case Study

Client: UNDP



Developing State Ecosystem and Biodiversity Conservation Strategy and Action Plan

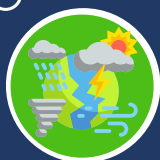
Client: UNDP, India



## Projects Under

Ongoing & Completed

## Climate Change & Disaster



Assessment of Indian Climate Mitigation Options in Power Sector and Implementation of INDC

Client: The World Bank



Developing Strategies and Action Plan for Net Zero Gurugram and Developing Climate Action Plan for 2050

Client: SSEF



Developing Investment Plans for SAPCC in Two States (Punjab & Telangana) of India

Client: GIZ, India



Climate Risk Assessment of Goa/Kerala to Low Carbon Development Resilient Pathways (LCDRP)

Client: The World Bank



## Projects Under

Ongoing & Completed

## Climate Change & Disaster



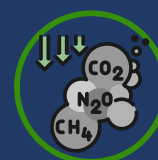
Conducting Comprehensive Needs Assessment for Developing Climate Finance Facility for the state of West Bengal

Client: UNDP



Regional Investment Planning for Low Carbon Technology Development for SDG-7 Implementation in Asia.

Client: ADB



GHG Mitigation Assessment for the Preparation of Sri Lanka's Market Readiness Proposal

Client: The World Bank

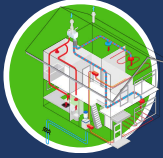
# Projects Undertaken by TCE



## Projects Under

Ongoing & Completed

## Sustainable Urban Development



Developing Cooling Action Plan at Subnational Level

Client: ISEF



Assessment of cooling and electrical demand in commercial buildings of 4 cities of India

Client: GIZ



Limit to Urbanization: Climate Resilient Sustainable Urban Development in India

Client: The Toyota Foundation, JP



Regulatory Impact Assessment for Potential Policy Approaches under Article 6

Client: GGGI, South Korea



## Projects Under

Ongoing & Completed

## Integrated Resource Planning



Implementing Energy Market Integration in the East Asia Summit Region

Client: ERIA & ASEAN



Development of Dashboard for District Climate Action Plan for Uttar Pradesh

Client: State Govt. of Uttar Pradesh



Developing Energy Plan and Action Plan for the Indian States of West Bengal, Goa, Uttarakhand, Punjab

Client: GIZ India



Decarbonization of Indian Power Sector

Client: ADB



Power Market Reform to Enable RE based Electric Vehicle Charging in India

Client: GIZ India



Regional Investment Planning for Low Carbon Technology Development for SDG 7 Implementation in Asia

Client: ADB



## Projects Under

Ongoing & Completed

## Integrated Assessment Model



Developing India\_MESSA GEix Macro Model for Deep Decarbonization Assessment

Client: SSEF



Bangladesh Energy Model and DST

Client: The World Bank



Impact of RE/EV-Need Assessment on System Strengthening

Client: KESB



Developing Deep Decarbonization Planning Model for BBNI & Contribution assessment toward Article 6


Client: The World Bank



Developing Macro economic Impact Assessment Framework for Investigating Low Carbon Interventions in Bhutan


Client: The World Bank

# Projects Undertaken by TCE



**Projects Under**  
Ongoing & Completed


**Macro-Economic Models**



**Costing of India's Climate Announcement**

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Client: The World Bank



**Economic Valuation of Ecosystem and Biodiversity Methodology and Case Study**

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Client: UNDP



**Developing Macro Economic Impact Assessment Framework for Investigating Low Carbon Interventions in Bhutan**

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Client: The World Bank



**Economic Valuation of High Himalayan Ecosystem in Ladakh**


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Client: UNDP



**Projects Under**  
Ongoing & Completed


**Data Analytics**



**Costing of India's Climate Announcement**

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Client: The World Bank



**Developing Decision Support Tool for NITI Aayog, GoI for National Energy Planning**

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Client: The World Bank



**Updating India's Energy Security Pathway Calculator (IESS 2047)**

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Client: The World Bank



**Odisha Energy Security Pathway Calculator**

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Client: The World Bank



**Health Cost Module Development for IESS 2047 Model**

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Client: FICCI, India

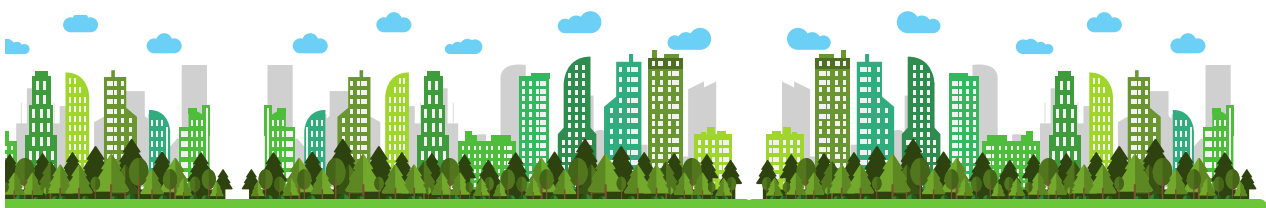


**Developing Decision Support Tool for Low Carbon Development Planning for Bangladesh**

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Client: ADB

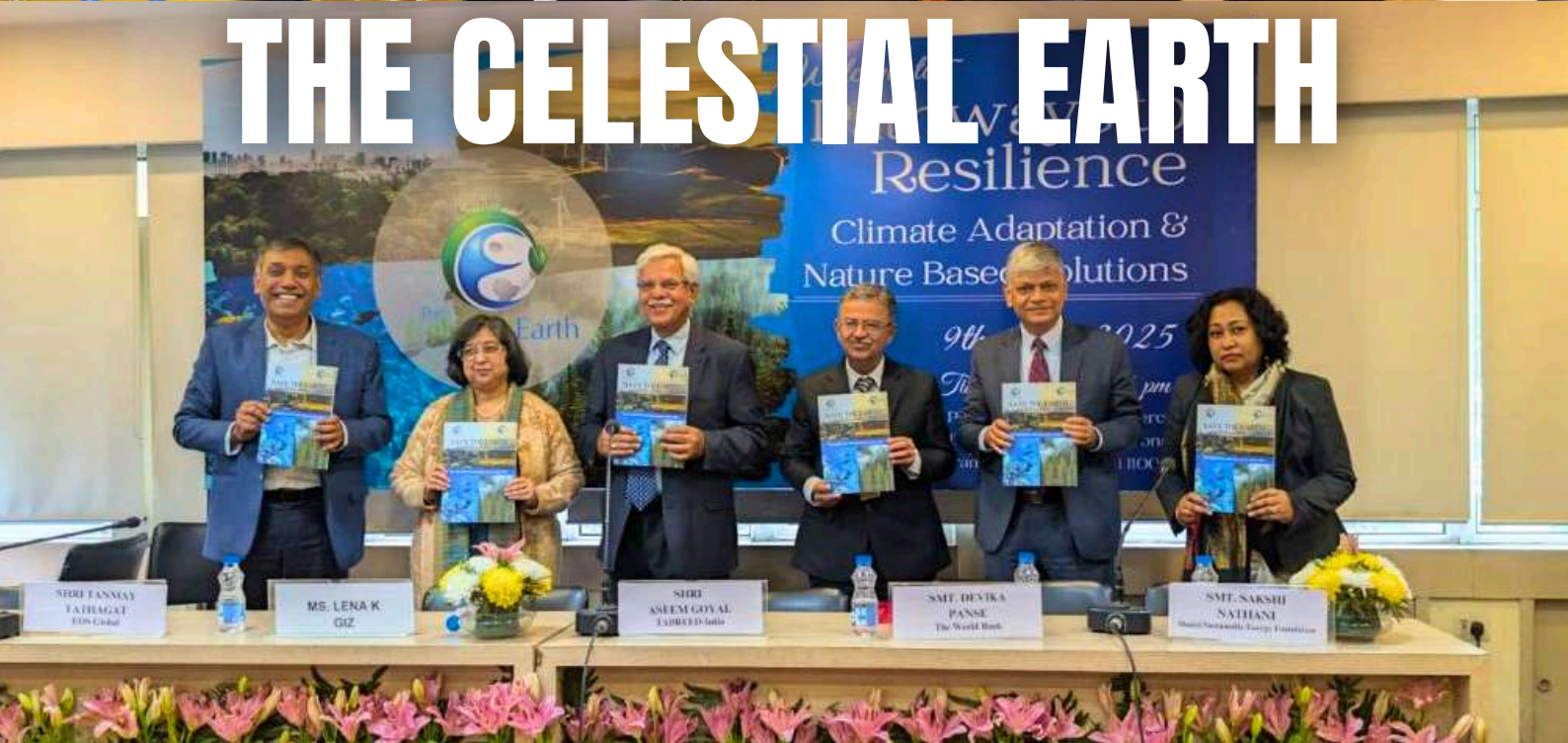
Refer to the website for project details:  
<https://www.thecelestialearth.org/projects-clients/>





# EVENTS OF 2025:

# THE CELESTIAL EARTH



# INTERNATIONAL EVENTS



KEIO UNIVERSITY, JAPAN'S INTERNATIONAL CONFERENCE ON~  
**INNOVATIONS IN DISASTER RISK REDUCTION,  
CLIMATE CHANGE, AND SUSTAINABLE DEVELOPMENT:  
PATHWAYS FOR A RESILIENT FUTURE**

## GLIMPSES FROM THE EVENT



## HIGHLIGHTS

### **"BLOCKCHAIN-DRIVEN STRATEGIES FOR MITIGATING DISASTER IMPACTS AND PROMOTING SUSTAINABLE FOOD SECURITY**

Dr. Tania Ray Bhattacharya, CEO of The Celestial Earth, spoke at the International Conference on Disaster Risk Reduction and Climate Change at Keio University, Japan (June 19, 2025), presenting on "Blockchain for Disaster Management and the Blue Economy."

The event fostered regional collaboration among experts from Japan, India, China, Korea, Nepal, and Bangladesh.

### **OTHER HIGHLIGHTS**

The International Conference on Innovations in Disaster Risk Reduction, Climate Change, and Sustainable Development was held on June 19, 2025, at Keio University, Japan. It brought together experts from across Asia to explore emerging risks, policy innovation, and technological solutions—ranging from flood management, earthquake preparedness, and urban resilience to blockchain, AI, and nature-based strategies. The event fostered interdisciplinary dialogue through keynote talks, technical sessions, and a dedicated young scientists' forum.

# INTERNATIONAL EVENTS



## **TCEC'S ED DR. ANINDYA BHATTACHARYA BEING A TRAINER AT ASEAN ENERGY TRANSITION WORKSHOP**

The Celestial Earth's Executive Director, Dr. Anindya Bhattacharya, delivered training with SEforALL in Bangkok, supporting ASEAN member countries on Just Energy Transition planning and capacity building, reaffirming the organization's commitment to inclusive, data-driven regional energy transitions.



## **THE CELESTIAL EARTH, ON DISCUSSION WITH AP-PLAT AT TSUKUBA JAPAN**

On 18 June 2025, The Celestial Earth's Executive Director, Dr. Anindya Bhattacharya, visited AP-PLAT at the National Institute for Environmental Studies, Japan, engaging with the team on ongoing activities, shared interests, and exploring opportunities for future collaboration in climate change adaptation initiatives.



## **TCE LEADERSHIP ATTENDING CONFERENCE AT THE LONDON SCHOOL OF ECONOMICS**

Dr. Tania Ray Bhattacharya and Dr. Anindya Bhattacharya attended the conference "Blended Finance Needs to Scale 10x: Can It, Will It?" at the Global School of Sustainability, LSE. The event featured Lord Nicholas Stern, author of the Stern Review on the Economics of Climate Change, along with Prof. Luiz Awazu Pereira da Silva and Odile Renaud-Basso (EBRD) on scaling blended finance for climate action.



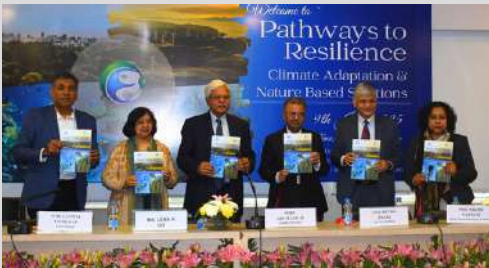
# NATIONAL EVENTS



THE CELESTIAL EARTH'S 12TH YEAR FOUNDATION DAY CONFERENCE

## “PATHWAYS TO RESILIENCE: CLIMATE ADAPTATION & NATURE-BASED SOLUTIONS” ON 9TH JANUARY AT NEW DELHI

### GLIMPSES FROM THE EVENT



### HIGHLIGHTS

#### “PATHWAYS TO RESILIENCE: CLIMATE ADAPTATION & NATURE-BASED SOLUTIONS”

The Celestial Earth hosted its 12th Foundation Day Annual Conference on January 9, 2025, in Delhi, under the theme "Pathways to Resilience: Climate Adaptation & Nature-Based Solutions." The conference brought together leading experts and stakeholders from India's climate change and sustainable development sectors. Six carefully curated panels focused on India's National Adaptation Plan and the financing mechanisms required to support it. The panels included a balanced representation of policymakers, practitioners, academicians, and industry leaders, with a strong emphasis on gender inclusivity.

# NATIONAL EVENTS



## THE CELESTIAL EARTH'S FINAL WORKSHOP ON SUBNATIONAL COOLING ACTION PLAN

### GLIMPSES FROM THE EVENT



### HIGHLIGHTS

#### **MULTI-STAKEHOLDER COLLABORATION FOR URBAN COOLING**

The workshop marked the culmination of a collaborative journey between The Celestial Earth, GMDA, and Shakti Sustainable Energy Foundation, aiming to shape a robust and localized cooling action plan for Gurugram—an urban area increasingly vulnerable to heat stress.

#### **EXPERT INSIGHTS AND LEADERSHIP**

With opening remarks by Dr. Tania Ray Bhattacharya and an inaugural lecture by Mr. Vivek Saxena, the event featured leading experts from GIZ, NITI Aayog, BSES, Tabreed, and more—sharing practical and policy insights.

#### **FOCUS ON SUSTAINABLE URBAN PLANNING**

The discussions emphasized energy-efficient and climate-resilient cooling measures, reinforcing the importance of integrating such solutions into city planning.

# NATIONAL EVENTS



## STAKEHOLDER CONSULTATION ON CLIMATE FINANCE NEEDS AND BLUEPRINT OF CLIMATE FINANCE FACILITY FOR WEST BENGAL

### GLIMPSES FROM THE EVENT



### HIGHLIGHTS

#### STAKEHOLDER CONSULTATION ON WEST BENGAL CLIMATE FINANCE ROADMAP

A two-day consultation and workshop on the West Bengal Climate Finance Facility Roadmap was held on 30–31 October 2025 at Taj Taal Kutir, Kolkata, guided by MoEF&CC and the Finance Department, Government of West Bengal, in collaboration with UNDP and The Celestial Earth.

#### STRENGTHENING CLIMATE FINANCE FRAMEWORK

The workshop focused on presenting the proposed structure and key analyses for creating a robust, inclusive, and financially sustainable Climate Finance Facility to support West Bengal's climate goals.

#### STEP TOWARDS CLIMATE-RESILIENT DEVELOPMENT

This milestone marks the beginning of a new chapter in West Bengal's journey towards climate-resilient, sustainable development, with continued support from MoEF&CC and the Finance Department.

# NATIONAL EVENTS



RELEASE OF

## 'WATERBODIES OF GURUGRAM CITY' COFFEE TABLE BOOK/REPORT AT ARAVALLI GREEN WALL PARTNERSHIP SUMMIT

### GLIMPSES FROM THE EVENT



### HIGHLIGHTS

#### 'WATERBODIES OF GURUGRAM CITY' COFFEE TABLE BOOK/REPORT

The Celestial Earth released 'Waterbodies of Gurugram City' coffee table book/report, developed under the expert guidance of Shri Subhash Chander Yadav Ji (IFS, Conservator of Forests, Gurugram) during the Aravalli Green Wall Partnership summit on February 2025. This initiative received strong support from the Municipal Corporation of Gurugram (MCG), the Gurugram Metropolitan Development Authority (GMDA), and the Haryana Forest Department.

#### INAUGURATED BY HONOURABLE MINISTERS

The work was formally launched by Shri Bhupender Yadav Ji, Honourable Union Cabinet Minister for Ministry of Environment, Forests & Climate Change, Government of India, and Shri Rao Narbir Singh Ji, Minister of Environment & Forest, Government of Haryana, at the Aravalli Green Wall Partnership Summit 2025, held in Gurugram from February 6-8. The event also saw the participation of other respected PCCFs of the Government of Haryana and eminent personalities.

# NATIONAL EVENTS



## TCE BEING FOUNDING MEMBER OF CARBON FORUM OF PHDCCI

The Celestial Earth, a founding member of PHDCCI's Carbon Market Forum, advanced climate action by launching its first knowledge series, featuring expert white papers to strengthen and standardize India's carbon market.



## THE CELESTIAL EARTH'S TRAINING SESSION ON PYPSA AT KERALA

The Celestial Earth successfully completed India's first PyPSA distribution-level training for DISCOMs, supporting renewable energy and EV expansion planning, with continued collaboration from GT colleagues, advancing sustainable and data-driven decision-making for India's power distribution sector nationwide.



## WORKSHOP ON WILDLIFE CONSERVATION FINANCE: INVESTING IN PEOPLE AND PLANET. IN JHABUA, HARYANA

The Celestial Earth, with Haryana Forest Department, organized the State-level World Wildlife Day 2025 workshop at Peacock and Chinkara Breeding Centre Rewari, highlighting conservation finance, biodiversity, and sustainable coexistence, with participation from state leadership, forest officials, and local stakeholders.

# NATIONAL EVENTS



## TRAINING OF THE TRAINERS WORKSHOP ON 'GREEN CLIMATE FUND AT MOEFCC, IIFM BHOPAL

The Celestial Earth's Founder and CEO Dr. Tania Bhattacharya participated in a Green Climate Fund readiness training in Chennai, gaining insights into proposal development and urban climate resilience, including a field visit highlighting ecosystem-based adaptation at Pallikaranai Marshland.



## DR. ANINDYA BHATTACHARYA BEING A SPEAKER AT NATIONAL CONSULTATION FORUM TO BUILD RESILIENCE

The Celestial Earth's Executive Director, Dr. Anindya Bhattacharya, spoke at the National Consultation Forum on the National Adaptation Plan and adaptation finance, organized by MoEFCC and the World Bank, contributing to dialogues on building climate resilience.



## WORLD ENVIRONMENT DAY 2025 FOR THE CELESTIAL EARTH IN KOLKATA

On World Environment Day, The Celestial Earth' Founder & CEO Dr. Tania Ray Bhattacharya and ED Dr. Anindya Bhattacharya joined West Bengal's Climate Finance Assessment meeting and the Kolkata Climate Action Plan launch, contributing to state climate strategy and advisory initiatives.

# NATIONAL EVENTS



## STAKEHOLDER CONSULTATION WORKSHOP ON THE DEVELOPMENT OF A FRAMEWORK FOR CLBS AT NEW DELHI

On 12th August 2025, The Celestial Earth's Founder & CEO Dr. Tania Ray Bhattacharya and ED Dr. Anindya Bhattacharya attended IIT Kharagpur's Circularity-Linked Bonds workshop in New Delhi, contributing to discussions on innovative finance for India's circular economy transition.



## LAUNCH OF GURUGRAM COOLONG ACTION PLAN REPORT AT THE STATE-LEVEL WILDLIFE WEEK CELEBRATION 2025

On 2nd October 2025, The Celestial Earth's Gurugram City Cooling Action Plan report was officially released by Union and Haryana ministers, which presents a roadmap for sustainable, energy-efficient, and climate-resilient urban cooling solutions for India.



## RELEASE OF "CAPACITY ENHANCEMENT PLANNING OF RENEWABLE ENERGY IN THE STATE OF GOA"

The Celestial Earth announced the release of its Goa renewable energy planning report, unveiled by Chief Minister Dr. Pramod Sawant, presenting a techno-economic, geospatial framework supporting the Goa Renewable Energy Policy 2025 and Clean Energy Roadmap 2050.

# NATIONAL EVENTS



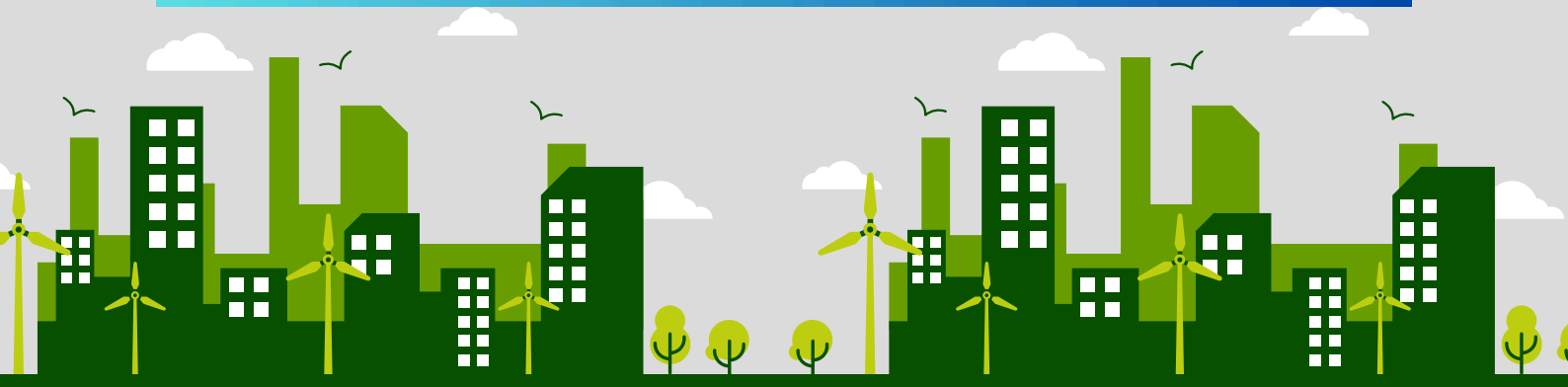
## COLLABORATION WITH CHANDIGARH POWER DISTRIBUTION LTD.

The Celestial Earth and Celestial Earth Development Council formalized an MoU with Chandigarh Power Distribution Ltd. to support renewable energy integration, DISCOM load research, and ML-driven rooftop solar planning through a geospatial building energy simulation platform.

# TCE'S ANNUAL EVENT 2025

*Welcome to ~*  
**Pathways to Resilience**  
Climate Adaptation & Nature Based Solutions

*9th Jan, 2025*  
*Time: 9:30 am - 5 pm*  
Venue: MMG Hall, PHD Chamber of Commerce and Industry, PHD House, 4/2 Siri Institutional Area August Kranti Marg, New Delhi 110016



# NATIONAL EVENTS (Women Centric Events)



## **Goldman Sachs for their 10,000 Women Program** **hashtag#GS10KW**

Our Founder CEO Dr. Tania Ray Bhattacharya has been honored to be selected for the Goldman Sachs 10,000 Women Program (#GS10KW), which is a globally selected program and conducted by IIM Lucknow EIC. This fully funded initiative empowers women entrepreneurs by strengthening strategic, financial, and operational capabilities to drive measurable business growth. The opportunity marks a significant step toward scaling her organization globally and deepening its impact, while engaging with a powerful global network of women leaders committed to change and sustainability.



## **'Resilient Economies Summit'** **by WEConnect International**

Our founder CEO Dr. Tania Ray Bhattacharya had a rewarding experience at the Resilient Economies Summit by WEConnect International, held on March 5th in New Delhi during International Women's Week. She was honored to speak on her session "Green Trade for a Sustainable Tomorrow," inspiring women entrepreneurs to adopt sustainable business practices and support India's net-zero goals. She was also deeply inspired by the address of the chief guest- Smriti Irani ji and enriched by interactions with fellow women leaders, thus, thanking Elizabeth Vazquez, Poonam Mehdiratta, and Eroshan Alagaretnam for organizing this impactful event.



# RECREATIONAL EVENTS



## WOMEN'S DAY CELEBRATION, 12 MAR 2025

The Celestial Earth, a women-owned organization, celebrated Women's Day 2025 with a lunch in Gurugram and discussions on key women's issues.



## SUMMER PARTY, 10TH JULY 2025

On July 10, 2025, The Celestial Earth hosted a summer party at the Hilton Hotel, Gurugram, offering relaxation and a memorable experience for employees.



## PRE-CELEBRATION OF 79TH INDEPENDENCE DAY OF INDIA, 14 AUG 2025

TCE held a pre-Independence Day celebration on 14th August 2025, at its office premises.



## PRE DIWALI PARTY, 15 OCT 2025

A Pre-Diwali celebration was held on October 15 at Castle Barbeque, Gurugram, fostering togetherness, festive spirit, and employee well-being.



## DIWALI CELEBRATION, 17 OCT 2025

On October 17, Team Celestial Earth celebrated Diwali with a rangoli competition, fostering joy, togetherness, and festive spirit among all attendees.



## CHRISTMAS CELEBRATION, 24 DEC 2025

On December 24, The Celestial Earth celebrated Christmas, at office with a potluck and Secret Santa, fostering warmth, togetherness, and festive cheer.

# BUSINESS IMPACT OF TCE

## SOCIETAL & ENVIRONMENTAL IMPACT OF TCE

How The Celestial Earth (TCE) bridges science, policy & practice to drive positive societal and environmental changes.



### Environmental Impact

- Evidence-based policy influence
- Biodiversity & ecosystem protection
- Climate resilience & adaptation pathways



### Societal Impact

- Strengthened governance & institutions
- Climate justice & social equity
- Public awareness & behavioral change



### Economic & Developmental Impact

- Green economy & sustainable finance frameworks: To support green finance, renewable energy and sustainable infrastructure.
  - Climate-resilient livelihoods & community well-being: To improve food security, livelihood and health through research.
- Nature-based solutions, data & innovation: To strengthen ecosystem resilience and evidence-based climate action.



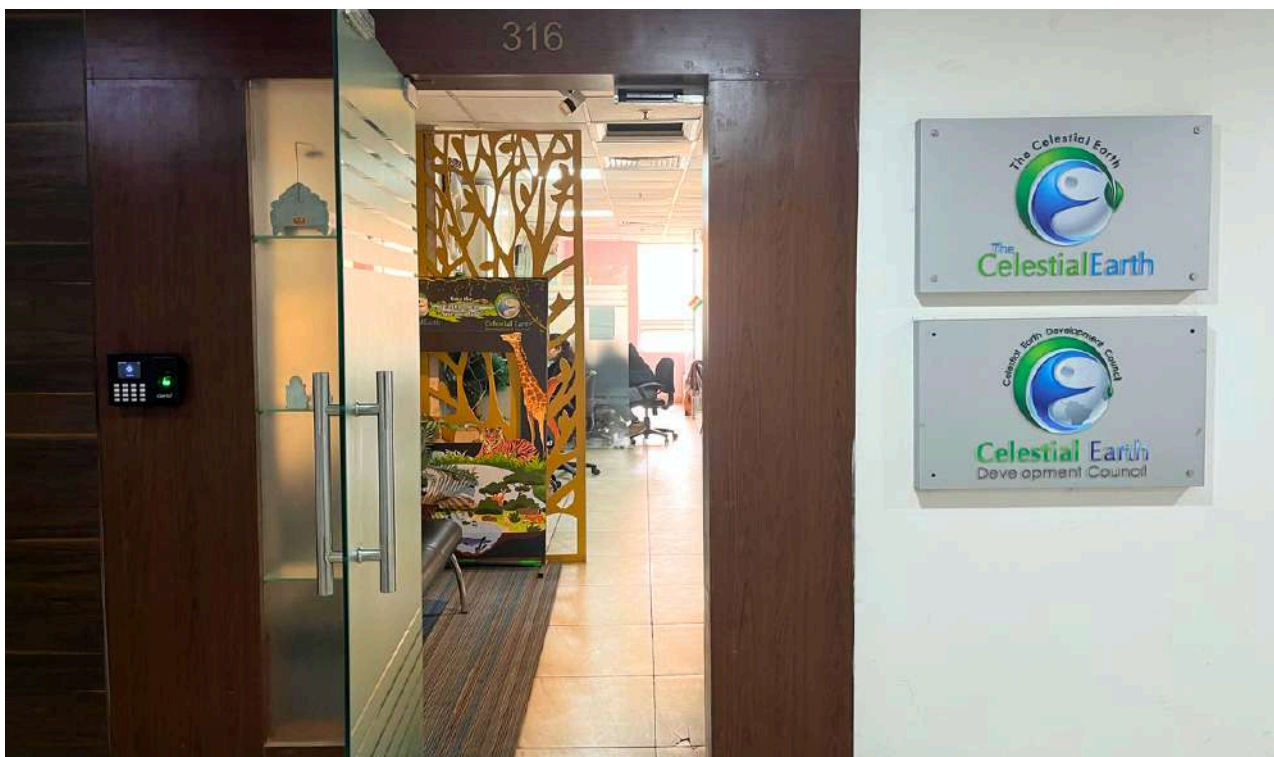
### Knowledge, Innovation and Capacity Building

- Science-policy knowledge integration
- Institutional strengthening & leadership development



### Global & Regional Impact

- Engagement in UNFCCC, CBD, IPBES, SDGs
- South-South & North-South cooperation
- Regional environmental collaboration



THE CELESTIAL EARTH OFFICE AT VIPUL TRADE CENTRE, SECTOR 48, GURUGRAM, INDIA

# 2026



## JANUARY

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## MARCH

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## APRIL

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## MAY

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## JUNE

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## SEPTEMBER

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## OCTOBER

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## NOVEMBER

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23	24	25	26	27	28	29
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## DECEMBER

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30	31					

# WAY FORWARD

As our mission is to align global growth with green, clean & sustainable development, The Celestial Earth is dedicated to various initiatives in the coming years~

## **CONTRIBUTION TOWARDS LOCAL SUSTAINABLE DEVELOPMENT**

Various initiatives to conserve and protect local environment, ecosystem & biodiversity in collaboration with local communities & governments.

## **CONTRIBUTION TOWARDS JUST TRANSITION & NET ZERO EMISSIONS**

Various initiatives on national, state and city level Climate Action Plans.

## **CONTRIBUTION TOWARDS DECENTRALIZED RE UPTAKE**

Developing open source power system modeling tool for DISCOMs to enhance their RE uptake share & better management of networks.

## **CLIMATE FINANCE FACILITIES OF VARIOUS STATES**

To replicate the work done for WB to other states also.

## **ESG MARKET PENETRATION AND TRAINING INITIATIVES**

With our efficiency and expertise, we are planning to integrate into ESG market, as well as initiating training (on relevant fields) and workshops under CEDC.

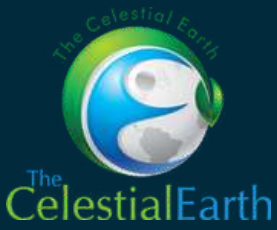
## **SPIBEAT PRO FOR BUILDING-LEVEL ELECTRICAL DEMAND ASSESSMENT AND NETWORK ANALYSIS**

SPIBEAT Pro integrates geospatial data, climate inputs, and building standards to estimate building-level electrical and cooling demand. It also analyses the distribution network to assess performance and identify RE, and EV integration opportunities, supporting decisions for energy-efficient and sustainable buildings and networks.



Onward we move,  
crafting a celestial  
and enduring Earth  
for all~

Photographer: Ms. Audrija Bhattacharya (London School of Economics),  
Location: Moss Garden, Museum of Art, Hakone, Japan  
Photo Specifications: Shot by - Nikon D3500, Lens: 700-300 mm



# SAVE THE EARTH SAVE THE PLANET SAVE THE LIFE



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