India's Adaptation Planning, Policy and Financing

White Paper

by:

The Celestial Earth

February 2025

The Celestial Earth

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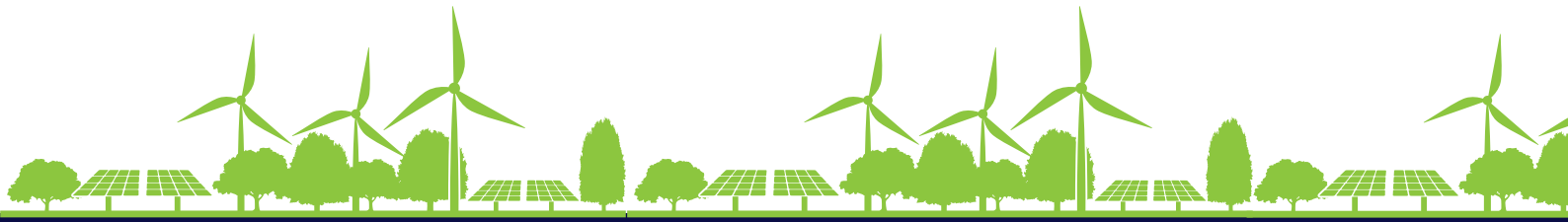


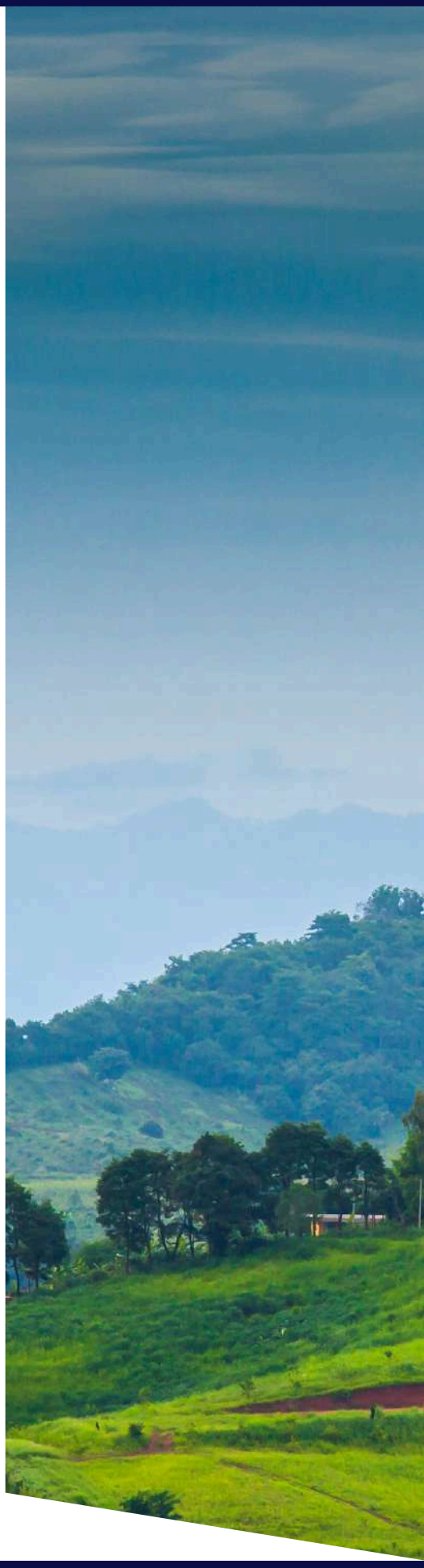
Foreword

Climate resilience and adaptation are vital for India's sustainable development. Increasing extreme weather events, rising temperatures, and water scarcity, among many current climate threats, pose risks to agriculture, infrastructure, and public health. A multi-pronged approach integrating adaptation financing, policy innovation, and community participation is essential to building long-term resilience.

Mobilizing adaptation finance requires a well-defined framework with clear taxonomies, regulatory mandates, and streamlined implementation policies. Engaging the private sector through blended finance, impact investments, and green credit initiatives is crucial. Partnerships between government, private entities, and local communities can effectively channel financial resources toward climate adaptation. Strengthening collaboration with multilateral development banks and global institutions will secure financial and technical support for large-scale adaptation initiatives.

Herewith, we are presenting this white paper, which is an outcome of The Celestial Earth's annual conference "Pathways to Resilience: Climate Adaptation and Nature-Based Solutions", held on 9th January 2025 in New Delhi, highlights the importance of India's adaptation planning, its financing mechanisms, and appropriate policy landscape. It identifies the key challenges and opportunities, offering actionable recommendations for financial resource mobilization. As India progresses toward its net-zero goals, integrating adaptation into its development agenda will ensure resilience for future generations. We are especially grateful to Smt. Rajasree Ray-Economic Advisor, MoEFCC-GOI and Shri. Pradeep Tharakan, Director of the Asian Development Bank, for setting the tone of the conference as the chief guest and the keynote speaker, and thus setting the framework of this white paper as a guiding document in the area of climate adaptation. Therefore, this document is a contribution towards the preparation of the National Adaptation Plan by the Ministry of Environment and Climate Change, Govt of India.

Dr. Tania Bhattacharya,
Founder CEO
The Celestial Earth



Key Message

India's national plan for adaptation requires a balanced, data-driven, and locally contextualized approach to effectively address the diverse impacts of climate change. A critical component is establishing uniform national guidelines that align with international frameworks while allowing flexibility for regional and sectoral nuances. Adaptation is inherently localized, as even minor shifts in climate variables, such as a 1°C rise in temperature, can cause a 10% increase in rainfall, which can have significantly different effects on rain-fed and irrigated agriculture. A robust adaptation strategy should integrate data analytics and climate risk mapping by overlaying datasets on heat exposure, crop vulnerability, and community demographics to effectively identify hotspots and target the most vulnerable groups.

Special attention must be given to vulnerable communities, incorporating their insights and needs into the planning process to ensure equitable and sustainable solutions. A comprehensive portfolio of Adaptation and Resilience (ANR) solutions is essential, ranging from nature-based strategies like mangrove conservation to urban heat resilience, climate-related healthcare preparedness, and predictive modeling for emerging challenges such as climate-induced pandemics. Scalable financing mechanisms are crucial, including innovative approaches like blended finance facilities or allocating a portion of infrastructure project costs to conservation efforts, as seen in Mumbai's mangrove restoration program. Additionally, sectoral integration should be prioritized, leveraging existing frameworks while exploring pragmatic solutions, such as Extended Producer Responsibility (EPR) and localized measures to address high-risk areas, bridging the gap between strategic planning and on-ground implementation.

Dr. Anindya Bhattacharya,
Executive Director
The Celestial Earth

1 Introduction

Climate resilient development is essential for sustainable development and achieving carbon neutrality or net zero emissions status. Mitigation is not the only solution, but adapting to climate change is also important for developing countries like India. While industries are moving towards net zero emissions by adopting various technological options, policies are also in place to support the transition. However, the transition is required in all spheres of life and does require a comprehensive assessment to fathom the efforts required to achieve the desired goals. While the Paris Agreement on Climate Change set the ball rolling, it is not enough to mitigate the expected damages that might occur due to global warming going beyond 1.5 °C. Efforts are required at a much larger scale, encompassing the natural, physical, and human capitals of the country, to mobilize them in the direction of climate-resilient sustainable development. Thus, a comprehensive approach is required for a country to understand, identify and implement a set of new policies and guidelines which can enable the transition. The discussion will cover various aspects of transition and low carbon climate resilient development and how comprehensively it should be done to capture the complexity and dynamism of the system in which our society is living.

Global warming has been clearly driven by human activity, mostly through the generation of greenhouse gases, between 2011 and 2020, the global surface temperature rose by 1.1°C over 1850-1900 (IPCC, 2023). Unequal historical and current contributions to the rise in global greenhouse gas emissions have come from unsustainable energy use, land use and landcover change, and patterns of consumption and production among people, between and within nations, and across regions (WMO, 2023). Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. Human-caused climate change is already affecting many weather and climate extremes in every region across the globe (United Nations, 2021). This has led to widespread adverse impacts and related losses and damages to nature and people, indicating the need for adaptation in climate action. All sectors and geographical areas have seen advancements in adaptation planning and execution, with varied degrees of success and verified advantages. Adaptation gaps still exist and will be widened at the current rate of implementation. In certain ecosystems and geographical areas, adaptability has reached both hard and soft limitations (Thomas et al., 2021). The execution of adaptation choices is hampered by the current global financial flows for adaptation, which are inadequate, particularly in developing nations like India (Wignarajah, 2023). Adaptation is no longer an option but a necessity now. Along with mitigation, adaptation is going to play a vital role for India to achieve net zero by 2070.

Adaptation planning is crucial for India due to its unique vulnerability to climate change. As a diverse and developing

nation with high developmental aspirations, India faces significant challenges, including rising temperatures, erratic monsoons, increasing frequency of extreme weather events, and the melting of Himalayan glaciers. These impacts pose threats to agriculture, water resources, health, and infrastructure, making adaptation planning essential for sustainable development.

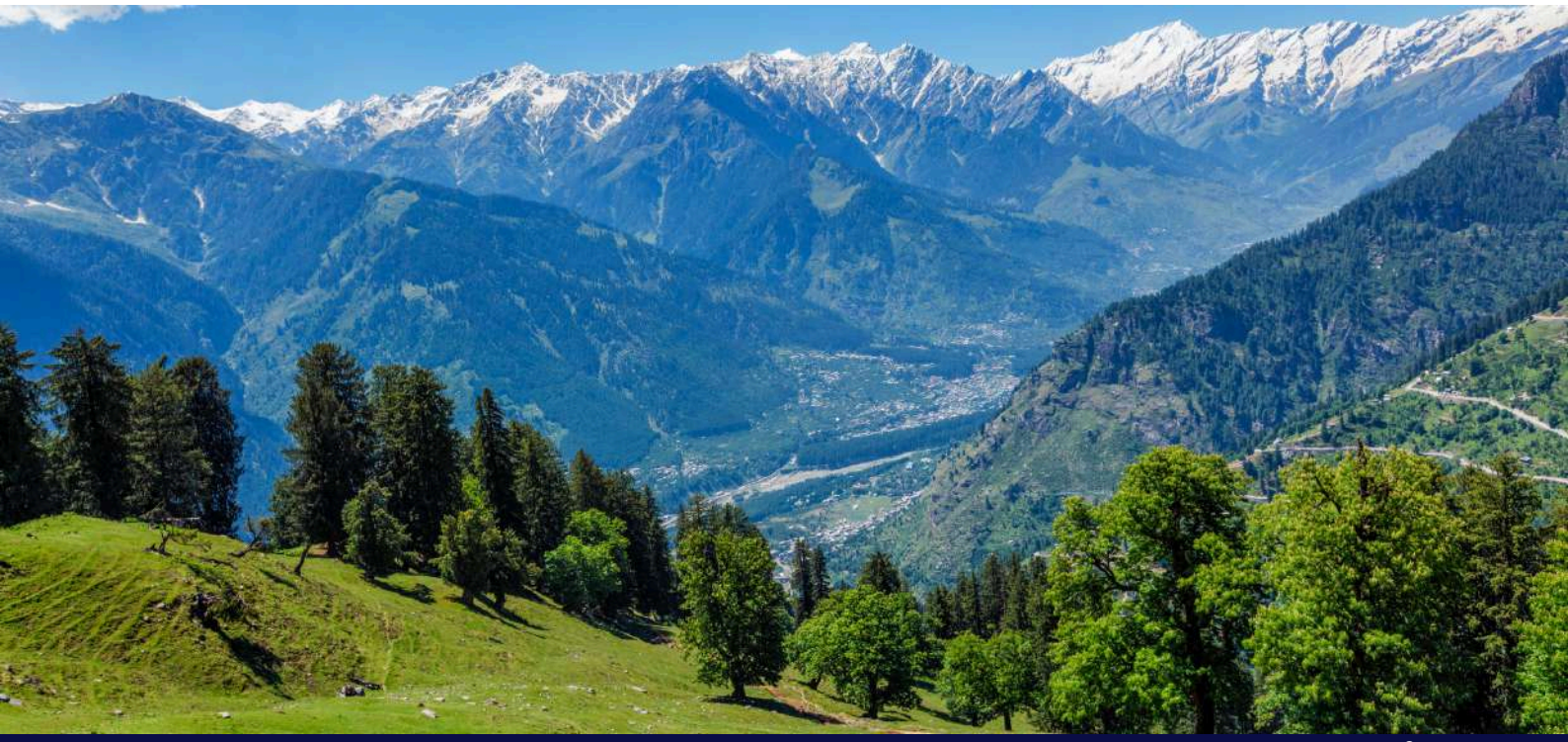
1. **Agricultural Resilience:** Agriculture, the backbone of India's economy, is highly sensitive to climate variability. Adaptation planning helps in developing climate-resilient crop varieties, efficient irrigation systems, and sustainable farming practices to safeguard food security.
2. **Water Resource Management:** With growing water scarcity and unpredictable rainfall patterns, adaptation strategies like rainwater harvesting, watershed management, and interlinking of rivers are vital to ensure equitable and sustainable water distribution.
3. **Disaster Risk Reduction:** India is prone to cyclones, floods, and droughts. Adaptation planning facilitates early warning systems, resilient infrastructure, and community-based disaster management programs to mitigate loss of life and property.
4. **Urban Resilience:** Rapid urbanization increases the vulnerability of cities to heatwaves, flooding, and water shortages. Adaptation planning promotes sustainable urban development through green infrastructure, energy-efficient buildings, and climate-resilient transportation systems.
5. **Health Preparedness:** Changing climates can lead to the spread of vector-borne diseases and heat-related illnesses. Proactive adaptation measures strengthen healthcare systems, enhance disease surveillance, and promote public awareness.
6. **Ecosystem Protection:** Adaptation planning is critical to conserving India's rich biodiversity and ecosystems, including mangroves, forests, and wetlands, which act as natural buffers against climate change impacts.
7. **Economic Stability:** Climate impacts can disrupt economic activities, especially in sectors like agriculture, tourism, and energy. Adaptation strategies ensure long-term economic resilience and create opportunities for green growth.
8. **Social Equity:** Vulnerable communities, including rural populations and indigenous groups, are disproportionately affected by climate change. Adaptation planning ensures inclusive approaches that address social inequalities and enhance community resilience.

Given India's commitment to global climate goals under the Paris Agreement and its own developmental priorities, robust adaptation planning is indispensable for achieving a sustainable and resilient future.

2 Overview of India's Adaptation Plans and Policies

On June 30, 2008, the Prime Minister of India unfolded the country's first National Action Plan on Climate Change (NAPCC). The eight core national missions under India's NAPCC aim to address climate challenges through targeted actions: promoting solar energy (National Solar Mission), enhancing energy efficiency (National Mission for Enhanced Energy Efficiency), integrating sustainability in urban planning and waste management (National Mission on Sustainable Habitat), improving water use efficiency (National Water Mission), conserving the Himalayan ecosystem (National Mission for Sustaining the Himalayan Ecosystem), expanding forest cover (National Mission for a Green India), advancing climate-resilient agriculture (National Mission for Sustainable Agriculture), and fostering climate science research (National Mission on Strategic Knowledge for Climate Change).

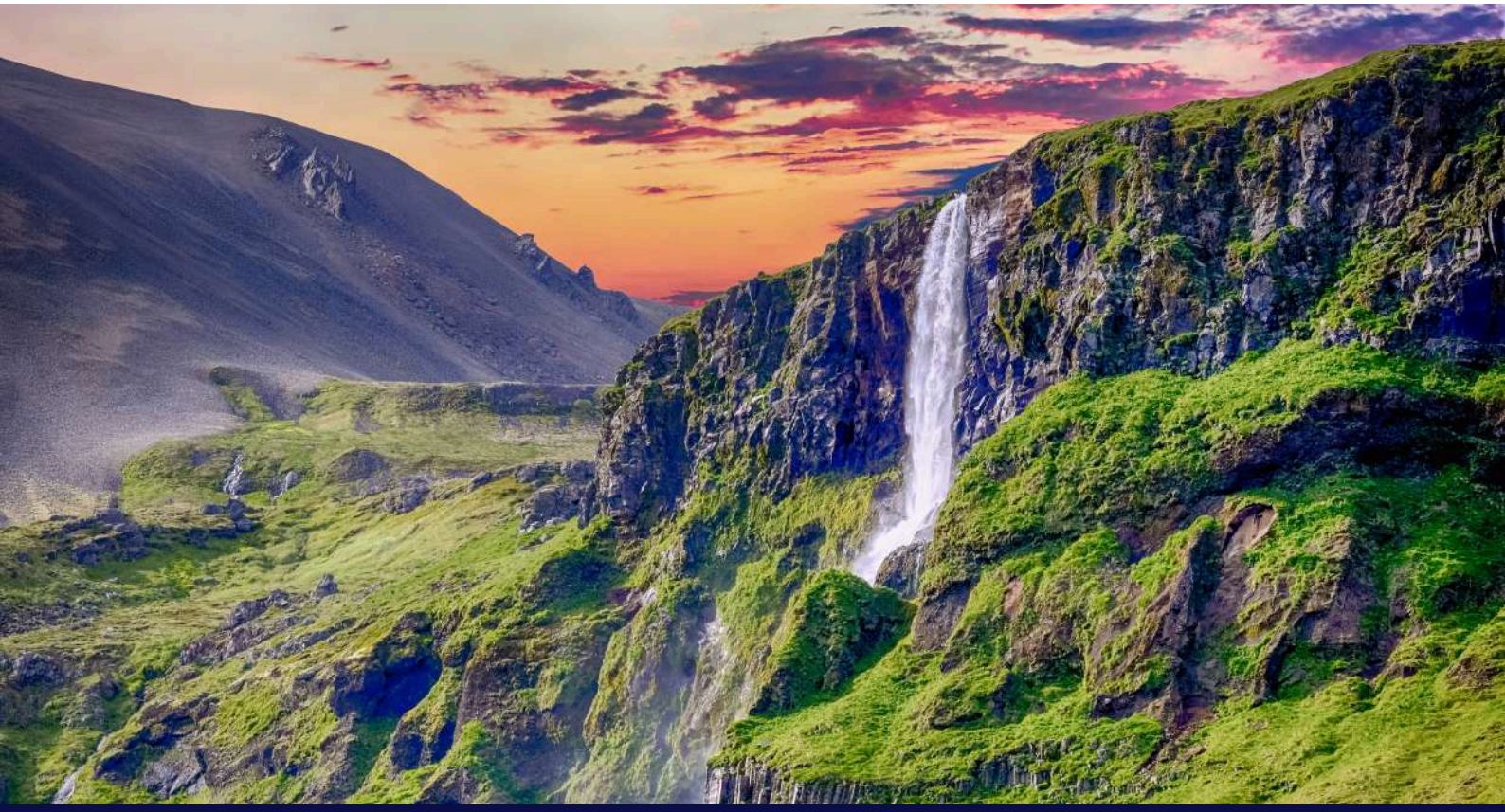
NAPCC claims that the Government of India's expenditure on climate change adaptation surpasses 2.6% of GDP, focusing on agriculture, water resources, health, and forestry. Notable initiatives include retiring inefficient coal plants, promoting renewable energy purchases, and mandating energy audits in industries. Additionally, programs target crop and livestock drought resilience, afforestation efforts enhancing carbon stocks, and innovative water usage. Coastal region protections, health sector enhancements for disaster response, and risk financing for farmers also contribute to comprehensive adaptation strategies (Spencer et al., 2024).



3 Objectives of the White Paper

The main purpose of this white paper is to discuss India's urgent need for Adaptation Planning and financing requirements in the coming years to fulfil its climate announcements and to contribute to the process of developing the Adaptation Plan of India, which MoEFCC, GOI is working on. Given India's NDC targets followed by the Net Zero goal by 2070 and India's high vulnerability to climate change, it is a daunting task for the country to strike a balance between economic growth, social development and climate challenges. Understanding the role of various adaptation needs in the context of the overall requirement of climate resilience building is a crucial factor in developing the nation's plan for adaptation. Adaptation is inherently a dynamic process and deeply linked to the other mitigation activities, including the natural process of carbon capture and sequestration. Therefore, it is important to see adaptation as part of a comprehensive approach to climate mitigation rather than as a standalone approach.

The following sections will address the strategic adaptation planning issues, the approach and potential methodology of its cost assessment, and ways and means to finance the adaptation action plans, including mobilizing investments for resilience building. It is important to develop a uniform approach and methodology to address the adaptation-related issues in India, and thus, the purpose of this white paper is to shed some light on that.



4 Approach and Methodology for Adaptation Planning

Chapter Highlights

1.0 Uniform methodology of adaptation needs assessment is necessary at a country level.

2.0 Adaptation measures need to give importance to local phenomena.

3.0 Resource conservation and circular economy is a meaningful approach for adaptation measure for India, leading towards implementation of LiFE.

4.0 Adaptation is a dynamic process and needs to be investigated through the lens of land-use & land-cover change as function of socio-economic growth.

5.0 Climate resilience building under different climate vulnerabilities shall be the essential part of the adaptation plan.

Adaptation planning is crucial for India to address climate change impacts, protect vulnerable communities and ecosystems, and support sustainable economic growth.

4.1 Nationally Unified Assessment Method with Focus on Local Climate Diversity

India's approach to assessing adaptation needs, measures, and costs requires both uniformity and localization. A nationally uniform framework is essential to establish a standardized climate adaptation taxonomy. Currently, there is no consistent methodology; rather, various states and departments adopt their own diverse approaches to assess the need for adaptation and their corresponding expenses. This lack of uniformity hampers cohesive planning and effective resource allocation.

At the same time, adaptation is inherently local, as climate impacts and vulnerabilities differ across regions. Therefore, any nationally uniform framework must incorporate mechanisms to reference and integrate local nuances. This dual approach would ensure a standardized starting point for adaptation planning while respecting and addressing the unique needs and challenges of individual regions. Thus, while India needs a nationally uniform approach, it must be flexible enough to accommodate the diversity of local contexts, enabling effective and inclusive climate adaptation strategies.

4.2 Concept of Circular Economy in Climate Adaptation

A circular economy offers multiple benefits for adaptation by reducing carbon emissions and simplifying supply chains, especially at the local level. Unlike linear supply chains, which are widespread and vulnerable to disruptions caused by climate disasters such as floods, circular systems are localized and community-driven. This localization enhances resilience to climate impacts and fosters the prosperity of local businesses and small enterprises.

Additionally, a circular economy reduces the exploitation of virgin materials, preventing soil erosion and biodiversity loss—key factors in bolstering nature's adaptability to climate change. Water-related circular practices, such as recycling and rainwater harvesting, mitigate the stress on water resources during droughts and other water-related disasters, strengthening community resilience.

To implement this effectively, India's adaptation plan and policy should include mechanisms like Extended Producer Responsibility (EPR) and deposit refund schemes, expanding their scope beyond plastics to materials like metals, glass, and other waste streams. These measures will ensure that producers take responsibility for sustainable product lifecycles, supporting adaptation while promoting environmental sustainability. Thus, a nationally uniform framework for assessing adaptation must integrate circular economy principles, ensuring it is both standardized and adaptable to sectoral and local needs.

4.3 Low Carbon Climate Resilient Development

The Low-Carbon and Climate-Resilient Development (LCRD) method of finding adaptation needs and financing is built on the concept of a nationally unified but locally focused assessment approach of climate mitigation, adaptation and resilience. This proposed approach could integrate adaptation with mitigation under the country's broader developmental efforts, using net emissions and dynamic land use and land cover (LULC) changes to assess vulnerabilities and resilience needs. This approach, thus, involves assessing adaptation needs through a multi-dimensional lens, considering socio-economic, environmental, and climate variables on a two-dimensional scale of space and time.

The LCRD model framework can integrate the bottom-up energy and LULC change demand into the economic growth path, which can provide spatial and temporal scale changes in GHG emissions and corresponding carbon stock and flow variation. These linkages can further help to assess granular level LULC change and the corresponding change in climate vulnerability, hazard and risk profile, leading towards the identification of adaptation needs and measures at both spatial and temporal scales. LCRD approach can make localized adaptation needs assessment over a temporal scale under different climate and development scenarios aligned to the national targets. The process emphasizes identifying adaptation needs by categorizing human, physical, and natural capital impacted by climate risks. Adaptation measures are prioritized based on quantified vulnerabilities and cost-effectiveness, using the concept of Marginal Cost of Adaptation.

This ensures that resources are allocated effectively to build climate resilience while supporting sustainable development goals.

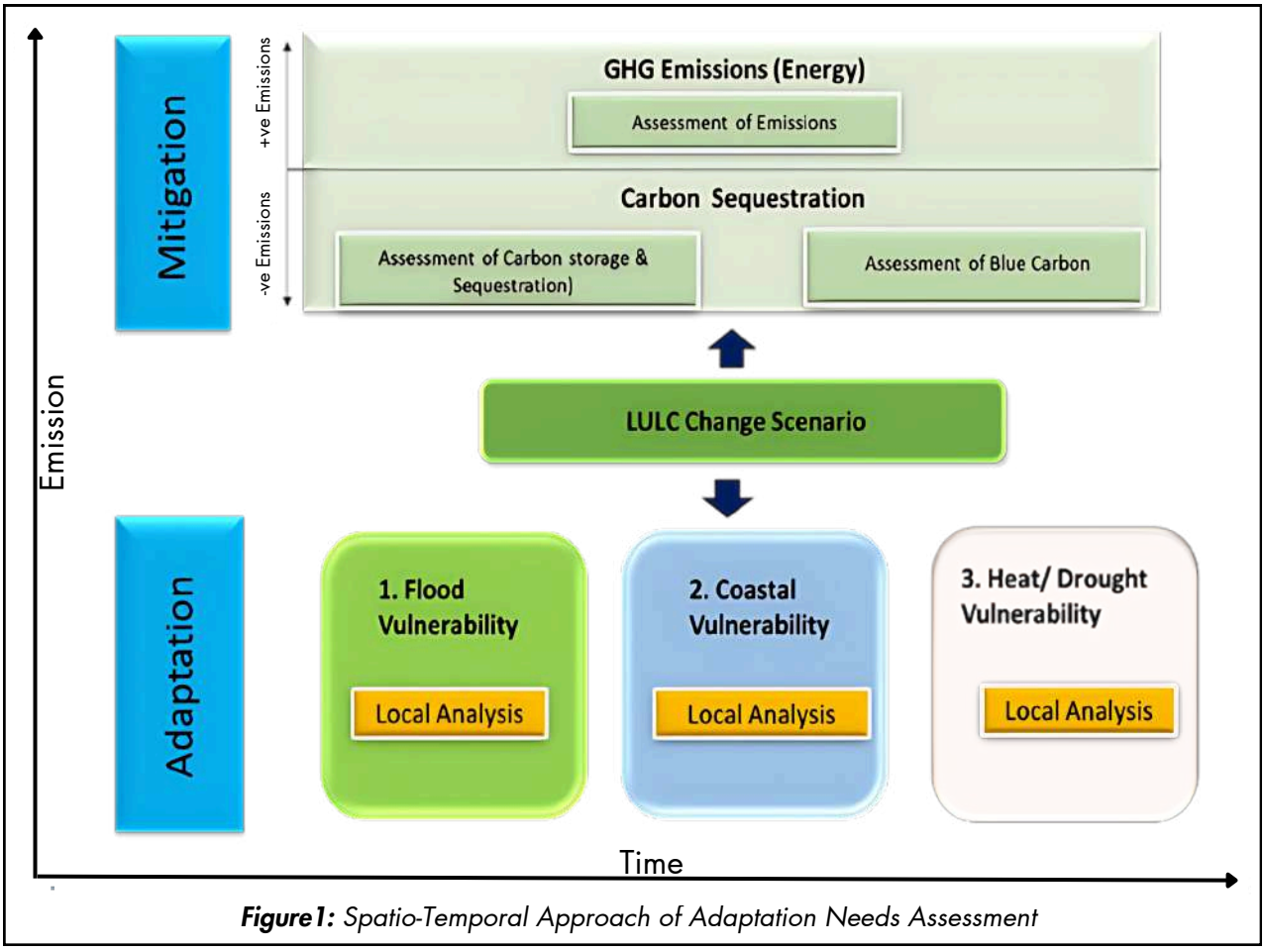


Figure 1: *Spatio-Temporal Approach of Adaptation Needs Assessment*

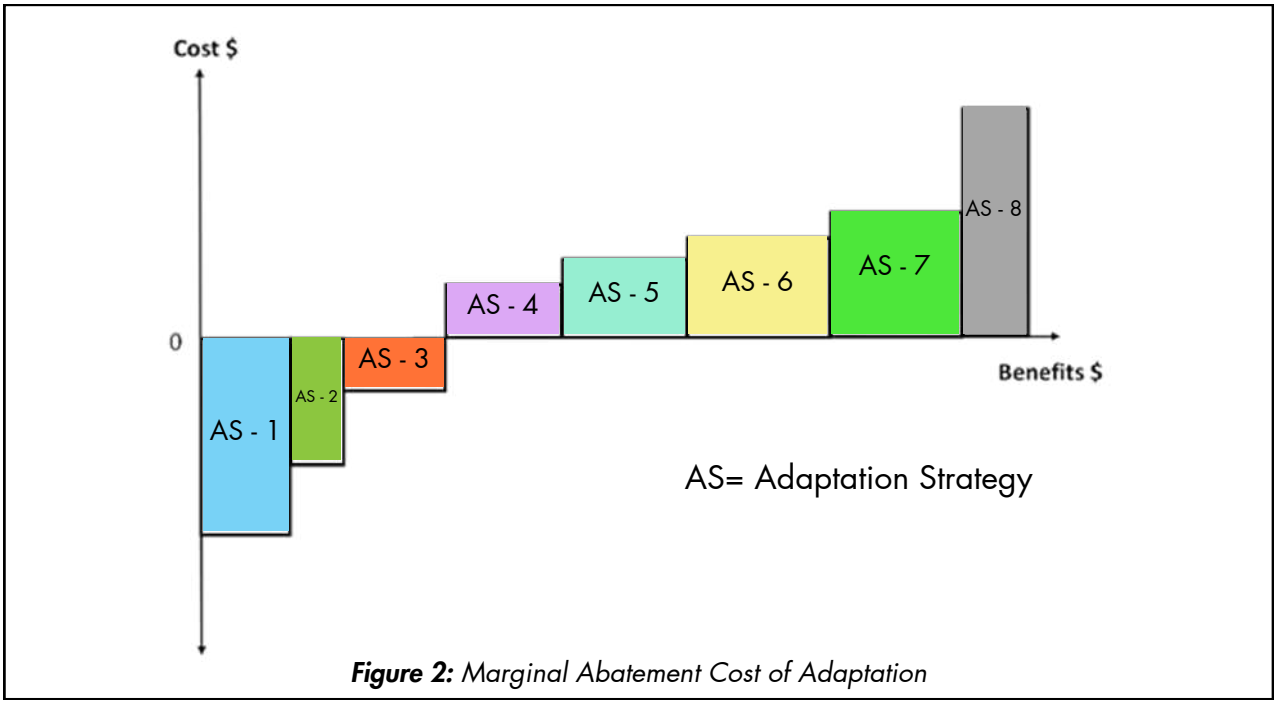


Figure 2: *Marginal Abatement Cost of Adaptation*

5 Mitigation and Adaptation Linkage

Chapter Highlights

1.0 Mitigation and Adaptation are linked and need to be dealt as a composite measures of climate change.

2.0 No adaptation is better than ill-adaptation and therefore, NAP needs to be localized.

3.0 Financial risks of adaptation projects can be hedged through mitigation activities while in combination.

4.0 Technology needs to take centre role in NAP implementation.

5.0 Development led transition and transition led development need to be balanced.

So far, adaptation and mitigation are dealt with separately in the context of climate change. However, it is increasingly evident that mitigation, including efforts of natural carbon sequestration (terrestrial & blue), does have an impact on the long-term vulnerability of human, physical and natural capital, and so does on adaptation needs and measures. Exploring the link between mitigation and adaptation by type and location is essential for effective planning of adaptation and resilience building of the community.

In the context of the net-zero concept, adaptation needs to be viewed as a dynamic, integrated process that interacts with mitigating techniques. According to research, adaptation and mitigation are inextricably interconnected and cannot be achieved as separate goals (Klein et al., 2007). Traditionally thought of, as measures intended only to lower greenhouse gas emissions, mitigation also includes carbon sequestration through natural ecosystems. Because they act as natural carbon sinks, natural resources—such as terrestrial ecosystems (forest and green covers) and blue carbon systems (wetlands, rivers, waterbodies, etc.) are essential to reduce emissions. Better management and conservation of terrestrial and blue carbon ecosystems can help increase the absorption of GHGs and reduce the net emissions of the country. In the state of Goa, for example, studies have shown that reforestation and redensification of degraded forest areas to increase green cover and managing wet-

lands and water bodies could reduce long-term adaptation costs by 15–20% (The Celestial Earth, 2023). These measures not only mitigate emissions but also strengthen adaptation strategies by enhancing ecosystem resilience.

5.1 Mitigation Affecting Adaptation

Land-use and land-cover changes reflect intricate and interdependent relationships between adaptation and mitigation. For decades, deforestation and land conversion have been major contributors to greenhouse gas emissions, often fostering unsustainable agricultural practices. Addressing this challenge through forest conservation incentives and efforts to expand forest cover not only reduces greenhouse gas emissions but also offers substantial co-benefits. These include improved local climate regulation, enhanced water resource management, and the preservation of biodiversity.

Carbon sequestration in agricultural soils represents a valuable link between mitigation and adaptation. By storing carbon in soils, it provides farmers with an economic asset (sequestered carbon) while simultaneously enhancing land value through improved soil and water conservation. This dual benefit strengthens both the economic and environmental dimensions of adaptive capacity.

Afforestation and reforestation have long been promoted as key mitigation strategies. While these projects can increase land competition, leading to higher land rents and commodity prices, they can also improve the economic position of landowners and enhance their adaptive capacity (Lal, 2004). However, the impact of reforestation on water resources vary significantly depending on species selection, geographical conditions, and regional climatic characteristics.

In regions with abundant water resources, even under changing climates, afforestation can yield several benefits, including soil conservation and flood control. Conversely, in regions with limited water availability, characterized by intense rainfall and prolonged dry spells, forests can increase average water availability.

However, in arid and semi-arid regions, afforestation often reduces water yields substantially. This can have wide-ranging negative effects on adaptation efforts across various sectors, such as agriculture (irrigation), power generation (cooling systems), and ecosystem protection (ensuring minimum water flows for rivers, wetlands, and riparian ecosystems).

5.2 Adaptation Affecting Mitigation

Many adaptation strategies across different sectors often lead to increased energy consumption, which can conflict with mitigation efforts if the energy is derived from carbon-emitting sources. Adaptation-related energy use can be categorized into two main types:

-> One-time energy input required for constructing large infrastructure, including materials and construction processes.

-> Incremental energy input required continuously to mitigate climate impacts while maintaining the provision of goods and services.

Balancing adaptation and mitigation requires integrating low-carbon energy solutions to minimize trade-offs and enhance sustainability.

The magnitude and relative share of sustained adaptation-related energy input

in the total energy balance depends on the impact sector and thus needs to be considered while developing the overall plan of adaptation. Adaptation influences not only energy consumption but also energy supply. In 2003, hydropower accounted for 16.3% of global electricity generation (IEA, 2021) while producing virtually no greenhouse gas emissions. However, climate change impacts and adaptation efforts across various sectors may reduce the availability of this carbon-free energy source. As competing demands for water intensify, conflicts over its use could further constrain hydropower generation in many regions.

5.3 Disaster Risk Management & Adaptation

Adaptation is a crucial pillar of climate action, enabling communities, ecosystems, and economies to withstand and respond to the impacts of climate change and related disaster risks. While mitigation focuses on reducing greenhouse gas emissions, adaptation builds resilience against climate-induced threats such as extreme weather events, rising temperatures, and changing precipitation patterns.

Disaster risk reduction measures work as adaptation and resilience-building mechanisms for the community. Disaster risk reduction applications such as environmental management, social aspects and safety nets, land use planning, protection of critical facilities from extreme weather events, structural measures, early warning systems and community awareness, etc. are all acts of adaptation measures. Integrating disaster risk management and adaptation planning and practices at the local level is crucial for India to combat climate change. Preparing disaster data and trends with the frequency and intensity of extreme events, the impacts on socio-economic factors are essential. It is equally important to public awareness of this information and data, which can make them aware, concerned and cautious. It is also important for the researchers to use this information for continuous research.

Adaptation also reduces long-term economic losses by minimizing climate-related damage and enhancing sustainability. A proactive adaptation approach, combined with mitigation, creates a comprehensive climate strategy that protects lives, livelihoods, and natural ecosystems while supporting long-term development goals. National Adaptation Plan needs to focus on establishing the clear link between disaster risk assessment, risk management and adaptation planning.

5.4 Natural Resources Playing Critical Role for Adaptation

India's diverse terrestrial and aquatic ecosystems play a vital role in climate adaptation by enhancing resilience, supporting livelihoods, and maintaining ecological stability. Forests act as carbon sinks, regulate microclimates, and reduce heatwaves, while agroforestry and sustainable agriculture improve soil moisture retention and prevent erosion. Grasslands help combat desertification, and mangroves serve as natural barriers against storm surges and coastal erosion. Wetlands act as sponges, absorbing floodwaters and ensuring water security, while rivers and watershed management enhance groundwater recharge and freshwater availability. Traditional water

conservation systems like Johads in Rajasthan and Stepwells in Gujarat further strengthen water resilience. Policy initiatives such as the National Plan for Conservation of Aquatic Ecosystems (NPCA), State Action Plans on Climate Change (SAPCCs), and the National Adaptation Fund for Climate Change (NAFCC) integrate ecosystem-based approaches into national adaptation strategies. By protecting and restoring natural ecosystems through a combination of scientific interventions, traditional knowledge, and community participation, India can effectively harness nature-based solutions to address climate challenges and enhance long-term sustainability.

5.5 Balancing Development-lead Transition and Transition-lead Development

India must put development first while incorporating sustainable practices into its growth trajectory, while achieving economic growth and raising living standards. Climate mitigation and adaptation activities are required to be in sync to the overall developmental agenda of the country. While poverty reduction, economic development, and infrastructure expansion are still important, they must be coordinated with lowering carbon intensity as mitigation efforts and must be protected under extreme climate events by enhancing resilience through appropriate adaptation measures. So until India reaches the desired standard of living and ensures livelihood for all, a development-led transition mechanism is important to follow. However, under the VikshitBharat vision, India is expected to achieve the desired economic development by 2047. As India's developmental goals are mostly met by then, attention can be turned to achieving deep decarbonization. Climate action could take centre stage in transition-led development, propelling economic expansion via advancements in green technologies, renewable energy, and circular economy models. This stage would put sustainability first, making sure that progress doesn't come at the expense of environmental deterioration.

5.6 Role of Technology in Adaptation

To improve resilience and facilitate successful climate change adaptation, technology is essential. It ensures that ecosystems and communities can effectively adapt by offering cutting-edge tools and solutions to predict, lessen, and respond to the effects of extreme weather occurrences. Catastrophic disasters like floods, hurricanes, and droughts can be detected early because of advanced technology like satellite imaging, AI-based prediction models, and Internet of Things sensors. Therefore, the communities can have plenty of time to plan and reduce damages. Early warning systems, for example, can help flood-prone areas to anticipate and address floods before they happen, minimizing both human and financial damage. Adaptation strategies can become more proactive, adaptable, and successful by utilizing these technologies. Since flexibility is essential to establishing long-term resilience, it is also crucial to make sure that the technologies we use do not produce inflexible dependencies.

6 Adaptation and Role of Nature-based Solutions

Chapter Highlights

1.0 NbS enhances climate resilience through disaster risk reduction, carbon sequestration, and food security.

2.0 Economic valuation tools and financing mechanisms like PES unlock NbS potential.

3.0 Adaptation needs to focus on combating land degradation and neutrality.

4.0 "Circle of Livelihood" can be the governing principle of adaptation planning

5.0 Consider forest as Green Guard to climate change and needs valuation for its protection and conservation.

6.0 Community-led initiatives drive sustainable NbS implementation and adaptation outcomes.

Nature-based solutions (NbS) are critical for addressing the twin challenges of adaptation and mitigation of climate change, offering cost-effective, sustainable, and inclusive pathways. Research indicates that NbS could contribute approximately 37% of the global climate change mitigation targets required by 2030 to meet the Paris Agreement goals (UNEP, 2022). In India, NbS projects hold immense potential to offset greenhouse gas emissions, enhance climate resilience, and generate socio-economic benefits. Initiatives like MISHTI and platforms such as the India Forum for Nature-Based Solutions highlight the country's growing focus on mainstreaming NbS through policies and collaborations. However, despite their proven benefits, global and domestic investments in NbS remain insufficient, underscoring the need for enhanced funding and private-sector engagement to unlock their full potential.

6.1 Role of Ecosystem Services in Climate Adaptation

Ecosystem services play a vital role in climate adaptation by providing natural solutions to mitigate and adapt to the impacts of climate change. These services, encompassing provisioning, regulating, supporting, and cultural benefits, enhance resilience in ecosystems and communities. Regulating services, for instance, help reduce disaster risks through coastal ecosystems like mangroves, salt marshes, and seagrasses, which act as natural buffers against storm surges, cyclones, and

sea-level rise. In Odisha's Bhitarkanika region, mangrove plantations have significantly minimized storm surge impacts during cyclones. Ecosystems such as forests and wetlands also contribute to carbon sequestration and climate mitigation. Restoration efforts under initiatives like the Green Climate Fund in Andhra Pradesh, Maharashtra, and Odisha have enhanced carbon capture, supporting global net-zero targets. Additionally, nature-based solutions sustain livelihoods and food security through climate-adaptive practices such as mussel and oyster farming and the System of Rice Intensification (SRI). These approaches not only ensure sustainable ecosystem functions but also provide economic opportunities for vulnerable communities, with women playing a pivotal role in these initiatives.

6.2 Importance of Ecosystem Valuation for Nature-Based Solutions

Nature-based solutions (NbS) offer innovative approaches to address societal challenges by leveraging natural processes, such as biodiversity conservation, climate adaptation, and economic resilience. To effectively implement and mainstream NbS, robust valuation methods are essential to quantify their ecological, social, and economic benefits. A few approaches to valuation could be the Total Economic Valuation of natural resources and ecosystems, and the cost of Inaction of not conserving and protecting the natural resources and ecosystems.

Total Economic Valuation (TEV) is a comprehensive framework that captures the full range of ecosystem services, encompassing both use values (e.g., provisioning and regulating services) and non-use values (e.g., cultural and supporting services). It forms the basis of global assessments like the Millennium Ecosystem Assessment (MEA), linking ecosystem services to human well-being and facilitating policy integration. For example, the TEV framework estimates the total stock value of tiger habitats in India at INR 1,60,000 crore (USD 25 billion), with annual flow benefits of INR 7,967 crore (USD 1.2 billion). These reserves provide critical services such as water regulation, carbon sequestration, and biodiversity conservation, offering a return of 200 to 530 times on investments.

Cost of Inaction approach quantifies the economic losses incurred when conservation measures are not implemented. By highlighting the stark contrast between inaction and proactive adoption of NbS, it underscores the urgency and long-term economic value of investing in nature.

6.3 Combating Land Degradation as Adaptive Measure & Food Security

More than 30% of India's total land area is under certain type of degradation. The rate of degradation is alarming and the most vulnerable land use for the same are rainfed agricultural areas and forest (Land Degradation Atlas of India, ISRO, 2021). Achieving the national target of land degradation neutrality by 2030 is a daunting task but the most needed one in the context of climate adaptation and resilience. Indian agriculture sector is highly vulnerable to climate change due to its heavy dependence on monsoon rain, low irrigation coverage, increasing heat stress, soil degradation, fragmented landholdings and lack of access to technology and finance. It is utmost

important that the NAP focuses on increasing the adaptative capacity and resilience of agriculture and its allied sectors. Besides crop diversification, increasing irrigation coverage and other physical measures, soil plays a critical role in the system as a nature-based instrument to enhance the resilience of the agricultural output and the corresponding farmers. Soil health and soil-ecosystem services are considered NbS, which can be acquired through practices such as crop diversification, agroforestry, and minimum tillage. These approaches improve organic carbon levels, optimize nutrient cycles, and create more resilient agricultural systems. For instance, **India's soil health card** initiative evaluates critical soil parameters like pH, nitrogen, and organic carbon, offering tailored recommendations to farmers for sustainable crop production. Additionally, NbS mitigates climate vulnerabilities, particularly in regions like arid and semi-arid, where both climatic and socio-economic challenges are severe. Poverty-linked land degradation and corresponding agricultural impact are important to observe where degradation-linked poverty is also prominent in several places in the country. The NAP, therefore, needs to establish a link between degradation and land neutrality to adaptation and agricultural productivity for sustainable livelihood. **Circle of Livelihood** is the concept of sustainable livelihood depending on agricultural activities in India.

NbS also contributes to increased agricultural productivity by restoring degraded lands and promoting sustainable water management. Addressing issues such as saline water intrusion and soil degradation through improved soil management practices has demonstrated significant enhancements in crop yields. Furthermore, NbS thrives on participatory approaches that integrate traditional knowledge with modern innovations. Farmer-to-farmer knowledge-sharing platforms and extension services play a crucial role in disseminating best practices while strengthening farmer-producer organizations and cooperatives, ensuring inclusivity and amplifying grassroots innovations. Collectively, these strategies empower farmers to adopt sustainable practices, fostering a resilient agricultural landscape that supports food security and environmental sustainability.

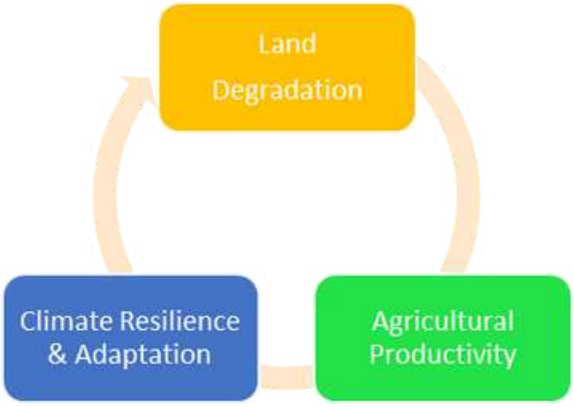


Figure 3: Circle of Green Livelihood

Food insecurity is one of the biggest vulnerabilities in climate change; therefore, addressing food insecurity is a critical part of the National Adaptation Plan. Nature-based solutions (NbS) play a vital role in addressing the intertwined challenges of agricultural sustainability and food security, particularly in the context of climate change. As a key objective of the Sustainable Development Goals (SDGs), food security is closely tied to sustainable agricultural practices. By leveraging natural processes, NbS enhances agricultural resilience, productivity, and environmental health,

contributing to both climate adaptation and mitigation efforts.

Food security depends on maintaining consistent agricultural productivity despite environmental challenges, and nature-based solutions (NbS) play a crucial role in achieving this. By focusing on restorative and adaptive methods, NbS ensures long-term stability in food supply, reduces reliance on synthetic inputs, and mitigates the risks of land degradation. Effective planning for climate adaptation through NbS involves a bottom-up approach, emphasizing multi-stakeholder involvement, from local communities to policymakers. For tangible impacts, programs must span six to seven years, allowing sufficient time to observe meaningful outcomes. Actionable data is essential for driving policy and financial support. For example, insights from initiatives like soil health card experiments demonstrate the effectiveness of adaptation measures, enabling informed policy decisions and attracting investments to scale up NbS initiatives. Additionally, integrating traditional farming knowledge with scientific techniques ensures practical, location-specific solutions that address community needs while fostering resilience and sustainability in agricultural practices.

6.4 Promoting Forestry as Green Guard to Climate Change

Among the various mitigation strategies, forestry emerges as a crucial 'Green Guard' against climate change, offering a sustainable and cost-effective solution for carbon sequestration, biodiversity conservation, and ecosystem resilience. Forests act as carbon sinks, absorbing carbon dioxide (CO_2) from the atmosphere and thereby reducing greenhouse gas (GHG) emissions. With India committed to achieving net-zero emissions by 2070, afforestation and reforestation programs are integral to fulfilling its climate commitments under the Paris Agreement. Besides playing the critical role of carbon capture and storage, forest cover also plays an essential role in climate adaptation by regulating temperature, humidity, and precipitation. Increased tree cover helps reduce the urban heat island effect, promoting rainfall and preventing desertification. Forests are home to 80% of terrestrial species, fostering biodiversity that ensures ecological balance. Additionally, they provide ecosystem services such as soil conservation, water purification, and flood regulation, which are essential for climate adaptation. Under the National Adaptation Plan, it is, therefore, essential to adopt forests as a Green Guard against climate change and to provide adequate protection and conservation. Tagging the existing national programs like the National Afforestation Program (NAP), Green India Mission, CAMPA, Nagar Van Yojona (NVY), Forest Fire Protection & Management Scheme (FFPM), Mangrove Conservation Program (MISHTI), etc., to the National Adaptation Plan will be important for the overall achievement of the targets and goals.

While considering the forest and green cover of the country as the natural green guard to climate change, the National Adaptation Plans need to give due consideration to their respective values of ecosystem services. Economic valuation of the services provided by the forest and corresponding ecosystem to climate change mitigation and adaptation will be an essential step towards mainstreaming

them in national adaptation measures. Assessment of economic values can fetch due respect to these natural resources and will help to generate financial resources for their conservation.

Forest-dependent communities in India are crucial for adaptation efforts and benefit from various forestry initiatives. Plantation drives by the Forest Department provide direct benefits, while eco-tourism offers financial benefits. Nature-based solutions from forests contribute to climate change resilience and safeguard communities by providing essential resources and livelihood opportunities. NAP shall also consider people's participation and cultural heritage while planning for adaptation practices. Indian Sacred Groves are the brightest examples of people-led forest and green cover conservation for thousands of years.

6.5 Need for Measuring Adaptation Benefits of Nature Based Solutions

The need for a clear framework to measure the adaptation benefits of nature-based solutions is urgent. While ecosystem-based services exist, they have not been integrated into policy planning. Markets exist for rewarding ecosystem services, and literature on payment for ecosystem services (PES) is available. Ecosystem-based services can be measured and their benefits monetized, which could help communities adapt to climate change. However, there is limited reference to ecosystem-based services in government development programs, particularly in terms of payment for services. Access and Benefits Sharing (ABS) is one such known PES mechanism which is covered under the National Biodiversity Act 2002. Integrating Payment of Ecosystem Services solutions into development planning is crucial, as governments and non-governmental agencies often focus on immediate benefits without long-term adaptation planning. To address this, a result-based financing framework at the government level should be established, utilizing various indicators and results to ensure that a part of development expenditure accounts for adaptation benefits. A National Adaptation Plan can indicate promoting ES valuation and corresponding PES mechanisms in various natural resource categories like forests, wetlands, water bodies and mangroves.

6.6 People's Participation in Adaptation

Community-based management is a cornerstone for ecosystem conservation and restoration, particularly in wetlands and forests. This approach integrates local knowledge, capacity building, and community participation to achieve sustainable outcomes. Empowering communities, as seen in projects like Women Climate Champions in Odisha, has demonstrated success in ecosystem restoration. Women trained in scientific techniques have mobilized their communities for mangrove restoration and disaster preparedness. Decentralized governance further strengthens these efforts, as initiatives supported by UNDP showcase how local stakeholders can lead restoration projects, fostering ownership, improving outcomes, and safeguarding biodiversity.

Community involvement also enhances resilience and disaster preparedness, ensuring rapid mobilization and effective response during events like cyclones in Odisha. Case studies underscore the

impact of community-based management. For instance, UNDP's Green Climate Fund project restored over 3,000 hectares of mangroves and 1,600 hectares of watersheds, benefiting approximately 2 million people across Andhra Pradesh, Maharashtra, and Odisha. Similarly, the Small Grants Initiative (SGI), funded by the Global Environment Facility, has supported over 600 projects that build local capacities and pilot innovative biodiversity conservation and climate adaptation measures. Moreover, efforts like the India Biodiversity Awards and OECM recognition highlight the role of communities in sustaining biodiversity, with UNDP documenting over 1,000 nature-based solutions, including effective conservation measures outside legally protected areas.

The National Adaptation Plan needs to focus on greater participation of the community in a systematic manner in order to increase the community's resilience and adaptation. It is important to give priority to the school curriculum on adaptation and resilience building among the children through reading and practice. Community-level climate adaptation and disaster preparedness training facilities can be built where regular interaction and knowledge sharing can take place.

7 Thermal Adaptation and Sustainable Cooling

Chapter Highlights

1.0 Health impact of Climate Change is an important aspect in adaptation, and heat stress increases the health vulnerabilities.

2.0 Thermal adaptation is an essential component of climate adaptation and NAP needs to focus on universal access (including animals) to thermal comfort.

3.0 India's growing cooling demand can be addressed by integrating passive and active cooling techniques

4.0 Public sector leadership is crucial for recognizing cooling as a utility, setting equitable standards.

5.0 Scaling up cooling solutions requires shifting industry mindsets, incentivizing efficiency, and leveraging technology and financing models supported by clear government policies.

Among the direct effects of climate change is the increase in the frequency, duration, intensity and severity of heat waves, which is very evident in India. In addition, understanding of the adaptation process of the exposed population remains limited, posing a challenge in accurately estimating heat-related morbidity and mortality and corresponding adaptation measures and costs. Climate and weather conditions significantly impact human health and well-being. Each year, millions of people die due to environmental factors, many of which are worsened by climate change. As a multiplier of global health threats, climate change exacerbates existing health issues, disproportionately affecting vulnerable populations—especially in low-income countries—by deepening inequalities.

Heat waves have been linked to a rise in gender-based violence, including an increased risk of femicides, as well as a surge in police reports and emergency calls (Sanz-Barbero et al., 2018). Similarly, droughts impact mental health, contributing to mood disturbances, a higher incidence of intimate partner violence, and an increased risk of suicide (Padrón-Monedero et al., 2024; Vins et al., 2015). Beyond these direct impacts, the broader climate emergency itself triggers anxiety, depression, stress, fear, suicidal behaviour, and eco-anxiety, among other mental health and psychosocial issues (WHO, 2022).

National Adaptation Plan thus needs to consider the heat stress-related

vulnerabilities caused due to climate change in a structured manner. Thermal adaptation is not only necessary for humans but also for all living beings in the country. Adaptation to heat stress by the animals, especially by the milch animals, is essential for the livelihood of the cattle farmers as the milk production is directly linked to the heat stress condition.

Overall, there is an unprecedented demand for cooling due to India's fast urbanization, increasing crop and milk production and corresponding rising temperatures, which are caused by global climate change. If current trends continue, it is estimated that cooling energy demand will account for more than 45% of total peak energy demand by 2050 (Barbar, Marc et.al. 2023). Thermal adaptation is essential because of the serious threats it poses to infrastructure, societal well-being, and economic sustainability.

To lower energy use while maintaining thermal comfort and resilience, thermal adaptation entails combining passive and active cooling techniques. In order to naturally control internal temperatures without heavily relying on energy-intensive technologies, passive cooling techniques emphasize enhancing architectural designs, such as the use of reflective roofing, natural ventilation, shaded facades, and green roofs. In many temperature zones of India, where region-specific designs can greatly reduce local heat stress, these solutions are very helpful. By centralizing cooling for numerous buildings, active cooling technologies such as district cooling systems offer effective solutions. When compared to traditional cooling techniques, these systems can significantly lower emissions and energy usage, making them a vital tool for urban areas with higher cooling needs.

Collaboration between local communities, technology developers, urban planners, and legislators is essential to the successful implementation of these policies. A comprehensive strategy guarantees that these cooling options are not only fair but also energy-efficient, helping the most disadvantaged groups impacted by temperature rise. By combining these tactics, India can effectively meet its increasing cooling needs while also optimizing energy use, advancing national climate goals, and improving social coherence and resilience in the face of global warming.

7.1 Urban and Rural Cooling Action Plan as Adaptation Strategy

As temperature rises and the population grows, widescale thermal comfort becomes essential rather than just a luxury. At many levels, including rural development plans, city master plans, and municipal strategies, there is an urgent need for sustainable interventions to fulfil the increasing demand for cooling without making environmental issues worse. Cooling leads to thermal comfort, which is an undebated adaptation measure in a country like India. However, the need for thermal comfort varies by climate zone, beneficiaries, and sectors. A fit-for-all plan is not sufficient to address the heat stress problem in India. India's Cooling Action Plan is a definite starting point for the same but not all. Aligning the cooling action plan to national adaptation planning is important to extend the thermal comfort support to every corner of the country with dignity and uniformity. Equitable and unfettered access to thermal comfort shall be the right of the people

living in India. National Adaptation Plan should aim for it. Providing necessary cooling and thermal comfort as a national plan is a daunting task indeed, which needs a humongous amount of resources in the years to come. However, dedicated planning and effective strategies can help the country to achieve it in a staged manner. NAP linked to the urban and rural cooling action plan can develop the pathways to achieve targets.

7.2 Integrating Energy Efficiency with Thermal Comfort and Adaptation

As India's need for air conditioning and cooling increases rapidly, especially until 2040, energy efficiency becomes a vital tactic to strike a balance between environmental sustainability and cooling. Even though passive cooling is crucial, active cooling systems also need to be tuned to manage the unavoidable increase in emissions. Incentives for the production and use of energy-efficient products, such as high-star air conditioners and cooling equipment, can help achieve this. The manufacturing and uptake of these energy-efficient solutions can be accelerated by offering manufacturers financial or subsidy-based help. In order to promote creativity and to create effective cooling systems, research and development expenditures are also crucial. India can lower emissions, aid in thermal comfort adaptation, and promote the shift to a sustainable lifestyle by incorporating energy efficiency into cooling operations. This would help the country to meet its national and international climate commitments.

7.3 Managing Cooling Demand & Achieving Thermal Adaptation

To meet the rising need for cooling, India has strong guiding frameworks such as the Energy Conservation Building Codes (ECBC) and the India Cooling Action Plan (ICAP). Although these solutions are available at the national level, subnational and local customization to meet particular needs is necessary for their successful implementation. While cities like Gurugram are investigating solutions to lower building sector cooling demand through scenario modelling for 2050, states like Kerala are concentrating on vulnerable groups to solve cooling demands. These strategies, which prioritize thermal comfort and adaptability, must be incorporated during the design and procurement phases in order to successfully lower cooling demand. India can promote sustainable cooling practices, reduce energy consumption, and develop a more resilient and climate-responsive cooling framework by modifying state and city-level cooling action plans to suit local conditions and aligning them with ICAP guidelines. Although there are thermal comfort standards for air conditioning system design, there isn't a national standard for what thermal comfort is considered acceptable. Implementation can be substantially aided by policy documents such as these. But the main emphasis should be on execution—moving from policy frameworks to concrete ground-level actions that involve states, cities, municipalities, and construction authorities. The National Adaptation Plan shall be instrumental in managing the cooling demand in the country while ensuring thermal comfort, as an adaptive measure.

7.4 Cooling as Service (CaS) & role of Public Sector in Thermal Adaptation

By recognizing cooling as a utility at par with water and electricity, public sector utilities can play a crucial role in promoting thermal comfort and climate adaptation. Shifting from the practice of cooling as an individual commodity ownership-driven service (private goods) to cooling as a service where ownership of assets and consumers are different can bring substantial benefits to the country in terms of savings of financial resources and materials and reducing emissions. NAP can be directed towards creating the necessary ecosystem in India, which can create a market for CaS. By requiring zoning and construction clustering in crowded urban areas, state and local authorities can promote holistic urban planning and make shared cooling options like district cooling systems possible. Mandatory feasibility studies for different cooling methods should be incorporated into urban planning, taking sustainability and environmental factors into account, in order to assist this. Efficiency and environmental performance can be further improved by using creative techniques, such as incorporating modular systems, renewable energy sources, and natural resources like rivers into cooling solutions. India can implement comparable centralized systems that are suited to its requirements by taking inspiration from international models, such as Germany's district heating systems. The public sector can promote long-term resilience and provide thermal comfort while also complying with climate adaptation goals by incorporating these strategies into urban development plans and greenfield projects. National Adaptation Plan shall provide a wholistic direction on the same.

7.5 Resource Mobilization for Thermal Adaptation

Technology and finance are not the great barriers to scaling up sustainable cooling solutions, as they are both accessible when the appropriate market players are engaged. Innovative cooling models are being actively funded by international funds, project finance lenders, and multilateral development organizations. The difficulty, though, is in changing the industry's perspective to one of efficiency since many developers continue to ignore cooling systems' electrical efficiency. Developing an ecosystem that incentivizes developers, cooling service providers, and end users to emphasize thermal adaptation as the necessity of the country, along with energy efficiency, is essential to breaking the market inertia.

National Adaptation Plan in this context can create the regulatory and policy related enabling environment which can help the market to break the ice and start moving. As an example, by offering the opportunity to transfer these advantages to end users, developers can be encouraged to adhere to strict efficiency goals and build cooling performance indicators (CPI). Standardizing the Cooling Performance Indicators for the buildings, establishing precise guidelines and providing suitable incentives backed by government intervention is essential for scaling up the thermal adaptation measures through multiple options.

7.6 Addressing Thermal Adaptation for Wildlife and Animals

The National Adaptation Plan shall not only look into the thermal adaptation for humans but also consider wild and domesticated animals, including cattle. Due to extreme heat conditions, wild animals face severe health issues like dehydration, DNA damage, food shortage, malnutrition, etc., which are beyond human measure. It is appropriate to take necessary measures under the NAP to create cooling provisions for wild animals in Protected Areas and designated reserve forests, including animals living within human habitats. NAF can create an enabling facility to accelerate systematic monitoring and reporting systems of heat stress conditions of wildlife and animals so that cooling systems can be arranged.

8 Role of Renewable Energy in Adaptation

Chapter Highlights

1.0 DRE enhances energy access and climate resilience due to its ensured power supply even during natural disasters.

2.0 Creating a one-stop platform, use of digital tools like blockchain, aligning policies, incentivizing DISCOMs, and build public awareness can be the key solutions for DRE uptake.

3.0 National DRE schemes like PMSG, PM KUSUM etc. can be part of the NAP.

4.0 NAP can standardize DRE based income generation schemes as part of adaptation measures to the communities.

In the process of energy transition and sustainable development, RE is regarded as one of the most important components. However, RE is also essential to adaptation since it offers a timely and dependable energy supply even during extreme weather events and natural calamities when power lines and infrastructure are damaged. Decentralized RE, therefore, can provide consumers with more energy security during disasters. However, several technological, financial, and legal obstacles are preventing the adoption of decentralized RE, particularly solar rooftops, from accelerating at the same rate as large-scale installations. So far, renewable energy adoption is seen as a mitigation measure as it directly helps to reduce GHG emissions by replacing fossil fuel-based power generation. Nevertheless, besides mitigation, RE plays a crucial role in adaptation as well, by ensuring a life-saving energy supply during a disaster, as mentioned before, and also by providing economic and social leverage to the poorer section of society by making them prosumers (consumers + producers) and giving necessary protection during climate hazards. PM Surya Ghar Yojana is one of the classic examples of solar energy-based adaptation measures for India, which will provide necessary economic and social empowerment. Ministry of Power released a series of guidelines to enable renewable energy to reach a wider range of users while also reducing barriers and speeding up the process. Under the new standards, users

those who need up to 100 kilowatts of electricity can choose open-access green energy on their own initiative. This allows newer users to enter the market because it is less than the previous cap of one megawatt required (Kumar, 2022). The National Adaptation Plan needs to further promote renewable energy use as an adaptation measure in India, which can provide multiple benefits to a variety of users, starting from households to farmers using agro-photovoltaic systems for irrigation and farm mechanization. Reducing dependency on imported high-cost fossil fuels can immediately leverage financial benefits to the users, which will, in turn, make them economically stable and more resilient to any natural disasters.

8.1 Decentralized Renewable Energy (DRE) and Adaptation

Decentralized RE systems producing and consuming locally, irrespective of grid conditions, can be considered a climate adaptation and resilience-building effort. Uninterrupted supply of electricity during natural calamities and extreme weather conditions is a robust resilience to the community while facing natural disasters. DREs are even more effective as adaptation measures in rural areas where grid access is low, and network supply is unstable due to remoteness. As a national adaptation plan, while equality and uniformity of access to resources without exclusion is the governing principle, DRE qualifies on all accounts. Beyond just producing energy, DRE also enables the effective use of regional renewable energy resources, such as biomass, small hydro, waste, tidal, etc., for power generation. These initiatives contribute to energy security and climate resilience by improving energy access and lowering reliance on fossil fuels. As an adaptive measure, power utilities (DISCOMs) can decentralize electricity generation, lower transmission losses, and guarantee the seamless integration of RE into the grid by encouraging the use of rooftop solar systems and any form of community-based RE projects.

Decentralized Renewable Energy (DRE) has become a major force behind enhancing energy security and advancing fair access to electricity, especially in underserved and rural areas. Nevertheless, a number of obstacles stand in the way of its widespread acceptance and effective application, notwithstanding its potential. Unlocking the full potential of DRE systems, including rooftop solar installations, requires removing these obstacles through strategic planning, openness, and efficient procedures. The National Adaptation Plan can keep provisions for promoting DRE by addressing the obstacles.

8.2 Role of Technology in RE Uptake: Adaptation Support

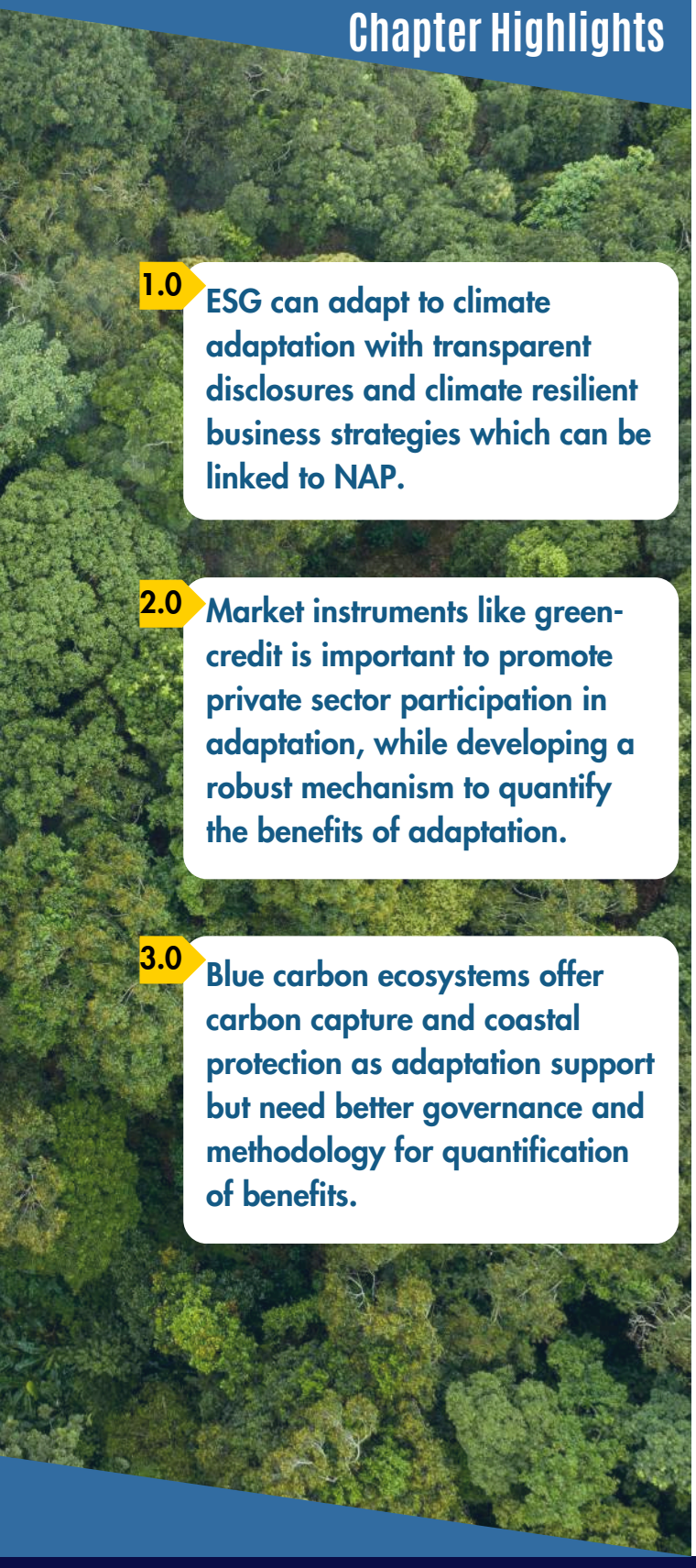
Adaptation and climate resilience building is an essential part of the NAP. As a matter of fact, Renewable Energy plays an important role in providing climate resilience through uninterrupted power supply, providing options for additional income generation and by providing access to energy for all. Nevertheless, technological interventions further enhance the renewable energy uptake and corresponding resilience in the system by overcoming the existing obstacles. As a result, NAP can play a crucial role in the promotion of RE in the country and can support several ongoing national policies

and schemes such as PMSG, PMKUSUM, etc.

To achieve energy security and climate goals, India must embrace and integrate renewable energy (RE). However, obstacles, including demand forecasting, grid integration, operational inefficiencies, and the absence of efficient power distribution network management, sometimes impede the adoption of RE. Similar to how the Unified Payments Interface (UPI) revolutionized India's banking industry by bringing efficiency, automation, and transparency, utilizing AI and ML can completely overhaul the RE sector. Real-time and historical data can be analysed by AI/ML algorithms to accurately forecast patterns in energy demand. With the use of these insights, DISCOMs can effectively balance the supply and demand for energy, cutting down on waste and guaranteeing the best possible use of renewable energy sources like wind and solar. AI/ML applications can automate a number of DISCOM operations, including grid management, fault management, billing, and customer support. Decentralized energy grids may be monitored and managed by AI-powered systems, guaranteeing the smooth integration of renewable energy sources. The use of AI/ML can help integrate the Early Warning System and RE generation forecasting to provide better information to the disaster management authorities about the potential impacts of any upcoming natural disaster. In order to preserve stability and dependability, ML models can dynamically modify grid operations and forecast variations in solar and wind energy generation. AI/ML tools can evaluate hazards like extreme weather events that could affect RE infrastructure by analyzing climate data and other variables. During emergencies, this proactive approach to risk management guarantees electricity supply continuity and resilience. Peer-to-peer energy trading can be facilitated via AI-enabled platforms, enabling users to sell extra renewable energy to other users or back to the grid. This increases the uptake of RE and encourages decentralized generation. Dynamic pricing models based on current supply and demand can also be produced by ML algorithms. This promotes energy saving and helps users to optimize their energy use.

9 Private Sector & Market Mechanism in Adaptation

Chapter Highlights



1.0 ESG can adapt to climate adaptation with transparent disclosures and climate resilient business strategies which can be linked to NAP.

2.0 Market instruments like green-credit is important to promote private sector participation in adaptation, while developing a robust mechanism to quantify the benefits of adaptation.

3.0 Blue carbon ecosystems offer carbon capture and coastal protection as adaptation support but need better governance and methodology for quantification of benefits.

Building climate resilience in all spheres of life has become a critical focus at global, regional, and local levels, particularly when mitigation options reach their limits to provide the necessary benefits of emissions reduction. The private sector is well aware of climate change and its related risks associated with their respective business lines. To achieve climate goals, the market mechanism plays a crucial role. Historically, the Kyoto Protocol and CDM mechanisms play the most effective role in bringing private sector participation in the market to adopt various emissions reduction technologies without any governmental finance. The tradable credit-based incentive for emissions reduction creates an enabling environment for the private sector to take part in the mitigation measures. However, adaptation is a complex system where the estimation of credit generation is not straightforward. The Green Credit mechanism launched by the Govt. of India is an attempt to create a credit-based market for various adaptation activities like water conservation, afforestation, etc. Outcome-based green credit mechanisms can further be linked to adaptation activities where the individual or community can get the financial benefits of their adaptive measures. Additionally, the integration of ESG principles is discussed as a pathway to unlock the potential of these markets in supporting adaptation mechanisms and fostering sustainable development.

9.2 Linking Market Mechanism and Adaptation

The National Adaptation Plan needs to consider linking mechanisms between adaptation activities and market-based instruments for benefit sharing among the stakeholders. Unlike mitigation activities, adaptation has no single unified direct measuring indicators like GHG emissions measured in CO_2 equivalent. It is, therefore, important for adaptation that outcome-based indicators are selected to measure the benefits. NAP can explore selecting the outcome indicators of adaptation measures by sector for national standardization and benchmarking. Like the standard approach & methodology for emissions reduction for mitigation projects by sector, adaptation benefit assessment can also have standard A&Ms, which can be nationally recognized. NAP plays a crucial role in mobilizing the stakeholders to develop certain A&Ms. Market-driven adaptation activities could be a long-term and effective solution to achieve the desired level of climate resilience.

9.2 Link Between National Adaptation Priorities and ESG Compliance

The integration of adaptation within ESG (Environmental, Social, and Governance) regulations has become increasingly critical for private sector entities. Initially, the focus of sustainability and climate-related disclosures was on mitigation; however, adaptation is now receiving equal importance due to its role in ensuring business continuity and resilience against climate risks.

The journey of ESG disclosures began with frameworks like the GRI (Global Reporting Initiative), which provided a foundation for organizations to report on sustainability. Over time, standards like the TCFD (Task Force on Climate-related Financial Disclosures) have introduced a strategic approach to climate risk management. TCFD emphasizes assessing potential risks, strategizing to mitigate them, and ensuring resilience in business operations. For instance, companies may evaluate how extreme weather events, such as floods, could disrupt operations and supply chains. They use tools like Think Hazard and Aqueduct to analyze climate projections and refine financial planning, ensuring adequate budget allocation for adaptation measures.

A significant aspect of adaptation in ESG is transparency. Public disclosures of risks, such as operational vulnerabilities or supply chain disruptions, are critical for investors and stakeholders. These disclosures necessitate the formulation of robust adaptation strategies. By building climate-resilient infrastructure, companies ensure preparedness against future risks, safeguarding revenue and operational stability.

Adaptation is also tied to the evolving requirements of ESG rating agencies and questionnaires. Agencies like Carbon disclosure projects (CDP) and frameworks like Morgan Stanley Capital International (MSCI) and Digital Governance Standards Institute (DGSI) increasingly include questions on adaptation and climate risk. This shift underscores the growing expectation for companies to not only identify risks but also demonstrate proactive adaptation strategies. For instance, companies in sectors like textiles may prioritize sourcing climate-resilient crops to mitigate risks in their supply chain.

Moreover, the financial implications of

adaptation extends beyond internal operations. Investors and rating agencies closely monitor a company's risk assessments, adaptation investments, and resilience strategies. The competitive edge gained through high ESG ratings incentivizes companies to adopt robust adaptation measures, addressing reputational and transition risks alongside physical risks. Thus, the National Adaptation Plan can further attempt to prioritize the adaptation related ESG activities by climatic zones in India to enhance the effectiveness of the ESG initiatives. Linking overall ESG activities in the country to the national adaptation priorities by climate zones will be a step further towards the climate-resilient development of the country.

9.3 The Indian Carbon Market

The Indian carbon market is poised for significant transformation as Article 6 of the Paris Agreement has now formalized the mechanisms for carbon trading, making it mandatory both domestically and globally. This shift holds immense potential for India, which has over 6,000 companies listed under environmental compliance frameworks, presenting a substantial opportunity for the private sector.

As the market launches, industries are expected to face several challenges, primarily revolving around compliance costs and the adoption of frameworks. These include the integration of advanced technology, the costs associated with scaling, and establishing approval mechanisms. Furthermore, the uncertainties surrounding the verification, validation, and monitoring processes for carbon credits remain a key concern.

To address these challenges, the establishment of stringent and transparent standards is critical. These standards should guide independent verification agencies and set rigorous monitoring protocols for registered projects. Transparency in these processes, supported by technology and the involvement of NGOs, stakeholders, and chambers of commerce, is essential for building trust and ensuring the system's credibility.

The carbon market also necessitates a legal framework to facilitate the trading of carbon offsets while promoting renewable energy adoption and net-zero commitments. Companies are increasingly expected to align their supply chains with renewable energy goals and other sustainability objectives, which underscores the importance of capacity building and expertise in this domain.

India holds a significant position as a global supplier of green credits, commanding over 70% of the market share. If managed effectively, this advantage could propel India into a leadership role in the international carbon market. The sector also presents a range of opportunities, including the creation of over 20,000 specialized jobs in environmental engineering and related fields. Revenue generated through the carbon market can be utilized to fund adaptation projects in vulnerable areas, incentivizing businesses to invest in climate-resilient practices.

9.4 Potential of Blue Carbon in Adaptation

India's vast coastline and rich coastal ecosystems, including mangroves, seagrasses, and salt marshes, present significant potential for developing a

robust blue carbon market. These ecosystems are highly efficient at sequestering carbon—five times more than terrestrial systems—while offering economic benefits such as fisheries, tourism, and carbon credits. They also protect coastal communities from storms and rising sea levels, supporting biodiversity and enhancing resilience.

However, challenges like underdeveloped markets, weak governance, limited infrastructure for high-quality credit validation, and lack of standardized guidelines hinder progress. Drawing from successful international projects, India can scale coastal restoration, engage communities, and foster private-sector collaborations. Establishing clear policies, reliable methodologies for carbon quantification, and platforms for transparent credit trading is essential.

With strategic investments and governance reforms, India can harness its blue carbon ecosystems to achieve climate goals and drive sustainable development.

To effectively leverage blue carbon markets in India, a multi-pronged approach is crucial. This includes developing robust governance frameworks, investing in infrastructure for high-quality credit validation, and establishing clear methodologies for carbon quantification. Scaling coastal restoration efforts, engaging local communities, and fostering private-sector collaborations are essential for unlocking the potential of these valuable ecosystems. By addressing these key areas, India can harness its blue carbon resources to achieve climate goals, drive sustainable development, and enhance coastal resilience.

10 Adaptation Financing

Chapter Highlights

1.0 For easier flow of private sector finance in adaptation, adopting climate portfolio approach can be beneficial in terms of managing investment risks.

2.0 Climate risk profiling of all important assets in the country is important to attract adaptation finance.

3.0 National Adaptation Taxonomy / Green Taxonomy is essential to mobilize financial resources under NAP.

4.0 Valuation of major ecosystem services is essential for measuring the quantum of investment required for adaptation.

5.0 It is important to develop *Adaptation Financing Priority Matrix* under the auspice of NAP.

6.0 It is important to have a *National Portal on Adaptation Plan and Finance* for one stop information platform for all stakeholders.

10.1 Climate Portfolio Approach of Adaptation Financing

For India to achieve comprehensive climate goals, the cost of adaptation must be included in the country's overall transition cost. Because of the uncertainty surrounding returns, which frequently discourages investors, financing adaptation is a challenging task. For adaptation, the risk is unknown, so the uncertainty in investment. However, combining adaptation and mitigation into one package might lower overall portfolio investment risks by hedging the adapting risk through mitigation. A portfolio risk optimization approach of financing the adaptation projects could be a potential solution for long-term and sustainable financing of the same. National Adaptation Plan shall, therefore, encourage increasing the bankability of the adaptation projects by adopting a portfolio approach. Funding for adaptation measures that would not otherwise have obvious financial incentives is made easy using this strategy. To guarantee that the costs of adaptation are inherently included in the transition plan, the government can also enact laws mandating adaptation elements in major energy and infrastructure projects. Subsidies or tax breaks for these integrated projects may also attract investment.

10.2 Climate Risk Assessment and Adaptation Finance

Given the severity of climate hazards and corresponding losses and damages, it is important that India mandates climate risk profiling of all important assets in the

country. Primarily, there are three main classes of assets: Physical, Natural and Human. All infrastructures like roads, rails, bridges, airports, water dams, etc. are physical assets which are key to our national income and growth.

Protecting all of them from climate disasters is of utmost importance to avoid economic and social damage. Climate vulnerability, exposure to extreme weather events and corresponding hazard estimates are essential to determine the overall risks that those assets are bearing in the context of climate change. To hedge the risk, adequate protection measures are required to be in place in the form of physical guards, financial insurance and an early warning system. In a similar way, other assets like soils, forest covers, wetlands, rivers, coastlines, mountains, sand dunes and deserts are also required to be protected from extreme weather events like floods, wildfires, cyclones, sea level rise etc., so that lives and livelihoods are safe, and economy can keep continuing receiving respective ecosystem services from these natural resources. Natural resources are providing billions of dollars of ecosystem services to the economy, which are quite often undetected and unmeasured. There are a few examples of conducting ecosystem valuation of certain classes of ecosystems like forests and wildlife (tigers mainly), but not for all. As a result, the economic value of the ecosystems is severely under-assessed and, thereafter, unserved through financial protection. Unless the value of the assets and their services is not estimated, there will be a perennial challenge to get adequate financing for the same from mainstream financial institutions. Finally, the value of human capitals are also essential to be estimated and documented for ease of implementing various insurance policies linked to climate change. Due to extreme weather events such as floods, landslides, cyclones and also due to extreme heat stress, people lose their income due to loss of working days, illnesses, disabilities and even death. As of now, there is no national standard for valuing human life (either due to disability or death), which is the biggest hindrance to assessing the need for adaptation funds to protect vulnerable communities from climate threats. National Adaptation Plan, therefore, shall look into these extremely important issues to give direction to have national standardization of the following items:

- Climate Risk ranking of all important and critically important physical assets of the country.
- Economic valuation of the major ecosystem services provided by the major natural resources like forest, designated wetlands, major rivers, coastal zone, sand dunes and beaches, mountain ranges, and desert.
- Climate risk profiling of all major ecosystem services provided by the major natural resources like forest, designated wetlands, major rivers, coastal zone, sand dunes and beaches, mountain ranges, and desert.
- Valuation of human life loss, semi and permanent disabilities.
- Climate risk ranking of all major cities with a clear indication of risk exposure to human and animal lives and livelihood.

10.3 Role of Private Sector in Adaptation Financing

Adaptation finance tracked in the 2023

Global Landscape of Climate Finance (GLCF) reached a record high of USD 63 billion annually for 2021/22, a 28% increase from 2019/20. However, this remains far below the estimated USD 212 billion needed annually by 2030 for developing economies. Public actors dominate adaptation finance, while private sector contributions remain minimal (CPI, 2024) It is tracked that just USD 1.5 billion per year in 2021/22 in the developing countries. In 2020, it is estimated that around US$4 trillion would be needed for India for essential adaptation investments (DEA, 2020). For infrastructure alone, approximately US$178 billion would be required to enhance resilience against climate impacts (Garg et al., 2015).

Currently, there is no comprehensive tracking of public or private adaptation finance in India. However, in 2019–20, CPI estimated that funding for three key adaptation solutions—disaster monitoring and emergency response, flood mitigation, and drought management—amounted to US$5 billion, with 94% sourced from central and state government budgets (CPI, 2021) and only 5% from the private sector.

The actual private sector investment is likely much higher, but limited reporting poses challenges in tracking overall adaptation flows. Current tracking efforts fail to capture key areas such as adaptation-focused SMEs, private equity and venture capital investments in early-stage adaptation companies, insurance premiums incentivizing resilient construction, consumer spending on adaptation solutions, and corporate balance sheet investments in asset adaptation.

Nevertheless, a common understanding between the finance team and the Environmental, Social, and Governance (ESG) or corporate sustainability group about the significance of adaptation and mitigation-related activities by the companies is important for channelling funds for adaptation. Beyond the conventional emphasis on immediate cost savings, regular interaction across these departments enables finance experts to see the long-term benefits and importance of these measures within the company. By encouraging cross-departmental cooperation, companies can motivate stakeholders to consider the wider advantages of combining adaptation and mitigation strategies rather than just the immediate costs. Bringing internal mindsets into alignment facilitates the smooth adoption of sustainable practices and expedites project approvals. Creating a national adaptation taxonomy/ green taxonomy, followed by a robust tracking system of investment by category (mitigation/ adaptation) at the corporate/private sector level, will bring the desired benefits of private sector financing in adaptation. NAP is expected to take note of the same and create an enabling environment of an adaptation taxonomy-based tracking system of private sector investment in adaptation.

10.4 Role of Multilateral Development Banks (MDBs) in Adaptation Finance

Multilateral Development Banks (MDBs) play a critical role in supporting India's national adaptation planning by addressing gaps in finance, technical expertise, and capacity building. They are instrumental in mobilizing and scaling adaptation finance, bridging the

significant funding gap for adaptation projects. In 2022, only 5% of global climate finance was allocated to adaptation, and while India's public expenditure on adaptation accounted for 6% of GDP, private sector participation remains limited due to low visibility of returns from adaptation investments. MDBs can attract private sector involvement by offering low-interest loans and blended finance solutions, using pilot projects to demonstrate the viability and impact of adaptation initiatives.

Additionally, MDBs strengthen technical expertise and capacity building, addressing the lack of local-level capacity to design and implement adaptation projects. Through technical assistance programs, such as those supporting the Ministry of Environment, Forest and Climate Change (MoEFCC), MDBs help create an enabling environment for scaling adaptation priorities. Operating across multiple nations, MDBs also facilitate knowledge sharing and regional collaboration. MDBs leverage regional expertise and global insights to offer tailored solutions for India's adaptation planning while promoting collaborative learning platforms. Moreover, MDBs drive innovative financing mechanisms, such as blended finance models, integrating public, private, and other resources to prioritize climate resilience. They also enhance monitoring, evaluation, and policy support, ensuring adaptation measures are effective by assessing outcomes and aligning projects with national and international climate goals. Pilot projects, such as the ADB's $850 million investment in adaptation financing in 2024, further demonstrate practical solutions and enable scaling successful initiatives, paving the way for broader adoption of climate resilience measures in India.

The National Adaptation Plan can take advantage of the strong presence of the MDBs in the adaptation domain in the country by prioritizing the activities to be supported under various MDB programs at various climatic zones and areas. As the priority changes by location for adaptation, it is important that an Adaptation Financing Priority Matrix is developed under the auspice of NAP, which can guide and help monitor the flow of MDB funds to the priority areas as per requirement.

10.5 Innovative Financing Mechanisms for Adaptation

Adaptation is diverse in nature and localized by characteristic, and therefore, complex in terms of creating a unified approach of financing it. Addressing the challenge of delivering financial benefits to the end users under adaptation program requires innovative mechanisms tailored to local needs.

One effective approach is the line of credit mechanism. Through this, MDBs provide funding to intermediary financial institutions, such as local banks or microfinance organizations, which then sub-lend at concessional rates to community-level stakeholders without fear of loan default. This structure ensures that benefits, such as low-interest loans or grants, are accessible to the most vulnerable groups. By transferring financial advantages through these intermediaries, funds can be targeted towards specific conservation activities like mangrove restoration, offering both economic and ecological benefits.

Payment for Ecosystem Services (PES) is another financial mechanism. This approach incentivizes communities, like fishermen, to continue conservation activities by compensating them for the ecological benefits they provide. For instance, without the efforts of fishermen in mangrove restoration, the public sector would face higher costs to manage these ecosystems. PES acknowledges and monetizes this value, ensuring that local communities are rewarded for their contributions.

Similarly, innovative solutions can support farmers shifting to agroforestry by addressing the economic gaps during the transition period. In states like Punjab, where farmers traditionally earn biannual incomes, transitioning to agroforestry can result in delayed financial returns. To mitigate this, MDBs can introduce tools like delayed moratoriums on loans and blended financing solutions. These mechanisms combine concessional loans, grants, and private sector investments, providing the necessary financial cushion to sustain livelihoods and cash flows during the shift to sustainable practices.

Additionally, MDBs are increasingly focusing on defining and tracking localized outcomes and co-benefits through the Result Based Financing route. For any adaptation or conservation initiative, clear outcome indicators are being established, ensuring projects deliver tangible benefits at the community level. These indicators include metrics such as improved livelihoods, enhanced fish stock sustainability, or strengthened mangrove ecosystems.

This dual emphasis on financial accessibility and measurable outcomes not only addresses immediate financing gaps but also ensures that such projects provide long-term, sustainable benefits to local stakeholders. Ultimately, a combination of institutional support, concessional financing, and robust outcome tracking is key to empowering communities like fishermen to lead conservation efforts effectively.

The National Adaptation Plan needs to focus on the dissemination of information about the available financing options, available funds for specific activities and the list of intermediaries who can support. Quite often, due to a lack of this basic information, local communities, small and medium-sized industries, farmers and associations, etc., are unable to apply for financial help even though the projects are robust and the benefits are tangible. NAP shall work on creating a **national portal for Adaptation Financing,** which can be a one-stop information platform for all.

10.6 Framework for Effective Mobilization of Adaptation Finance

To ensure adaptation finance effectively reaches the end-users where conservation work is carried out, India needs a robust framework that integrates clear definitions, regulatory mandates, and innovative market-based instruments. A critical first step is establishing a comprehensive adaptation taxonomy for adaptation projects, addressing the current lack of standardized definitions. This taxonomy should align with mechanisms like the Green Credit Program and incorporate localized indicators to measure tangible community-level benefits. Market-based instruments, such as carbon credits and payment for ecosystem services (PES), can effectively direct funds to local stakeholders. For instance, fishermen

safeguarding mangroves could receive compensation for the ecological services they provide under a PES scheme. However, the operationalization of such mechanisms requires regulatory clarity, particularly in mandating industries or entities to purchase these credits. Regulatory bodies like the Pollution Control Board can enforce compliance, ensuring a steady demand for these credits, similar to mandates in the circular economy.

Private sector participation also holds immense potential, with companies like insurers and tech firms contributing through climate risk assessments and early warning systems, as demonstrated by initiatives like SpaceX's involvement. Implementation remains a critical challenge, as bureaucratic hurdles and administrative inefficiencies often delay projects. Streamlining processes, strengthening institutional capacity, and ensuring accountability are essential for effective execution. Finally, operationalizing existing mechanisms like the Green Credit Program requires creating user-friendly payment systems and incentivizing local stakeholders to engage actively. These measures collectively ensure that adaptation finance reaches the ground level and contributes meaningfully to climate resilience and ecosystem conservation.

Blended Finance, a form of debt financing, is recommended for projects aimed at improving infrastructure and climate resilience, but it is difficult to quantify and measure adaptation, making it best for projects where clear results in infrastructure and climate resilience can be seen. Many governments are already facing significant debt stress. In addition to blended finance, fiscal support (government expenditure) and voluntary markets play a significant role in financing adaptation. Government budgetary support is crucial for vulnerable communities facing climate change, but voluntary markets can provide financial support. The challenge lies in expanding markets beyond carbon to reward non-carbon benefits. Currently, most credits only reward carbon benefits, and non-carbon benefits are not recognized. A system for measuring, verifying, and generating credits that account for adaptation benefits and ecosystem services is needed. This would improve sustainability and increase income levels for farmers and workers. Existing methodologies, like the government's green credit initiative, can be integrated into policy frameworks to provide these benefits.

The National Adaptation Plan can also create the provision of developing a national tracking system of adaptation financing from all possible sources, including private and public sector companies, philanthropic organizations and MDBs. Use of technologies can be introduced through various means to develop the National Adaptation Finance Tracker.

11 What to Expect from National Adaptation Plan?

In order to guarantee that sustainable development and climate goals are fulfilled, India's National Adaptation Plan (NAP) calls for a comprehensive approach that integrates mitigation, adaptation, and finance across all sectors of the Indian economy. In agriculture, food security, production resilience and livelihoods shall be supported by the NAF through encouraging and implementing sustainable climate-resilient agricultural practices, including agroforestry, efficient irrigation systems (like drip irrigation), soil conservation, and crop diversification. Innovative financing facilities and climate insurance shall be prioritized to protect the livelihood of the farmers from climate hazards and related crop failure.

NAP envisages promoting conservation and protection of all three categories of capitals, physical, natural, and human, in order to reduce economic loss and mitigate damages due to extreme weather events. NAP shall integrate disaster risk assessment and corresponding adaptation strategies in a localized manner considering the diversity of the impacts and local need for adaptation.

NAP shall recognize the importance of local ecosystems, their services to the people, and their corresponding economic value, which can help mobilize financial resources for conservation and protection. In order to improve biodiversity and lower the risks of flooding, urban heat, and other climate hazards, ecosystem-based adaptation techniques such as urban greening, wetland restoration, and upstream habitat recovery is essential. Nature-based solutions (NbS) are expected to play a crucial role in climate adaptation in India. NAP is expected to acknowledge the importance of the NbS and should make provisions to value their services, too.

NAP is envisaged to recognize cooling as an adaptation measure. Given the fact of increasing temperatures due to climate change, heat and related stress will be a major vulnerability of the Indian people in the coming years. Not only humans but also cattle and wildlife will also be seriously impacted due to prolonged extreme heat conditions. NAP shall cover plans and policies for extending thermal comfort to all through various means of expanding both active and passive cooling options. NAP can provide direction towards efficient but affordable cooling through mandating and standardizing alternative building material use, star rating of air conditioning machines, cooling as service, etc. (district cooling systems) to meet India's rising cooling need as an adaptation measure. NAP shall also look into the matter of human health impacts of heat stress and corresponding loss of life and income. NAP can indicate the creation of insurance facilities to protect livelihood loss due to heat stress. With reference to the recommendation of the India Cooling Action Plan (ICAP), NAP can further extend it to a local cooling action plan based on local climatic conditions, livelihood pattern and other socio-

economic status and can create an enabling environment for robust public-private partnerships, financial incentives, and the development of local technical expertise.

NAP is envisaged to consider the DRE (Distributed Renewable Energy) system as an adaptation measure. Microgrids and rooftop solar are examples of decentralized renewable energy (DRE) systems that can provide essential power supply to disaster victims during extreme weather events. Solar Roof Top programs such as PM Surya Ghar can be part of the national adaptation plan and measures. Targeted interventions are necessary for faster adoption of DRE (viz. PMSG). Technological interventions are important to identify location, potential, and demand for power, along with the risk of climate vulnerability of the location, in order to prepare a robust adaptation plan. The development of open, centralized digital platforms for project monitoring, application, and maintenance of the DRE systems will be important during disasters. NAP can also create a provision of contribution to national adaptation measures by the DISCOMs through the DRE route. DRE integration into the National Adaptation Plan can be further accelerated by providing incentives to DISCOMs through suitable financial incentive mechanisms.

NAP is envisaged to encourage investments in nature-based solutions (NbS), sustainable production techniques like just-in-time manufacturing, resource efficiency, etc., which can be further stimulated by the national carbon and green credit markets with strong governance frameworks and open verification procedures. By incorporating Environmental, Social, and Governance (ESG) principles into these adaptation plans through capacity-building programs, financial incentives, and climate risk disclosures, businesses will become more aligned, and it will attract more private sector engagements.

To ensure and enhance fund flow in the adaptation activities, NAP is required to speed up the development and implementation of Adaptation/ Green Taxonomy in India. To guarantee that services efficiently reach the grassroots level, adaptation financing needs to be streamlined. To cut down on bureaucratic obstacles, innovative methods such as carbon credits, Payment for Ecosystem Services (PES), and blended finance models should be given priority alongside regulatory reforms. Adaptation taxonomy will be crucial to move forward in this regard.

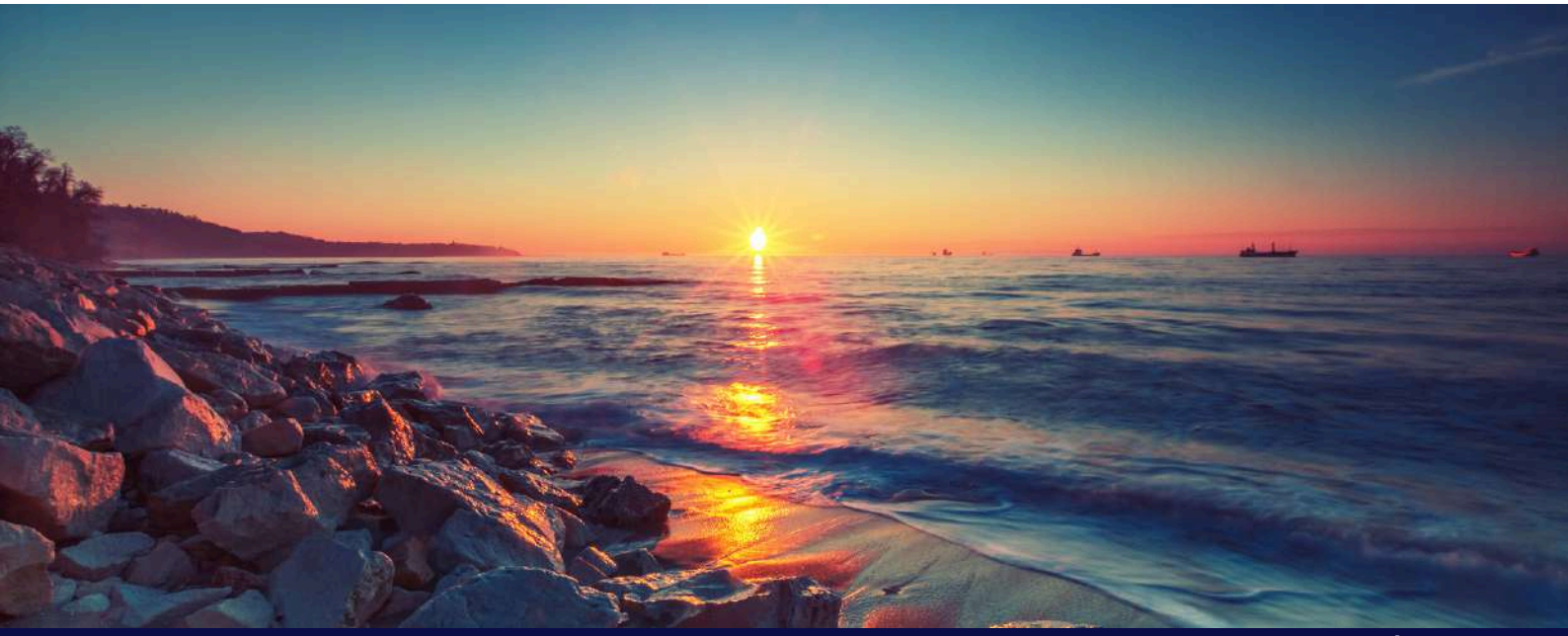
Application of technologies to track finance for adaptation, such as blockchains and AI/ML tool kits, could be effective for India to mobilize resources for adaptation and evaluate the adaptation-related schemes and policies. In order to ensure equitable and inclusive adaptation efforts, gender equal community-based approaches are essential. NAP is expected to ensure gender equality and universal access to adaptation through checks and balances in the process.

Strengthening NAP implementation through regional and international collaboration, stakeholder capacity building, and regular monitoring can position India as a global leader in climate adaptation and mitigation, balancing social equality, environmental sustainability, and economic prosperity.

Abbreviations

ABS	Access and Benefits Sharing
ADB	Asian Development Bank
AI/ ML	Artificial Intelligence/ Machine Learning
ANR	Adaptation and Resilience
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CaS	Cooling as Service
CDM	Clean Development Mechanism
CDP	Carbon disclosure projects
CO_2	Carbon Dioxide
CPI	Cooling Performance Indicators
CPI	Climate Policy Initiative
DEA	Department of Economic Affairs
DGSI	Digital Governance Standards Institute
DISCOMs	Distribution Company (In India)
DNA	Deoxyribonucleic Acid
DRE	Distributed Renewable Energy
DRE	Decentralized Renewable Energy
ECBC	Energy Conservation Building Codes
EPR	Extended Producer Responsibility
ESG	Environmental, Social, and Governance
FFPM	Forest Fire Protection & Management Scheme
GDP	Gross Domestic Product
GHG	Green House Gases
GLCF	Global Landscape of Climate Finance
GOI	Government of India
Govt.	Government
ICAP	India Cooling Action Plan
ISRO	Indian Space Research Organisation
LCRD	Low-Carbon and Climate-Resilient Development
LULC	Land Use and Land Cover
MEA	Millennium Ecosystem Assessment
MDBs	Multilateral Development Banks
MISHTI	Mangrove Conservation Program
MoEFCC	Ministry of Environment, Forest and Climate Change
MSCI	Morgan Stanley Capital International

NAF	National Adaptation Fund
NAP	National Afforestation Program
NAPCC	National Action Plan on Climate Change
NbS	Nature-based solutions
NDC	Nationally Determined Contribution
NGOs	Non Governmental Organizations
NPCA	National Plan for Conservation of Aquatic Ecosystems
NVY	Nagar Van Yojona
OECM	Other Effective Area-Based Conservation Measures
PES	payment for ecosystem services
PMKUSUM	Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan Scheme
PMSG	PM Surya Ghar
RE	Renewable Energy
SAPCC	State Action Plans on Climate Change
SDGs	Sustainable Development Goals
SGI	Small Grants Initiative
SRI	System of Rice Intensification
TCFD	Task Force on Climate-related Financial Disclosures
TEV	Total Economic Valuation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UPI	Unified Payments Interface
USD	United States Dollar
WMO	World Meteorological Organization



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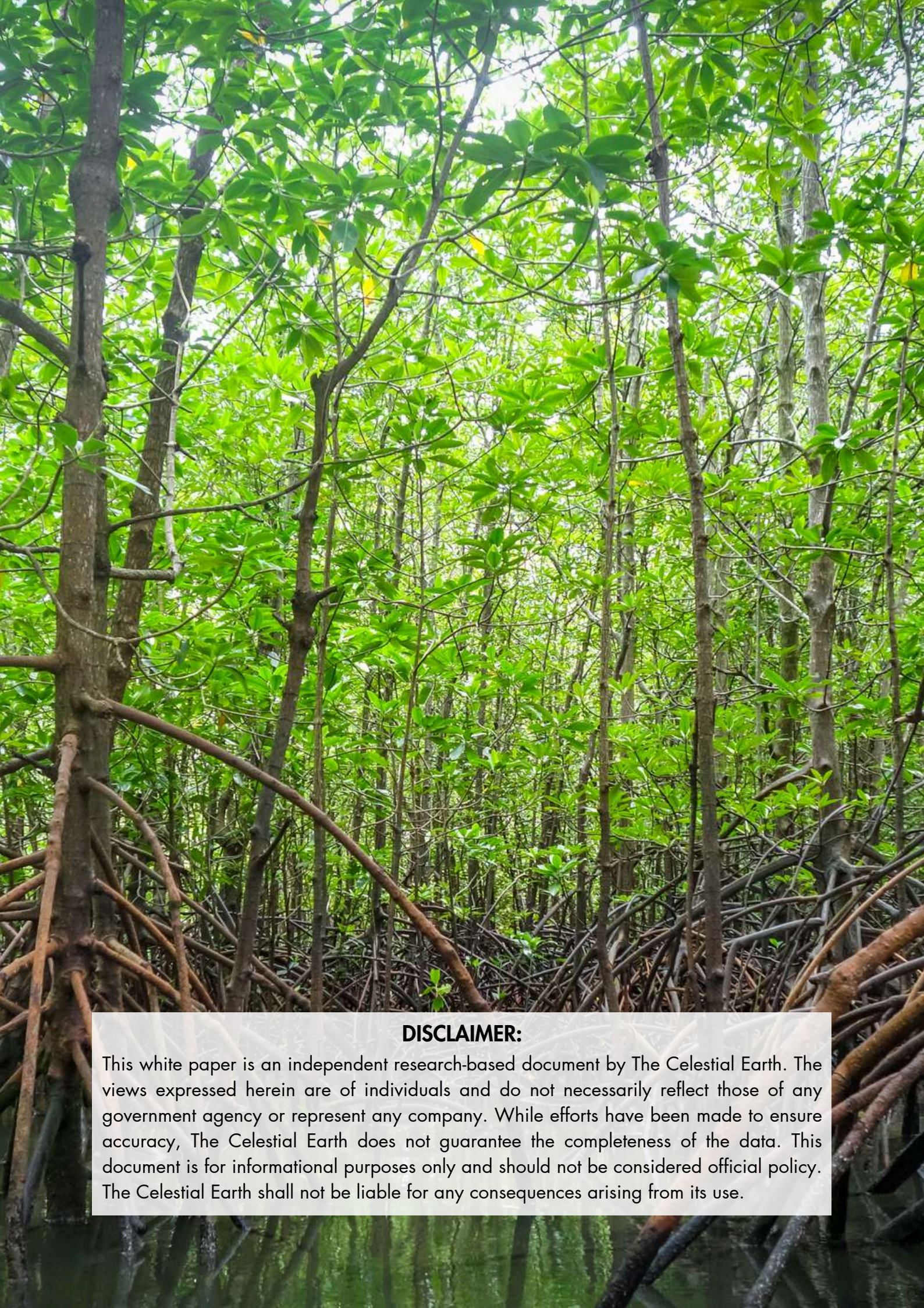

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