



STRATEGIC INNOVATION FOR NORTHEASTERN INDIA

INSA-NECTAR WHITE PAPER

Authors

Ashutosh Sharma^{1*}, Pranav Sharma¹, Famida Khan¹, Veda Krishnan², Arun Sarma³, Smita Pandey Mishra⁴

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^{1*} [Indian National Science Academy & Indian Institute of Technology – Kanpur, \[president@insa.nic.in\]\(mailto:president@insa.nic.in\)](http://www.insa.nic.in)
Indian National Science Academy

² ICAR-Indian Agricultural Research Institute

³ North East Center for Technology Application and Reach

⁴ Fandoro Technologies Pvt Ltd

Glossary

NECTAR	North East Center for Technology Application and Reach
SDGs	Sustainable Development Goals
ESG	Environment, Social and Governance
NE	North East
RPO	Renewable Purchase Obligations
ETS	Emissions Trading Scheme
NESIDS	North East Special Infrastructure Development Scheme
GCAM v6.0	Global Change Analysis Model v6.0
NZ	Net Zero
CEEW	Council on Energy, Environment and Water

1. Executive Summary:

Northeast (NE) India, a region of strategic geopolitical importance due to its position as a bridge between South Asia and Southeast Asia, faces significant challenges that hinder its development and economic integration. The region's political geography, influenced by historical migrations and colonial boundaries, has led to a diverse socio-cultural landscape with varied ethnic groups and economic differences.

NE is developing but looking at its actual resources in all sectors, infrastructure development is a crucial area needing urgent attention. Despite the identification of critical sectors such as transportation, power, and communication, progress remains slow, hindered by overlapping agency roles and inadequate maintenance. The socio-political dynamics, including corruption, ethnic tensions, and land disputes, further impede sustainable infrastructure development. These issues necessitate a refined approach to promote accountability, inclusive planning to engage civil society, newer frame works for land acquisition and ownership disputes, enhanced dialogue, and robust legal frameworks.

The region's vulnerability to climate-induced phenomena like floods and landslides calls for stringent environmental regulations and the integration of climate resilience into infrastructure planning. Furthermore, inclusive planning and community engagement are vital to ensure that development projects address local needs and respect cultural sensitivities.

In addressing these challenges, it is recommended to establish a comprehensive carbon market tailored to the NE States, align carbon farming with agricultural policies, and leverage the region's rich biodiversity and cultural heritage through eco-tourism. Enhancing digital connectivity, especially in remote areas, is also crucial to bridging the digital divide and supporting sustainable development.

A holistic policy approach, sensitive to the unique dynamics of NE India, is essential for transforming these challenges into opportunities for growth and stability, promoting regional integration, and fostering sustainable development through innovative and inclusive strategies.

2. Review of the Region:

The NE states of India serve as *northeastern borderlands* of South Asia and the *northwestern borderlands* of Southeast Asia encompass two distinct sub-continent, making the regions strategic for state and state policies. The populace is a melting point of Asia, where people have historically migrated from various regions such as Tibet, Southwest China, and Southeast Asia, in addition to colonial rule-induced migrations from different parts of India and Nepal. A thin landmass, commonly

referred to as the Siliguri corridor or the chicken's neck, measuring 21 km in length and making up just 2% of its border with mainland India, has emerged as this Asian miniature.

The contemporary political geography of the region is predominantly ascribed to the geopolitical dynamics of colonialism, which formerly constituted a socio-cultural domain. The partitioning of British India and Burma in 1937 and the subsequent partition of India in 1947 resulted in the establishment of arbitrary borders, leading to the division of numerous ethnic groups within this culturally interconnected area and their subsequent allocation into distinct nation-states. The establishment of these borders was a result of the actions of uninformed and apathetic colonial rulers who made decisions without considering geographical and historical circumstances, ethno-demographic factors, or economic inter-connectedness. The phenomenon of colonial geopolitics has been further intensified by the increasing rigidity of international borders since 1947.

The profound geopolitical, demographic, and economic transformations that ensued after India's independence engendered a feeling of unease among the diverse segments of the region's population. The Indian government's development initiatives in this region have been primarily driven by security considerations, resulting in a state-centric security approach that has historically contributed to the region's isolation and underdevelopment; however, the scenario is undergoing a significant transformation after the establishment of specialized institutions and dedicated policy frameworks. Due to the lack of connectivity and market access, the region's economy has regressed by at least 25 years, which has also contributed to ethnic unrest and alienation.

The region has often seen economic development as a solution to all problems, but these efforts have yet to achieve the desired results, especially in remote borderlands. Because of how common corruption and illegal networks are, it is important to set up good monitoring systems, ways to hold people accountable, and strict adherence to deadlines for completing different projects [1].

Given the understanding of regions with predominating tribal populations, and geopolitical and cultural factors, the ultimate objective should be to prioritize localized sustainable development, which can be accomplished by fostering self-sufficiency among the population by restoring natural markets, focused local solutions, and technological interventions.

Historically, the traditional policy response, including counterinsurgency measures, ethnic homeland creation, and heavy developmentalism, has often proved counterproductive. These policies, while intending to solve problems, have sometimes exacerbated conflicts and hindered effective governance. In the contemporary context, there is a shift from frontier to post-frontier in NE India that brings its own unique set of challenges. This includes the transformation of non-state spaces into state-controlled spaces, which has led to resistance and competing political

agendas within the region's diverse ethnic landscape. The focus on bridging developmental gaps through massive financial infusions has not yielded the expected results. This approach often ignores crucial aspects such as institutional quality, effective governance, and the complex socio-political dynamics of the region [2].

In a post-frontier paradigm, policy needs to be sensitive to the unique dynamics of NE India. This includes addressing context-specific challenges. Being a landlocked border region, a trans-national policy intervention can be envisioned to address cross-border issues.

3. Key Policy Interventions Arenas:

Infrastructure development is a critical concern in NE India, particularly in relation to the economic sectors highlighted in the 2001 Rangarajan Commission Report. Despite the report's identification of key sectors such as transportation, power, and communication, there remains a significant gap between the recognized needs and actual infrastructure provisions. This discrepancy is particularly evident in rural and border areas, where development lags. The need for organized and contextualized planning is paramount to address these gaps effectively. Such planning should encompass a comprehensive approach, ensuring that infrastructure projects are not only aligned with the specific needs of the region but also strategically prioritized and executed to foster balanced growth and economic integration.

Efforts to address these gaps, such as the North East Special Infrastructure Development Scheme (NESIDS), have been initiated, but the translation of policies into action remains sluggish. The presence of multiple agencies with overlapping roles exacerbates the situation, leading to ineffective maintenance of infrastructure projects and perpetuating the region's underdevelopment.

It is imperative to address these challenges to facilitate sustainable infrastructure development and to align policy intentions with tangible outcomes. This necessitates refining land acquisition processes and adjudicating land ownership disputes through enhanced dialogue and robust legal frameworks.

Moreover, the ecological sensitivity of the region, coupled with its vulnerability to climate-induced phenomena—such as floods, erosion, and landslides—demands the stringent enforcement of environmental regulations specific to infrastructure projects. It is critical to incorporate climate resilience measures into the infrastructure planning and design phases to mitigate potential environmental impacts.

Additionally, inclusive planning and stakeholder consultations are essential to respect and integrate cultural sensitivities of local communities. This approach not only ensures equitable development

but also enhances the effectiveness and sustainability of infrastructure projects by fostering local engagement and support.

The 2023 CEEW study [3] examined the potential impact of implementing an emissions trading scheme (ETS) in India to achieve net-zero emissions by 2070. Using the Global Change Analysis Model v6.0 (GCAM v6.0) with India-specific parameters, the study explored scenarios including Net Zero (NZ), NZ combined with ETS, NZ combined with Command and Control (CC), and NZ combined with Renewable Purchase Obligations (RPO) plus ETS. It highlighted the electricity sector's crucial role in emission reduction and the cost-effectiveness of transitioning from coal to renewable energy under an ETS facilitating cross-sector trading. The study emphasized the need for coordinated action to prevent the devaluation of carbon prices due to the interaction between ETS carbon pricing and existing RPO policies. It identified allocation and auctioning of emission allowances as significant factors with potential for substantial government revenue generation and impact on financial transfers within the ETS. Additionally, it examined emission reduction strategies in industrial sectors such as iron, steel, and cement, emphasizing diverse approaches including fuel switching, electrification, and hydrogen adoption.

The study's findings regarding the comparative cost-effectiveness of ETS versus command-and-control strategies for emission reductions are crucial for informing policy formulation, advocating a balanced approach addressing both price and non-price barriers to decarbonization.

Establishing a comprehensive carbon credit market requires a regulatory body for oversight, potentially a government agency or coalition of stakeholders. Regulations and standards for credit creation, verification, and trading need development, alongside defining a baseline for emissions measurement. Generating carbon credits involves identifying eligible project types such as renewable energy and reforestation and implementing a rigorous verification and certification process, potentially involving third-party auditors. The market operation requires a trading platform, digital or physical, and a pricing mechanism, market-driven or regulated through fixed prices. Inclusive participation from entities including businesses, governments, and individuals is essential, ensuring transparency and accessibility. A robust tracking system is crucial for transparency, avoiding double counting, and mandating public reporting of market activities. Legal and financial structures must be established for compliance, enforcement, and financial transactions, integrating with global carbon markets and standards, addressing offset treatment relative to direct emissions reductions.

Agriculture, being a significant CO₂ emission source, can potentially transform from a net emitter to a net sequester of CO₂. Practices like conservation tillage, crop rotation with legumes, composting, managing livestock waste, and agroforestry are discussed as methods to enhance soil

organic carbon. Given the agroeconomic nature of the NE states, integration of carbon farming into agricultural practices offers a win-win solution for both environmental sustainability and farmer income [4]. Policy support is crucial to realising the full potential of carbon farming in mitigating climate change and enhancing agricultural productivity. Carbon farming encompasses various land management techniques like zero tillage, agroforestry, and the use of methane-reducing feed supplements to maximise carbon capture and reduce emissions. Landholders can earn carbon credits by storing carbon in the soil, which can be sold to government agencies or other entities looking to offset their emissions. This exchange not only provides financial benefits to landholders but also supports sustainable agricultural practices.

The rich biodiversity of NE India is encapsulated within seed banks, housing invaluable germplasm adept at adapting to changing environmental conditions such as extreme weather, pests, and diseases. This germplasm also caters to evolving consumer preferences, including demands for instant cooking, gluten-free options, and immunity-boosting products. There is a critical need to harness the market potential of these genetic reserves. Entrepreneurs are positioned to meet these demands and can innovate sustainable technologies that enhance productivity while responding to the challenges of climate change.

The agri-biodiversity of NE India presents unique opportunities for diversification and niche marketing within agricultural value chains. This includes catering to growing consumer interest in specialty, organic, and heritage products. This is not only a repository of genetic diversity but also a vital component of cultural heritage and traditional knowledge systems. This encompasses indigenous farming practices, seed saving techniques, and culinary traditions.

Entrepreneurs can forge partnerships with local communities to conserve and enhance traditional agricultural knowledge and practices. By promoting heirloom seeds and cultural practices, they can leverage eco-tourism, culinary tourism, and sustainable agri-food enterprises. Such initiatives not only preserve biodiversity but also contribute to sustainable economic development in the region. The COVID-19 pandemic exposed stark digital disparities between urban and rural areas in India, notably in NE India's hilly regions. Remote villages struggled with inadequate digital connectivity, hindering students' access to online education and essential services. This lack of infrastructure reflects political decisions that often favor certain communities, shaping power dynamics in the region given that remote locations in NE India face significant challenges in science and engineering education.

Persistent challenges persist in digital connectivity, particularly in remote border villages like Pangsha along the Indo (Naga)-Myanmar border, exacerbating vulnerabilities, especially during emergencies. Borderland communities face exclusion and subordination by the state due to

inadequate infrastructure, hindering their development and governance effectiveness, particularly for indigenous tribes. The digital gap in tribal areas represents the initial stage of the digital divide, with rural and hilly regions facing barriers in accessing reliable internet and digital tools.

NE India witnesses digital exclusion among marginalized communities, irrespective of caste, religion and gender, due to geographic challenges and adequate infrastructural deficiencies. Urgent initiatives such as solarized cell towers and digital infrastructure in tribal villages are needed, particularly in schools and medical dispensaries along with comprehensive research into digital governance and service delivery methods.

4. Challenges

1. **Development and Infrastructure:** Despite government initiatives, the region faces developmental challenges, particularly in infrastructure. There is a need for improved connectivity through better road, rail, air, and inland waterways, and for projects like the National Bamboo Mission and Digital Northeast Vision 2022.
2. **Resource Management and Environmental Concerns:** The abundance of natural resources in the region, while a potential asset, also poses challenges in terms of sustainable and equitable resource management, environmental protection, and addressing the concerns of residents.
3. **Scaling up of skills to address local challenges:** Skill building and enabling a congenial ecosystem for fostering innovation, incubation, entrepreneurship, and business development need more prominence. It's also endeavouring to change mindsets from job seekers to job creators by working on enhancing leadership and soft skills, critical thinking, and skills needed for modern technological tools like water soluble oil extraction mechanism, 3D printing technology, drone technology, etc.
4. **Economic Disparities and Livelihood Issues:** Economic activities in the region are often limited, leading to disparities in income and livelihood opportunities. There is a need for economic diversification and support for local industries.
5. **Land and Agricultural Issues:** Given the agricultural nature of the region, there are challenges related to land management, agricultural productivity, and sustainable farming practices. High vulnerability to natural calamities leads to low and uncertain agricultural productivity. A large proportion of small and marginal farm households, traditional and low-input agricultural practices coupled with the problem of insurgency have affected the agricultural economies adversely in the region. Specific problems in the agriculture sector like over-adherence to traditional practices, low adoption of modern varieties, weak

institutional credit delivery system, poor agro-processing, and poor monitoring and accountability of public delivery systems need to be addressed.

6. **Healthcare and Education:** Accessibility to quality healthcare and education remains a concern, with potential for improvement through technological interventions. Adopting telemedicine facilities could address these challenges effectively.
7. **Digital Connectivity and Technology Access:** Enhancing digital connectivity and access to technology can play a significant role in addressing various developmental challenges which seems to be lacking right now.
8. **Climate Change and Disaster Management:** The region is prone to natural disasters, and climate change exacerbates these risks, necessitating better disaster management strategies and climate-resilient development.
9. **Conflict and Insurgency:** Some parts of NE India experience periodic conflicts and insurgency movements, which disrupt agricultural activities, displacement of communities, and hinder overall socio-economic development.
10. **Cultural & Ethnic Diversity:** NE region is renowned for its rich blend of cultures, languages, and ethnicities, which contribute to the region's unique identity. However, effectively managing this diversity can present complexities in maintaining social cohesion, ensuring equal political representation, and enhancing governance. It's essential to adopt a nuanced approach that acknowledges and respects the diverse rights and identities of each ethnic community while fostering a sense of unity and integration. Prioritising inclusive policies and strategies that uphold cultural heritage while promoting mutual understanding can contribute to sustainable development in the region.
11. **Strengthening Coordination:** Efforts should be made to streamline governance structures and enhance coordination among various agencies involved in infrastructure development. Clear delineation of roles and responsibilities, as well as effective mechanisms for monitoring and evaluation, are crucial to avoid duplication of efforts and ensure accountability.
12. **Sustainable Financing:** Innovative financing mechanisms, including public-private partnerships and leveraging national and global sources of funding, should be explored to overcome fiscal constraints in infrastructure development. This entails enhancing revenue generation capacities at both the state and regional levels while ensuring transparency and accountability in fund utilisation.
13. **Community Engagement:** Meaningful engagement with local communities is essential to ensuring that infrastructure projects address their needs and priorities. Consultative

processes should be institutionalised to solicit input from diverse stakeholders, including marginalised groups, in decision-making processes related to infrastructure development.

14. **Inadequate Startup Ecosystem:** The entrepreneurial landscape is fraught with numerous challenges that hinder business scalability and sustainability. A critical gap is the lack of mentorship for entrepreneurs, compounded by the absence of a robust startup ecosystem that is essential for scaling businesses. Furthermore, there is a notable deficiency in financial literacy among entrepreneurs, with many lacking a clear understanding of funding sources and effective financial management. This knowledge gap extends to sustainability; there is a widespread lack of awareness and understanding of sustainable business models, rendering current business strategies less attractive and scalable to investors.

Logistical and communication challenges further exacerbate these issues, as poor physical infrastructure—encompassing inadequate transportation, unreliable power supply, and limited internet connectivity—impedes efficient operations. These infrastructural deficiencies are particularly severe in remote areas, where connectivity gaps restrict market access. The rugged terrain typical of some regions poses additional supply chain challenges, complicating the sourcing of raw materials and distribution of products. Entrepreneurs often struggle with presenting their services effectively or packaging their products appealingly.

Additionally, women entrepreneurs face unique obstacles beyond these universal challenges. Gender biases and entrenched societal norms frequently restrict their access to resources and opportunities, placing them at a further disadvantage in the entrepreneurial ecosystem. Addressing these multifaceted issues requires a concerted effort to enhance infrastructure, improve financial and sustainability education, expand mentorship programs, and foster an inclusive environment that supports all entrepreneurs, particularly women.

5. Recommendations

Some of the areas that need very urgent action are logistics support, building a vibrant ecosystem and building responsible investor outlook for NE particularly where we need to look at scale and investments through a sustainability lens and not just returns.

1. **NE-specific carbon market:** A carbon market designed for carbon credit offset, balancing environmental integrity with economic viability and ensuring robust participation and compliance. This would also require network of agencies that can help utilise the credit. This could also be linked to project financing in the region.

2. **Align carbon farming with agricultural policies:** To ensure a holistic approach to sustainable farming and climate mitigation. Integrate carbon farming practices into agricultural extension services and raise awareness among farmers about carbon financing from the initial stages. It is crucial to develop and implement appropriate policies in collaboration with state agriculture departments.
3. **Untapped potential of agrobiodiversity:** focus on diversified, high-value (including aromatic rice, orchids, patchouli, passion fruits, ginger, pineapple, turmeric, citronella, natural rubber, spice, etc.), organic horticultural crops, and other IP-protected commodities needs to be channelled towards sustainable business models
4. **Foster entrepreneurship and startups:** Optimize the educational infrastructure of institutions to promote start-up and entrepreneurship opportunities for students and faculty. Entrepreneurs need mentorship, networking, and collaborative spaces to thrive. Matching local resources with global technologies can foster new products and entrepreneurship opportunities. Establishing startup incubation centers in all major cities is essential, especially for encouraging agricultural entrepreneurs.
5. **Transnational Innovation and Technology Corridor (TITC):** Establishing a Transnational Innovation and Technology Corridor (TITC)/Technology Demonstration and Training Centre (TDTC), focusing on collaboration, actual operational environment, technological development, and fostering regional stability through science and innovation. This corridor will enhance connectivity by developing guidelines for stakeholders for developing entrepreneurial agenda, creating a skilled workforce, managing IPR ownership, technology licensing etc to drive sustainable economic growth by leveraging the region's strategic position as a landlocked border area and fostering public-private partnerships.
6. **Key Performance Indicators (KPIs):** Identify and flag region-specific KPIs for strategic innovation, and entrepreneurial performance, and conduct sector-specific impact assessments.
7. **Strengthen climate resilience:** There is a need to strengthen the capacity of frontier technology to the local communities, government agencies, and stakeholders to adapt to climate change by providing training on climate-smart agriculture, ecosystem-based adaptation and disaster preparedness. Invest in resilient infrastructure and early warning systems to mitigate climate risks and enhance overall resilience.

8. **Utilize NE's biodiversity for eco-tourism:** Develop eco-tourism by leveraging the region's rich biodiversity and culture, generating revenue while promoting environmental and cultural preservation through responsible tourism and community involvement.
9. To ensure broader acceptance of bamboo products, it is essential to focus on quality, certification, and coding. Developing appropriate institutional mechanisms where needed is crucial. To enhance the effectiveness of the ecosystem, establishing a dedicated institution for bamboo technology, such as an Indian Institute of Bamboo Technology, would be beneficial.
10. **Expand startup incubators:** Support entrepreneurs by establishing more start-up incubators and accelerators in key cities of NE India. Additionally, introduce an Academia-Industry Internship Program for postgraduate students to foster entrepreneurial skills and industry connections.
11. A Broad policy initiative is needed for development of bamboo sector. This will include the following: -
 - Encourage bamboo plantations on all types of lands, as an economic activity. Also recognize bamboo as an agriculture/horticultural/commodity produce and allow unrestricted movement of bamboo and its processing and marketing by removing all legal constraints from bamboo from forest and set up a bamboo board to promote the bamboo value chain under one roof.
 - Promote development, designs, markets, standards and quality for new bamboo products. An online portal can be introduced for effective reach.
 - Establishing a “Centre of Excellence on Bamboo” in the region that will work on the R&D and promote bamboo’s bamboo value chain in the form of Indian Institute of Bamboo Technology.
12. **Building a vibrant Startup Ecosystem:** Policies should encourage the establishment of co-working spaces, incubators, and innovation hubs. And sustainability should be integrated from the start.
13. **Leverage the Mission Organic Value Chain:** Development for NE Region supporting agri-entrepreneurs across the entire value chain.
14. **Promote diverse products:** Encourage the production and marketing of unique products like kiwi wine, herbal tea, and black rice by offering tax incentives or subsidies to organic startups.
15. Focus on skill development, digital literacy, and technical support for artisans and micro-entrepreneurs. Promote Hi-Tech startups through industry connectivity.

- 16. Prioritize infrastructure development:** Policies should prioritize Infrastructure development and improve connectivity within the regions. A network of local logistics support should be explored too.
- 17. Address supply chain inefficiencies:** Policies should address supply chain inefficiencies and promote local production and distribution networks.
- 18. Integrating Sustainability in Investment Evaluation:** Implement a policy mandate requiring that sustainability impact assessments be included as a critical factor in the evaluation of all investments. Additionally, provide comprehensive training programs for investors to enhance their understanding and ability to implement sustainability considerations into investment decisions.
- 19. Financial support for small-scale businesses:** Develop financial support mechanisms specifically designed to accommodate the unique needs of small-scale businesses in NE India. This should include the provision of resources through diversified financial instruments such as equity investments, debt financing, and convertible shares, ensuring accessibility and flexibility for emerging enterprises.
- 20. Enforce ESG regulations:** Enforce a regulation across all incubators and accelerators within the eight states of NE India, making it compulsory for both founders and investors to regularly report on the Environmental, Social, and Governance (ESG) risks and the Sustainable Development Goals (SDGs) they are addressing. This policy will promote transparency and encourage more socially responsible and environmentally sustainable business practices.
- 21. Create sustainability funds:** Create dedicated sustainability funds for the NE states to support projects and enterprises that contribute positively to environmental conservation, social development, and economic sustainability. These funds should focus on scaling innovative solutions that address specific regional challenges and promote long-term ecological and community well-being.

References

- [1] Haokip, T. (2015) *India's Look East Policy: Prospects and Challenges for Northeast India*, Studies in Indian Politics, 3(2), pp. 198–211. doi: 10.1177/2321023015601742.
- [2] Baruah, S. (2007). *Postfrontier blues: toward a new policy framework for Northeast India*. Washington, D.C.: East-West Center Washington. Available at: <http://hdl.handle.net/10125/3521>
- [3] Malik, A., Chaturvedi, V., Sandhani, M., Das, P., Arora, C., Singh, N., Cui, R.Y., Iyer, G., & Zha, A. (2023). *Implications of an Emissions Trading Scheme for India's Net-zero Strategy: A Modelling-based Assessment*. New Delhi: Council on Energy, Environment and Water.

[4] Das, S., Roy, A. & Singh, N., 2020. *Carbon sequestration through carbon farming to earn carbon credit.*