# Application of 'Ecosystem-based' Adaptation: The Phayeng Case

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**Abstract**

This article focused on India's first Carbon Positive Eco Model Village, Phayeng, Manipur, India, and utilized Ecosystem-based Adaptation (EbA) as the theoretical lens. A combination of institutional analysis, review of climate change policies, and environmental secondary data were used in evaluating forest restoration, sustainable farming, and renewable energy from decentralized sources in both reducing emissions and sequestering carbon simultaneously. The results show that carbon positivity in the village is not a technical result of the intervention; it is part of an advanced EbA model that is combined with hybrid governance to link community-based stewardship practices with state-level climate funding. The study also enhances the overall climate change conversation by redefining rural carbon positivity as a governance-driven, socioecological result rather than a simply proposed carbon footprint measurement.

**Keywords**: phayeng, ecosystem-based adaptation, climate change policies, hybrid governance, carbon footprint

## Introduction

Ecosystem-based Adaptation (EbA) is a viable and robust matrix for closing the gap between local community adaptation and global climate mitigation. By utilising biodiversity and ecosystem services to support communities' adaptation to the effects of climate change, it is an alternative to traditionally engineered adaptation measures. EbA interventions (watershed management and afforestation) have the additional benefit of providing community resilience to climate change (adaptation) while expanding capacity of ecosystems to act as carbon sinks (mitigation). There is not enough data to show how EbA operationalizes carbon positivity at the village level, despite EbA's conceptual promise. Most papers on EbA treat the concept as a project-based intervention instead of a long-term governance framework.
The village, Phayeng, located in the Kangchup foothills of Manipur, Northeast India, is an important case for these. The village suffered from significant deforestation and drying up of water sources but

was ultimately designated as India's first carbon positive eco model village. This change occurred due to the National Adaptation Fund for Climate Change (NAFCC) integrating community-based forest protection efforts with state-based technical reform and support for the adoption of renewable energy **[1].** Thus, Ecosystem-based Adaptation (EbA) supports human resilience mainly through ecological restoration and sustainable management of natural ecosystems. Theoretical underpinnings for EbA derive from recognizing ecosystems are not victims of climate change; but also help in strengthening ecological resilience against the impacts caused by climate-related disturbances (e.g., extreme weather events). In order to protect themselves from climate change, communities must enhance their ecosystem services (e.g., hydrologic regulation, soil stability and biodiversity) to create natural barriers that provide protection from climate-related disturbances. The framework of EbA provides a way to integrate both conservation and development in a structural manner rather than opposites to each other.

Another important theoretical contribution of EbA is the capacity to bridge the divide between climate adaptation (resilience-building) and mitigation (sequestering carbon). While EbA was originally considered to be a resilience strategy, many forms of ecological restoration generate a 'carbon dividend'. For example, by reforesting previously developed areas, these efforts create both biomass and increased soil organic carbon. The restoration of watershed areas leads to increased density of vegetation and, lastly, sustainable agriculture has the ability to lower levels of methane and nitrous oxide emissions while simultaneously increasing soil sequestration. In rural landscapes, the land use is the main variable that determines the flow of carbon. Carbon positivity is instead be viewed as an outcome of the condition/use of the ecosystem. This is in contrast to urban-industrial solutions that focus mainly on the energy transition; as such, rural areas will need to re-define 'carbon neutrality' as an extension of beyond net-zero balance to be considered as a net-carbon sink.

Phayeng is an example of a governance-mediated ecological transition as it combines multiple layers of community forest committees, state-supported multi-departmental coordination, and changes to community livelihoods. This article uses Phayeng to assess whether EbA can be replicated as a model to achieve rural carbon positivity. The carbon positive aspects of rural communities will be understood within the context of climate change from an EbA perspective. It will present a new perspective of climate change based on a rural rather than an urban focus, as the article will demonstrate the Himalayan region of rural communities produces a substantial amount of carbon. As a result, carbon positivity will be shown to be a product of integrated governance process as opposed to simply a theoretical or conceptual phenomenon.

**Materials and Methods**

The article evaluates the Ecosystem-based Adaptation (EbA) and rural carbon positivity as being implemented in Phayeng, Manipur. The village is selected as the primary unit of analysis due to its designation as India's first carbon-positive eco model village and because of its integrated into the National Adaptation Fund for Climate Change (NAFCC) framework. This study is based on a systematic review of secondary sources and published official documents where no primary field-based data collection (interviews or surveys) was conducted. The data used for the study are:

1. *Primary Policy Documents* such as: the Detailed Project Proposal (DPR) submitted to NAFCC; gazetted documents of the Directorate of Environment and Climate Change, Government of Manipur; and Climate Change Action Plans developed by the state government.
2. *Institutional Records* such as funding mechanisms, inter-sectoral integration reports and recorded environmental results held by governmental archives.

3. *Secondary Literature* such as peer-reviewed journal articles and guides on the governance of climate change provide additional context for understanding EbA, hybrid governance, and socio-ecosystem resilience.

**Results and Discussion**

The regeneration in Phayeng village is viewed as reversing long history of ecological decline within an ecosystem. The local villagers experienced significant systems decline as a result of past felling of trees and soil degradation. The declines created a "vulnerability feedback loop"; leading to reduced groundwater recharge and dry hill stream flows making rain-fed agriculture extremely vulnerable to erratic monsoon rainfall. The village regeneration was initiated by the shift from passive degradation to active socio-institutional stewardship. In the beginning, the community started reviving traditional norms related to the protection of forests, which were supported by NAFCC (National Adaptation Fund for Climate Change) **[2].** Unlike typical government driven (top down) afforestation projects, Phayeng's approach focused on planting indigenous species that helped regulate water, improve soil stability, and restore ecosystems. Therefore, the restoration of forests served a dual purpose of building resiliency through adaptation (protecting water and soil resources) and mitigating environmental damage through biomass carbon sequestration.

To date, Phayeng has derived benefits from the combination of traditional indigenous ecological normative behaviour, and the actions taken by the governments to support traditionally and environmentally friendly approach to land management. As such, it is very difficult to establish the arrangement of "hybridity" that have experienced considerable fragmentation of land ownership/use. Therefore, the case of Phayeng should be viewed through the lens of its local context; however, it provides a framework for developing/rural landscapes that includes additional components that may not be found in Phayeng. Meanwhile, there is a gap in the climate literature regarding the dual structure described above, where central-level policy lacks local legitimacy, and grassroots organizations do not have sufficient resources to conduct long-term monitoring of carbon-insensitive activities. The emerging climate mitigation and adaptation relationship provides important insights to construct efficient policy solutions. The village shows that integrating ecosystem-based adaptation techniques produces "natural co-benefits" in terms of cost effectiveness: For example, reforestation helps stabilize hydrologic cycles (i.e., adaptation), while simultaneously providing carbon sequestration services (i.e., mitigation). Through Sustainable Agricultural Development (SAD), food security is improved (i.e., adaptation), and methane emissions are reduced (i.e., mitigation). Finally, renewable energy sources provide reduced energy costs (i.e., adaptation), and decrease CO2 emissions (i.e., mitigation) **[3].** Through this integration process, conflicts are reduced and local involvement can be encouraged by achieving global mitigation goals which in turn tangible benefits at the local level. Financial sustainability and scalability are two critical perspectives of the Phayeng model, which is successful but experiences constraints at both the structural and operational level. At the village level, carbon accounting continues to rely on modelled (or estimate-based) rather than high-frequency, empirical verification to substantiate actual emissions. This, in turn, presents a major challenge to the financial sustainability of NAFCC gains, which may vanish absent the support of government funding cycles or other state priorities.

Hence, the contribution of the Phayeng case is most importantly a challenge of urban bias in carbon discourse and climate policy. The dominant storyline focused on decarbonizing industrial activity within cities and transitioning to smart grids, but instead, Phayeng redirects attention to rural landscapes as being regenerative contributors towards establishing a global carbon budget. As a result, the Phayeng case shows that EbA is a proactive way of reducing carbon emissions and additionally, it is a valid way to sequester carbon. While previous research has tended to be limited by focusing on resilience building

through interventions such as slope stabilization and watershed protection; the results from Phayeng show there is an increase in potential for carbon sinks when using these interventions. The Phayeng village created three separate types of carbon sinks (e.g., carbon sequestration from forest regeneration, increased organic and carbon content in soils, and the use of decentralized mitigation technologies) collectively. This demonstrates that EbA provides a framework for implementing rural-scale mitigation strategies. Also, our results support the idea that managing and mitigating carbon footprints is not only an urban issue.

Moreover, the following are some of the limitations to this approach.

1. Reliance on Data: The data for USDA and CARB's carbon sequestration and reductions in emissions are based on reported institutional data. As such, these reports do not have a basis in independent, primary biophysical measurements.
2. No Field Confirmation: The lack of ethnography precludes any depth of analysis regarding the movement of individuals within households and community or internal power dynamics.
3. Time Limitations: The study only reviews the project in the timeframe of its documented implementation cycle. Therefore, ecological and/or financial sustainability will not be empirically able to be verified long-term.

Despite the issues, a systematic analysis of policy and program documentation represents a valid and widely-accepted methodology for the evaluation of governance structure. By placing these documents in a structured theoretical framework, this study assists in the provision of an evidence-based evaluation of the transformation of Phayeng as an EbA governance-mediated model.

**Conclusion**

This article provides adequate details on EbA as an alternative way in creating rural carbon positive trajectories. Similarly, this article has transitioned from providing environmental descriptions of the area to focusing on carbon positive as an outcome of socio-ecological governance. The findings demonstrate that Phayeng's transformation resulted from many factors, not only from technological advances and perceived environmental enhancements, but also from a combination of serious ecological regeneration of the landscape, intentional approaches to reducing carbon emissions at all levels of the economy, and effective interaction among diverse institutions. The Phayeng case supports the theory that EbA can integrate both mitigation and adaptation policies into a single governance structure. Instead of treating adaptation as a resilience-building strategy and mitigation as a separate commitment to reduce emissions, the above model prescribes how ecological restoration provides synergies or co-benefits to both streams of benefit. Forest restoration resulted in increased carbon storage and also provided water resources; Sustainable agriculture resulted in reduced methane emissions and increased livelihood stability; and renewable energy reduced dependence on fossil fuels and improved the resiliency of households. The combined interrelationship of mitigation-adaptation in this case demonstrates the unique cost-effectiveness and policy cohesion of ecosystem-based approaches to climate change governance in rural areas.

Even so, this study presents some important caveats. Rural carbon positivity is still dependent on an ongoing commitment by key institutions, sustainable financing, and strong monitoring capacity. Gains from sequestering carbon are reversible from both biological and political perspectives and are therefore at risk of being undone by a decline in the strength of governance or an increase in land-use pressure. Additionally, carbon accounting at the community level usually relies on modelled rather than directly observed data. In addition, the Phayeng village is a model for replicability, not a template that can be used everywhere **[4].**

The study has made three main contributions to the literature. It has reconceptualized rural carbon positivity from being solely a technical metric for measurement (or measuring the carbon dioxide in the

atmosphere) to being a broader definition based upon governance (i.e., an ecological state of being). Additionally, it has built upon existing research of ecosystem-based adaptation (EbA) to demonstrate that EbA can deliver successful integrated climate outcomes through its operational capabilities. Lastly, this work demonstrates how hybrid governance/partnerships are fundamental in sustaining long-term carbon positive trajectories. Future studies should continue to develop these themes with both longitudinal carbon measurements and comparative studies across the entire Eastern Himalayas. Phayeng ultimately concludes that rural carbon positivity is an actual phenomenon when ecosystem restoration, institutional coordination, and participatory governance all come together in a systematic framework.

Ecologically, the restoration of tree cover and conservation of soil will result in carbon stocks and thereby aid in sequestering carbon, while stabilising hydrology and microclimate. Decentralised renewable energy systems, methane reductions in wet rice production and livestock management have all contributed to decreased emissions of greenhouse gases and have supported through these processes. The success of all these strategies in terms of their long-term viability and effective operation relies upon governance elements aligning with local stewardship that are part of the national and state climate action plan.

The Directorate of Environment and Climate Change, Government of Manipur has provided financial and scientific support through the National Fund for Climate Change, but it is the local forest community committees and village institutions who made right on a day-to-day basis and complied with the rules. Thus, this joint approach was critical for continuing to achieve results from regenerative actions.

**References**

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3. Government of India's Ministries. (2014). The Government of India has released Operational Guidelines that give direction on how to run the National Adaptation Fund for Climate Change.
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***Research Presentation**: The Phayeng example illustrates how rural carbon density can be achieved through environmental vulnerability when implemented as an ecosystem-based adaptation strategy via the use of hybrid governance models, resulting in the combined benefits of both mitigation and adaptation.