International Journal of Humanities and Social Sciences (IJHSS)
ISSN (P): 2319–393X; ISSN (E): 2319–3948
Vol. 8, Issue 6, Nov–Dec 2019; 111–122

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

CLIMATE CHANGE AND INDIGENOUS FUTURES IN EASTERN INDIA

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ABSTRACT

Climate change is one of the biggest challenges facing the world today. It is changing the way people think about forests, land, natural resources, and development. Its effects are not experienced equally. Many communities that have contributed very little to global emissions are among those facing the greatest environmental risks. Eastern India reflects this reality. The region is rich in forests, rivers, hills, biodiversity, and mineral resources, yet these landscapes are increasingly affected by industrial expansion and ecological stress. The movements in Kashipur, Niyamgiri, Kalinganagar, and the POSCO project area are usually discussed as struggles against displacement and industrial projects. However, they also represent efforts to protect forests, water sources, coastal ecosystems, and traditional livelihoods. This paper argues that these movements offer important lessons for climate resilience and environmental sustainability. They show how indigenous communities use long-standing ecological knowledge to protect natural systems that are essential for a more sustainable future.

KEYWORDS: *Climate Change.*

Article History

Received: *08 Dec 2019* | ***Revised:*** *11 Dec 2019* | ***Accepted:*** *16 Dec 2019*

INTRODUCTION

Climate change is fundamentally altering the terms on which development, energy, and resource extraction are debated across the world. Forests that were once valued primarily for their timber are now understood to be irreplaceable carbon stores. Hills that fed rivers are recognised as water towers for entire regional ecosystems. Coastal forests that provided firewood for fishing communities are now barriers against storm surges and cyclone-driven erosion. As scientific understanding of these relationships deepens, the communities that have long inhabited and protected such landscapes are demanding that their knowledge and their tenure be taken seriously in policy decisions that affect the planet's ecological future.

Eastern India presents a particularly important case for examining how indigenous movements intersect with climate resilience. The region, and Odisha in particular, is both ecologically exceptional and economically contested. Odisha's landscapes include the hill ranges of the Eastern Ghats, the forests and streams of the Rayagada and Kalahandi districts, the densely settled agricultural belt along the Mahanadi delta, and the coastal forests of the Bay of Bengal. These landscapes support enormous biodiversity, regulate regional water cycles, and provide livelihoods for millions of people, a disproportionate number of whom belong to Scheduled Tribe and other marginalised communities. At the same time, Odisha holds nearly 28 percent of India's coal reserves, 59 percent of its bauxite, 98 percent of its chromite, and a quarter

of its iron ore, making the state the focus of intense industrial investment since economic liberalisation began in 1991.[1]The conflict between ecological wealth and industrial expansion gave rise to major people's movements in Odisha. Kashipur, Niyamgiri, Kalinganagar, and the POSCO resistance are often studied as struggles for land and rights. Yet they were also efforts to protect forests, hills, water sources, and coastal ecosystems that play an important role in ecological stability and climate resilience.This paper explores three questions. How are indigenous movements linked to the protection of climate resilient ecosystems? What environmental functions such as carbon storage, water security, biodiversity conservation, and coastal protection were defended through these struggles? What lessons can these movements offer for climate governance? By examining four major movements, the paper connects ecological concerns with community experiences and local environmental knowledge.[2]

The analysis has three objectives. First, it highlights the climate importance of the landscapes involved in these movements. Second, it shows how resistance helped protect forests, water sources, sacred sites, and local livelihoods. Third, it examines what these experiences can teach us about climate resilience and sustainable development. The third is to develop the concept of climate resilience from below, meaning the protection of climate-sensitive ecosystems through community-led resistance rather than state-designed conservation schemes. Together, these objectives allow the paper to contribute to both climate studies and the study of social movements in a way that neither field has yet pursued in depth.

CLIMATE CHANGE AND INDIGENOUS KNOWLEDGE

To understand why indigenous movements in eastern India matter for climate resilience, it is necessary to examine how climate science and indigenous knowledge scholarship have converged in recent decades. Three theoretical concepts connect these movements to broader environmental futures: climate resilience, indigenous knowledge systems, and environmental stewardship. Each of these concepts carries a distinct meaning in the scholarly literature, but they point toward a shared understanding of how communities and ecosystems sustain themselves in the face of stress and disruption.[3]

Climate resilience refers to the capacity of communities and ecological systems to absorb shocks, adapt to changing conditions, and maintain the essential functions that support human life. In ecological terms, resilience is closely tied to biodiversity, forest cover, water retention, and the stability of soil systems. In community terms, it involves local knowledge, diversified livelihoods, and governance arrangements that allow people to manage natural resources sustainably over time. Crucially, resilience is not simply a property of healthy ecosystems in isolation. It depends on the relationship between communities and their environments, and on the practices through which communities maintain that relationship across generations.[4]

Indigenous knowledge systems represent accumulated understanding of local environments built through long, sustained interaction with specific ecological landscapes. This knowledge is not merely practical information about which plants can be eaten or which soils support particular crops. It includes understanding of seasonal patterns, the relationships between forest cover and water availability, the role of particular species in maintaining ecological balance, and the

[1]*Padmanabha Hota and Bhagirath Behera, "Extraction of Mineral Resources and Regional Development Outcomes: Empirical Evidence from Odisha, India," The Extractive Industries and Society 6, no. 2 (2019): 267–278.*
[2]*Vijay Joshi and Ian Malcolm David Little, India's Economic Reforms, 1991–2001 (Oxford: Oxford University Press, 1996), 45–50.*
[3]*Fikret Berkes, Sacred Ecology, 3rd ed. (New York: Routledge, 2012), 22–30.*
[4]*Carl Folke et al., "Resilience Thinking: Integrating Resilience, Adaptability and Transformability," Ecology and Society 15, no. 4 (2010): 20.*

spiritual dimensions of the human-nature relationship that enforce community norms about resource use. Environmental scientists have increasingly recognised that indigenous knowledge systems often contain detailed observations of ecological change that can complement and extend formal scientific monitoring. In the context of climate change, this knowledge is particularly valuable because it captures long-term patterns that short-term scientific monitoring may miss.[5]

Environmental stewardship refers to the care and protection of natural resources by local communities. Indigenous communities often protect forests, water sources, sacred groves, and farming systems through long established practices. These actions help conserve biodiversity, strengthen water security, and maintain ecological balance. Such practices contribute directly to climate resilience and environmental sustainability.[6]

Table 1: Key Theoretical Concepts and Their Climate Relevance

Concept	Ecological Mechanism	Climate Relevance
Climate resilience	Biodiversity, water retention, soil stability	Community and ecosystem adaptation to stress
Indigenous knowledge systems	Long-term ecological observation and practice	Supplementing scientific monitoring, managing change
Environmental stewardship	Sacred groves, seasonal restrictions, agro-forestry	Resource protection and carbon stability
Sustainable futures	Diversified livelihoods, community governance	Long-term ecological and human sustainability

What existing scholarship has not adequately done is bring the climate resilience literature into conversation with the study of indigenous movements in India. Movement scholars have documented displacement, land rights violations, and political mobilisation with great care. Climate scientists have mapped the ecological functions of forests, hills, and coasts with increasing precision. But the insight that acts of resistance can simultaneously be acts of ecological protection has rarely been developed into a sustained analytical argument. This paper attempts that synthesis, arguing that movements like those in Kashipur and Niyamgiri were not only struggles for justice but also, in their ecological consequences, a form of climate action undertaken decades before that concept entered mainstream policy debate.[7]

ECOLOGICAL WEALTH OF EASTERN INDIA

Eastern India, and Odisha in particular, sits within one of the most biologically and hydrologically significant landscapes on the subcontinent. The region encompasses a remarkable diversity of ecological systems within a relatively compact geographical area: dense deciduous and semi-evergreen forests, ancient hill ranges belonging to the Eastern Ghats, major river systems, wetlands, and one of the most climatically dynamic coastlines in the Bay of Bengal. Understanding the ecological character of these landscapes is essential to appreciating why the industrial conflicts discussed in this paper carried consequences far beyond the communities directly displaced.[8]

The forests of eastern Odisha perform multiple climate functions simultaneously. They store carbon in their standing biomass and soil organic matter, moderate local temperatures, reduce surface runoff, and maintain groundwater levels that support agriculture and drinking water supply across wide areas. The hill forests of the Niyamgiri range and the Baphilimali plateau in Rayagada district are particularly important in this regard. These forests sit above major river

[5]*Fikret Berkes, "Traditional Ecological Knowledge and Resource Management," in Linking Social and Ecological Systems, ed. F. Berkes and C. Folke (Cambridge: Cambridge University Press, 1998), 18–34.*
[6]*Berkes, Sacred Ecology, 3rd ed. (New York: Routledge, 2012), 8–12.*
[7]*Joanna Macy and Molly Young Brown, Coming Back to Life: The Updated Guide to the Work That Reconnects (Gabriola Island: New Society Publishers, 2014), 60–62.*
[8]*Hota and Behera, "Extraction of Mineral Resources and Regional Development Outcomes," 270–272.*

catchments and generate the perennial streams that feed agricultural systems in the plains below. Scientific surveys of the Niyamgiri hills have documented around twenty species of orchid, numerous medicinal plants, and wildlife populations that depend on forest corridors extending across the Eastern Ghats.[9]Major rivers such as the Brahmani, Vamsadhara, Nagavali, and Mahanadi support water supply, fisheries, agriculture, and livelihoods. Their health depends on forests and hills that regulate water flow, maintain ecological balance, and support surrounding communities. Where hill forests are cleared for mining or industrial development, sedimentation increases, seasonal stream flow becomes erratic, and the downstream communities that depend on reliable water access face growing vulnerability.

Table 2: Ecological Systems of Eastern India and Their Climate Functions

Ecological System	Climate and Environmental Function
Hill forests and plateaus	Carbon storage, water recharge, biodiversity corridors
River systems and catchments	Ecosystem support, flood moderation, fisheries
Coastal forests and mangroves	Storm protection, erosion control, carbon sequestration
Agricultural wetlands and deltas	Food security, local climate regulation, water storage
Biodiversity and endemic species	Ecological stability, resilience to climate stress

The Odisha coast is highly vulnerable to cyclones and coastal hazards. Coastal forests, mangroves, and sand dunes help protect villages from storms and erosion. In Jagatsinghpur, local communities developed livelihoods based on betel cultivation, fishing, and horticulture that supported both economic security and ecological balance.[10] What makes eastern India ecologically distinctive, and what gives the movements discussed in this paper their broader significance, is the degree to which human livelihoods and ecological systems have co-evolved over centuries. The Dongria Kondh communities of Niyamgiri maintain terraced horticulture on hill slopes that limits soil erosion and sustains forest cover. The fishing and farming communities of coastal Odisha cultivate crops specifically adapted to the salinity and storm risk of the coastal belt. The tribal farmers of Kashipur practice agro-forestry that integrates forest species with cultivated crops in ways that maintain soil fertility and local water cycles. These are not primitive survival strategies. They are sophisticated ecological adaptations whose value for climate resilience is now widely recognised in sustainable agriculture and conservation science.[11]

DEVELOPMENT AND ECOLOGICAL CHANGE AFTER LIBERALISATION

The economic reforms introduced in India in 1991 opened the country's mineral sector to private and foreign investment in ways that had profound ecological consequences for resource-rich states like Odisha. Before liberalisation, state-owned enterprises dominated the mining and heavy industry sectors, and industrial expansion, while significant, was constrained by centralised planning and slower capital accumulation. After 1991, the combination of deregulation, competitive industrial policy, and global commodity demand dramatically accelerated the pace at which mineral-rich landscapes were brought into the industrial economy.

After economic liberalisation, Odisha actively promoted investment in mining, steel, aluminium, and infrastructure projects. Many industrial agreements were signed in mineral rich districts and coastal regions. However, these areas were already inhabited by tribal and rural communities whose livelihoods depended on forests, farmland, water

[9]*Saxena et al., "Report of the Four Member Committee for Investigation into the Proposal Submitted by the Orissa Mining Company for Bauxite Mining in Niyamgiri," Unpublished Report, Ministry of Environment and Forests, GoI(2010): 24–28.*
[10]*Subhakanta Nayak, "Industrial Development vs Resistance: A Study of Posco Project in Odisha," International Letters of Social and Humanistic Sciences 50 (2015): 57–62.*
[11]*Mihir Deb and Sanjib Chandra Sarkar, "Issues of Sustainable Development in the Mines and Minerals Sector in India," in Minerals and Allied Natural Resources and Their Sustainable Development, ed. Parthasarathy et al. (Singapore: Springer, 2017), 522–526.*

resources, and local ecosystems that faced significant transformation. The ecological footprint of post-liberalisation industrial expansion was substantial and multidimensional. Open-cast mining operations for bauxite, iron ore, and chromite required the clearing of forest cover, the excavation of hill slopes, and the disposal of overburden in ways that permanently altered local topography. Steel plants demanded enormous volumes of water from nearby rivers, creating downstream impacts on irrigation, fishing, and drinking water access. Port development and coastal infrastructure in districts like Jagatsinghpur involved the reclamation of coastal land and the disruption of shoreline ecology. Industrial corridors and transport infrastructure fragmented forest habitats and interrupted wildlife movement across the Eastern Ghats.[12]

Table 3: Sectors of Industrial Expansion and Their Ecological Impacts

Industrial Sector	Primary Ecological Impact	Climate Consequence
Bauxite and mineral mining	Forest loss, hill degradation, stream disruption	Carbon release, reduced water security
Steel plants	Land transformation, water diversion, air pollution	Habitat loss, increased industrial emissions
Ports and coastal infrastructure	Coastal land reclamation, mangrove loss	Reduced storm protection, erosion
Industrial transport corridors	Habitat fragmentation, deforestation	Biodiversity loss, ecosystem destabilisation

This paper asks what happens when ecologically important landscapes are transformed into industrial zones. The impact goes beyond the loss of land. Forests, hills, wetlands, and coastal ecosystems help regulate climate, store carbon, protect water resources, and reduce environmental risks. When these systems are damaged, both local communities and the wider environment become more vulnerable to climate change and ecological instability.[13] The movements that resisted this industrial expansion were not framed, by their participants or their supporters, in the language of climate science. They spoke of land rights, cultural survival, and democratic participation. But the ecological reality is that in protecting their hills, forests, streams, and coasts from industrial destruction, these communities were also preserving the climate functions that those landscapes perform. The following sections examine each movement in turn, focusing on the ecological systems they defended and the climate relevance of that defence.[14]

KASHIPUR AND THE PROTECTION OF MOUNTAIN ECOSYSTEMS

The Kashipur movement in Rayagada district centred on the proposed extraction of bauxite from the Baphilimali hills and the establishment of alumina refineries in the region surrounding Kashipur block. What is often overlooked in accounts of the struggle is the ecological significance of the Baphilimali plateau and the hill systems of which it forms a part. These hills are not merely mineral deposits awaiting extraction. They are elevated water catchments that generate perennial streams providing drinking water and irrigation to hundreds of villages in the valleys below. Their forests store carbon, moderate local temperatures, and maintain the soil stability that makes agriculture possible across wide areas of Rayagada district. The tribal communities of Kashipur depended on forests, streams, and agricultural land for their livelihoods. Their farming and resource management practices helped maintain ecological balance and water security. Through the Prakrutika Sampada Surakshya Parishad movement, villagers protected the Baphlimali hills, forests, and water sources that were important for both local livelihoods and environmental sustainability.

[12] *Balaji Pandey, "The Kalinganagar Tragedy: Development Goal or Development Malaise," Social Change 38, no. 4 (2008): 609–616.*
[13] *Geetanjali Naik, "Displacement and People's Movement: A Study of UAIL Project in Odisha," International Journal of Human Resource Management and Research 9, no. 2 (2019): 143–147.*
[14] *Achyut Das and Vidhya Das, Chronicle of a Struggle and Other Writings (Kashipur: Agragamee Publication, 2006), 34–40.*

Table 4: Ecological Resources Protected in Kashipur and Their Climate Importance

Resource	Community Function	Climate Importance
Baphilimali hill forests	Timber, non-timber forest produce, sacred groves	Carbon storage, temperature moderation
Perennial streams and springs	Drinking water, irrigation, fishing	Water security, groundwater recharge
Hill slopes and soil systems	Agriculture, grazing, soil fertility	Ecosystem stability, erosion prevention

Although the movement witnessed violence and loss of life, its deeper significance lay in the protection of the Baphlimali ecosystem. Large scale bauxite mining would have affected forests, natural drainage systems, and water sources. By resisting the project, local communities helped safeguard a mountain watershed that supported agriculture, water security, and ecological stability across the surrounding region.[15]

NIYAMGIRI AND SACRED ENVIRONMENTAL STEWARDSHIP

The Niyamgiri hills of Rayagada and Kalahandi districts present what is perhaps the most instructive case of the relationship between indigenous cultural practice and ecological protection. For the Dongria Kondh communities who have inhabited these hills for generations, the Niyamgiri range is not primarily a resource base. It is a sacred landscape whose integrity is maintained through a system of cultural institutions, ritual prohibitions, and community norms that have functioned as a form of environmental governance long before the concept existed in formal policy language.For the Dongria Kondh, the Niyamgiri hills are sacred and closely linked to their way of life. Community traditions help protect forests, water sources, and wildlife habitats. Sacred groves, resource use restrictions, and customary land practices have helped maintain biodiversity, forest cover, and ecological balance across the Niyamgiri landscape for generations.

Table 5: Sacred Practices and Their Ecological Outcomes in Niyamgiri

Cultural Practice	Mechanism	Ecological Outcome
Sacred groves and hill shrines	Prohibition on felling, hunting, and extraction	Forest protection, biodiversity preservation
Seasonal ritual restrictions	Regulated use of particular resources	Sustainable resource conservation
Community customary norms	Collective governance of forest and water access	Shared stewardship, groundwater stability

When the Niyamgiri Suraksha Samiti mobilised Dongria Kondh villages against Vedanta's bauxite mining proposal, and when the Gram Sabhas of twelve villages in 2013 voted unanimously to refuse consent for mining, they were exercising a form of environmental governance grounded in sacred tradition. The ecological significance of that decision is now beyond scientific dispute. The Niyamgiri plateau is the hydrological source for tributaries of both the Vamsadhara and Nagavali river systems. Mining operations at the hilltop would have destroyed or degraded the perennial stream sources on which hundreds of downstream villages depend for water. The cultural institutions of the Dongria Kondh, by protecting the sacred character of the hills, had for generations performed the ecological function that formal conservation law failed to protect.[16]

[15] *Naik, "Displacement and People's Movement: A Study of UAIL Project in Odisha," 144–148.*
[16] *Bijayashree Satpathy, "Forest Rights Act Implementation in Odisha: Redressing Historical Injustices," South Asia Research 37, no. 3 (2017): 262–268.*

KALINGANAGAR AND THE ECOLOGICAL COST OF INDUSTRIAL GROWTH

The Kalinganagar movement in Jajpur district offers a different but equally important dimension of the relationship between indigenous resistance and climate ecology. Unlike Kashipur and Niyamgiri, where the primary ecological systems at stake were hill forests and sacred watersheds, the conflict in Kalinganagar centred on the transformation of a mixed agricultural and forest landscape into one of the most ambitious industrial steel complexes in eastern India. The land that was acquired across dozens of villages in the Sukinda and Danagadi blocks included agricultural fields, commons, forest patches, village ponds, and grazing lands, each of which played a role in the local ecological system.

The communities who lived on this land before industrial acquisition had developed farming systems adapted to the ecology of the Brahmani river plain. Their agriculture integrated paddy cultivation with forest-edge gathering, livestock grazing on commons, and access to village ponds for water and aquatic resources. These practices, taken together, maintained soil organic matter, local water retention, and a degree of ecosystem diversity that larger monoculture or industrial landscapes typically cannot sustain. When the Visthapan Virodhi Jana Manch mobilised against land acquisition and the construction of steel plant boundary walls, they were responding to displacement, but the ecological consequence of the transformation they resisted was substantial.

Table 6: Ecological Losses in Kalinganagar and Their Climate Implications

Ecological Asset	Community Role	Climate Consequence of Loss
Agricultural land and mixed farming	Food production, soil health, local livelihood	Reduced local ecological resilience
Village forest patches	Fuel, grazing, non-timber produce	Carbon loss, reduced biodiversity
Ponds and water commons	Irrigation, aquatic resources, local water cycle	Water resource stress, reduced groundwater

The police firing of 2 January 2006, which killed thirteen people from the protesting tribal communities, brought national attention to Kalinganagar as a site of state violence against the displaced. But the longer ecological story of what was lost through industrial expansion in the region deserves equal attention. The conversion of thousands of acres of mixed agricultural and common land into industrial infrastructure erased the ecological diversity that those landscapes had supported. In climate terms, this represents not only a loss of carbon storage and water regulation capacity but also a reduction in the ecological diversity that gives communities and landscapes the flexibility to adapt to climate variability. The tragedy of Kalinganagar is inseparable from its ecology.[17]

POSCO AND COASTAL CLIMATE RESILIENCE

The resistance to the POSCO steel project in Jagatsinghpur district draws attention to a dimension of climate resilience that is distinct from the hill and forest ecologies of inland Odisha. The coastal belt of the Mahanadi delta and the Bay of Bengal shoreline is one of the most cyclone-exposed stretches of coastline in South Asia. Communities in this region have historically built their livelihoods and their settlements in ways that account for the rhythms of storm seasons and the ecological buffers that coastal forests provide. The villages of Dhinkia, Gobindapur, and Gadakujanga, which formed the core of POSCO resistance, sat within a coastal ecology whose climate functions were directly threatened by the proposed industrial complex.

[17] *Bikram Keshori Jena, "Development-Induced Displacement in 21st Century India," Proceedings of the Indian History Congress 75 (2014): 1186–1190.*

Coastal forests, including stretches of casuarina, patches of mangrove vegetation along creek margins, and the dune systems that separate agricultural land from the sea, perform essential climate services along this coastline. They reduce the impact of cyclone winds before they reach human settlements, stabilise sandy soils against storm-driven erosion, and provide a natural buffer against the inland penetration of salt water during storm surges. The betel vine cultivation that provided the primary livelihood for many households in the project area was itself embedded in this coastal ecology, requiring the maintenance of vegetated enclosures that helped stabilise local microclimate and soil moisture.[18]

Table 7: Coastal Ecological Assets and Climate Functions in Jagatsinghpur

Coastal Asset	Community Livelihood Role	Climate Protection Function
Coastal forest patches	Fuel, building material, ecological boundary	Wind barrier, carbon storage
Sand dune systems	Natural boundary for agriculture	Erosion control, storm surge buffer
Creek-side mangroves	Fishing grounds, nursery habitat	Storm protection, salinity regulation
Betel vine cultivation systems	Primary income, agro-ecology maintenance	Soil stabilisation, microclimate regulation

The POSCO Pratirodh Sangram Samiti's decade of non-violent resistance, which included maintaining village barricades, organising protest marches, and challenging environmental clearances through the courts, effectively prevented the conversion of this coastal ecology into a steel plant complex and captive port for nearly ten years. In climate terms, the movement preserved a coastal buffer zone whose value would only become clearer as cyclone intensity in the Bay of Bengal continued to increase. The communities who resisted were not making arguments about climate science. They were protecting a productive rural economy that happened to be embedded in an ecologically critical coastal landscape.

INDIGENOUS FUTURES AND ALTERNATIVE DEVELOPMENT

Looking across the four movements, several themes emerge that deserve to be read not simply as resistance strategies but as propositions about alternative development futures. The communities of Kashipur, Niyamgiri, Kalinganagar, and POSCO-affected Jagatsinghpur were not arguing against development as such. They were arguing against a particular model of development that treated their land as an industrial input and their ecological knowledge as an obstacle to progress. In doing so, they were articulating, in practical rather than theoretical terms, what a climate-resilient development model might actually look like at the ground level.[19]

The first common theme is forest protection as both livelihood and climate function. In all four movement regions, communities-maintained forest access as a central component of their economic and ecological life. The forests of Niyamgiri provided the Dongria Kondh with food, medicine, building materials, and the hydrological security on which their horticulture depended. The forest patches of the Kashipur hills sustained agricultural microclimates and stream flow. The village forests of Kalinganagar provided commons that supplemented agricultural incomes and maintained local water cycles. In each case, protecting forests meant protecting climate. The movement's insistence on forest rights was, simultaneously, an insistence on ecological function.

A second common theme is water security. Communities in Kashipur, Niyamgiri, Kalinganagar, and Jagatsinghpur depended on streams, rivers, ponds, and coastal water systems for farming, fishing, and daily life. By resisting projects that threatened these resources, they also protected local water systems. These efforts strengthened

[18] *Sandeep Pattnaik and Samantha Balaton-Chrimes, "Who wants a 'Development' that doesn't Recognise Alternatives?," in Postdevelopment in Practice (Routledge, 2019), 152–157.*
[19] *Binay Kumar Pattnaik, "Tribal Resistance Movements and the Politics of Development-induced Displacement in Contemporary Orissa," Social Change 43, no. 1 (2013): 58–64.*

community resilience and helped preserve important forms of climate adaptation developed over generations.A third common theme is biodiversity protection. The forests and hills of eastern India support rich plant and animal life that has been maintained through long interaction between communities and nature. In Niyamgiri, the Dongria Kondh protect forests, wildlife habitats, and diverse traditional crops through their everyday practices. By defending these landscapes, communities were also helping to conserve biodiversity and strengthen ecological resilience for future generations.

A fourth common theme is community governance. In Kashipur, Niyamgiri, Kalinganagar, and Jagatsinghpur, local organisations played an important role in both resistance and environmental protection. These community institutions helped manage natural resources, resolve local issues, and protect forests, land, and water systems. In this sense, community governance also functioned as ecological governance. They were unified expressions of communities governing themselves in relation to the landscapes they inhabited.[20]

Table 8: Ecological Contributions of Each Movement

Movement	Primary Ecological Contribution	Climate Function Preserved
Kashipur	Protection of Baphilimali hill watersheds and mountain forests	Carbon storage, water security, stream flow regulation
Niyamgiri	Sacred conservation of hill biodiversity and hydrological sources	Biodiversity, downstream water supply, forest corridor integrity
Kalinganagar	Critique of agricultural land and common resource destruction	Soil health, local water cycles, ecological diversity
POSCO	Coastal ecology and agricultural resilience in storm-exposed belt	Storm protection, coastal erosion control, agro-ecology

What unites these themes is the concept of climate resilience from below. This refers to the protection of climate-sensitive ecosystems not through formal conservation policy or externally designed green development schemes, but through the resistance and governance practices of the communities that live within and depend upon those ecosystems. Climate resilience from below is not a new invention. It is what indigenous and rural communities in ecologically complex landscapes have practised for generations. What is new is the urgency with which formal climate governance now needs to recognise and support it, rather than treating these communities as obstacles to development whose demands can be overridden in the name of national economic growth.[21]

The four movements examined in this paper suggest that climate resilience from below rests on three interconnected foundations. The first is secure land tenure, which allows communities to invest in the long-term management of ecological systems rather than focusing on short-term extraction under conditions of insecurity. The second is recognition of indigenous knowledge as a legitimate form of ecological understanding, not merely as folklore but as a body of practice whose climate functions can be demonstrated scientifically. The third is democratic participation in decisions about land and resource use, which ensures that the communities with the deepest ecological knowledge and the greatest stake in long-term sustainability have a voice in shaping development trajectories.

LESSONS FOR GLOBAL CLIMATE GOVERNANCE

The indigenous movements of eastern India are not unique in their ecological significance. Across the world, communities inhabiting ecologically critical landscapes are engaged in similar struggles against resource extraction, land acquisition, and development models that prioritise industrial growth over ecological sustainability. The parallels between the Odisha

[20] *Pattnaik, "Tribal Resistance Movements," 66–70.*
[21] *Berkes, Sacred Ecology, 3rd ed., 100–108.*

movements and comparable struggles in the Amazon basin, Australia, and Canada illuminate the global dimensions of what this paper has described as climate resilience from below.[22]

In the Amazon, indigenous communities protecting forest territories from deforestation, illegal logging, and ranching expansion have become widely recognised as among the most effective defenders of the world's largest tropical carbon sink. Research consistently shows that indigenous territories in the Amazon experience significantly lower rates of deforestation than surrounding areas under state or private management, precisely because communities with secure land rights and traditional governance systems have both the incentive and the capacity to protect long-term ecological integrity. The Brazilian government's weakening of indigenous land protections during the 2010s coincided with sharp increases in Amazon deforestation, providing an inadvertent demonstration of what community-based ecological governance actually contributes.[23]

Similar patterns can be seen in other parts of the world. In Australia, Indigenous communities play an important role in protecting biodiversity and managing landscapes. In Canada, First Nations communities have opposed projects that threaten land and natural resources. Although the settings differ, these struggles share a common goal of protecting ecologically important landscapes from unsustainable forms of development.[24]

The lesson for global climate governance is straightforward but has yet to be fully absorbed into mainstream policy frameworks. Protecting indigenous land rights is one of the most cost-effective strategies available for maintaining the ecological systems on which global climate stability depends. The communities that resisted industrial projects in Kashipur, Niyamgiri, Kalinganagar, and POSCO-affected Jagatsinghpur were doing more than defending their own livelihoods. They were, in their resistance, performing climate services whose value the world is only beginning to understand. Global climate governance frameworks that focus primarily on technology, carbon markets, and state-level policy while neglecting indigenous land rights and ecological governance miss a fundamental dimension of the climate challenge.[25]

CONCLUSION

This paper has argued that the indigenous movements of eastern India were more than struggles against displacement. They were also efforts to protect important ecological systems that support climate resilience and environmental sustainability. The experiences of Kashipur, Niyamgiri, Kalinganagar, and Jagatsinghpur show that local communities were defending forests, hills, water sources, agricultural land, and coastal ecosystems that are vital for both people and nature. The study has shown that indigenous knowledge and community practices played an important role in maintaining ecological balance. In Niyamgiri, community traditions helped protect forests, biodiversity, and water resources. In Kashipur, local communities defended hills, forests, and streams that supported livelihoods and ecological stability. In Kalinganagar, resistance highlighted the environmental costs of large scale industrial expansion. In Jagatsinghpur, communities protected coastal ecosystems that help reduce the impacts of cyclones and coastal hazards. A key finding of this paper is that these movements can be understood as examples of climate resilience from below. Local communities were not only protecting their rights and livelihoods. They were also safeguarding ecological systems that store carbon,

[22] *Dina Gilio-Whitaker, As Long as Grass Grows: The Indigenous Fight for Environmental Justice from Colonization to Standing Rock (Boston: Beacon Press, 2019), 52–58.*
[23] *Ibid., 60–64.*
[24] *Rob Nixon, Slow Violence and the Environmentalism of the Poor (Cambridge: Harvard University Press, 2011), 4–8.*
[25] *Ibid., 12–18.*

conserve biodiversity, regulate water resources, and strengthen environmental resilience. Their actions demonstrate that community based environmental protection can make an important contribution to sustainable futures.

The paper also suggests that climate policy should pay greater attention to indigenous knowledge and local environmental stewardship. Climate solutions are often discussed in terms of technology, investment, and regulation. While these remain important, the experiences of eastern India show that communities possess valuable knowledge and practices that support long term ecological sustainability.

The movements examined in this study remind us that protecting nature and protecting communities are closely connected. As climate change places increasing pressure on forests, water systems, biodiversity, and coastal regions, the lessons from Kashipur, Niyamgiri, Kalinganagar, and Jagatsinghpur become even more relevant. Their experiences offer important insights for building a more sustainable and climate resilient future.

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