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Beyond Vulnerability: Indigenous Knowledge In PVTG Climate Adaptation Strategies

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Abstract
The sustainability of ecological processes has become a global concern, emphasizing the importance of studying indigenous knowledge systems. These systems, developed through generations of interaction with nature, represent a vast body of knowledge rooted in trial-and-error methods and holistic perspectives. Indigenous knowledge often complements scientific understanding and is culturally unique, reflecting local communities' worldviews. This paper investigates the adaptive strategies of Particularly Vulnerable Tribal Groups (PVTGs) in India in the face of climate change, focusing on the critical role of indigenous knowledge (IK). PVTGs, characterized by their unique cultural identities and deep reliance on natural resources, possess a rich body of IK developed through generations of interaction with their environment. This study examines how climate change impacts their livelihoods, food security, and cultural practices, while simultaneously exploring how PVTGs integrate IK into their adaptation strategies. By analysing the strengths and weaknesses of these strategies, the research aims to identify key challenges and opportunities for PVTGs in maintaining and adapting their IK amidst modernization and environmental degradation. The findings of this study will inform policy interventions that support sustainable development and climate adaptation among these vulnerable communities while respecting and valuing their indigenous knowledge systems.
Key Words *Particularly Vulnerable Tribal Groups (PVTGs), Climate Change, Indigenous Knowledge, Adaptive Strategies.*

INTRODUCTION

India ranks just behind Africa in terms of the size of its indigenous population. Historically, tribals primarily relied on hunting, gathering Non-Timber Forest Produce (NTFP), livestock rearing, shifting cultivation, and artisan work. While they hunted, it was limited to their daily needs. They also collected fibers, fruits, flowers, and other forest products from remote areas, contributing to biodiversity conservation. Many Particularly Vulnerable Tribal Groups (PVTGs) still lack basic amenities like electricity and transport, relying instead on natural resources for food, water, and light. They also maintain a strong connection with nature, as seen during the 2004 tsunami, where the Andaman tribes escaped after hearing birds, highlighting their environmental awareness. Sacred groves like peepal, mahua, neem, and banyan are protected by PVTGs within their habitats. Forests play a key role in their livelihoods, offering food, medicinal herbs, and raw materials like skins and hides for commercial use. However, this agro-forest-based economy is vulnerable to environmental changes. Challenges facing PVTGs include the erosion of their cultural traditions due to modern technologies, conversions to other religions that disrupt their rituals, and instances like the killing of an American pastor by the Sentinelese. Many PVTGs also struggle with economic sustainability as they don't save for the future. The loss of forest rights and encroachment by non-tribal people threaten their existence, and globalization accelerates the extinction of their languages and traditions. Additionally, non-tribal people benefit from tribal reservations, undermining the tribes' rights.

Particularly Vulnerable Tribal Groups (PVTGs) in India

Tribal communities in India face heightened vulnerability due to low literacy rates, limited access to technology, and economic challenges. Certain sub-groups remain isolated and excluded from government welfare initiatives. In 1973, the Dhebar Commission introduced the category of Primitive Tribal Groups (PTGs) for the most underdeveloped tribes, which was renamed as PVTGs in 2006 by the Government of India. According to MoTA (2014), 75 tribal groups have been classified as PVTGs based on their social, economic, and educational status. These groups typically use pre-agricultural technologies, have low literacy, a subsistence economy, and show stagnant or declining populations (SCSTRTI, 2015). PVTGs

are distributed across 18 states and one union territory, with Odisha hosting the highest number (13), followed by Andhra Pradesh (12), Bihar and Jharkhand (9), and others as per Census 2011.

REVIEW OF LITERATURE

The review of literature highlights the significant role of indigenous knowledge (IK) in helping communities adapt to climate change, particularly among Particularly Vulnerable Tribal Groups (PVTGs) in India. Studies reveal how traditional agricultural practices, such as intercropping, water management, and agroforestry, have enhanced resilience to environmental changes. Indigenous communities like the Apatani, Baigas, Birhors, Lahaulas, and Kondh have developed adaptive strategies based on centuries of ecological observation. Despite facing challenges like industrialization, climate change, and displacement, PVTGs continue to rely on their deep connection to nature, underscoring the importance of integrating indigenous knowledge with modern solutions to promote sustainable development and climate adaptation.

Indigenous knowledge encompasses the wisdom, practices, and belief systems of Indigenous peoples, cultivated over countless generations through deep engagement with the environment and continuous adaptation to dynamic ecological shifts and societal transformations, including the impacts of colonization and globalization (Adger et al. 2014; UNESCO 2017).

Son et al. (2020) in their research come up with interesting findings establishing interrelationship between the Indigenous knowledge system and its role in strengthening community resilience to climate change in Vietnam's northern mountainous regions. In northern Bac Kan, local communities have adopted a mixed-cropping system that includes bananas alongside ginger and medicinal species such as Ardisia silvestris and Gynostemma pentaphyllum. This diversified farming approach has proven more resilient to drought, as it enhances ground coverage, minimizes soil degradation, boosts moisture retention, and offers greater adaptability than traditional single-crop methods. Local people observed that rising temperatures benefit plant growth, accelerating fruit ripening and shortening harvest times, particularly for banana, which thrives in warmer winters and remains largely unaffected by changes in rainfall patterns. However, extreme cold waves can harm the plants, highlighting the importance of adjusting cropping patterns to support local socio-economic development amidst climate changes.

According to Aich et al. (2022), climate change poses serious risks to agricultural systems, threatening the food supply for vast populations living in tropical and subtropical areas.

Climate-smart agriculture (CSA) promotes sustainable practices to enhance resilience, but developing a universal framework for diverse agrarian landscapes remains challenging. Rai (2005) observe the Apatani tribes practice fully organic cultivation, avoiding artificial soil supplements entirely. Their paddy-cum-fish agroecosystem is strategically located to capture nutrient-rich runoff from the hills. Additionally, they enhance soil fertility through the consistent use of livestock manure, agricultural waste, kitchen scraps, and rice chaff.

Singh et al. (1996) highlight that the Lahaulas of the Lahaul Valley's cold desert engage in seasonal agriculture, farming only between June and November due to persistent snow cover during the rest of the year. In spite of the region's extreme climate, they maintain rich agricultural diversity by blending traditional methods with modern crops, practicing integrated farming with livestock, and implementing innovative ice-water harvesting techniques. Their distinctive irrigation system—designed for the region's cold, dry climate and rugged terrain—channels snowmelt to fields through traditional earthen conduits known locally as Nullah or Kuhi.

Kondh farmers have developed a remarkable agricultural method by cultivating up to 80 different crop varieties, including coarse grains, edible roots, seasonal greens, cereal crops, protein-rich seeds, corn and oilseeds, within a single dongor—the traditional farmlands on lower hill slopes. The sowing period spans from April to August, with harvesting extending from October to February, based on climatic suitability. Genomic studies on crops like finger millet, pearl millet, and sorghum highlight their suitability as climate-smart grains, thriving in drought-prone and heat-intensive environments. Similarly, traditional upland paddy varieties used by Kondhs are drought-resistant, requiring less water and maturing within 60 to 90 days. Consequently, the risk of complete crop failure in dongors remains minimal, even under drought-like conditions.(Singh et al. 2016; Varshney et al. 2017; Mishra et al. 2018).

Soren et al. (2024) explicate that Jharkhand, a mineral-rich state in eastern India, is home to several Particularly Vulnerable Tribal Groups (PVTGs) like the Asur, Birhor, and Paharia, who rely on traditional practices such as shifting cultivation, hunting, and gathering. However, industrialization, mining,

deforestation, and infrastructure development have disrupted their environment, threatening their livelihoods and cultural heritage. PVTGs face heightened risks from environmental hazards like land degradation, drought, and lightning due to their dependence on natural resources. Mining-induced displacement, pollution, and climate change have further exacerbated their vulnerabilities, leading to loss of livelihoods, food insecurity, and social disintegration. Despite their cultural and ecological significance, these communities remain marginalized and susceptible to environmental and economic challenges.

As observed by Prasad (2022) the Achanakmar-Amarkantak Biosphere Reserve, home to the Baiga, a Particularly Vulnerable Tribal Group, relies on its primeval ecosystem for sustainable forest-based livelihoods. However, mining and climate change have disrupted this balance, leading to difficulties in resource collection and increased environmental challenges like droughts and soil erosion. As forest resources dwindle, the Baiga are turning to alternative livelihoods. Urgent afforestation and awareness efforts are needed to address these issues.

Das (2020) observes that the Hill Korwas, traditionally preferring isolation, have experienced significant changes due to climate-induced factors like forest depletion and changing laws. These environmental changes reduced their access to forest resources, forcing them to depend more on farm produce and local markets for subsistence. Despite efforts to improve their socio-economic conditions through development schemes, these initiatives have struggled due to the tribe's deep reliance on forests and their limited engagement with mainstream society.

Sabar et al. (2024) investigate the age-old farming methods of the Chuktia Bhunjia community in Odisha, India, focusing on how their close relationship with the natural environment supports both sustainable food production and livelihood resilience. Based on insights drawn from field interviews and direct observation, the authors emphasize that the community's farming methods are closely intertwined with their ecological surroundings, spiritual traditions, and ancestral wisdom. Notable techniques include growing multiple crops together, integrating trees with crops, rotating plant varieties seasonally, preserving genetic diversity in crops, collecting rainwater for irrigation, and nurturing soil health. These practices are shaped by generations of observation and experimentation and are culturally transmitted through hands-on engagement and rituals tied to agriculture.

The Chuktia Bhunjia's approach to farming plays a crucial role in preserving soil fertility and moisture, reducing greenhouse gas emissions, and promoting carbon sequestration, thereby contributing to ecological balance. Their agroforestry-based methods, combined with cultural beliefs, rituals, and indigenous technologies, make their agriculture both cost-effective and ecologically sustainable. Additionally, their climate-resilient agricultural decisions help mitigate crop failure while ensuring sustainable food production and livelihoods. However, the proposed displacement of the Chuktia Bhunjia due to the "tiger project" poses a significant threat to their agricultural knowledge and cultural heritage. Given the critical role of traditional agriculture in their livelihood, integrating their knowledge systems with scientific approaches could foster sustainability for both the environment and their communities. Most of the studies based on either empirical work or case studies. In my knowledge, there is lacuna of systematic review, which might contribute to the knowledge of literature. Therefore, this paper try to provide systematic literature review in the field of knowledge. The major objective(s) of this paper are (i) to investigate the adaptive strategies of Particularly Vulnerable Tribal Groups in response to climate change through indigenous knowledge and practices, and (ii) to examine the impact of climate change on the livelihood of Particularly Vulnerable Tribal Groups.

STUDY METHODOLOGY

The present paper employs secondary source data analysis and predominantly qualitative analysis. Certain key words like Particularly Vulnerable Tribal Groups (PVTGs), Climate Change, Indigenous Knowledge, Adaptive Strategies have been searched in JSTOR, Springer Link, and Science Direct etc. About 80 articles were downloaded, but only those articles were kept in reference which were found relevant as per the scope of the article. The entire scheme of search of articles have been put in a tabular form, which is given below. The present study has two objective:

1. To explore how Particularly Vulnerable Tribal Groups (PVTGs) in India utilize indigenous knowledge systems to develop adaptive strategies in response to climate change.
2. To analyze the challenges and opportunities in preserving and integrating indigenous knowledge of PVTGs within contemporary climate adaptation and development frameworks.

Type of Source	Possible Databases/Sources
Academic Journals	- Google Scholar - JSTOR - Scopus - Science Direct - Wiley Online Library
Books and Book Chapters	- Cambridge University Press - Springer - Elsevier - Routledge
Government Reports and Official Documents	- Government Websites (e.g., moef.gov.in) - United Nations (UNESCO) - Food and Agriculture Organization (FAO)
Institutional and NGO Reports	- CCAFS (CGIAR Research Program on Climate Change, Agriculture, and Food Security) - World Resources Institute - PLOS - Glocal
Conference Proceedings	- IEEE Xplore - Elsevier - Event-specific websites and archives
Traditional Knowledge and Reports	- Anthro Source - SAGE Journals - Interdisciplinary academic archives

Climate Change and Indigenous Resilience: The Case of PVTGs in India

A significant portion of India's rural poor depend on land and forest resources for their survival and livelihood. As the country has an economy primarily based on agriculture, the majority of the population is directly engaged in farming, either as landowners or agricultural workers. Climate variation will have a direct impact on the livelihoods of many people, with the degree of impact differing across various regions. Climate change is expected to affect agricultural productivity, alter crop patterns, and jeopardize food security, thereby threatening people's livelihoods. Even minor changes in temperature and rainfall can have a considerable impact on both the quantity and quality of crops. Additionally, the poor may face severe consequences related to soil erosion and degradation, which negatively affect soil fertility and health. Droughts, insufficient rainfall, and seasonal water shortages, coupled with rising temperatures, are major threats to India's impoverished population.

Scientists at the Indian Agricultural Research Institute (IARI) have assessed the impact of climate change on agriculture by employing a variety of crop growth models. Their findings suggest that climate change will reduce grain yields in many regions. They also predicted that the areas suitable for crop cultivation might shift. This is particularly critical for India's small and marginal farmers, who typically rely on small landholdings. Climate change is expected to cause a more severe decline in production for rain-fed crops in areas with limited water availability, given the weak coping mechanisms of these small-scale farmers.

Overall, temperature increases are projected to reduce rice yields, with a 2-4°C rise leading to reduced productivity. The eastern regions are expected to be most affected by higher temperatures, resulting in fewer grains and a shorter grain filling period. According to the study, under a 2°C temperature rise by the 2050s, India may need to import more than double the amount of food grain compared to what would be necessary without climate change. Due to the complex nature of these impacts, the researchers

stress the urgent need for better agricultural management practices and climate-proofing measures to safeguard the livelihoods of India's marginalized and poor communities (Singh, 2014).

Rajasekhran and Indumathy (2016) while exploring the climate adaptability among Irula tribes found that the Irular tribes are keen observers of nature, passing down traditional knowledge that links weather phenomena to biological activities and atmospheric conditions. They predict rainfall by observing behavioral changes in dragonflies, termites, ants, and sheep. Atmospheric signs such as a ring around the moon, evening rainbows, and morning cloudiness are seen as indicators of impending rainfall, while dense fog is viewed as a sign of dry conditions. Additionally, the Irular possess extensive traditional expertise in climate, weather forecasting, and rainfall prediction.

Communities that rely on forests have also felt the effects of changing climate patterns. In the Indian context, many of these groups are classified as 'tribes,' often living in isolated regions and maintaining culturally distinct lifestyles rooted in forest ecosystems. These tribal populations are frequently viewed as socially and economically marginalized due to their strong dependence on natural resources. Among them, the Particularly Vulnerable Tribal Groups (PVTGs) face even deeper levels of exclusion, with their livelihoods intricately tied to the surrounding environment. Unlike other disadvantaged communities, PVTGs are uniquely reliant on nature for sustenance. Today, tribal identities are formally acknowledged, and their ongoing struggle largely revolves around defending their access to and stewardship of natural resources in the face of external pressures. As Roy Burman (1992) states, "the indigenous are those whose livelihood and lifestyle are tied up with the land and forest in a system of mutual reinforcement- as a moral contract where social living and negotiation with human and non-human, animate beings are basically attuned to the sonic and sensual rhythms of the earth."

Padhi (2019) notes that climate change stands as one of the most profound threats confronting human civilization, as well as its social, political, and economic structures. Its global repercussions are vast, disrupting agriculture, water systems, coastal regions, public health, economies, biodiversity, and triggering more frequent extreme weather events. The connection between climate fluctuations and challenges such as poverty, livelihood insecurity, and uneven development is particularly strong, with the poorest and most marginalized populations—those least responsible for the crisis—experiencing the heaviest burdens.

Literature reviews suggest that Climate Impact assessments based on General Circulation Models are limited, as they fail to provide detailed information for smaller regions, particularly regarding the effects of climate change on the livelihoods of less-explored communities like tribal regions. This lack of data makes future scenarios even more uncertain, complicating decisions on adaptive responses. The present research seeks to address this gap by focusing on community-centered studies of livelihood vulnerability, specifically from the perspective of climate variability.

From Tradition to Action: Tribes and Climate Sustainability

Indigenous communities maintain a deep symbiotic relationship with nature, significantly contributing to environmental management through their traditional knowledge (Tripathi, 2016). Globally, they are reclaiming cultural stewardship to restore ecosystems, traditions, and biodiversity. In the United States, indigenous groups actively work to manage their homelands and wildlife (Martinez et al., 2023). Similarly, New Zealand's Maori, guided by the principle of kaitiakitanga, integrate human and environmental well-being, emphasizing sustainable resource use and preservation for future generations (Whaanga, 2012). In rural India, tribal communities demonstrate a strong connection to nature, relying on natural resources for their livelihood, with government policies increasingly recognizing their critical role in environmental conservation. (Rai & Nath, 2003).

Indigenous peoples are frequently identified as an "at-risk" group (Ford et al., 2020) due to their disproportionate exposure to biodiversity loss and environmental degradation (Sisham, 2020). Their dependence on natural resources in forested or riverside regions makes them particularly vulnerable to resource depletion and environmental damage (Behera et al., 2022a).

Research highlights various instances of vulnerability among indigenous communities (Hahmann, 2020; Vinyeta et al., 2015). In Cambodia, for example, the conversion of land to sugarcane plantations has caused significant challenges, including reduced access to water, agricultural land, education, and livelihood options, alongside cultural degradation and weakened social structures (Notess, 2018). In Bangladesh, indigenous groups face heightened vulnerability to drought (Paul, 1998; Behrawan, 2008) and rainfall-related issues (Habiba, 2012; Selvaraj et al., 2006; Shafiqul et al., 2017). In South Africa,

indigenous populations in arid areas experience risks from drought, floods, and sand and dust storms (DEA, 2013). In Canada, groups such as the Metis and Inuit are highly vulnerable to climate change, as disrupted ecosystems lead to the loss of traditional food and medicinal resources (Ford et al., 2020). Similarly, in the United States, American Indian and Alaska Native tribes face crop and traditional medicine losses due to water scarcity linked to climate change (Lynn, 2013). Nigerian indigenous communities have adopted traditional techniques like bunds, embankments, and early harvesting to combat flood impacts (Obi et al., 2021), while the Afar tribe in Ethiopia combines indigenous and modern strategies to address climate variability and change (Balehegn et al., 2019).

Climate change has significant socio-economic implications for tribal communities in India (Shivpriya, 2020). In Jharkhand, irregular rainfall and temperature fluctuations have adversely affected tribal livelihoods (Barla, 2016; Vatta et al., 2017). In Nagaland, extreme flooding caused by climate change has led to displacement, deteriorating living conditions, reduced water quality, limited food access, and inadequate healthcare (Government of Nagaland, 2011). Maharashtra's tribal communities face displacement and migration due to prolonged droughts and erratic rainfall (Khan, 2015), with further challenges including poor education access, increased child labor, and compromised health (Gerber & Sztokman, 2022). In Nagaland, the Angami and Ao tribes encounter landslides, water scarcity, and moderate droughts linked to climate variability (Kuotsu et al., 2017). In Jammu and Kashmir, shifting climatic patterns have disrupted the migratory behaviors of the Gujjars and Bakerwals (Sharma, 2023). In Tamil Nadu's Nilgiris District, smaller family sizes have emerged as a strategy for adapting to landslide risks among indigenous tribes (Geetha et al., 2023).In India, Indigenous communities officially classified as “Scheduled Tribes” (STs) are often characterized by traditional worldviews, economic vulnerability, and poor health indicators (Tribal Health in India: Executive Summary Recommendations, 2018). Jharkhand, a tribal-majority state located in eastern India, is witnessing the adverse impacts of changing climate patterns, such as prolonged dry periods, erratic monsoon behavior, and rising temperatures (Wadood and Kumari, 2009; Government of Jharkhand, 2014; Kumar et al., 2016; Ahmad et al., 2018; Tirkey et al., 2018). Climate data from the region points to a sharp reduction in overall rainfall and an increase in extreme weather phenomena, including heatwaves, hailstorms, and cold spells (Government of Jharkhand, 2014). Disasters like droughts, forest fires, lightning strikes, and heavy rainfall have become more frequent (Minj, 2013; Ahmad et al., 2018). These environmental changes severely disrupt the livelihoods of tribal groups, who depend largely on subsistence agriculture and forest-based activities that are central to their traditional food systems (Misra et al., 2008; Bhattacharjee et al., 2009; Ghosh-Jerath et al., 2020a, 2021). Additionally, rampant deforestation continues to degrade ecosystems, posing a significant threat to biodiversity and further weakening the social, cultural, and economic structures of these communities (Kayet et al., 2016).

Particularly Vulnerable Tribal Groups (PVTGs), such as the Sauria Paharia in Jharkhand, are among the most at risk due to their reliance on shifting cultivation, limited access to resources, and extreme poverty (Maternal Health and Nutrition Report, 2014; Ghosh-Jerath et al., 2020a,b). Despite living in biodiversity-rich areas, these tribes suffer from malnutrition and poor health (Ghosh-Jerath et al., 2020a,b). Geographical remoteness restricts the PVTGs' participation in development initiatives, intensifying their exposure to the impacts of climate-related disruptions (Maternal Health and Nutrition Report, 2014; Jamwal, 2019).

While policies aimed at enhancing food security amid changing climate conditions have gained momentum (Vermeulen et al., 2012; Climate-smart agriculture for food security, 2014), there is still limited insight into how vulnerable communities, particularly PVTGs, perceive and respond to these challenges. Existing research on indigenous small-scale farmers in regions such as Africa (Mapfumo et al., 2016; Ayanlade et al., 2017; Zamasiya et al., 2017; Aniah et al., 2019) and Central America (Roco et al., 2015; de Sousa et al., 2018) has provided some understanding of their responses to climate impacts. However, investigations into the experiences of tribal farming communities in India remain scarce (Minj, 2013; Sharma, 2019). This study addresses this gap by focusing on the Sauria Paharia tribe in Jharkhand, exploring their views on climate variability, its implications for agriculture and food availability, and the adaptive methods they employ. The analysis integrates data on agroforestry practices and dietary trends to offer a holistic view of how climate change influences food systems in these communities. The research aims to expand global discourse on the resilience and challenges faced by indigenous smallholder farmers in the context of a shifting climate.

Ghosh et al.(2021) notes that Climate change significantly threatens the livelihoods of indigenous smallholder farmers like the Sauria Paharia of Jharkhand, India, who rely on agroforestry for food and income. A mixed-methods study across 18 villages in Godda district revealed that erratic rainfall and prolonged dry spells reduced crop productivity, agroforestry diversity, and food availability, pushing households toward migratory wage labor and food insecurity. Focus group discussions and surveys highlighted the community's reliance on indigenous climate-resilient crops, seed conservation, and forest foods for coping. Nevertheless, the adoption of hybrid crops raises concerns about its possible impact on traditional food systems. Encouraging sustainable adaptation methods can strengthen agricultural resilience, improve food availability, and support diverse diets.

Case Study 1:

"Guardians of the Green: The Tangkhul Way of Facing Climate Change"

In the remote highlands of Manipur, the Tangkhul Naga tribe offers a powerful example of how indigenous communities respond to climate disruptions not with dependence, but with deep-rooted knowledge and adaptability. Their agricultural life is not merely a means of survival but a cultural rhythm—marked by communal rituals and centuries-old practices that align closely with natural cycles.

As climate variability increasingly threatens crop cycles and water availability, Tangkhul farmers have responded with grounded pragmatism—altering planting schedules, diversifying crops, and drawing on their understanding of local biodiversity. Their landscapes are carefully managed through systems that blend conservation and utility, where specific zones are preserved to maintain ecological balance.

At the heart of this resilience are traditional governance structures like the Village Authority and local women's collectives, which guide resource use and community decisions. These institutions could act as vital intermediaries between local realities and state-level climate policy—but they are often overlooked.

The Tangkhul experience underscores the importance of recognizing indigenous knowledge as a living, adaptive system. For climate policies to be effective in such regions, they must move beyond consultation and into genuine collaboration—where science meets tradition on equal terms, and communities are empowered to lead from within.

Case Study 2:

"Resilience Amid Ruins: The Baiga's Battle with a Changing Climate"

In the forested highlands of Chhattisgarh, the Baiga tribe—one of India's Particularly Vulnerable Tribal Groups—faces a mounting ecological crisis. As bauxite mining scars the sacred Achanakmar-Amarkantak landscape, this indigenous community grapples with vanishing forests, erratic rainfall, and depleted water sources. Once sustained by mixed farming, forest gathering, and ritual-rich land stewardship, the Baiga now navigate shrinking access to wild foods, medicinal plants, and traditional hunting grounds.

To survive, they've turned to wage labor, roadside construction, and working in stone-crushing units—tasks far removed from their ancestral rhythms. Despite this upheaval, the Baiga maintain pockets of resistance, cultivating kitchen gardens, preserving heirloom crops, and invoking sacred forest deities to uphold ecological balance.

Their story underscores the urgent need for climate action rooted in cultural context. Rather than displace traditional systems, policy must empower them—preserving not just forests, but the wisdom of those who've lived in harmony with them for generations.

Conclusion

In conclusion, this research underscores the critical role of indigenous knowledge (IK) in enhancing the resilience of Particularly Vulnerable Tribal Groups (PVTGs) to climate change in India. The findings demonstrate that PVTGs possess a wealth of traditional ecological knowledge developed over generations through their intimate connection with their environment. This IK encompasses a range of practices, including agroforestry, crop rotation, and traditional seed saving, which contribute to climate change adaptation. However, the study also highlights the significant challenges faced by PVTGs in maintaining and adapting their IK amidst rapid environmental and social changes. These challenges include modernization, market integration, and the erosion of traditional cultural practices.

Helping PVTGs navigate climate challenges demands an appreciation for their traditional wisdom and environmental understanding. This calls for development strategies that are inclusive, community-driven, and grounded in local experiences. To be effective, policies must emphasize:

- Strengthening local governance and decision-making processes to ensure that PVTGs have a voice in shaping development and climate adaptation initiatives.
- Supporting the documentation and dissemination of indigenous knowledge through community-based initiatives and partnerships with academic institutions.
- Supporting livelihood options that align with indigenous customs while strengthening their ability to withstand climate-related stresses—for example, integrating tree-based farming systems and locally managed resource conservation.
- Tackling the root causes of PVTGs' vulnerability by improving access to basic services, reducing economic hardship, and bridging social disparities in areas like education and health.

By recognizing the value of indigenous knowledge and supporting the resilience of PVTGs, we can ensure that their unique contributions to environmental conservation and sustainable development are preserved for future generations.

Policy Recommendations

The major task lies in putting in place some concrete measures in terms of Government action , especially policy based intervention for ensuring

- Institutionalize Indigenous Knowledge (IK) in Climate Policy
- Establish formal mechanisms to integrate IK into state and national climate adaptation frameworks. This includes creating dedicated platforms for dialogue between indigenous communities, scientists, and policymakers.
- Legal Protection and Land Rights
- Strengthen legal safeguards for land, forest, and water rights of PVTGs to protect their ecological spaces and prevent displacement caused by mining, deforestation, and large infrastructure projects.
- Community-Led Climate Monitoring
- Support community-based climate monitoring programs using both indigenous indicators and scientific tools. Training PVTG youth as “climate stewards” can bridge generational knowledge and modern data collection.
- Culturally Sensitive Development Schemes
- Tailor welfare and livelihood programs to align with traditional practices and socio-cultural norms of PVTGs, ensuring that interventions do not disrupt indigenous ways of life.
- Documentation and Intergenerational Transmission of IK
- Fund and facilitate community-led documentation projects (e.g., oral histories, farming calendars, ritual practices) to preserve and transmit IK, especially under the threat of cultural erosion due to modernization.
- Inclusive Governance and Decision-Making
- Mandate the inclusion of PVTG representatives in local and regional governance bodies that make decisions on resource use, conservation, and climate adaptation.
- Promote Climate-Resilient Indigenous Crops
- Recognize and invest in the cultivation and conservation of traditional, climate-resilient crops grown by PVTGs, such as millets and upland paddy, which require fewer inputs and can withstand climate extremes.
- Create Tribal Climate Resilience Funds
- Establish dedicated funds to support PVTG-driven adaptation projects, ensuring financial autonomy and long-term resilience planning at the community level.

The future scope of this article entails upon primary data collection and research. Primitive knowledge and resilience strategies are unique and are of immense use for present day time. So, combined efforts of Government as well as other stakeholders could be pulled up for preserving the indigenous knowledge for adapting to climate change.

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