Deforestation in Tirah Valley: Local Knowledge, State Negligence, and Climate Vulnerability

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ABSTRACT

The Tirah Valley in Khyber Pakhtunkhwa, Pakistan, is among the country's most ecologically significant yet critically threatened highland forest systems. Situated between the Khyber Pass and Khanki Valley at elevations of 1,500–2,100 m, its forests have historically sustained biodiversity, regulated hydrological systems, and underpinned community livelihoods through a customary governance regime rooted in tribal law and collective responsibility. Post-2000 insurgency, military operations, and mass displacement dismantled these indigenous institutions, creating a governance vacuum exploited by organised criminal timber networks. A structurally weak state forest administration has proven unable to fill this gap, while credible allegations of official complicity in timber smuggling further erode institutional credibility. Drawing on in-depth qualitative interviews with community elders, activists, and displaced residents, supplemented by policy documents, grey literature, and international case studies, this paper adopts a comparative institutional approach. It situates the Tirah case within regional frameworks, including Ostrom's (1990) common-pool resource theory and Scott's (1998) legibility critique, alongside comparative evidence from Nepal and the Philippines, as well as Pakistan's own indigenous governance traditions, including the Jirga, Shamilat, and Rewaj systems. The study examines the multi-layered causes of deforestation, the historical architecture of customary forest governance, structural shortcomings of state environmental policy, and the ecological and climatic consequences observed by communities. Respondents documented dramatic reductions in snowfall and rainfall, accelerated soil erosion, biodiversity loss, and the emergence of previously unknown disease burdens. The paper argues that persistent deforestation reflects a fundamental disarticulation between local knowledge-based governance systems and a state apparatus that has systematically failed to engage with them. Effective conservation in Tirah demands formal legal recognition of community authority, structural reform of enforcement accountability, and governance frameworks built upon, rather than displacing, the institutional traditions of tribal forest stewardship.

Keywords: deforestation; Tirah Valley; indigenous forest governance; traditional ecological knowledge; Khyber Pakhtunkhwa;; climate vulnerability; Pakistan.

INTRODUCTION

Forest ecosystems in the northwestern regions of Pakistan constitute some of the country's most ecologically vital and culturally embedded landscapes. These environments regulate local and regional microclimates, stabilise soils on precipitous mountain slopes, sustain hydrological networks critical to downstream agriculture, and support the livelihoods and cultural identities of millions of people (FAO, 2018; Millennium Ecosystem Assessment, 2005). Among these ecosystems, the forests of the Tirah Valley in Khyber Pakhtunkhwa occupy a position of extraordinary ecological and sociocultural significance; yet, they remain among the most acutely threatened and least formally studied forest systems in the country. The Tirah Valley is a mountainous region situated in the west-central portion of Khyber Pakhtunkhwa, geographically positioned between the Khyber Pass to the north and Khanki Valley to the south, straddling the districts of Khyber and Orakzai (Dawn, 2015). Encompassing an estimated 600 to 700 square miles of rugged terrain at elevations ranging from 1,500 to 2,100 m above sea level, the valley is nourished by the Mastura, Khurmana, and Khanki rivers, which originate near Mount Mitta (3,801 m) in the Spin Range. Its dense conifer forests, alpine meadows, and glacial streams form an ecosystem of remarkable biodiversity (Roberts, 1977). By October 2022, local sources documented the

removal of seven to eight truckloads of timber per day, with the activity continuing openly under the nominal oversight of the forest department and district administration (Pakhtunkhwa Bulletin, 2022).

While this study draws primarily on qualitative fieldwork and community testimony, it also acknowledges the current limitations in publicly available ecological and spatial datasets for Tirah Valley. The absence of consistent forest cover records, hydrological monitoring, and long-term climate data reflects the region's historical marginalisation. As such, this research prioritises locally grounded knowledge as a primary source of evidence, while recognising that future work should integrate satellite-based forest cover analysis, rainfall data, and biodiversity assessments to further strengthen and triangulate these findings.

For generations, Tirah's forests were managed through customary tribal governance systems, collectively referred to as Qabayili law, which assigned clearly defined rights and responsibilities over forest resources to different tribal groups, enforced through the institutional authority of the Jirga and the social weight of communal norms. These systems proved remarkably effective, sustaining forest cover and ecological balance across centuries of intensive human habitation. Their erosion, accelerated dramatically by the post-2000 surge in militancy and ensuing military operations, triggered an environmental crisis whose consequences are still deepening. The institutional context was further complicated by the 2018 merger of the Federally Administered Tribal Areas (FATA) into Khyber Pakhtunkhwa Province. While the merger theoretically brought Tirah under the fuller authority of KP's forest governance framework, implementation has been persistently inadequate. Journalistic sources have documented that the extension of forest legislation to Tirah remains mired in administrative and political obstacles (Dawn, 2023a). Meanwhile, forest department officials in Khyber district have faced serious public allegations of involvement in timber smuggling, which they are charged with preventing (Tribal News Network, 2023), and seven Khyber forest department officials were suspended in 2023 following investigations into misconduct (Dawn, 2023b).

Despite the severity and visibility of this crisis, systematic academic investigation of the Tirah case remains conspicuously absent. This paper addresses this gap through a structured qualitative analysis that integrates community testimony, comparative institutional analysis, ecological observation, and policy critique. It argues that the persistence of deforestation in Tirah reflects not merely an enforcement failure but a deeper structural problem: the systematic marginalisation of locally legitimate governance institutions by a state apparatus that has neither the capacity nor the apparent will to replace their functions.

LITERATURE REVIEW

Pakistan's forest governance history reflects a persistent tension between centralised state administration and community-based resource management. Colonial-era policy, largely inherited intact by the post-independence state, treated forests as extractable assets to be administered through formal bureaucratic mechanisms, systematically displacing the customary tenure regimes through which communities had long governed forest access and use (Ahmed & Mahmood, 1998; Dove, 1993). Scott (1998) theorises this pattern as a broader strategy of state 'legibility', the imposition of standardised administrative categories that simplify complex local realities but destroy the institutional knowledge embedded within them. Subsequent decades witnessed an incomplete policy shift toward participatory and community-centred approaches, culminating in the National Forest Policy of 2015, which nominally endorses community participation and devolved management (Government of Pakistan, 2015). However, the gap between policy aspiration and institutional reality has remained wide, particularly in the former tribal areas (Chaudhry, 2020).

Ostrom's (1990) landmark analysis of common-pool resource governance provides the theoretical foundation for understanding Tirah's governance crisis. Ostrom identified design principles that characterise successful community management regimes globally: clearly defined membership boundaries, locally adapted rules, participatory rule modification, effective monitoring, graduated sanctions, and recognised rights to organise. Tirah's historical governance system embodies most of these principles; its collapse provides a near-textbook illustration of the consequences Ostrom's framework would predict. Crucially, Ostrom challenged the 'tragedy of the commons' paradigm (Hardin, 1968), demonstrating that communities are capable of rational, long-term resource stewardship when institutional conditions permit. The concept of 'institutional fit' (Young, 2002) is equally relevant: governance systems perform best when their structure matches the ecological and social

dynamics they regulate, a calibration that Tirah's customary system achieved through generations of adaptation, but that imported state bureaucratic structures have failed to replicate (Cox et al., 2010).

Regional comparative literature on indigenous forest governance consistently demonstrates that community-based management, when formally recognised and legally secured, outperforms state-centric approaches in both conservation and livelihood outcomes. Nepal's Community Forestry program, where the devolution of management rights to local user groups from the 1980s onwards produced measurable improvements in forest cover, biodiversity, and household livelihoods, is the most extensively documented regional success case (Agrawal & Chhatre, 2006; Nagendra, 2007). In the Philippines, the Ancestral Domain framework grants indigenous communities legal titles to their traditional territories and recognises indigenous governance institutions as legitimate management authorities, producing substantially better forest outcomes in titled than in untitled communities (Colchester, 2004). Berkes (2008) synthesises this evidence under the concept of traditional ecological knowledge (TEK): a cumulative body of place-specific, adaptively managed, and culturally transmitted knowledge that constitutes a substantive epistemic resource for governance, the loss of which through institutional displacement represents an irreversible impoverishment for both ecosystems and communities.

Within Pakistan, several indigenous governance systems provide a direct comparative context for the Tirah case. In Gilgit-Baltistan, Butz's (1996) foundational work on the sheng system identified community-negotiated seasonal resource regulation as highly effective, sustained by social sanctions and collective norms rather than external enforcement. In Swat, Sultan-i-Rome (2007) demonstrated that the traditional Jirga served as an effective forum for forest dispute resolution and resource management prior to displacement by state administrative structures, a pattern whose consequences in Tirah are directly analogous. The Shamilat system of common property management practiced across Punjab, KP, and Azad Kashmir further illustrates how communally governed land bodies can allocate use rights, enforce conservation rules, and resolve disputes without reference to state authority (Gazdar & Mallah, 2013). The Rewaj (customary law) framework underpinning these systems encodes detailed ecological knowledge in practice: seasonal rotation systems, extraction prohibition periods, designated sanctuary zones, and graduated sanction systems that distinguish between subsistence and commercial violations, embodying precisely the institutional design principles that comparative analysis identifies as markers of effective common-pool resource governance (Ostrom, 1990). The 2018 FATA merger compounded pre-existing challenges by introducing prolonged institutional transition, administrative uncertainty, and contested authority in areas previously governed under the Frontier Crimes Regulations. KP's REDD+ Action Plan (Government of KP, 2022) acknowledges governance challenges in the merged districts and identifies deforestation as a critical concern, although Tirah's specific circumstances have received insufficient analytical attention, a gap this paper seeks to address.

Research Questions

1. What are the primary drivers of deforestation in the Tirah Valley, and how have these factors interacted across time and at different scales?

2. How did traditional forest management systems function historically in the valley, and what institutional features account for their multi-century effectiveness?

3. How do local communities perceive and experience the consequences of environmental degradation, and why have state-led conservation efforts failed to produce meaningful protective outcomes despite the existence of formal legislation and enforcement mechanisms?

RESEARCH METHODOLOGY

This study employs a qualitative research design to investigate the socio-ecological dynamics of deforestation in Tirah. This methodological orientation is appropriate given the complexity of the institutional and social processes under examination and the limited availability of quantitative historical data for this politically marginal region. The approach draws on both oral history and textual analysis, integrating community testimony with comparative institutional analysis and policy critique. Primary data were collected through in-depth, semi-

structured interviews with community elders with detailed knowledge of historical forest governance, former participants in traditional resource management institutions, environmental activists, individuals displaced by conflict, and residents with direct experience of the ecological transformation of the landscape. These interviews documented both historical knowledge systems and contemporary perceptions of environmental change. Given the scarcity of textual sources on Tirah's history, itself a reflection of the region's long administrative marginalisation, oral testimony is treated as a primary form of historical evidence rather than a supplement to documentary records (Portelli, 1991). Secondary sources include policy documents, journalistic reporting, grey literature, and peer-reviewed comparative literature on indigenous forest governance. The comparative institutional framework draws on cases from Nepal, the Philippines, and Pakistan to situate Tirah's governance dynamics within a regional analytical context.

Ethical Considerations. All participants provided informed verbal consent and were made aware of their right to withdraw. Identities are held in strict confidence except where individuals made public statements and consented to attribution.

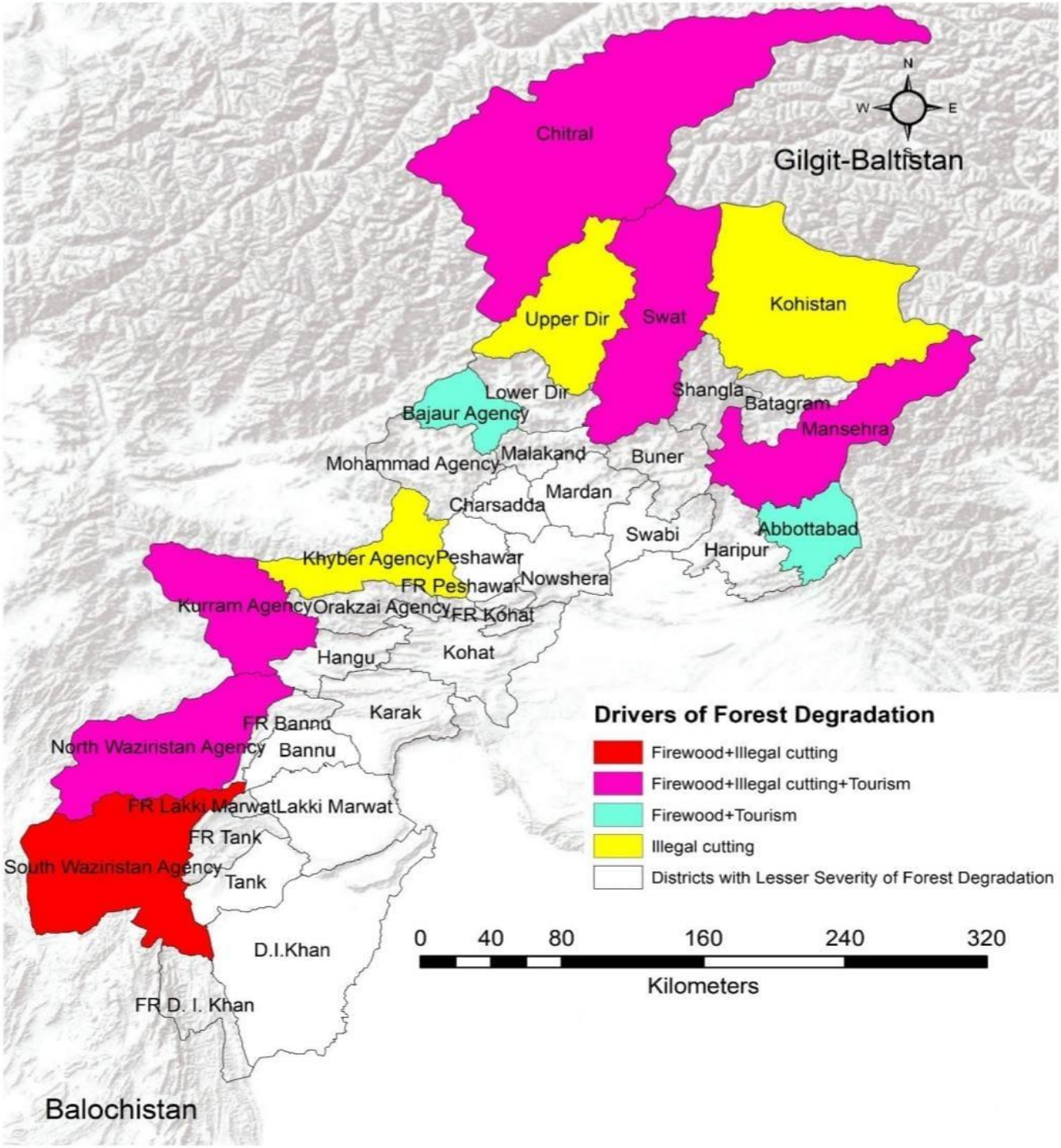
Data Availability. Raw interview transcripts cannot be shared publicly due to participant confidentiality and security sensitivities. All secondary sources are accessible via the URLs in the reference list.

Methodological Note on Quantitative Data. This study does not incorporate systematic quantitative ecological data, such as GIS-based forest cover change statistics, biodiversity indices, or long-term hydrological and rainfall measurements. This is a direct consequence of data unavailability rather than a methodological preference. Consistent, publicly accessible ecological datasets for Tirah Valley do not exist. The region's prolonged administrative marginalisation under the Frontier Crimes Regulations, compounded by the security restrictions of the post-2000 conflict period, has precluded the systematic environmental monitoring that would be required to generate such data. In its absence, this study draws on multiple corroborating qualitative sources, independent interviewee testimony, journalistic documentation, grey literature, and regional policy reports, to build an evidence base whose internal consistency across distinct and independently gathered accounts provides a form of triangulation appropriate to the epistemological constraints of the research context. The study explicitly identifies the development of a quantitative evidence base for Tirah as a research priority. Future work should pursue: (1) remote sensing analysis of forest cover change using Landsat or Sentinel-2 imagery for the period 2000–present; (2) participatory biodiversity surveys drawing on community ecological knowledge to guide systematic species inventories; (3) hydrological monitoring of the Mastura, Khurmana, and Khanki river systems; and (4) long-term rainfall and temperature station data to ground-truth the climate observations reported by community members. Such data would not supersede the governance analysis advanced here but would substantially strengthen its empirical foundation and expand its policy traction.

Drivers of Deforestation in Tirah Valley

Political Instability and the Breakdown of Governance

The most significant proximate driver of accelerated deforestation in Tirah has been the collapse of effective governance following the intensification of militant activity after 2000. The Taliban's seizure of the valley and subsequent military operations prompted the mass displacement of the civilian population, with thousands of families leaving their homes for extended periods (Dawn, 2015). These events dismantled the social and institutional infrastructure through which communities had historically governed forest resources. The physical withdrawal of communities from forested areas created conditions in which forests became effectively ungoverned, accessible to commercial timber interests operating without accountability to any community or state authority. Research on conflict-affected forest landscapes demonstrates that governance breakdown is among the most powerful proximate drivers of accelerated deforestation, as the withdrawal of institutional actors removes the collective oversight mechanisms on which sustainable extraction depends (Nackoney et al., 2014). Renewed militant activity in recent years, including the re-emergence of Tehrik-i-Taliban Pakistan, Lashkar-i-Islam, and IS-Khorasan, triggered further displacement orders (Dawn, 2024). Each cycle of displacement extends the period during which forests are ungoverned and accessible to extraction.



GIS map of KPs showing spatial distribution of forest degradation drivers including firewood collection, illegal cutting across the province.

Illegal Logging and Organised Timber Extraction

The governance vacuum created by conflict enabled illegal logging at a scale without historical precedent. The Pakhtunkhwa Bulletin (2022) reported testimony from Tirah residents describing an influential timber mafia conducting operations openly, removing seven to eight truckloads of timber per day with apparent impunity. The Express Tribune (2021) documented a single deforestation event in the Rajgal area in which hundreds of acres were stripped overnight, with timber smuggled directly to Afghanistan. These were not opportunistic acts of subsistence extraction but coordinated commercial operations requiring capital, equipment, transport networks, and protection (Global Financial Integrity, 2015; UNODC, 2016).

Cut timber and felled trees scattered across a hillside, showing evidence of large-scale deforestation in a conifer forest of Tirah.

The analytical distinction between subsistence and commercial extraction is crucial. Local residents' fuelwood collection and small-scale construction timber cutting represent one dimension of forest pressure: diffuse, continuous, and driven by genuine livelihood needs. Commercial timber mafia operations represent an entirely different phenomenon: large-scale, organised, and capable of stripping ecologically significant areas within days. Conflating them in generic enforcement discourse obscures the structural dynamics of the crisis and leads to policy responses misaligned with its actual drivers.

State Incapacity and Alleged Official Complicity

The formal state's limited administrative and enforcement presence in Tirah is a structural product of the region's historically exceptional legal status under the Frontier Crimes Regulations, which kept the area outside the ordinary framework of provincial administration for decades. This structural absence meant that even where forest law nominally applied, the institutional infrastructure required to implement it—trained staff, equipment, local legitimacy, and accountability chains—was effectively non-existent. When the 2018 FATA merger theoretically brought Tirah under KP's provincial forest governance framework, it did not produce a corresponding transfer of functional capacity. The governance gap was therefore not a failure of legislation but a failure of state presence, rooted in long-standing administrative neglect of the former tribal areas. This distinction matters analytically: addressing the deforestation crisis requires not merely enacting stronger laws but building the institutional infrastructure—and community legitimacy—necessary to give those laws operational meaning. The specific ways in which state enforcement has failed in practice, including the checkpoint system and the documented involvement of officials in smuggling networks, are examined in detail in the State Forest Policy section below.

Tribal Disputes and Demographic Pressure

In addition to macro-level drivers of conflict and external extraction, localised intra-community tensions have contributed to forest degradation in specific areas. Disputes over land and resource boundaries between tribal groups, often exacerbated by the disruption of customary tenure arrangements during displacement, have, in some cases, been expressed through targeted tree-felling as a form of assertion or retaliation. Population growth and the erosion of alternative livelihood options have contributed to baseline forest pressure through subsistence extraction. In the absence of a reliable electricity supply, fuelwood collection remains the primary source of domestic energy for most Tirah households. The Government of KP's REDD+ Action Plan (2022) acknowledges that livelihood insecurity is a fundamental driver of forest loss in the province's tribal districts and that sustainable alternative must accompany any conservation strategy.

Traditional Forest Governance: Structure, Logic, and Global Parallels

The Architecture of Qabayili Forest Management

For centuries prior to the disruptions of the post-2000 period, Tirah's forests were managed under a customary governance system embedded within the broader framework of Qabayili (tribal) law. This system was not a discrete environmental regulation scheme but an integrated set of norms, obligations, and institutional mechanisms through which communities articulated and enforced collective rights and responsibilities over forest resources as components of a unified social order. Environmental stewardship was, in this context, inseparable from the social and political organisation of tribal life, a characteristic shared with indigenous governance systems across South and Southeast Asia (Berkes, 2008).

At its operational core, the traditional system functioned through clearly defined rights and duties assigned to different tribal groups and families in relation to specific forest areas. Use rights encompassed specific extraction permissions, timber for construction, fuelwood collection within specified limits, fodder gathering, and explicit prohibitions during ecologically sensitive periods and in designated protected zones. The Jirga provided the institutional forum through which these rules were negotiated collectively, violations were adjudicated, and regulations were updated in response to changing ecological and social conditions. This institutional architecture aligns precisely with Ostrom's (1990) design principles: boundaries were defined, rules were locally adapted, enforcement was effective, and sanctions were graduated.

Social Mechanisms of Compliance and Traditional Ecological Knowledge

The effectiveness of the traditional governance system derived not primarily from coercive enforcement capacity but from the social embeddedness of its norms and the reputational consequences of violation. In closely-knit tribal communities, where social standing, kinship networks, and collective reputation carried substantial material and symbolic value, the costs of violating community forest norms were high. Sanctions for illegal extraction included fines payable to the collective, social ostracism, and reputational damage extending to the violator's lineage, consequences whose gravity was commensurate with the social importance of collective resource maintenance. The effectiveness of such socially-embedded compliance mechanisms in common-pool resource governance has been extensively documented cross-culturally (Baland & Platteau, 1996; Agrawal, 2001). These social mechanisms of compliance operated efficiently and at low cost, producing outcomes that external enforcement systems have subsequently failed to replicate, despite substantially greater formal resources.

Author interviewing local elders on deforestation and indigenous forest knowledge.

Beyond its institutional architecture, the traditional governance system rested on a body of ecological knowledge developed through generations of close observation and accumulated practice. Community members possessed detailed, place-specific understanding of which forest areas were most vulnerable, which species required special

protection, which seasons demanded extraction restrictions, and which management interventions sustained forest health over time. This knowledge, what contemporary scholarship describes as traditional ecological knowledge (TEK),was not codified in formal documents but reproduced through practice, transmitted through apprenticeship, and institutionally enacted through the Jirga's regulatory decisions (Berkes, 2008). The loss of the institutional context in which this knowledge was exercised represents not merely a governance failure but an epistemological impoverishment, a degradation of the community's capacity to understand and steward its own environment.

Comparative Indigenous Systems: Global Parallels and Pakistani Analogues

The institutional logic of Tirah's customary system is not unique; it reflects a broader pattern of indigenous forest governance in South and Southeast Asia with demonstrated empirical effectiveness. Nepal's community forestry user groups (CFUGs) operate on analogous principles: defined user membership, locally adapted rules, Jirga-equivalent community assemblies, and graduated sanction systems. Agrawal and Chhatre's (2006) analysis of 95 Himalayan forest communities found that user groups with greater autonomy and accountability produced significantly better forest outcomes, a finding directly applicable to the Tirah case. In the Philippines, Cordillera indigenous communities practice muyong, a system of privately owned but communally regulated forest patches maintained for water supply, timber, and biodiversity, alongside communal forests governed by tribal law analogous to Qabayili rules (Colchester, 2004). The muyong system demonstrates that indigenous governance can maintain fine-grained, spatially differentiated resource management that formal state systems are unable to replicate. Pakistan's own portfolio of indigenous governance systems provides the most direct comparative evidence. The sheng system in Gilgit-Baltistan (Butz, 1996), the Shamilat commons in KP and Punjab (Gazdar & Mallah, 2013), and the Jirga-based management documented in Swat (Sultan-i-Rome, 2007) all demonstrate that Pakistan's tribal communities possess sophisticated, locally adapted, and historically effective frameworks for governing shared forest resources. The common thread running through these systems is that effectiveness depends not on external technical expertise but on secure tenure, institutional recognition, and the social embeddedness that generates voluntary compliance. These are precisely the conditions that state policy in Tirah has consistently failed to create.

The Erosion of Traditional Institutions

The breakdown of Tirah's traditional governance system was not a sudden event but the culmination of a process of institutional erosion spanning several decades. The progressive expansion of state administrative authority had already begun displacing customary mechanisms before 2000, reducing the Jirga's authority in resource matters and creating ambiguity about the legitimacy of customary sanctions. The conflicts of the post-2000 period accelerated and completed this process: mass displacement removed the social substrate on which the governance system depended, the physical absence of communities from their territories prevented the exercise of collective oversight, and the return of some community members has not been accompanied by the restoration of institutional frameworks that previously gave collective norms their enforceability. Community respondents described this as a condition of disorientation and institutional limbo, uncertain about their authority, their rights, and the appropriate institutional channels through which to exercise protective action.

State Forest Policy: Legislative Framework and Implementation Failures

Legal Instruments and the Governance Gap

Pakistan's formal forest governance framework includes the KP Forest Act, provincial forest rules, and the National Forest Policy of 2015, which nominally emphasises sustainable management and community participation. The 2018 FATA merger extended this framework to the former tribal areas, including Tirah. In principle, these instruments provide a legal basis for forest protection that should apply across the region. In practice, however, the gap between legislative provisions and implementation has been profound. Dawn (2023a) specifically reported that the extension of forest laws to Tirah Valley remains in a state of administrative limbo, with ambiguous regulatory authority, minimal institutional presence, and negligible enforcement capacity. Scott's (1998) analysis of 'high modernist' state development projects is particularly illuminating here. Scott argues that state institutions systematically undervalue local, practical knowledge in favour of standardised,

technically legible solutions, often with catastrophic consequences. Pakistan's forest governance apparatus exemplifies this pattern: it imposes formal regulatory categories on a social and ecological landscape whose complexity far exceeds their representational capacity, while dismissing the accumulated institutional knowledge of communities as informal, unofficial, and therefore illegitimate. The result is a governance system that is technically present but institutionally hollow.

The Checkpoint Paradox and the Legitimacy Deficit

The establishment of forest department checkpoints at Sheenkamar and Takhta Baig in 2018 represented the state's most visible enforcement response to the deforestation crisis. The gap between this symbolic action and actual outcomes was stark. Community testimony, journalistic reporting (Pakhtunkhwa Bulletin, 2022), and the persistent scale of timber extraction documented in subsequent years indicate that the checkpoints have not materially reduced smuggling. The suspension of seven Khyber District forest officials (Dawn, 2023b) and the allegations of departmental involvement in smuggling networks (Tribal News Network, 2023) provide formal confirmation that enforcement failure reflects not resource constraints but structural institutional capture. When enforcement personnel are participants in the criminal networks they nominally police, the institutional premise of checkpoint-based enforcement collapses. These two conditions—state incapacity and official complicity—are not independent failures but mutually reinforcing dimensions of the same systemic breakdown: a governance apparatus that lacks both the capacity to enforce and the integrity to be trusted. This dual diagnosis carries a direct implication for reform. Addressing incapacity alone, through more checkpoints or additional personnel, will not produce conservation outcomes if the problem of complicity is left structurally unresolved. Conversely, accountability reforms without parallel investment in community-based governance capacity will leave enforcement dependent on a state apparatus whose legitimacy with local communities has been fundamentally eroded. Only an integrated approach—one that simultaneously transfers meaningful enforcement authority to communities and institutes independent accountability mechanisms for forest officials—can break this structural deadlock.

Beyond enforcement capacity, state forest governance in Tirah faces a fundamental legitimacy problem rooted in the historical relationship between the Pakistani state and the tribal communities of the former FATA. The formal state has, for most of its history, been experienced by these communities as an instrument of coercion, extraction, and the suppression of customary rights rather than as a provider of services or a partner in resource stewardship (Khan & Ali, 2019). Community respondents expressed widespread scepticism about the state's commitment to their welfare. Rebuilding the trust required for effective co-management will require not rhetorical commitments but demonstrated behavioural change on the part of state institutions, a process that will take years of consistent action to produce.

Ecological and Climate Consequences of Deforestation

Soil Erosion, Hydrological Disruption, and Biodiversity Loss

The removal of forest cover from Tirah's steep slopes has triggered severe soil erosion, fundamentally altering the landscape's capacity to retain moisture, regulate water flow, and support vegetative recovery (Calder, 2007; Bruijnzeel, 2004). Community testimony describes dramatic changes in seasonal river behaviour: increased peak flows and destructive flood episodes during the monsoon, reduced dry-season base flows as shallow groundwater reserves decline, and a proliferation of landslide events on previously stable slopes. These changes damage agricultural land, disrupt water supplies for domestic and irrigation use, and increase physical risks for communities in the valley bottoms. Tirah's forests supported diverse faunal and floral communities, the composition of which is documented in local ecological knowledge, even in the absence of formal scientific survey data. Oral testimony consistently documents marked declines in the abundance and diversity of wildlife since the onset of intensive deforestation, including the disappearance of mammalian and avian species previously regarded as characteristic of the landscape. The Express Tribune (2021) noted that fires and logging in KP's forest areas have decimated habitats without triggering a meaningful response from the Forest Department. Forest biodiversity loss is not merely an ecological concern but has direct implications for ecosystem resilience: diverse forest communities are more resistant to pest outbreaks, disease, and climate perturbations than simplified or degraded forest systems (Cardinale et al., 2012).

Disrupted Precipitation Regimes and Community Climate Vulnerability

Local communities have reported observable changes in precipitation and temperature patterns over the past 15–20 years, which they attribute in part to the loss of forest cover. Sheil and Murdiyarso (2009) demonstrated that forests play an active role in generating precipitation through biotic moisture recycling, canopy evapotranspiration, and the production of biogenic aerosols that serve as cloud condensation nuclei. Deforestation disrupts these processes, reducing atmospheric moisture recycling and potentially altering precipitation patterns across the wider landscape. In mountainous settings such as Tirah, where orographic precipitation processes are dominant, forest loss can amplify temperature extremes, reduce cloud formation, and shift the seasonal timing of precipitation. The most powerful evidence came from Fareed Afridi, an octogenarian elder, who described the change in snowfall patterns with quantitative precision: snowfall once measured in meters is now measured in inches, and rainfall has declined substantially over the past 15–20 years (Fareed Afridi, personal communication, 2025). The cumulative ecological consequences of deforestation have substantially increased the climate vulnerability of Tirah's communities. Water insecurity, heightened landslide and flood risk, declining agricultural productivity on eroded soils, and the loss of non-timber forest product access represent direct material losses that fall most heavily on the communities least capable of adapting through market substitution or geographic mobility. Environmental degradation thus intensifies pre-existing inequalities, compounding the costs of political and economic marginalisation with the additional burden of ecological impoverishment.

Emerging Health and Economic Consequences

Among the most alarming consequences reported by community members is the emergence of disease patterns previously unknown or rare in the valley; interviewees described the appearance of skin diseases, respiratory ailments, and gastrointestinal illnesses at frequencies and in seasons that have no precedent in their living memory (Fareed Afridi, personal communication, 2025). The mechanisms linking deforestation to emerging disease burdens are multiple and well-documented: intact forest ecosystems regulate populations of disease-carrying insects through predator–prey dynamics and microclimate regulation, whereas deforestation creates warm, stagnant water pools and fragmented habitat edges that favour mosquito and tick proliferation (Patz et al., 2004). Water quality degradation associated with deforestation provides an additional pathway to disease, with increased sediment loading and reduced dilution capacity creating conditions conducive to waterborne illness (Townsend et al., 2011).

The economic consequences are equally severe and interconnected. Community testimony describes crops failing in seasons when rainfall was expected but did not arrive, or being destroyed by flash floods, the frequency of which has increased markedly as deforested slopes shed water rather than absorbing it. Multiple respondents described reductions in livestock herd sizes attributable to the disappearance of grazing pasture, the drying of streams, and the loss of forest-derived fodder and medicinal plants. The Government of KP's REDD+ Action Plan (2022) identifies ecosystem services provided by KP's forests, including watershed protection, soil stabilisation, and climate regulation, as having substantial economic value that is systematically omitted from conventional accounting frameworks. The degradation of these services in Tirah represents an economic loss that does not appear in formal indicators but is acutely experienced at the household level.

Field Testimonies: Local Voices on Deforestation and Governance

Community-Led Forest Protection and Institutional Capacity from Below

Ali Marjan, a resident of Maidan Valley, described the functioning of a locally constituted committee established specifically for forest protection (Ali Marjan, personal communication, 2025). The committee had formalised its mandate in a written document comprising 18 operational points, articulating principles and procedures for forest protection drawn from local ecological knowledge and customary governance practice. The document's existenceand positive reception when reviewed by a visiting Khyber District forest officer demonstrate that local communities not only possess the motivation to protect their forests but also the organisational capacity to articulate that protection in systematic and formally communicable terms. Marjan also described a direct confrontation with security forces who were felling trees for fuel, a practice he challenged by pointing out that

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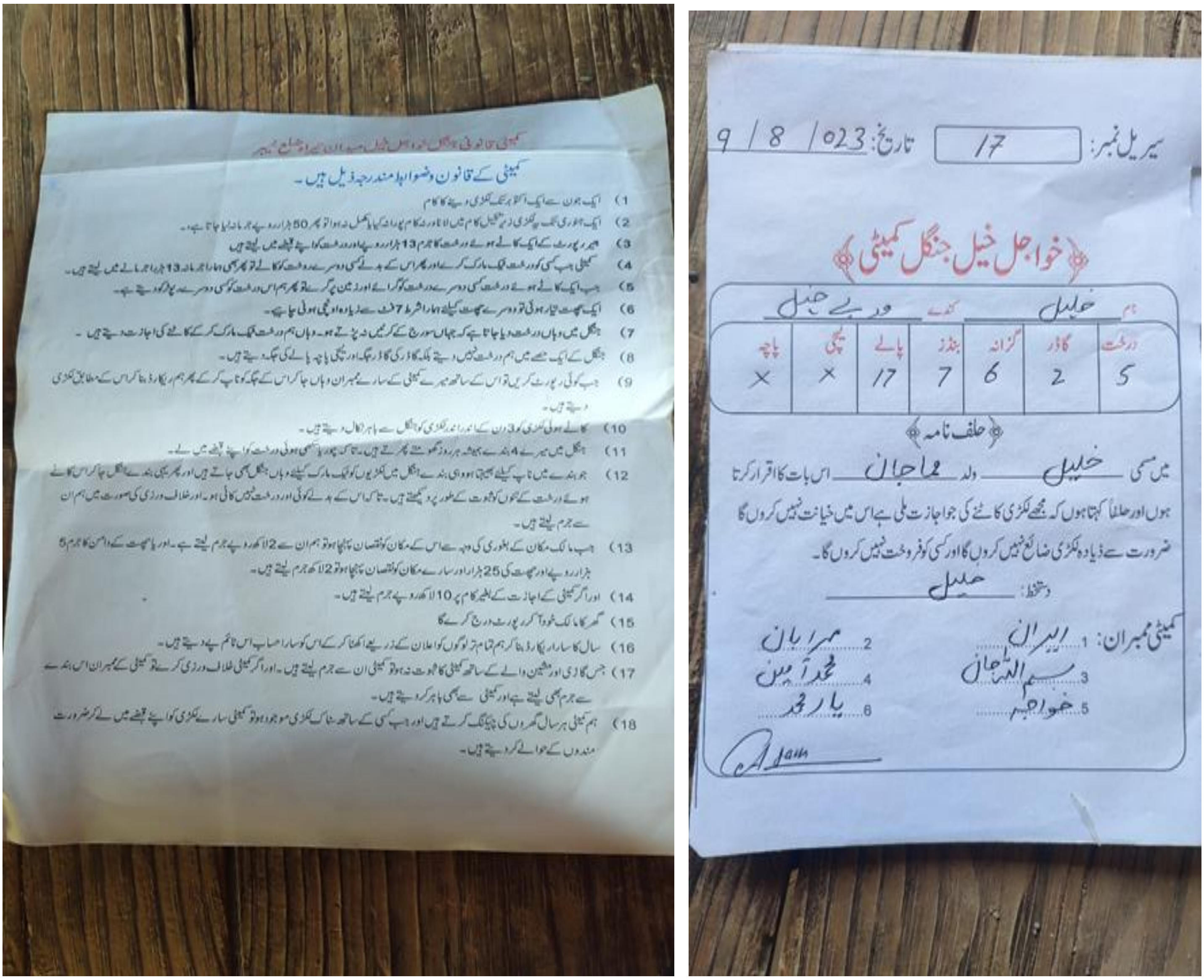
the forces were already supplied with gas cylinders and therefore had no operational justification for timber cutting. He described his commitment to forest protection in explicitly religious terms, framing stewardship of natural resources as a sacred duty, an understanding consistent with Islamic principles.



A wood-cutting permit and accompanying rulebook issued by the Khwajal Khail Jungle Committee, representing a local community-based forest governance system with 18 formal regulations governing cutting seasons, timber quotas, and fines.

State Complicity and the Erosion of Community Trust

Shanawaz, an elder from Meraban Kalay, made the allegation of state complicity explicit at a public press conference, stating that the state institutions nominally in control of the region (Shanawaz, personal communication, 2025) support the timber mafia operating in the area. This assertion aligns with the formal findings that led to the suspension of seven Khyber forest officials (Dawn, 2023b). A testimony from a young resident of the Rajgal area illustrates the demoralising consequences of this complicity: acting on a directive from the local camp commander who had pledged punishment for illegal loggers, community members apprehended individuals engaged in illegal logging and handed them over to the security forces. The following day, the detained individuals were released without any disciplinary action. This sequence, community mobilisation, cooperation with official authority, and then betrayal through official inaction, captures in miniature the dynamic that has systematically eroded community trust in state enforcement across the region. Shanawaz articulated the broader institutional paralysis with striking clarity: the region exists in a limbo-like condition between local authority and government jurisdiction, in which neither party has a clear or operational

mandate, and communities are consequently immobilised with respect to formal enforcement. Yet, his conclusion was unambiguous: if communities were formally empowered and legally authorised to protect their forests, they would do so with their lives. This statement reflects not rhetorical excess but the depth of the connection between forest stewardship and community identity in Tirah's cultural tradition.

Historical Memory and Comparative Governance Assessment

Idrees Afridi's testimony provides a temporal bridge between the period of effective community-based governance and the present crisis (Idrees Afridi, personal communication, 2025). Having worked with a community organisation that actively managed and protected forests approximately two decades ago, he described the organisation's enforcement of customary rules against commercial timber extraction without community authorisation, conducting, in practical terms, the kind of locally legitimate, institutionally grounded regulation that formal governance systems have since failed to sustain. He also explicitly connected deforestation to observable ecological consequences, including accelerated soil erosion and broader environmental change. Sanaullah Afridi offered the most analytically comprehensive assessment, providing a multi-causal account of the deforestation crisis that closely maps onto the framework developed in this paper (Sanaullah Afridi, personal communication, 2025). He identified the primary drivers as illegal timber smuggling, fuelwood and construction timber cutting, absent government oversight, corruption, and security disruptions. Regarding the state response, he characterised existing measures as fundamentally insufficient: limited in scope, inconsistent in application, and lacking in transparency. His vision for effective engagement, characterised by community partnership, transparency, and sustained institutional commitment, aligns precisely with the governance framework recommended by this paper's analysis.

CONCLUSION AND POLICY RECOMMENDATIONS

This paper examined the drivers, governance dimensions, and ecological consequences of deforestation in the Tirah Valley across three interconnected analytical levels: the historical architecture of indigenous forest governance and its displacement; the structural failures of state forest policy and the problem of official complicity; and the tangible ecological and climatic consequences documented through community testimony and supported by scientific literature. The evidence assembled points toward a clear and convergent conclusion: the deforestation crisis in Tirah is not primarily a technical problem of inadequate enforcement resources or legislative gaps, but a governance crisis rooted in the systematic marginalisation of locally legitimate institutions by a state apparatus that has neither the capacity nor the demonstrated will to replace their functions.

The traditional governance system that maintained Tirah's forests across centuries was not an archaic relic but a sophisticated, locally adapted, and socially embedded institutional arrangement capable of effective enforcement, adaptive management, and community-wide compliance. Its destruction through the combined forces of conflict, displacement, and state administrative encroachment has created a governance vacuum that commercial timber interests have exploited with devastating consequences. Comparative evidence from Nepal, the Philippines, and Pakistan's own highland systems confirms that community-based governance, when formally recognised and supported by appropriate institutions, consistently outperforms state-centric management in both conservation and livelihood outcomes.

The implications for policy are both specific and urgent. This paper advances six interconnected policy recommendations grounded in empirical evidence assembled from field testimony, comparative institutional analysis, and the scientific literature.

Forest governance frameworks for Tirah and the broader post-merger tribal districts must explicitly incorporate and formally recognise traditional governance institutions, including the Jirga and customary resource rights, rather than displacing them with state bureaucratic structures that lack local legitimacy. The extension of forest laws to Tirah, currently mired in administrative limbo, must be designed from the outset as a framework for community-state co-management rather than as the imposition of external regulatory authority. Drawing on the comparative models of Nepal's Community Forestry Act and the Philippines' Ancestral Domain framework, Pakistan should develop a legal instrument that grants indigenous governance bodies formal standing in resource management decisions, recognises customary tenure rights, and establishes accountability mechanisms for

community governance institutions. The Ancestral Domain framework is particularly instructive: it grants indigenous communities legal title to their traditional territories, recognises indigenous governance as a legitimate management authority, and has produced measurable conservation outcomes in communities with secure tenure. Concretely, a Tirah Community Forest Co-Management Framework should establish the following institutional arrangements: (1) formal recognition of Jirga-based forest committees as co-management authorities with legally binding decision-making powers over their territories; (2) demarcation and legal registration of community forest boundaries, drawing on TEK mapping conducted jointly by community members and forest department technical staff; (3) negotiated and legally encoded extraction quotas and seasonal prohibitions reflecting Qabayili custom, ratified by community assemblies and registered with the provincial forest authority; (4) a revenue-sharing mechanism under which any timber permits issued within community territories generate direct payments to community forest funds; and (5) a five-year transition period during which state forest department officers serve in a technical advisory rather than regulatory authority role, with management authority progressively transferred to recognised community institutions as their governance capacity is demonstrated.

The systemic problem of official complicity in timber smuggling must be addressed as a governance priority rather than treated as an incidental failure of individual officials. The suspension of forest officials in Khyber and the persistent allegations of departmental involvement in smuggling networks indicate a pattern of institutional capture that requires structural remediation. Drawing on the evidence that community-based monitoring is typically more effective and lower-cost than bureaucratic oversight, enforcement credibility must be rebuilt through the following concrete mechanisms: (1) establishment of an independent Forest Crimes Investigation Unit specifically covering the merged districts, reporting directly to the provincial Anti-Corruption Establishment rather than to the forest department hierarchy; (2) mandatory quarterly public disclosure of all timber permits issued, checkpoints staffed, cases investigated, and disciplinary actions taken in Tirah and adjacent districts; (3) formal empowerment of community forest committees to document, photograph, and report violations through a protected whistleblower channel, with legal protections for community monitors who report official misconduct; (4) GPS-tracked vehicle monitoring for all forest department vehicles operating in Tirah, with data accessible to both provincial oversight bodies and community representatives; and (5) rotation of forest department personnel between districts every two years to prevent the entrenchment of local patronage networks that facilitate institutional capture.

State forest management plans for Tirah must formally incorporate traditional ecological knowledge as substantively equivalent in authority to scientific forest management expertise. This requires a systematic process of TEK documentation in collaboration with community knowledge holders, the development of hybrid management protocols that translate customary ecological rules into formally applicable management guidelines, and the recognition of elder community members as legitimate technical advisors in forest management decisions. Pakistan's own experience with sheng governance in Gilgit-Baltistan and shamilat management in KP demonstrates that the institutional knowledge required exists and can be accessed if governance frameworks create space for it. The material conditions that drive subsistence-level forest extraction, energy poverty, livelihood insecurity, and the absence of alternative income sources must be addressed as integral components of any conservation framework. Specific interventions include gas cylinder provision for households currently dependent on fuelwood, subsidised solar energy systems for remote communities without grid access, support for sustainable non-timber forest product enterprises (medicinal plants, honey, and fruit), and community-managed ecotourism in a valley described consistently as possessing extraordinary natural beauty. KP's REDD+ Action Plan acknowledges these priorities in principle; the challenge is to implement them at scale in a region whose governance infrastructure is still being reconstructed after decades of conflict.

The health and economic consequences of deforestation-driven climate change documented in this study demand recognition as a distinct and urgent policy domain. Field testimony reveals that the communities of Tirah are experiencing the emergence of previously unknown diseases, contamination of water sources, and cascading agricultural and pastoral losses that are eroding household economies across the valley. A cross-sectoral response, integrating forest restoration, agricultural support, clean water provision, and primary healthcare, is required to address the human costs of environmental degradation alongside their ecological causes. Pakistan's National Adaptation Plan should explicitly address the forest health nexus documented in highland communities, with Tirah designated as a priority intervention area for integrated environmental health programming.

A phased native species reforestation program, designed and implemented under community governance authority, is required to begin reversing the ecological damage of the past two decades. Drawing on the evidence from Nepal's successful reforestation under community forest management, where forest cover increased by an estimated 2.7% between 1992 and 2016 in community forest areas (Paudel et al., 2019), a community-governed reforestation program in Tirah should prioritise native conifer and broadleaf species, employ community members as forest guards and nursery operators, establish community-controlled seed banks drawing on TEK of local forest composition, and link reforestation targets to formal recognition of community tenure rights. The forests of Tirah are the ecological and cultural foundation of a society that has maintained them for generations through institutional ingenuity, communal commitment, and accumulated ecological knowledge. This knowledge persists in the memory and moral frameworks of the communities whose testimony informs this paper. What is required is not the invention of new governance solutions but the political will to recognise and empower the governance capacity that already exists. The lessons of Tirah carry significance that extends well beyond a single highland valley in northwestern Pakistan. They speak directly to one of the most consequential debates in contemporary global environmental governance: whether indigenous and community-based forest stewardship systems should be recognised as legally protected pillars of climate and biodiversity strategy, or whether they will continue to be treated as informal arrangements subordinate to state authority. The growing international consensus—reflected in Target 22 of the Kunming-Montreal Global Biodiversity Framework (CBD, 2022), which commits signatories to recognising the rights and stewardship roles of indigenous peoples, and in the IPCC's Sixth Assessment Report (IPCC, 2022), which identifies secure indigenous land tenure as among the most effective and cost-efficient climate mitigation and adaptation strategies available—strongly supports the former position. Tirah illustrates in unusually stark terms what is lost when this principle is violated: the destruction of a centuries-old governance system, the collapse of forest cover, and the deepening climate vulnerability of communities who bear no responsibility for the failures that produced their predicament. If the governance reforms advanced in this paper are realised, the valley could yet become something different: a documented case of highland forest recovery under community stewardship, a replicable model for the post-merger tribal districts of KP, and a contribution to the global evidence base demonstrating that indigenous governance, when legally empowered and institutionally supported, is not merely a cultural value to be preserved but an environmental necessity to be acted upon.

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