
Tribal Knowledge and Climate Change Adaptation: A Case Study of the Tangkhul Nagas

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This article critically engages with the dichotomy of modern climate science and tribal understandings of climate change. Based on qualitative fieldwork, I consider how the traditional knowledge system of Tangkhul Nagas reflect indigenous know about and adaptation to climate change in the domains of agricultural practices and landscape management. This article reflects on the opportunities and challenges in the co-production of knowledge. I propose bridging forms of knowledge and incorporating the roles of traditional institutions in government climate change policymaking. State interventions must not undermine tribal sovereignty over their ecological resources and customary land rights in order to preserve the integrity and self-determination of unique tribal ecologies.

Key Words: adaptation, climate change, knowledge systems, local institutions, tribal knowledge

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Introduction and Background of the Study

The Intergovernmental Panel for Climate Change (IPCC) (2014) defines climate change adaptation as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities”. Conversely, the indigenous and tribal communities, usually the marginalised section of people, are among the most vulnerable communities to increasing climate change impacts due to historical marginalisation, sensitive biogeographical locations and the close intricacies of livelihoods with the ecological systems (IPCC 2014). Tribals, or largely indigenous communities, are affected as climate change unfolds several ecological crises

(Abate and Kronk, 2013; Shaffril et al., 2020; Filho et al., 2021), yet, indigenous communities have, in the past and present, shown credible adaptability and resilience capacity to change through their knowledge and information on local-level environmental change and climate variability; the proximity of livelihoods and ways of life to natural systems leading to a better understanding of adaptive ways (Berkes et al., 2000; Ramos et al., 2017; Daigle et al., 2019; IWGIA 2023).

Thus, to understand and streamline climate change adaptation in the context of tribes, the concept and ontology of ‘tribal ecology’ must be intentionally mainstreamed through the intersection of traditional ecological knowledge systems, land and resource governance and traditional institutions in the state’s adaptation intervention policies and programmes. While indigenous, traditional, or local knowledge are terms used to describe the specific knowledge and skills of a particular group or culture (Berkes et al., 2000), it has a strong foundation in the age-old tribal ways of managing land and natural resources and diverse agro-ecologies and local governance (Xaxa, 2008), which are crucial components for enabling effective adaptation to climate change. Moreover, this knowledge system is assimilated with the local community's cultural traditions, beliefs, values and worldviews (AIPP, IWGIA, & SDC 2012). A significant factor in many communities' ability to adapt to climate change and establish resilience to climate extremes is the local understanding of its environment and seasonality, founded on indigenous or traditional ecological knowledge (Salick and Byg 2007; Whyte 2018). It iterates from living together in harmony with nature for ages by deriving everyday chores through agricultural livelihoods and community engagement with the eco-cultural systems (Shimray, 2012). This also corroborates the establishment of tribes exerting their identity through ecology and nature-human relationship in shaping the discourse of ‘tribal ecology’ (Bodhi and Ziipao, 2019).

In the dichotomy of modern climate science primarily based on empirical evidence and traditional understanding of climate change, usually based on the holistic interpretation of ecological processes and observational narratives (Shaffril, 2020), existing climate policies at national and local scales are mostly confounded on the former. This has led to the inappropriate formulation of climate adaptation policies and ineffective climate strategies, especially among the indigenous and tribal communities. However, recent literature has recorded the perception of climate change by indigenous communities over recent times through observed anomalies in climate parameters such as increased warming, erratic monsoons, and extreme events, along with ecological indicators and biomarkers (Ishaya & Abaye, 2008;

Varah & Varah, 2022). This perceived knowledge of changing environment, climate, and traditional ecological knowledge is crucial in formulating and co-producing a ‘new knowledge system’ by bridging traditional knowledge system and modern scientific knowledge. The new knowledge system may direct adaptation intervention programs which address contemporary climate issues without undermining tribal sovereignty over their ecological resources and customary land rights. This is imperative to keep the integrity and self-deterministic components of ‘tribal ecology’, which is the claim of the right to uphold a tribal way of life and have autonomy or control over land and resources (Karlson, 2001; Hill et al., 2020).

However, bridging these two knowledge systems has sometimes been challenging as different channels and stakeholders are required to facilitate the whole process, and the interplay of institutions is one of the most crucial factors. The role of local institutions in effective climate adaptation is well established as local institutions directly connect with local communities and are mechanisms for different knowledge systems (Agarwal et al., 2012; Tiwari et al., 2013). Moreover, climate change impacts are locally experienced; hence they must be locally addressed, and institutional decentralisation for climate policy and diversification of responsibilities is crucial (Berkes, 2009; Agarwal et al., 2012; Dubash, 2016). Guston’s conception of ‘boundary organisations’ as specific organisational efforts to mediate between science and policy (2001), is significantly relevant in this study. The concept has been increasingly used in studies of environmental governance and bridging knowledge systems (Berkes, 2009; Gustafsson and Lidskog, 2018) while also gaining popularity in climate change adaptation governance (Hoppe et al., 2017). As the efforts for climate change adaptation is contextual and localised, local institutions play important role in implementation of adaptation measures. Therefore, in a tribal society or community, local institutions could act as ‘boundary organisations’ which is a medium or conduit for connecting various stakeholders, state and non- state, involved in climate change adaptation efforts. This can happen through dissemination of information and in the long run, exchange of different knowledge systems. There is also a need for frequent consultation processes between stakeholders for formulation of important policies and implementation of climate measures. In most tribal societies, local institutions have direct contact with the local communities by bringing the mandates of common people into governance hence, these institutions can serve as a boundary organisation.

As tribal knowledge systems and their transmission are epistemologically and structurally related to tribal/indigenous governance, it is crucial to take along local institutions such as the Village Authority (VA) and local social groups or civil society organisations as essential stakeholders in mainstream climate adaptation planning. In the context of Tangkhul Nagas, Village Authority (VA hereon) or the 'Hangva' is the first or lowest form of government at the village level, which is constitutionalised under the Manipur (Village Authorities in Hill Areas) Act, 1956 in Manipur, a Northeastern state of India. It is constitutionally distinctive in its nature of governance based on the principles of recognition and subsidiarity and not decentralisation per se (Khobung 2012). The VA has jurisdiction over land and resource management and governance in the tribal areas (Ruivah 1987). However, in India, the state climate adaptation measures are delivered through the framework of actions called as the State Action Plan for Climate Change (SAPCC) and mainly through formal institutions such as the government line departments and various consultation partners. The adaptation strategies are scaled so interventions are planned sector-wise and overlap considerably with state development policies and programs. However, the existing institutional framework for adaptation to climate change gives narrow importance to the local institutions, limiting the local community's role, specifically the tribal community, in planning and implementation. This also reflects the tribal communities' contestation on the nature of developmentalism with the state in most peripheries of Northeast India, which is essential and foundational in the discussion of 'tribal ecology'. Moreover, the already non-effective developmental strategies and adaptation interventions designed and introduced mostly based on reductionistic scientific knowledge do not work and are inefficient primarily in tribal regions. In these plans, formulating various actionable strategies for adaptation and mitigation happens at the top-down approach, lacking contextual problem-solving and ineffective intervention programs. However, there are challenges in the process of knowledge co-production; firstly, if not cautious, it could lead to an 'extractive knowledge production' (Klenk et al. 2017) where combat traditional or local knowledge is interpreted separately from its context and space.

Another is the changing opinion on traditional knowledge due to external factors such as education, technology and modernity, especially among the younger generations (Tang & Gavin, 2016). Various literature has recorded the declining trend of knowledge and practice of traditional ecological knowledge from older to younger age groups (Ripert, 2002; Yuan et al., 2014). For example, among Gaddis

in Himachal there is declining youth interest in pastoralism (Christopher and Phillimore 2023) and intertribal debate about which communities ‘count’ as Scheduled Tribe (Christopher 2020). Moreover, climate change is already disrupting the ecological balance on which traditional ecological knowledge is mainly based, making the knowledge unreliable and confusing in many circumstances. Another huge challenge in the co-production of knowledge systems is the lack of an effective and robust institutional framework to include traditional institutions as stakeholders in climate policy formulation. Finally, the complex political ecology of the state, such as Manipur about land resources, stemming from the hangover of colonial history even though India is a ‘postcolonial state’ plays a role in the power struggle of different entities in the tribal lands (Bodhi 2013; Xaxa 2016; Kikon 2006). As a result, a great hindrance in the assimilation and co-production of different knowledge systems.

A case of the Tangkhul Naga tribe native to the Northeastern Himalayan state of Manipur has been chosen to analyse the opportunities and challenges of knowledge co- production and understand how local institutions can play a role in bridging traditional and modern scientific knowledge systems. The Tangkhul Naga tribes are an ethnic sub-tribe deeply engaged in agriculture and forests dependent for livelihood; hence the perception of climate change by the community is also explored. Moreover, the ‘village republic’ local governance among the Tangkhul community is subject to the Village Authority. Also, the institutional framework is governed by traditional customs, laws and practices and closely tied with other local groups and informal civil society organisations, which plays a channelling role in bridging knowledge systems. Moreover, the land use/land holding systems through the intersections of agriculture and livelihood, forestry, and biodiversity management are still primarily based on the traditional and customary laws to this day (Kamei 2008). This forms the foundation and repository of the rich traditional ecological knowledge of the community. The study also focuses on the Tangkhul tribal understanding and perception of climate change through narratives and the role of VAs/ Hangva and other social organisations in knowledge co-production through land management and agricultural systems. Then finally, it discusses the different challenges in the co-production of knowledge.

Study area and methods

The Nagas are native ethnic groups residing in northeastern India and northwestern Myanmar. The Tangkhuls are one of the sub-tribes of the Nagas,

majorly inhabiting the state Manipur, situated on the Indo-Myanmar border, a biodiversity hotspot. The state's inhabitants are broadly classified into the 'valley people' and 'hill people' or the tribals. In total, 34 tribes are recognised by the government as 'Scheduled Tribes' in Manipur, of which the Tangkhuls are a significant sub-tribe. While the valley inhabitants, referred to as Meiteis or Manipuris, live in the state's valley region state, and the tribals inhabit the hills. The socio-ecological order from land management, land use and agricultural systems and institutional arrangements of the hills and valley areas are very distinct. The Tangkhuls are a profoundly agrarian community and socio-politically a 'republic of villages' governed and managed by the VA (Shimray 2007). The tribal people control the land and resources through the different constitutional rights given to the tribals via the Village Authority Act of 1957 and the Forest Rights Act of 2006. The sovereignty over land usage in the tribal area is also determined by the exclusion of the hill areas from the land revenue act of the state vis-à-vis the Manipur Land Revenue and Land Reforms Act of 1960 (MLRLR). Since, the state has had a complex and tumultuous socio-political history based on 'territorial politics' between the valley and the hill inhabitants, which continues to the present (Kipgen 2018).

A qualitative ethnographic approach has been adopted as the broad methodology using the method of a case study of the Tangkhul Naga tribe. For the secondary data and policy analysis, a literature review was done from published government documents, policy documents and peer-reviewed journals on the subject of interest. The methods of participant observation, key-informant interviews and focus group discussions were employed for primary data collection. The data collection was done from October 2020 to September 2021. A total of three focus group discussions with the Village Authorities (5 members each) were done in East Tasom village in the southeastern region to represent the shifting cultivation community and other two in Chingjaroi Khullen and Phungcham village in the northern region to represent the settled wet paddy farmers community. While another interview with the headman of Shungri village was also done. To capture the perception of climate change by the community in detail, in-depth personal interviews with 14 farmers, 6 females and 8 males were held in the same two villages. All the farmers have had farming experience for more than 15 years. Moreover, two in-depth interviews were conducted with representative figures from civil society organisations, Tangkhul Wungnao Long, the village chief's

association, and Tangkhul Shanao Long, the representative women's association of the Tangkhul tribe.

The Tangkhul tribe practices shifting cultivation and settled paddy farming as primary agricultural practices. Hence, the site selection for the focus group discussions, key informant interviews and participant observations were made so that the data represent communities of both agricultural systems. The study's results and discussions are drawn from the primary findings with the support of secondary literature. Moreover, the theoretical arguments of the case study are supported by literature from similar studies done across indigenous communities. A considerable portion of the analysis is also based on participant observation, as the researcher's positionality is in close cultural proximity to the tribe under study.

Findings and Discussions

1. Tribal Knowledge Systems and Climate Change Adaptation a Context from the Tangkhul Naga Tribe

The IPCC defines climate change adaptation in human systems as 'the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities' and in natural systems as 'the process of adjustment to actual climate and its effects' (2022). In a shorter period, Nelson, Adger, and Brown (2007) defined adaptation as the set of decision-making processes and activities taken to address disturbances of social- ecological systems while protecting future alternatives. Even though climate change is a global phenomenon, its impacts are pervaded cross-scale and felt local; hence local knowledge systems are crucial for effective adaptation processes. Adaptation has evolved as a discourse distinguished by the imperative need to incorporate various knowledge systems in formulating adaptation policies (Klenk et al., 2017). In the process of adaptation, starting from an understanding of the ecosystem; then assessment and mapping of resources; identification of adaptation options; planning and implementation of actions till the monitoring and evaluation stage, the involvement of community knowledge leads to contextual adaptation for placed-based tribal societies (Berkes, 2009; Hill et al., 2020). Several studies have shown that disregarding the traditional ecological knowledge systems in adaptation efforts has led to poor planning and implementation of climate adaptation strategies resulting in structural and institutional maladaptation (Whyte, 2018 and 2020,) creating more risk and vulnerability to climate change impacts. As Haraway (1988) also puts it, "situated knowledge" or place-based knowledge is required for

defining local pathways and mobilisation of adaptation measures in the contextual delivery of climate change adaptation governance (IPCC 2014; Mekonnen et al. 2021).

The production and assimilation of traditional ecological knowledge in tribal communities are manifested and transferred through the intersection of land and water management, biodiversity conservation, traditional irrigation systems, and land reclamation (Shimrah, 2017), crop diversity knowledge at different elevations, and various other ways of life. Moreover, adaptation to the changing climate in a tribal ecological setting results as a natural response to any ecological change driven by the tribal ways of life mostly revolving around farming and gathering, livelihood approaches and socio-cultural constructs entailing social relations, institutions and local networks. Hence, recognising traditional ecological knowledge is vital for climate change adaptation. Most often, local adaptation efforts stem through two primary premises- as a community/individual response to the perceived change in climatic factors and subsequent environmental anomalies within the ecological realm and through resource management and local resource governance; another is at public scale through government adaptation intervention programs and action plans (IPCC, 2014).

Indigenous and tribal communities, although affected by climate change impacts, have shown resilience and adaptation on the foundation of indigenous or traditional knowledge through community-based disaster risk reduction (Taiban et al., 2020), agricultural practices and traditional resource governance (Salick and Byg 2007; Klenk 2017). The Tangkhul Naga tribe is an agrarian tribal community, with most of the population depending on agriculture and allied activities for their livelihood. Hence the impacts of climate change are experienced in the everyday lives of the community, especially the farmers. The community practices two agricultural systems- terraced wet paddy and jhum cultivation. It is important to note here that for the Tangkhul community, agriculture entails much more than food production. However, it is a tribal way of life because of several societal relationships and kinships; cultural values and practices, like festivals, rituals, and traditions, revolve around the annual agricultural calendar. One such important example is that every cycle of agriculture is marked by festivals such as the 'Luirā Phanit', the seed sowing festival and 'Mangkhap Phanit', marking the completion of ploughing and transplantation of rice.

Various studies also have documented that the Tangkhul tribe or the community has evolved with rich traditional ecological knowledge within its agricultural ecosystem and natural resource management regime (Shimray 2012; Shimrah 2017; Varah & Varah 2021). A few examples of traditional knowledge practised among the Tangkhul tribes are understanding of crop diversity in different elevations, knowledge of various uses of medicinal herbs and the traditional fire management system in the jhum cultivation. The fire management technique has worked for so many years as jhum cultivation involves clearing forests and is explained through the community's topographical understanding of forest and wind patterns at the landscape level. This traditional knowledge and practices have sustained the community in the face of ecological changes in the past and remain crucial for climate change adaptation.

Shimrah's (2017) study also puts five approaches through which the Tangkhul community adapt to climate change – biological, institutional, technological, policy and ecosystem approaches. While in the following section, the argument will detail the discussion by including how the community and farmers perceive climate change based on traditional ecological knowledge and biomarkers. It will also discuss the knowledge of tribal governance over natural resources and its importance in climate change adaptation.

1.1 Perception of Climate Change, Climate Adaptation and Traditional Knowledge Systems

Climate change is usually understood in anomalies of climate parameters such as temperature and rainfall and frequent climate extremes (deviation from the normal) such as droughts, flash floods, heat waves, etc. (IPCC, 2012). These changes are documented to be well observed by local communities worldwide, especially those engaged in agricultural activities or whose livelihood depends on the natural systems. There is a rich literature on tribal and indigenous communities which have perceived and responded to these changes over the temporal and spatial scale (Rahman and Alam 2016; Yang et al. 2019; Negi et al. 2021; Varah and Varah 2021; Bhalerao et al. 2021). Likewise, the Tangkhul community, also a place-based tribal community, perceives changes in the environment of any form, either ecological or climate change, in terms of shifts and anomalies away from everyday observations and understandings of nature. This perception of change is a 'knowledge of change' culminated over ages from the community's close relationship with its ecosystems through agricultural engagement. Other livelihood

activities include gathering firewood for individual consumption and charcoal trade, foraging wild vegetables and herbs, and river fishing, a significant economic activity of the Tangkhul tribe.

Through the focus group discussions and in-depth interviews, it was found that climate change in the region is perceived through changes like the nature of rainfall and temperature- shifts of monsoon timing and unusual temperature patterns across seasons. Moreover, the impacts of these changes were also recorded through observed ecological changes and narratives using bioindicators and ecological jargon, of which the detail is recorded in Table 1.

Table 1 Narrative perception of climate change cited by respondents

Themes	Narrative quotes
Change in temperature	<p><i>“.... summers have become harsh. There are many days when it is too hot to work past 11 am in the field. So, now we work in the mornings and evenings”.</i></p> <p><i>“.... earlier March-April were the hottest times of the year, but nowadays, even in between monsoon seasons, the days are so hot....”.</i></p> <p><i>“.... getting heatstroke was uncommon in the past, but now we must be careful when working in the fields”.</i></p>
Rainfall anomalies	<p><i>“.... I remember how June and July used to be when we were young, there were many days filled with fog and mist, and we did not even see the sun for days, but it did not rain as much in the past 5-6 years.”</i></p> <p><i>“.... seasonal rain like the autumn/winter rain (Maherram*) has also changed, which is crucial for staple crops like rice. Now we cannot predict this rain anymore either it does not come at all or at odd times.”</i></p>
Ecological indicators	<p><i>“.....pests very commonly infest rice and corn we do not even know the name of”.</i></p> <p><i>“..... indigenous cherry trees and Kapaiwon* are flowering much sooner than they used to”. “.... many wildflowers are giving flowers in unmatched season.”</i></p> <p><i>“..... fruits which grew only in warmer places are thriving in my village example, oranges did not bear fruit 7-8 years ago, but they are now giving good, sweet fruits....”.</i></p> <p><i>“.....it is so surprising that leeches have been appearing in my field for the past 4-</i></p>

Source: Author (collected from fieldwork)

While these perceived understandings of climate change are not necessarily quantified as in the case of climate science domains with measured and numbered evidence, it shows that tribal communities perceive climate change through their traditional ecological knowledge and is marked and interpreted through the jargon and lived narratives. This knowledge is indispensable for enhancing the contextual

adaptation process and place-based implementation of adaptation efforts. The tribal community also has good spatial information and knowledge about their ecological space, features, and shifts brought upon by climate change through observations and lived experiences as elucidated in detail in the above table. Furthermore, the community at individual or household level are adapting to these changes by adaptation measures such as changing the time of sowing and planting depending on the arrival of monsoon. Out of 14 farmers interviewed, eight said they had changed the timing of rice transplantation by adjusting to the arrival of monsoon; as a farmer recalls, “Usually, we transplant our rice saplings in a paddy field from the end of May till the end of June. But, for 5-6 years now, we are even transplanting till late July as there is a delay in the onset of monsoon, and this has affected the yield of our rice crop”. Another farmer from East Tasom village opined, “The climate has become so much warmer so now I am planting low altitude crops like pineapple and oranges in my farm. These crops are usually grown in villages nearer to valleys as they are warmer.”

These narratives suggest that the farmers are reactively adapting with their ecological knowledge and in accordance with the understanding and perception of changes in climate parameters. The Tangkhul traditional knowledge system is further elucidated in the following sections by diving into the intersection of agriculture and resource governance through customary laws and management.

1.2 Agricultural Practice, Landscape Management, and Knowledge Systems

The land use and land management system of the Tangkhul tribe is laden with traditional ways, from land use classification to conservation through customary laws and customs. Shimray (2007) broadly categorises the land use systems of Tangkhuls into three: (i) Village Settlement Area, (ii) Community and Clan land, and (iii) Forests area, while according to Ruivah (1987), village land use could be categorised as a (i) Village settlement area, (ii) Woodland, the nearest forest to the village settlement area, (iii) Jhum- area, (iv) Public or village community land, and (v) Sedentary terraced paddy field. This classification of land use systems tailored for each specific purpose results from the evolution of ecological knowledge, which was tested in time and space. As the land use system is deeply related to the agricultural system of the tribe, it is vital to further elaborate on the two broad types of agricultural practices across the study area. The south-eastern territory of the Tangkhul tribe practices jhum or shifting cultivation, whereas the other, north-western territory, practices sedentary terraced paddy plus secondary shifting

cultivation. Hence, the land use practices, management, and ecological knowledge are heterogeneous and rich across the geographical locations.

Shifting cultivation, known as jhum, besides its debatable environmental consensus in mainstream ecological studies, is more than an agricultural system for the Tangkhul tribe, as in the case of East Tasom village. It is a bio-cultural system defining the political ecology of the tribal community since it encompasses cultural and economic livelihood, conservation, and indigenous governance. Moreover, most of the jhum-practicing villages in the eastern territory of the study area still have a jhum cycle of over ten years, which is considered sustainable and ecologically viable in literature across the jhum practicing community of northeast India (Lal, 2005; Datta et al., 2014). The focus group discussions in East Tasom and Shungri villages found that the jhum cycle in most eastern villages has been increasing in the last decade, as shown in the table below.

Table 2 Fallow cycle for four villages in the Southeastern territory of Tangkhul tribe

VILLAGES	JHUM CYCLE
EAST TASOM	13 years
SORDE/SHUNGRI	16 years
NINGCHOU	12 years
NINGTHI	13 years

Jhum cultivation also reflects agriculture as a collective community affair. Every single process of the jhum cycle, starting from the space selection, fire management, and crop timeline, involves community consensus, with every activity withholding specific ecological knowledge. In the study area, within the shifting cultivation landscape, forests and biodiversity conservation also go hand in hand in the form of Community Conserved Areas (CCAs).

The conserved areas in East Tasom and Shungri villages are of different types- 'Uyok', the 'green belt' or the reserved forests circumference surrounding the settlement area (approx. 1.5 sq km), or a specifically conserved and untouched 'Lamtuk', a local connotation for a 'patch' of jhum land with traditional boundaries. Shimrah (2017) refers to this as 'landscape conservation', a widely practised technique where a particular stretch of landscape with ecological significance is conserved and managed as one entity. In addition to cultural reasons, conservation is considered necessary for the undisturbed flow of

ecosystem services from the forests- enhancing the water cycle and rejuvenation processes. In villages like East Tasom and Shungri, one primary purpose for conservation is to protect wildlife and biodiversity locally.

Measures like logging in certain identified areas, such as spring sheds, riverfront, and field boundaries, are prohibited. A complete hillock is sometimes conserved for nesting wildlife by keeping check on hunting, cutting wood, fishing, or even foraging. In areas where sedentary cultivation is practised, conservation occurs mainly in the loosely bounded community land with no specific size but marked by ecological boundaries such as rivulets, streams and rocks, as in the case of Chingjaroi Khullen village. When the secretary of the Shungri Village Authority was asked about the purpose, history and conceptualisation of the conserved areas, he opined.

These conserved areas and their conceptualisation have been in our village since time immemorial. Although there are many challenges on the governance front, we take the act of conservation very seriously. We do not conserve it for any other person but for us, the villagers and as God has blessed us with immense natural resources, it is our duty to protect our forests and land from human greed and destruction. Moreover, the 'Hangva' (Village Authority) and elders who understand and know the village's geography collectively decide the site for conservation. For the village, conservation is part of our agricultural system. By conserving our forests, our cultivable land also rejuvenates in terms of water and soil fertility overall. Since we depend on wildlife for our dietary consumption, conserving some corridors provides a haven for the breeding of wild animals.

These conservation practices are not new to the tribal community. It indicates that the Tangkhul Naga community in the past knew the importance of conserving and safeguarding one's natural resources and believed in nature's regenerative processes. However, in the recent past, non-profit organisations with the locals also do intervention programs to enhance and emulate the practice at a larger scale. As one of the CSO representative of the community said,

The intervention program from North Eastern Regional Community Resource Management Programme for Upland Areas (NERCORMP) through formation of the natural resource management group (NaRMG)

has helped in sustaining the conservation efforts through technical assistance and capacity building in many Tangkhul villages.

Thus, the Tangkhul tribal land management systems and agricultural practices have various knowledge on agro-ecological systems and its governance. In addition, land and forest management practices through the community-conserved areas serve as an agency of ‘nature-based climate solutions’ for mitigation and adaptation to climate change, which is also in accordance with the latest IPCC report (2022), that gives primary focus on ‘nature-based solutions’ for climate actions.

Besides conservation, the traditional agricultural systems also provide premises for various agro-practices regarded as essential climate change adaptation strategies, such as multi-cropping, intercropping and homestead gardening. As several records show, the cropping system in shifting cultivation has a vast genetic pool of food crops and wild vegetables from the fallow land. Table 3 gives the various types of food crops grown in a single plot of jhum land recorded from the field.

Table 3 Types of crops grown in a jhum field

CROP VARIETIES	INDIGENOUS CROPS	NON-INDIGENOUS CROPS
GRAINS	Rice, Corn, Jobstears	Rice and Corns (hybrids or HYVs)
TUBERS	Yam (Pairui)	Potato, Tapioca
PULSES	Indigenous beans (Sentithei, Kazikthei, Leipamthei, Theireithe, Ramreithe, Sheiromthei, Maranthei)	Peas and HYV beans
VEGETABLES	Mustard leaves, cabbage, cucumbers, pumpkins, chilly, guard family (~7 types)	Brinjal, Cauliflower, Tomatoes
HERBS AND SPICES	Coriander, onion, garlic, ginger, yongpa, sari (type of tuls), namrei-namra (leek family), shomri (Naga garlic/Rakkyo onion/Chinese onion)	--

Source: Author (collected from fieldwork)

In villages where settled paddy farming is more dominant, like Chingjaroi Khullen and Phuncham villages, homestead gardening is also as a commonly adopted activity in the study area, plays a vital role in securing the nutritional security of households, thereby, the community and a repository of agro-biodiversity. Overall,

community farmers have a vast knowledge of the indigenous ‘seed systems’ in terms of seed selection, seed storage and exchange, keeping the gene pool of indigenous agro-biodiversity intact.

An important remark here is that with various agents of change and evident factors such as the interplay of land use change, commercialization of crops, market forces and modern technology, transformation in the understanding and interpretation of ecological knowledge systems is inevitable and hence in its practice. However, the scope of the article is to capture the relevance of traditional knowledge systems in tackling climate change impacts, therefore, the more significant focus on it. Furthermore, climate change has and is anticipated to bring new challenges in the near future; henceforth, knowledge of all forms and interventions from various sources is crucial in the climate adaptation process. Moreover, evidence shows that both knowledge systems- traditional/indigenous knowledge and modern scientific knowledge must come together to effectively adapt to climate change without compromising the integrity and the self-deterministic principle of tribal ecology. The self-determination component is crucial as it elucidates protecting tribal rights and interests over their land and tribal sovereignty for control over resource utilization. It is further elaborated on and substantiated in the following section.

2. Bridging of Knowledge Systems and Institutional Role in Climate Change Adaptation

The need for bridging diverse knowledge systems in solving complex problems such as environmental issues and climate change is now an already established typology in commons governance (Armitage et al. 2011; Rathwell et al. 2015). Additionally, successful governance solutions to these issues must confirm the reliability of various knowledge systems in understanding the problems and the tactics employed to deal with their effects (Armitage 2008). In our context, ‘bridging knowledge’, as referred to by many scholars (Reid et al. 2006; Rathwell et al. 2015), means the interface of traditional/indigenous and scientific knowledge systems to co-produce a knowledge system with traditional ecological knowledge as the base and backbone for strengthening modern scientific interventions. In this section, the study tries to analyse the fundamental concepts of bridging knowledge systems and their relevance in adaptation to climate change and establishing traditional tribal institutions as the medium for bridging knowledge systems.

Lemos and Morehouse (2005) define the concept of ‘co-production of knowledge’ as the contribution of numerous knowledge sources and capacities from various

stakeholders spanning the interface of science, policy, and society to co-create knowledge and information to guide environmental decision-making. It is possible only when different knowledge systems are bridged through collaborative research and development within local communities and other mainstream stakeholders. In a tribal setting where traditional knowledge systems play an essential role in the ecological processes and social order, the co-production of a new knowledge system by bridging traditional and modern scientific knowledge systems is very important for adaptation to unprecedented climate impacts. Also, ‘adaptive co-management’, a governance strategy that values scientific and indigenous knowledge's viewpoints on environmental change and stresses power-sharing in resource governance (Armitage et al., 2007; Azhoni et al., 2020), is also imperative to knowledge co-production and climate change adaptation. These theoretical concepts are crucial as they foster connections between traditional partners, in our case, the Village Authorities and other social bodies, with the mainstream state institutions founded on mutual trust, respect, observance of cultural norms, and governance.

Guston (2001) established the concept of ‘boundary organisations’, which in the present context could be transcribed as the local tribal stakeholders vis-à-vis the Village Authorities and other social bodies that connect social entities and communities with the larger state establishments. Boundary organisations are significant in bridging knowledge systems and the co-production of knowledge as they can provide resources and linkages through social networks and are also in direct contact with the local communities. These concepts are important for the case study, as the Tangkhul tribal community has solid traditional institutions and various civil society organisations functioning on customary laws and practices. A few other examples of successful boundary organisations in the literature are the Inuit Tapiriit Kanatami (ITK), a political advocacy organisation that seeks to bridge Inuit indigenous knowledge and scientific knowledge to direct Canadian policy in studying Arctic environmental changes (Inuit Quajisarvingat, 2013). Another is the Dsumzas, the traditional local institutions of Sikkim in India based in the Lachen and Lachung valleys. They help the government utilise resources, conservation, pasture management, conflict resolution, community mobilisation, and local governance (Ingty, 2017). The Dzumsa thus forms a critical institutional link between natural systems and social structures and could be seen as counterparts of the Village Authorities and other social networks of the Tangkhul tribal community. Apart from the Village Authority, which is the first or lowest

formal institution responsible for managing and regulating land resources, there are other multiple decision- making civil society organisations, such as the Tangkhul Naga Long (TNL), which is the apex civil society organisation; the Tangkhul Wungnao Long (TWNL), the representative organisation of Tangkhul village Chiefs and the Tangkhul Shanao Long (TSL), women representative organisation which functions within the social order. These tribal bodies are directly or indirectly involved in the resource management regime of the Tangkhul tribes at the village level and community levels. Other informal groups are the ‘Yarthot’ (cohort of same age groups), youths, and religious groups in most villages which have different roles in managing the ecology through their livelihood approaches. An excerpt from an interview with a representative civil body, Tangkhul village chiefs’ association, explains the importance of a social body to act as a boundary organisation that connect the community’s concerns with mainstream government agencies.

We are the representative of the ‘Republic of Villages’ of the Tangkhul Naga tribe. With the traditional responsibility bestowed to us by the forefathers and elders to lead the villages, we as the representative know and care about what is ailing our natural resources and forests today. There are several actions we want to take up to forward our conservation efforts, but it depends a lot on how the government wants to help us as well. Because we are a financially poor community. If the government is truly sincere to solve problems together, we know the root problems and we would like to be part of it. We know where our river flows, we know where good trees are grown, and we know our land.

In another perspective, the representative of the women group, Tangkhul Shanao Long (TSL) opined about the importance of women institutions in keeping knowledge systems intact. This also explains the need of gender specific institutions to address gender centred problems and solutions.

Tribal women hold array of traditional knowledge systems by upholding culture, rituals and mostly, biodiversity by keeping the seed knowledge systems alive. In every household, women are the ones who has most information about the ecological knowledge of their land and fields. They know which kinds of seed grows in what type of land or at what elevation. They also have better and updated information on new types of seeds in the market since knowledge transfer occur through neighbours, social gatherings and labour sharing processes. Moreover,

women groups must be empowered by giving more space in decision making in terms of natural resource management within the tribe and also at the state level. Entities like women Self Help Groups (SHGs) from each village can be channelised to ensure representation of women group. Women led institutions like Tangkhul Shanao Long (TSL) must be given the space in advocacy to enable adaptation to climate change.

Climate change impacts are multifaceted and pervasive on a sectoral and temporal scale; hence the adaptation measures must also be multipronged. Moreover, it is expected to bring new risks and impacts that have never been faced before and need preparedness. With this cognisance, in many circumstances, creating solutions requires knowledge and intervention measures beyond the community's capacity and what the community already knows. Usually, local communities lack the institutional or economic capacities to respond to these changes; hence, intervention from the government comes through climate action plans and modern adaptation strategies. These strategies roll out mainly through formal institutions, government line departments, and other implementing agencies involving multiple stakeholders; therefore, the role of institutions in delivering these strategies is paramount. To do that, taking hold of the traditional local institutions as stakeholders in decision-making and adaptation planning by the mainstream government is inevitable for formulating effective climate adaptation policies. Moreover, bridging traditional ecological knowledge and scientific knowledge systems must be iterative and, simultaneously, objective in the sense that they should be transpired at all the stages of planning, methods, and processes for any adaptation efforts or strategies. The participants from the focus group discussions put forward many times that most developmental projects and adaptation-related works need more planning and transparency in the implementation process. The practice of contractual implementation of these projects gives little space for the consultation process, hence losing out on the chance to bring out collective knowledge.

Most often, adaptation interventions through modern scientific knowledge are found to be foreign or inappropriate for the tribal ecological system as they are structurally imposed through the working procedures outlined in the developmental and adaptation programmes, projects, policy designs, etc. In the case of the Tangkhul tribe, it was found that tribal actors and agencies are frequently missing in the planning and implementation of developmental strategies and, more specifically, in this case, climate adaptation planning. This impedes the

channelling of tribal traditional knowledge to the other body of knowledge for contextual understanding and responding to climate change impacts. A narrative from an interview with the village secretary of Shungri village adds to the example of inappropriate technological implementation in the village as a result of improper consultation with the village stakeholders.

The water department had built a community water tank a few years ago. Still, it has been left unused for over a year because the motor for pumping the water was not appropriate for the slope of the water source, which was situated downhill. Even though we asked for technical assistance in Imphal, the engineers couldn't figure out how to fix the issue. We couldn't request additional funds because the project was only a single term. Our villagers even considered contributing to the repair work, but the cost was too high for us. We may not know the technicalities of how some things work. Still, this wouldn't have happened if the concerned people had consulted us during the whole project process or had thoroughly investigated the topography and geography of the water source. It's a waste of resources and a loss for the village.

As Manipur is a state with complex political ecology both in the present and history, the study also brings out the dichotomy of core and periphery governance, where the decision-making power lies with a majoritarian or the dominant party. In our context, the tribal agencies are at the periphery as the state has a clear demarcation of hill and valley governance. A narrative from a focus group discussion with the Village Authorities at East Tasom village condenses the argument when the Headman of the village says:

We have heard about the drafting of the state's climate change policy, and a few of us attended the latest consultation program in the town. It was a half-day program, and several officials from the valley had come. The agendas were lengthy, with many formal speeches from officers and bureaucrats telling us how to conserve our environment and face climate change. However, that is what the village has been doing for many years. We were asked what policy or changes we would like to recommend, and several recommendations were made, but in a half-day consultation, how much can we even discuss? There was also no discussion on implementation pathways for the suggested strategies from local stakeholders. It was just a program of collecting opinions, and it looked like they were doing it for formalities and

were hurrying to wrap up the program. After that day, neither did we hear from the officials again, nor did any projects or benefits regarding climate change adaptation programs reach our village.

3. Challenges in Knowledge Co-production in a Tribal Context

As many opportunities as knowledge co-production offers for adaptation to climate change, there are multiple underlying challenges and caution to be considered in the process. First and foremost is the theoretical concern drawing attention to the dangers when knowledge co-production is exercised through extractive strategies to support globally framed climate governance by mining traditional knowledge regimes. Instead, it should serve to ‘decolonise knowledge systems’ by defying the homogenisation of knowledge systems in global and local environmental dialogues and specifically in the climate adaptation regimes. Klenk et al. (2017) also argue that co-designing knowledge systems should come from automatic processes instead of extractive ones. While some scholars have an opinion that indigenous knowledge or tribal traditional knowledge cannot be combined with western science because to do so would displace indigenous knowledge from its context or place-based significance (Cruikshank 2005, 12-14). To some extent, it is valid that traditional knowledge systems are often regarded as essential just for documentation or utility. This reduces the knowledge to a mere data baseline that backs up and reinforces the ethical value of the dominating scientific climate data. Taking cues from the case study, this could be elaborated by looking into the state’s Action Plans for Climate Change and other adaptation-related developmental activities. The policy documents may have included or mentioned the importance of traditional ecological knowledge systems. However, a working framework or an enabling mechanism for implementing this knowledge system remains missing at an institutional level. It is attributed to the complex political ecology of the state owing to different land laws and land-use systems of the core and periphery mentioned earlier and the centralisation of power within a particular party. This has created huge trust deficits between the local institutions and the state institutions. An example to elucidate this assertion comes from an interview extract from a CSO representative and a comment from FGD participant in one village.

For tribals like us, our land rights are the only solid security that can save us from any enemies. We don’t want to be enemies with the state as we all want development. But we know that the dominant party controls all the

development packages in the valley and we are given peanuts share in every development project. Talking about climate change, we are not even aware of any project or activity taken up related to climate change. How can we trust each other as we lack sincerity on both sides. (personal interview)

Whatever plantation drive the government does is just for namesake. For example, their strategy for conservation is simply distributing saplings which don't even grow in our soil and assuming that they grow. We don't really trust their schemes. There are other beneficial schemes, but when it comes to conservation schemes it never works. Because trees do not grow on their own, we need to plant appropriate trees at the right place and need constant nurturing. (FGD 1)

At a larger scale, this issue is also a trickle-down effect of the lack of recognition of tribal ecologies across the country and hence limited research and established typology on tribal indigenous knowledge systems that could enter the mainstream climate policy. Further, the extractive nature of knowledge systems also stems from treating traditional knowledge systems and state governance in silos, making co-production a facilitative role rather than an instrumental tool in determining policy outcomes for climate change adaptation (Latulippe and Klenk 2020, 1-2).

Another major challenge for the co-production of knowledge systems is the changing nature of the perception of traditional knowledge among the younger generations. Over the years and at present, as tribal ecology evolves due to globalisation and several socio-economic transformations such as access to education, new technology, pervasive market forces, and centralised policy instruments via institutionalisation, the traditional knowledge systems are found to be losing their relevance, especially among the young populations. As younger generations venture into diversified livelihood options and change land use patterns by adopting homogenous farming systems like monoculture, the relevance of traditional ecological knowledge is compromised. A farmer aged 27 years, who considers himself as a modern farmer, responded that, he gives less importance to ecological indigenous knowledge as modern farming like monocropping is more beneficial for income generation. He plants only broccoli and cabbage seasonally. Several studies across other tribes in India have documented these changes as well (Ripert, 2002; Saini, 2020). Moreover, as climate change is causing several ecological changes, indigenous ecological knowledge based on bioindicators and seasonal markers is losing accuracy in many cases, especially in weather and

seasonal predictions, hampering several socio-ecological beliefs and practices. For example, shift in the treeline of several species, the phenology of flora and fauna and changing seasonal patterns were reported in interviews with farmers, making knowledge based on these observations critical and ambiguous.

The next significant challenge lies on the socio-political and institutional front. A critical examination of the existing international and national institutions shaping the knowledge systems in climate science and policies gives a pattern where knowledge and information are homogenised and standardised, leaving little room for traditional knowledge. These knowledge systems are materialised and implemented through action plans and policy reports from institutions such as the IPCC and government ministries/departments of environment and climate change. Similarly, India has a National Action Plan for Climate Change (NAPCC) policy under which each state has its own State Action Plan for Climate Change (SAPCC). If one goes through the institutional framework laid down in these policies, the role of traditional institutions through which local knowledge is rolled out does not have a significant place.

Specifically, Manipur's climate action plan does not involve tribal institutions as essential stakeholders for decision-making, starting from planning till the climate adaptation strategies are implemented. This lack of conducive policy mechanisms through the exclusion of tribal institutions leads to non-cognizance of traditional or place-based knowledge and hence ineffective and faulty, in many cases, implementation of the action plans. In one of the interviews with a key informant, a representative of a critical Tangkhul tribe CSO who wishes to remain anonymous opined on similar lines:

Our tribal institutions remain crucial in the management of our natural systems. They will remain instrumental in reviving our lost environment over the years and combating climate change's impact in the future. However, we have little or limited resources to take up action without the support of the government. So far, the government, the climate action plan officials, or any other offices from the environment department have never invited our organisation for policy consultation processes. However, the complex political ecology of the state also has a role to play as the land law across the tribal and non-tribal territory is also not uniform in Manipur. Therefore, it is, instead, primarily a political issue.

Albeit the need for collaborative engagement of the local institutions with the mainstream state institution for the co-production process, the underlying complex political ecology of the state remains the biggest challenge to get through, which is also iterated in the above narrative. Again, bringing to the core and periphery problem of governance in Manipur, where most decisions regarding any development activities or policies on adaptation strategies are taken and concentrated in the valley. This has led to an undeniable mutual trust deficit between the respective institutions stemming from the yearlong differences in cultural and ecological realities and aspirations.

Moreover, the differences in ecological systems from agricultural practices, management of natural resources, and the complex land-holding systems of the tribal areas have only added to the challenges. Wherever a trust deficit exists between institutions, co-production and dissemination of knowledge systems will remain strenuous. Thereby, for a tribal society, the role of local institutions in the governance of land and resources remains an act of aspiring for power-sharing and a self-deterministic community identity by asserting sovereignty and autonomy over land. Moreover, the case of the Tangkhul Naga tribe represents the larger tribal ecology in northeast India under similar political ecology embedded in the power play with the dominant state machinery. As long as the state recognises these challenges, bridging different knowledge systems and co-production of knowledge will remain challenging and unfruitful.

4. Conclusion and Recommendation

Climate change and its impacts are already affecting the marginalised section of people, especially the tribal communities. While tribal communities have been perceiving these changes through close engagement with their agroecological systems and cultural entities, for which the narratives from the case of the Tangkhul Naga tribe are the evidence. They also have been adapting to several environmental changes through their traditional ecological knowledge. However, as climate change has brought new and complex problems, communities would need interventions from the government and formal institutions through modern scientific adaptation strategies and capacity building. Hence, these two knowledge systems- the traditional knowledge systems and scientific knowledge- must bridge to co-produce a new knowledge system that guides contextual adaptation intervention programs without compromising the tribal sovereignty over their ecological resources and customary rights over land. To do so, traditional tribal

institutions and other tribal networks must be brought in as enablers for channelling traditional ecological knowledge as they are in direct contact with the knowledge holders' communities. It can only take shape when the institutional framework for the State Action Plan for Climate Change (SAPCC) includes these institutions, especially the Village Authority and major tribal CSOs, as critical decision- making stakeholders at the village and community levels. However, the existing state action plan excludes the functional role of local institutions, and this has led to several ineffective adaptation interventions in the past and maladaptation in many cases.

There are several challenges to the co-production of knowledge systems, such as the changing opinion of traditional knowledge in the modern world and the complex political ecology owing to the state's unique land-holding system. As interventions through modern scientific knowledge are required to address the new challenges climate change brings, traditional ecological knowledge shall remain relevant for adaptation to climate change as most of the population still depends on natural resources and the ecosystem for their livelihood. One way forward is to revive and popularise traditional ecological knowledge through research and advocacy. The SAPCC has a dedicated mission for knowledge creation, the Mission for Strategic Knowledge for Climate Change. It aims to network existing knowledge institutions, capacity building & improving understanding of key climate processes and issues. The state could use this platform to focus on strengthening traditional ecological knowledge by conducting research and advocacy at the local scale and incorporating local institutions in the process. It could lead to better informed and contextual formulation of community adaptation pathways.

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