

Original Article

Ecological Adaptations of Nilgiris Tribes - Bioresources in Todas and Kotas Livelihoods

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Abstract - In recent decades, the environment and humanity have paid greater attention to the notion of sustainability. Because of the usage of ecological resources, ethnic settlements with a larger extent of forests have become prominent targets for ethnobotanical surveys. The study was conducted by a questionnaire survey and observations using empirical methods among the tribal settlements of Todas and Kotas of Nilgiris during the year 2022-2023 that showcase the information on the source of innovation in the application of bioresources available in the environment, as well as their traditional construction expertise. It has been shown that biological resources are used to provide sustenance, especially among tribal communities. Identifying the rich traditional ecological knowledge that has been an essential component of sustainable living. Traditional ecological knowledge of these indigenous people about the values of bioresources and their vernacular construction methods has enabled them to undertake sustainable design and planning against the climate where they live. This study provides insights to understand the socio-cultural and economic elements that determine settlement patterns and habitats, as well as material and construction in a typical mountainous area of South India. The study further examines the settlement's unique importance and significant reliance on natural resources for subsistence. The findings of the study help to comprehend how bio-resources were integrated into their habitat and in a living environment. It also helps to re-explore the concepts of good practices and attempts to encapsulate the diversity of traditional ecological knowledge among these settlements.

Keywords - Vernacular knowledge, Traditional Ecological Knowledge (TEK), Kotas, Todas, Nilgiris, Sustainable livelihood.

1. Introduction

The ethnic settlements have a long history of traditional ecological knowledge, which is essential for creating a routine harmony between people and the environment (Brondízio et al. 2021). This traditional ecological knowledge is fostered by age-old customs, which offer the solutions and answers for the practical utility and viability of natural resources, which have been passed down through many generations. The design of vernacular built-forms is culturally expressive and environmentally responsive, presumably impacted by human behavior and surroundings (Lawrence et al. 1990). Indigenous knowledge was used for survival by ethnic or tribal people who were assimilated with the natural bioresources in the forest (John et al. 2015). Thus is the primary factor defining their way of life, culture and the sustainability factors for their future. The indigenous communities are also referred to as "forest dwellers" since they live within the protected areas, reserved Forests, on the buffers, and also outside at peripheral fringes as nature is considered at the center of their socio-cultural existence (Kenterelidou et al. 2021). The availability of resources and employment prospects for tribes has

decreased due to forest degradation, which has also had an impact on the tribes' access to food, subsistence, and livelihoods (Blay et al., 2007). The Forest Department has been extensively involved in tribal welfare activities in the state of Tamil Nadu and has undertaken numerous efforts through programs like the Integrated Tribal Development Programme (ITDP), Hill Area Development Programme (HADP), and Tribal Action Plan (TAP) for tribal development. The ethnic tribes depend more heavily on the environment for their way of life and physical structure (Khoris 2022). The readily available bioresource materials are more environmentally friendly, energy-efficient, and long-lasting, and they should not be thrown away in the pursuit of modernism (Amos Rapoport 1969). Despite the massive loss of traditional homes, there are still several noteworthy examples of vernacular urban fabric and buildings that can be considered and defended for their authenticity and integrity. It is important to comprehend in greater detail how the tribal people currently interact with and depend on their natural surroundings, as well as how ecological disruptions have changed their way of existence. Compared to other indigenous



people of south India, the Toda and Kota tribes of the Nilgiri District of the state of Tamil Nadu have unique building techniques that are strongly ingrained in their culture. Their traditional home structures are mostly composed of locally accessible bio-resource materials, demonstrating a sustainable approach to construction. Bamboo, thatch, mud, and timber were supplied from the neighboring forests and mountains. Toda homes are distinguished by their distinctive barrel-vaulted roof structures made of bamboo and thatch, whereas Kota homes frequently include timber and mud walls with thatched roofs. These structures not only represent their strong connection to nature but also show their resourcefulness in employing locally accessible resources. Further investigating the utilized bio-resource materials in their house construction gave important insights into sustainable building techniques and the intellectuality of indigenous knowledge and its conservation among these indigenous people. The objectives of the study were to examine the connections between bioresources and the livelihood of both the Toda and Kota communities, as well as the significance and rationale in the selection of bioresources used in the communities with respect to socio-cultural and economic values.

2. Methodology

The study employed an empirical methodology to document the ecological adaptations of the Toda and Kota tribal communities in the Nilgiris region during 2022-2023 (Figure 1).

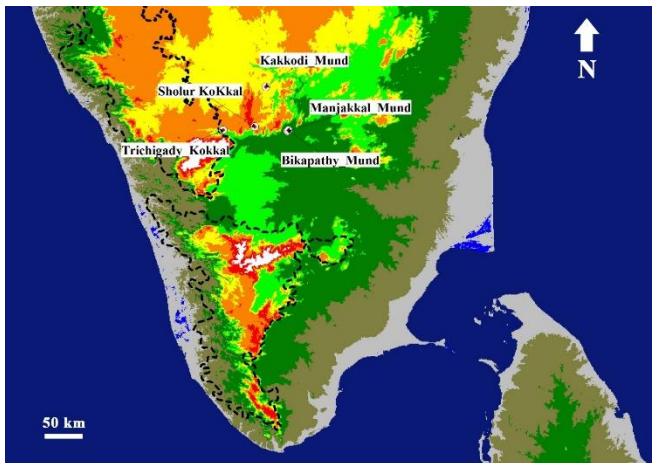


Fig. 1 The map shows the study sites of the tribal settlements

The study is intended to use questionnaire-based surveys and observational techniques to systematically collect data on the traditional ecological knowledge of the indigenous people, settlement patterns, and bioresource utilization. The research focused on understanding how these indigenous communities interact with and utilize local bio-resources, particularly in the context of their traditional housing construction and livelihood practices. Data collection involved direct field observations of tribal settlements, interviews with community members, and comprehensive documentation of the materials, construction

techniques, and cultural significance of their dwellings. The researchers analyzed the collected information was analyzed through a multidisciplinary lens, examining the intricate relationships between the tribes' cultural practices, architectural design, and ecological environment. The study aimed at the specific use of locally available materials like bamboo, thatch, clay, and wood to explore the sustainable design principles and traditional ecological knowledge embedded in the communities of Toda and Kota.

3. Indigenous Architecture and Ecological Wisdom

3.1. Toda Community

The Todas are a tiny group of people, as shown in (Figure 2(d)), who are descended from Dravidian left after the Aryans invasions in South India's Nilgiris Hills (Grigg 1880). The Todas settlement is surrounded by a densely vegetated forest region, as shown in (Figure 2(a)). Todas are a pastoral community that practices polyandrous marriage (Choyimanikandiyil 2013). Their population density is extremely low and has decreased significantly over the last few decades. Over the previous century, the Todas population has fluctuated in relatively small numbers, as evidenced by the 2011 census, which states the population was 2002 in numbers. The buffalo is the most significant domesticated animal among Todas, having a separate circular pit bounded with rocks near the village, as shown in (Figure 2(b)-(c)). They often divide buffalo herds into two categories: common and sacred. Dairy product sales are the main source of income. They now cultivate crops and practice agriculture, as shown in (Figure 2(a)).

Particularly in their traditional building techniques, the Toda people of the Nilgiris exhibit a strong connection between culture and nature. Their habitat is a prime example of their peaceful relationship with nature, as it is deeply woven into the surrounding ecology (Nobrega and Nitya, 2011). The Toda mund (village) architecture, which is strongly linked to the region's bioresources, is a physical manifestation of their cultural identity (Rivers, 1906). Through a thorough comprehension of ecological linkages and sustainable resource management techniques, the Todas' and Kotas' Traditional Ecological Knowledge (TEK) greatly increases biodiversity in their ecosystems. In order to promote biodiversity conservation and climate change resilience, TEK comprises a cumulative body of information that has been passed down through the generations. This knowledge includes insights into local flora and fauna, soil health, and landscape dynamics (Nepal, 2024). Additionally, their generation-tested traditional management systems offer useful instruments for biodiversity stewardship, emphasizing the significance of combining scientific methods with indigenous knowledge for improved conservation results (Nabhan & Martinez, 2012). In addition to protecting biodiversity, this collaboration enhances the ethical and cultural aspects of environmental stewardship in their local communities.

"Biocultural adaptation" (Maffi, 2005). Their building process represents a sophisticated system of ecological knowledge passed down through the centuries, in addition to material value. Their material culture is based on the abundant resources of bamboo, cane, and reed species that thrive in the area (Manandhar, R, 2019). In addition to being used in construction, these natural materials represent the Toda people's deep awareness of their environment and sustainable way of life (Atalay, A.,2023).

More than just a practical decision, the use of indigenous materials like bamboo, cane, and reed exemplifies "material culture adaptation" as defined by environmental anthropologists (Cédric, C et al., 2021). This strategy reveals the Toda's deep awareness of the biodiversity in the area and their ability to use resources responsibly without upsetting the natural equilibrium. The distinctive barrel-vault design of the traditional Toda hut is a prime example of indigenous engineering and cultural expression. At 5.5 meters long, 2.7 meters wide, and 3 meters high, these constructions are physical manifestations of Toda customs and ideals (Priya R. et al., 2019).

Amazing engineering insights may be seen in the barrel-vault architecture and the Toda mund's structural design. Modern architectural ethnographers highlight how these designs are not just practical but also encode intricate cultural narratives and environmental knowledge, going beyond the dimensions. (Rahman, F. 2024). Traditional beliefs of Todas and Kotas follow customs that support ecological balance and the sustainable use of biological resources Yin, L. (2023). The Bamboo Framework includes the fundamental elements of the Toda hut and its cultural significance. The basic structures of curving bamboo poles symbolize the Toda people's ability to live in harmony with the environment by using locally available resources to meet their needs (Kaur, P. 2018). Additional theoretical frameworks for comprehending the building practices of the Toda are offered by the ethnoecological research conducted by Berkes (2012).

These academics contend that through complex cultural practices that preserve ecological resilience, indigenous groups like the Toda co-create habitats rather than just inhabiting them. Rattan's use to secure bamboo components shows the community's generation-to-generation transmission of ancestral knowledge and wisdom (Balakrishnan et al., 2020). Roof with Thatch: In addition to providing protection, the hay and dried grass thatch demonstrate the Toda people's understanding of regional climate cycles and their ability to adapt to their surroundings (Priya, R. and Radhakrishnan, S., 2019).

The Toda's relationship to their land and their resourcefulness in using readily available resources are demonstrated by the locally obtained stone used for the front and rear façades. In addition to its practical use, the small,

square wooden door (0.9 meters in width and height) has cultural importance and may represent the Toda people's need for security or seclusion. According to Low (2003) and Rapoport (1980), architectural features frequently mirror intricate social processes, such as ideas of privacy, communal boundaries, and religious convictions.

The construction of these traditional huts is essential to Toda culture and calls for the use of traditional ecological knowledge as well as community involvement (Muthamia, S. 2021). This strategy ensures that cultural traditions are passed down to future generations and fortifies social ties (Madandola, M. and Boussaa, D. 2023). The Toda's reliance on regional bioresources for building is a prime example of their sustainable lifestyle and role as environmental stewards (Kala, M. and Sharma, A. 2009).

The use of these resources is indicative of a deep respect for the natural world and an understanding of ecological balance (Hockings, 2013). Such cooperative methods guarantee not just architectural continuity but also social cohesiveness and cultural memory, as highlighted. In addition to being a place of habitation, the Toda hut is a cultural artifact that represents their history, customs, and relationship to the natural world. The choice and use of building materials are more than just practical; they are a tangible representation of Toda identity, knowledge, and their long-term coexistence with the Nilgiri ecosystem (Cordero, R.,2018).



Fig. 2 The Toda settlement, (a) Farming land of Todas at Kakkodi Mund, (b) Toda Temple at Manjakkal Mund, (c) The scared animal buffalo's Skull near Toda temple at Bikkapathy Mund, (d)Toda people with the traditional attire, and (e) The circular pit with boundary wall for buffalo shed.

3.2. The Kota Settlements in Nilgiris

One of the primitive tribal groups includes the Kotas village, which lives in Tamil Nadu's mountainous Nilgiris district. Kotas, as shown in (Figure 4(c)) are the Canarese type of Dravidian, a member of one of the aboriginal races of India (Grigg 1880). Seven villages made up this community in the Nilgiris district, namely, Kollimalai (Kolmel), Kundah (Meenaad), Pudhu Kotagiri (Porgaad), Kil Kotagiri (Kinnaad), Sholur kokkal (Kurgoz), Tiruchigadi (Trisigari), Gudalur kokkal (Kalaas). The Kota settlements are known by the name “KOKKAL” (Ghosh 1976). The Todas neighbors who raised buffalo served as service providers for the Kotas in exchange for the Toda buffalo's milk, skins, ghee, and meat. Additionally, they maintained ceremonial and commercial ties with their Neighbors, the farmers and hunter-gatherers Kurumba and Irulas, respectively. They are great craftspeople who provide smithing (Figure 4(b)), carpentry, and pottery (Figure 3(d)) services to other hill tribes that are currently engaged in agriculture and cow domestication (Figure 3(a)).



Fig. 3 The Toda settlement house and illustrations made during the survey, (a) The typical Toda Traditional huts at Bikkapathy Mund, and (b) The Toda temple at Bikkapathy Mund.

The Kota people of the Nilgiris demonstrate a complex relationship with their native nature through advanced construction techniques that transcend basic shelter. Employing plentiful bio-resources such as bamboo, cane, rattan, and reed species, they exemplify an exceptional methodology for settlement construction that amalgamates ecological understanding, cultural identity, and environmental stewardship. Their Traditional Ecological Knowledge (TEK) constitutes a holistic framework that fosters biodiversity protection, bolsters climate change resilience, and safeguards cultural memory (Hosen N et al., 2023; Berkes, 2012). The Kota settlements, structured into Keri (streets), exhibit a

complex social hierarchy grounded on clan systems, with architectural configurations that demonstrate advanced land use and communal interdependence. The selection of materials for Kota houses goes beyond mere practicality, reflecting a deeply spiritual and ecological perspective. Their animistic viewpoint endows natural entities with spiritual importance, rendering creation a sacred act of environmental interaction (Bhanu, 1989; Bird-David, 1990; Nazarea, 2006). Locally obtained materials such as clay, soil, and bamboo reeds serve as concrete manifestations of their profound reverence for the natural environment and complex ecological comprehension (Hockings, 2013; Raman and Raman, 2019). The construction process is a community-oriented endeavor that conveys ancient wisdom and preserves cultural heritage. Every curved bamboo pole and meticulously fastened rattan joint conveys a narrative of intergenerational ecological knowledge (Nazarea, 2006). Architectural features, like timber columns, interior flooring, and the unique storage attic, function as vessels of cultural knowledge and workmanship, exemplifying the community's agricultural legacy (Enwin, A. 2024). The collecting of resources, generally limited to a 3-4 km radius of the forest, demonstrates the Kotas' sophisticated comprehension of sustainable resource management and ecological limits (Nabhan & Martinez, 2012). Their spiritual affinity with the environment is notably manifested in rituals such as the reverence of sacred stones merging economic sustenance with spiritual practice.



Fig. 4 The Kota Settlement, (a) The settlement view of Kota at Sholur Kokkal, (b) The aerial street view of Kota Settlement, (c) The Kota People in traditional attire, and (d) The display of clay Products made by the Kota women.

The architectural design of Kota temples, notable for the lack of idols and the use of identical natural materials as their dwellings, underscores their comprehensive worldview (Tarrad, M. 2020). This method exemplifies a harmonious amalgamation of the sacred and the ordinary, wherein constructed spaces serve as an extension of the natural realm (Rival, 2007; Bird-David, 1990). The construction methods of the Kota community exemplify a complex ecological and cultural system characterized by notable resilience, adaptability, and profound environmental insight. Their architectural methodology converts construction methods into a manifestation of environmental management, demonstrating an exceptional capacity to coexist with the Nilgiri ecosystem (Hockings, 2013). This comprehensive approach to resource utilization creates functional living environments and exemplifies the Kota community's reverence for ecological equilibrium and their responsibility as environmental stewards.

3.3. Ecological Knowledge in Utilization of Bioresource in Toda and Kota Community

The current study documented a total of 9 bioresources (wood or plant species) utilized by the tribal group in the construction of traditional dwellings, as presented in Table 1. The Traditional Ecological Knowledge (TEK) cultivated by the community through extensive interaction with nature has allowed them to identify resilient and optimal plant species for constructing various components of buildings and to ascertain the appropriate harvesting seasons for plant materials. Bamboo and calamus served as the primary materials for constructing the framework of the traditional dwelling. In addition, the lumber was utilized in the construction of various components such as the front façade, doors, and shelves. The roofs predominantly employed grass, locally referred to as Korapullu (*Cyperus rotundus* L. or other *Cyperus* spp.). The survey indicates that the roofing thatch material has a lifespan of 6 to 7 years. Cane, divided into slender strips, served as a binding agent for joinery. In previous studies, The Todas and Kotas of the Nilgiris District demonstrate exceptional ecological expertise in their use of wood and plant materials, meticulously choosing species that ensure structural stability and optimal thermal comfort. Their architectural practices predominantly utilize locally available species like bamboo (genera *Bambusa* and *Dendrocalamus*), which provides outstanding thermal insulation due to its hollow cellular structure, forming natural air chambers that control internal temperatures (Balakrishnan et al., 2020; Bates, 2013). Bamboo species such as *Bambusa* bamboos are utilized with rattan (*Calamus thwaitesii* Becc.) for the binding and securing of structural elements, while thatch grasses like *Eriochrysis rangacharii* C.E.C.Fisch. (Toda grass)- an endemic grass species, *Imperata cylindrica* (L.) Raeusch. and *Saccharum spontaneum* L. offer roofing that mitigates heat and improves ventilation, lowering indoor temperatures by 4-6°C relative to traditional building materials. (Arminda, W; Kamaruddin, M. 2021).

The conventional barrel-vaulted edifices and mud-timber dwellings utilize several indigenous plant species, such as *Erythrina variegata* L. for timber and native *Eugenia* species for structural components. Timber species such as *Tectona grandis* L.f. (teak) and *Dalbergia latifolia* Roxb. (Indian rosewood) are deliberately chosen for their density and moisture-regulating characteristics, which ensure reduced heat absorption and offer natural insulation against the fluctuating climate of the Nilgiri region (Hockings, 2013). This intricate choice of materials transcends basic construction requirements, reflecting an advanced Traditional Ecological Knowledge (TEK) that illustrates the communities' deep comprehension of bioclimatic design and their interdependent relationship with the local ecosystem (Berkes, 2012). The diminutive, square timber doors (0.9 meters in both width and height) and locally sourced stone façades enhance the architectural design, embodying not only practical considerations but also complex social dynamics and cultural ideologies (Low, 2003; Rapoport, 1980). This comprehensive construction methodology guarantees structural integrity and thermal comfort while also safeguarding cultural heritage, enhancing social cohesion, and sustaining the fragile ecological equilibrium of the Nilgiri highlands. (Xu, W. 2022).

4. Results and Discussion

The indigenous Toda and Kota communities of the Nilgiris Hills exemplify the intricate relationship between Traditional Ecological Knowledge (TEK), cultural identity, and environmental resource utilization, showcasing a remarkable symbiosis between their socio-cultural practices and the use of bio-resources in traditional house construction. Both communities employ locally sourced materials such as bamboo, cane, reed species, clay, and indigenous stones not only as construction elements but also as living narratives of ecological comprehension and cultural memory, encapsulating a deeply spiritual and ecological viewpoint.

Their architectural methodologies, exemplified by the Toda's barrel-vaulted structures and the Kota's Keri (Street) settlements, embody intricate social hierarchies and profound environmental consciousness, with each curved bamboo pole, thatched roof, and meticulously chosen material acting as a repository of intergenerational wisdom. The construction of houses in these communities goes beyond mere shelter, evolving into a communal effort that fosters biodiversity conservation, strengthens climate change resilience, and safeguards cultural heritage through an integrated approach that harmonizes architecture, culture, spirituality, and ecology. The Toda and Kota communities exemplify an alternative model of sustainable living by regarding bio-resources as significant elements of their cultural landscape and showcasing advanced resource management within a 3-4 km forest radius. This approach blurs the distinction between sacred and ordinary spaces, offers deep insights into human-nature interactions, and imparts valuable lessons in ecological

stewardship that contest modern methods of resource utilization and cultural preservation. The results indicate that bioresources play a crucial role in catering to the essential requirements of the Todas and Kotas tribes. These communities are economically dependent on forest products. In addition, shelter construction predominantly relies on bio-resources, as evidenced by the extensive utilization of bamboo, thatch, clay, and lumber in conventional building techniques, as shown in (Table 1). The Todas distinctive barrel-vaulted edifices and the Kotas mud and timber

residences serve as tangible manifestations of their profound comprehension of indigenous materials and environmentally conscious building methodologies. The Todas and Kotas communities, indigenous to the Nilgiris, exhibit a symbiotic rapport with their natural environment, as their subsistence strategies are built upon bio-resources. This research underscores the significance of acknowledging and endorsing the sustainable practices of indigenous communities, which safeguard the traditional ecological knowledge integrity and cultural heritage.

Table 1. List of construction materials samples collected from the Toda and Kota community

S.No	Category	Scientific Name	Vernacular Name	Used As
1	Wood	Terminalia sp.	Karumarudhu or Marudham	Structural post
2	Bamboo & Twining/Interwoven materials	Dendrocalamus spp.	Kalmoongil	Wall
3	Poles	Calamus thwaitesii Becc.	Thadiperambu	Binding joineries and structural members
4	Grass	Eriochrysis rangacharii C.E.C.Fisch. - Endemic grass sp. Imperata cylindrica (L.) Rausch.	Toda grass & Darbhaipul or Nanal	Thatches in Roofing
5	Mixture of cow dung and sand	-		Wall plaster, flooring
6	Naga tree	Syzygium spp./ Eugenia spp.	Naga or Kaya	Wall, Structural member
7	Battens	Eucalyptus globulus Labill.	Thailamaram	roofing - rafters battens, Structural member
8	Rafters	Grevillea robusta A.Cunn. ex R.Br.	Malai savvukku	roofing - rafters battens, Structural member
9	Mandu	Adansonia sp.	Aanaipuliyam	Sacred plant

5. Conclusion

Through research on bioresource integration and human livelihood, the pattern of interaction between the populace, built environment, and adjacent forests is substantially comprehended in the debates. It has been observed that the native Toda and Kota prefer forest dwellings. They derive sustenance from readily available, locally sourced bioresources by utilizing their indigenous traditional knowledge and expertise. It is recognized that settlements and their socio-cultural composition are inextricably linked to their physical surroundings and are, therefore, integral components of the ecosystem. The indigenous population possesses a profound understanding of the regional natural resources and is adept at locating their settlements. The readily available resources in each locality have a substantial impact on the socio-cultural, agricultural, settlement and spatial planning and habitat construction practices of both populations. Evidently, it exemplifies their ability to harmoniously coexist with the surrounding constructed environment and their integration with the abundant biological resources in the vicinity. It is advisable that the customary resource utilization of the settlements be maintained, as this will serve the interests of future generations. Survival requires concentration on preventing the exploitation of bioresources and the identity of the tribal settlement, which inspired the

building of warm, traditional homes that preserve the natural harmony of the forests and traditional ecological expertise. The environment and the way of life of the tribal people are interdependent. Traditional means of subsistence deteriorate due to environmental degradation or disruption. It is more crucial to safeguard the biological resources and natural environment of tribal communities that reside near the environment. Beneficial to the community's long-term sustainable development is not only the preservation and protection of bioresources but also the application of indigenous traditional ecological knowledge on resource extraction for their livelihoods.

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