International Journal of Research - GRANTHAALAYAH
February 2026 14(2)
www.granthaalayah.com

Original Article

HARNESSING HIMALAYAN WISDOM: INDIGENOUS KNOWLEDGE SYSTEMS AND SUSTAINABLE ECOLOGICAL STEWARDSHIP IN INDIA

Dr. Sivakumar M V [1], **Virendra Kumar** [2*]
[1] Associate Professor, Department of International Relations and Politics, Central University of Kerala, India
[2] Research Scholar, School of Global Studies, Central University of Kerala, India

ABSTRACT

The Indian Himalayan Region (IHR) is a part of the most ecologically sensitive and culturally diverse treasures extending along the west to Jammu and Kashmir and eastward to Arunachal Pradesh; it is known as the Water Tower of Asia, providing all the major rivers, biodiversity, as well as home to various indigenous communities. The paper explores how Indigenous Knowledge Systems (IKS) that communities living in the Himalayas have developed throughout the centuries could promote sustainable management, i.e., in three spheres of agriculture, water management, and biodiversity preservation. This study adopts a qualitative approach, employing selected case studies of the communities found in the Himalayan region, ethnographic spottings, and a systematic literature review of the indigenous ecological practices. The results have revealed that Himalayan IKS can be significant in sustaining agriculture, water resource-effectiveness, and preservation of biodiversity due to adaptive, low-impact, and community-oriented practices. These processes demonstrate that the environmental problem has a context-oriented solution, and this type of system provides effective alternatives to the contemporary models of development that are resource-consuming. The paper concludes that Himalayan Indigenous Knowledge Systems, however relevant, are growing under threat, due to the fast pace of modernisation, marginalisation of the policy, and climate change; integrating IKS with contemporary scientific approaches is thus necessary in enhancing adaptive capacity, the sustainability, and the long-term ecological integrity of the Himalayan ecosystem. The paper contends that the recognition and institutionalization of indigenous wisdom are essential for developing a comprehensive and resilient framework of environmental governance in India.

Keywords: Indigenous Knowledge, Himalayan Region, Sustainability, Ecological Knowledge, Resource Management

INTRODUCTION

The Indian Himalayan Region (IHR), which is a geologically active region that stretches approximately 2,500 kilometers and occupies 16.2% of India's geographical territory, is an important ecological and strategic region. This region is spread across 13 Indian States and Union Territories, UTs (e.g. Jammu and Kashmir, and Ladakh), and the entirely enclosed states 9 (e.g. Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya) as well as the Partially Covered two States, Assam only the hill districts (Karbi Anglong and Dima Hasao) and West Bengal only the hill district of Darjeeling and Kalimpong. It is to be known as the 'Water Tower of Asia,' just because of a source of many rivers as well as feeding major river systems such as the Indus, the Ganges, and the Brahmaputra rivers, which feed hundreds of millions downstream. It contains one-third of the total Indian forest cover.

*Corresponding Author:
Email address: Dr. Sivakumar M V (sivakumar@cukerala.ac.in), Virendra Kumar (mashum.virendra@gmail.com)

Received: 25 December 2025; **Accepted:** 28 January 2026; **Published** 02 March 2026
DOI: 10.29121/granthaalayah.v14.i2.2026.6760
Page Number: 12-23
Journal Title: International Journal of Research -GRANTHAALAYAH
Journal Abbreviation: Int. J. Res. Granthaalayah
Online ISSN: 2350-0530, **Print ISSN:** 2394-3629
Publisher: Granthaalayah Publications and Printers, India
Conflict of Interests: The authors declare that they have no competing interests.
Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
Authors' Contributions: Each author made an equal contribution to the conception and design of the study. All authors have reviewed and approved the final version of the manuscript for publication.
Transparency: The authors affirm that this manuscript presents an honest, accurate, and transparent account of the study. All essential aspects have been included, and any deviations from the original study plan have been clearly explained. The writing process strictly adhered to established ethical standards.

Figure 1

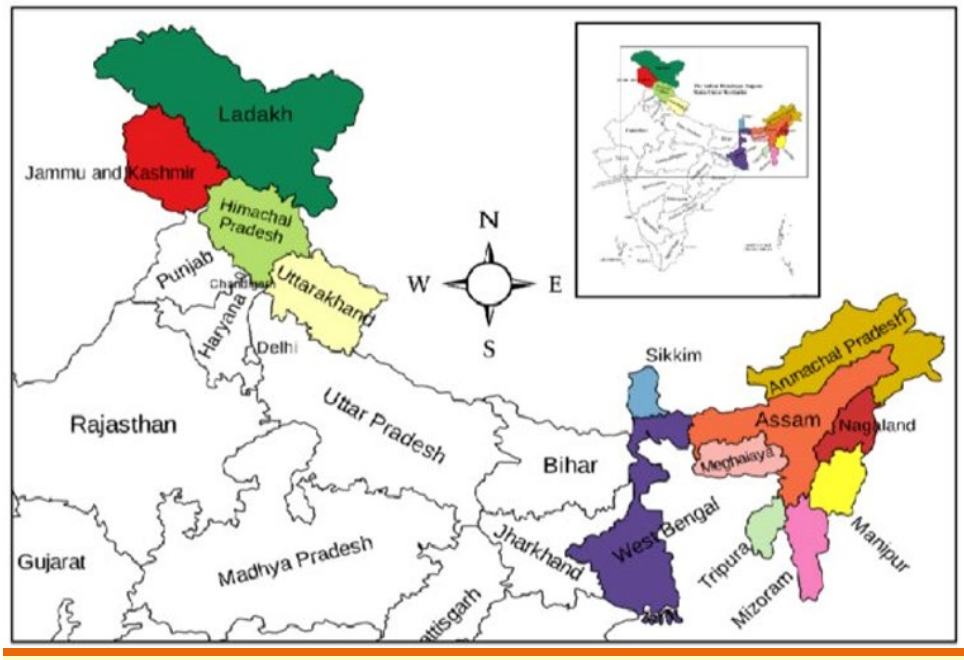

Figure 1 The Indian Himalayan Region (IHR), Highlighting Eleven States and Two Union Territories
Source: Junaid et al. (2024)

An estimated 370 million indigenous people, often known as "first" or "original" people, live on about 20% of our world and have a strong cultural and historical connection to their biodiversity Negi et al. (2023). Their diverse experience is with a tight rein in cultural harmony and environment, ensuring sustainable management of resources and environmental protection in a changing global environment Magni (2017). The Convention on Biological Diversity (CBD) defines the concept of traditional knowledge as the wisdom, creativity, and practices of indigenous and local communities around the world that have accumulated over years of practical experience and learning after trial and error Gadgil et al. (1993). Moreover, this information is transmitted and further through the generations as a part of the cultural transmission, and it symbolizes the mutual relationship that exists between individuals and their environment. Traditional knowledge systems are hence critical to the lives of millions of people Negi and Maikhuri (2013).

The native communities have worked out locally related strategies to manage their fragile ecologies and limited natural resources, including community forests, terracing agriculture, and indigenous water collection. These strategies are flexible in nature and reliant on an exceedingly descriptive interpretation of local ecology, and most frequently, are embedded in spiritual traditions and cultural norms that determine the human-environment interactions. The ecological balance and subsistence livelihoods that were maintained through such Indigenous Knowledge Systems have always been very significant in the Indian Himalayan Region. Nevertheless, the contemporary rate of climatic change, technological transformation, market evolution, and the active isolation of the indigenous population in the sphere of mainstream decision-making are becoming an escalating risk to the further survival of such knowledge systems. Despite the fact that these mechanisms are highly applicable in the protection of biodiversity and in helping to build resilience to climate change, the indigenous ecological regimes are still on the margins of mainstream development and policy approaches.

In this regard, this work examines how the Himalayan Indigenous Knowledge Systems can be used to develop sustainable development, especially when it comes to the traditional agricultural systems, water management systems, and biodiversity conservation plans. The research argues that there exists a necessity to merge the indigenous ecological experience with the contemporary scientific approaches to enhance the ecological resiliency and stand with the sustainability of the Himalayan socio-ecological system.

LITERATURE REVIEW

Indigenous Knowledge Systems (IKS) are receiving greater attention among people, researchers, policy makers, etc. regarding their application to aid sustainable development, particularly in the Indian Himalayan region. In this part, it is going to be crucial for the reason that demonstrates the diversity and depth of these time-honoured ancient ecological practices. These practices have been

shown to be very useful for sustainable agriculture practices, water management, and biodiversity preservation. The following are some of the important works that throw light on the significance of IKS in the Himalayan context.

Shruthi et al. (2022)pointed out that there is a manner in which the natives of Uttarakhand, in the Indian Himalayas, manage to keep their livelihoods in eco-friendly ways. The authors accentuate the ancient practices in agriculture, such as terrace agriculture, Kuls-intelligent water systems, that have been supporting food security and a healthy environment since time immemorial. They also demonstrate that these communities possess a comprehensive knowledge of how to manage their ecosystems, which is very important because the climate is becoming more erratic Shruthi et al. (2022). O'Neill and others found that the indigenous knowledge system is a refuge that safeguards the rich biodiversity in the Eastern Himalayan region. Moreover, the researcher again sheds light on the importance of local knowledge in safeguarding medicinal plants, water sources, as well as ensure way to flourish forest ecosystems. It claims that, particularly in the face of environmental degradation and deforestation occurring on a large scale, such old traditions are the basic keys to creating ecological resilience and enhancing sustainable development O'Neill et al. (2017).

Ingty's study, which was grounded in Sikkim and Arunachal Pradesh, found that there were improvements just because of residents' efforts; they developed resistance against climate change through going deeper into age-old ecological practices by using time-tested practices, such as agroforestry, crop rotation, and livestock management. The authors propose to combine these traditional practices with the modern strategies in order to come up with good results and strengthen the local resilience mechanism Ingty (2017). Sharma immerses himself in the numerous agricultural lifestyles of the Western Himalayas, where local agricultural practices such as organic farming and seed saving have increased the biodiversity and ensured the soil remains healthy. Moreover, authors have suggested the methods that are again time-tested and provide long-lasting solutions to daily farming problems, particularly those that occur on a macro-scale level in areas where water deficit and soil erosion occur Sharma et al. (2023). Nagahama's work is more about the Van Panchayats, i.e., community-managed forests in Uttarakhand. These ways the community was preserving biodiversity and the forest over there. In her work, the author figures out that indigenous folks understand how to utilise these forest resources sustainably so that future generations can enjoy the same. For the preservation of these strategies, it is important to acknowledge and incorporate these time-tested activities in the mainstream framework Nagahama et al. (2022). Joshi and his team visit the ancient techniques of water management, which people have been using for centuries, demonstrating how and in what way to manage water even in the rugged Himalayas. They make forays into such examples as the Kul irrigation systems in Himachal Pradesh and the system of Zabo in Nagaland. The authors also justify why these old techniques matter today, when climate change exacerbates the existing water issues Joshi et al. (2023).

Subba (2009) pointed out that the traditional knowledge of the Limbu, Bhutia, and Lepcha communities in Sikkim and Bhutan is one of the main pillars, i.e., working to develop some sort of resilience in the Eastern Himalaya. These communities did a good job to ensure food security, especially when the climate is unstable. They are paying much attention to agro-biodiversity, i.e., the production of hardy crops such as buckwheat and millet in place of industrial monocultures. In addition, community-based management and seed sovereignty guarantee independence from the outside market in times of environmental disturbance. He also finds that contemporary adaptation policy should incorporate such a vernacular wisdom to deal with the local vulnerabilities of the Himalayan ecosystem Subba (2009).

According to Kumar et al. (2021), the conventional cultivation techniques, e.g., seed exchange and mixed cropping, have long been helping the communities to deal with the climate-related issues, such as crop failures and low yield during the erratic rains Kumar et al. (2021). Singh et al. (2017) re-examines the idea of sacred groves in the Western Himalayas and examines how these special places are treasure troves of biodiversity, which are preserved by the spiritual and cultural practices of local people. The study emphasizes the fact that such groves not only help to preserve the life of rare animals and plants, but also serve as one of the main forces that make the ecological balance intact Singh et al. (2017). With a focus on organic farming, insect control, and soil fertility management, NITI Aayog examines the significance of “traditional knowledge system” in sustainable agricultural practices in the “Indian Himalayan Region” Aayog (2018).

Ramakrishnan (2007) figures out that in IHR, the indigenous knowledge system has a rich history, folks know how to manage forests in a sustainable manner so that people can get benefits from not only timber products but also from non-timber forest products and medicinal plants. Furthermore, the authors also emphasize how crucial it is to incorporate these traditional methods into official forest management systems in order to increase sustainability and maintain the health of forests Ramakrishnan (2007). Jasmine et al. (2012) pointed to the fact that it is not possible to make these practices as mainstream practices without national efforts, strategies, and programs. In doing so, the documentation on different platforms, such as the Traditional Knowledge Digital Library (TKDL) and the People's Biodiversity Registers (PBRs), as well as the implementation of traditional knowledge throughout the country, is necessary Jasmine et al. (2016).

The aims and actions include integration at the national and regional level to improve cross-border mediation, policy interpretation, and national cooperation. “The Department of Ayurveda” under the “Ministry of Health and Family Welfare” made a team with the CSIR from the Ministry of Science and Technology to launch the “Traditional Knowledge Digital Library (TKDL)”(www.tkdl.res.in). This digital library is a special project by the Government of India designed to (i) safeguard traditional knowledge and (ii) stop its misuse by breaking down language and format barriers, while also making this knowledge available to patent examiners in five additional languages Jasmine et al. (2016).

METHODOLOGY

The research methodology that is utilized in this study is qualitative, interpretive research based on an interdisciplinary lens of political ecology and sustainability science to explore the application of Indigenous Knowledge Systems (IKS) in sustainable ecological stewardship within the Indian Himalayan Region (IHR). Owing to the context-specific, experiential, and culturally embedded nature of indigenous knowledge, a qualitative method is most appropriate to capture the complex community-environment interactions. This research relies mainly on secondary sources of information—peer-reviewed articles, ethnographic studies, policy papers, government publications, and institutional reports on Himalayan ecology, indigenous practices, and sustainable development—that have been systematically retrieved from Scopus, Web of Science, JSTOR, and Google Scholar.

The discussion is based on the case-based evidence that has been specifically chosen to cover diverse ecological regions of Western, Central, and Eastern Himalayas and concentrates on the traditional behavior in the realms of agriculture, water management, and preservation of biodiversity. Thematic analysis was used to analyse the data to develop common patterns in terms of ecological resilience, resource governance, and knowledge transmission. Political ecology analytical lens stimulated the critical review of power relations and policy marginalisation, and sustainability science facilitated the review of adaptive capacity and long-term ecological sustainability. The issue of ethics was upheld by the fact that the indigenous knowledge was found in a respectful manner. Despite the use of secondary sources, the methodology does offer a sound structure through which the relevance of Himalayan indigenous wisdom in the modern context can be understood.

FINDINGS AND DISCUSSION

This study's findings indicate the crucial significance of Indigenous Knowledge Systems (IKS) in supporting sustainability, biodiversity protection, as well as climate resilience in the IHR. The findings of the study are presented in this part along with a discussion of their implications for sustainable development through an examination of traditional ecological practices in agriculture, water management, and biodiversity preservation.

ROLE OF IKS IN BIODIVERSITY CONSERVATION

Usually, each and every village had notional areas of woods and alpine meadows, and resource usage within these 'common lands' was determined by community's consent. Indigenous tribes have long practiced biodiversity conservation, especially in developing nations. The knowledge of the use of Phyto-resources can be useful in a significant way in preserving some species, including endangered species Negi et al. (2018). Due to its high dependence on natural resources, the IHR is more predominant in the traditional knowledge systems and practices. The local people in the region have a strong spiritual and cultural heritage and have developed a symbiotic relationship with nature Vidyarthi et al. (2013). The people in the area more or less rely on traditional ecological knowledge as a means of sustaining and controlling the forest resources to maintain ecological balance. The indigenous ways of biodiversity conservation portray forests as sacred forests, holy forest patches, or sacred groves. When a forest or a patch of forest is devoted to a local deity, then, automatically, the biodiversity of the area is preserved Negi and Maikhuri (2013). There have been reports of about 5800 holy groves in IHR, with 5000 of those being in Himachal Pradesh alone Sharma and Kumar (2021).In the IHR, sacred groves and woods are home to a variety of endangered, rare, and unique plant species in addition to significant wildlife. A research conducted in Uttarakhand revealed that the sacred groves and woodlands were home to rare, endangered, and endemic kinds of medicinal plants (MPs) Negi et al. (2018). With 343 plant species—at least 50 of which are medicinal—the Tark Eshwar holy Forest in Uttarakhand is among the greatest examples of a holy forest. One of Uttarakhand's oldest sacred groves, Hariyali Devi SG is renowned for its abundant floral and faunal variety; around 80 plant species from 44 families are said to have significant economic significance Singh et al. (2017).

Table 1

Table 1 Indigenous Knowledge Systems and Biodiversity Conservation Practices in the Indian Himalayan Region

Indigenous Practice	Region/State	Key Conservation Mechanism	Biodiversity Outcomes	Notable Sources
Sacred Groves (Devta Ban / Bugyal)	Himachal Pradesh and Uttarakhand	Deity-led governance: Strict taboos against felling green wood or wearing leather inside the grove.	High carbon sequestration; protection of Quercus (Oak) and Cedrus deodara (Deodar) stands.	Negi and Maikhuri (2013), Sharma and Kumar (2021)

Tarkeshwar Sacred Forest	Pauri Garhwal, Uttarakhand	Zonal protection: Total ban on extraction within a defined radius of the temple.	Home to 343 plant species; crucial micro-watershed for local springs.	Negi et al. (2018)
Zabo System	Phek District, Nagaland	Integrated resource management: Combining Forest preservation, water harvesting, and organic farming.	Preservation of indigenous paddy varieties and local fish species; soil erosion control.	Singh et al. (2018)
Apatani Integrated Land Use	Ziro Valley, Arunachal Pradesh	Community-enforced agroforestry: High-efficiency nutrient cycling without chemical inputs.	Conservation of Pinus wallichiana and high-altitude bamboo; sanctuary for migratory birds.	Sundriyal et al. (2002)
Van Panchayats	Uttarakhand	Democratized forest councils: Rules for lopping, grazing, and fire protection set by villagers.	Stabilized forest cover; recovery of non-timber forest products (NTFPs) like Rhododendron.	Sati (2023)
Monpa Sorig (Sowa Rigpa)	Tawang, Arunachal Pradesh	Amchi (Traditional Medicine): Sustainable harvesting cycles for high-altitude herbs.	Protection of Aconitum and Picrorhiza kurroa (vulnerable medicinal herbs).	Tsering et al. (2017)

Over 40,000 hectares of natural forest land are covered by the holy groves in the five northeastern Indian states of Arunachal Pradesh, Assam, Manipur, Meghalaya, and Sikkim Upadhyay et al. (2019). The use of forest resources for religious purposes is permitted when people are in need. Hence, the conservation and sustainable use of the forest ecosystem in Uttarakhand by means of sacred forests and sacred groves are important, and it is aligned with the main objectives of the Convention on Biological Diversity of 2021. Another form of forest management that is equally important is Van Panchayats or community forests, which play a significant role in maintaining the ecological balance, biodiversity conservation, and reduction of poverty in Uttarakhand Germain et al. (2018). To protect and manage the forest, there must be councils; these councils will look after the harvesting of wood, fodder, as well as Non-Timber Forest Products (NTFPs). This will help to use forest resources in a responsible way Pande et al. (2022). The Van Panchayats have been instrumental, playing a great role in biodiversity conservation and preventing deforestation. Indigenous societies in their area made unwritten laws that govern their forest, which in turn get long-term benefits from the forest. Studies indicate that over 500 million people are actively taking part in community-managed forests Niraula and Pokharel (2016).

ROLE OF IKS IN WATER HARVESTING AND MANAGEMENT

In the Himalayas, water is an essential resource for daily life and agriculture. The goal of indigenous water management techniques is to harvest and distribute water resources fairly among community members while making the best use of limited supplies. The indigenous communities of Kumaon region in Uttarakhand have IK to collect rainwater to use water throughout year for drinking and irrigation. This approach gave rise to traditional water management practices. Guhls and Kuls (Irrigation Canals): For generations, indigenous irrigation systems known as Guhls or Kuls have diverted water from mountain streams to agricultural areas in Himachal Pradesh and Uttarakhand Rawat and Sah (2009). These locally constructed, community-managed systems are intended to decrease soil erosion, cut down on evaporation, and preserve water. Besides watering crops, guls also powered Gharats—our local water mills—and provided drinking water. In some spots, we first dam the stream's flow to form the irrigation canal. For irrigating fields using a Gul or Kul, we build a small dam called Baan in our local tongue, or Kulayana in the Kumauni dialect.

Figure 2

Figure 2 Traditional Gul (Kul) Irrigation System in the Western Himalayas
Source: https://ecoheritage.cpreec.org/traditional-knowledge-of-water-management-in-kumaon-himalaya/

As for Khal, it's all about gathering rainwater in the big natural dips you find across the hills. They are often found in the saddle between two crests on top of mountains Prasad and Sharma (2019). Occasionally, little ponds are also excavated to catch rainfall. Water that has collected in Khals is utilized for irrigation during the lean time.

Figure 3

Figure 3 Indigenous Rainwater Harvesting System Khals in the Himalayan Region
Source: https://ecoheritage.cpreec.org/traditional-knowledge-of-water-management-in-kumaon-himalaya/

Jhora (Water Channelling Systems): In Sikkim and Darjeeling, indigenous water channelling systems called Jhora are utilized to gather and store monsoon water for cultivation and drinking Bhatt et al. (2024). These systems, which are frequently maintained by the community as a whole, are essential in ensuring water supply during times of drought. Dhara is a popular drinking water source that is found in both valleys and mountain crests Bhandari and Kaur (2023). Naula is meant to gather water from underground springs. These springs have extremely delicate flows that can be disrupted by water flowing via carved outlets from a spring or underground source Sah (2023).

Dhaan: Water gathered from tiny and huge streams gives the form of a lake. Irrigation and animal bathing are two uses for the collected water Rawat and Sah (2009). The IHR a home to several groups of people that hold springs, lakes, and rivers in high regard.

These bodies of water are frequently protected by traditional conservation practices that limit excessive usage or contamination. For instance, the Lepcha people in Sikkim preserve holy lakes by enforcing customs and restricting the use of water Joshi et al. (2023).

The Apatani Zaro tribes in the lower Subansiri district of Arunachal Pradesh have a system that gathers both surface water and groundwater to irrigate their fields Singh (2023). The Apatani people make bamboo frames to support earthen dams, about 0.6 meters tall, which split the valleys into neat plots. Each plot features an exit on one side and an inlet on the opposite side, with the inlet of a lower plot doubling as the exit for the one above it. There are deeper channels linking these intake and output points by simply opening or closing the inlets and outlets points whenever necessary; they can flood the terraced plots with water or let it drain away from their plots. To capture stream water, they build sturdy walls—2 to 4 meters high and 1 meter thick—along the forested hillsides. From there, a network of channels carries the water down to their fields.

Zabo: The north-eastern Indian state of Nagaland uses the Zabo method, which translates to "impounding run-off." Also referred to as the Ruza system, it integrates agriculture, forestry, and animal care with water conservation Negi et al. (2023).

Figure 4

Figure 4 Ruza: Indigenous Rainwater Harvesting Practice in Nagaland

Source: https://india.mongabay.com/2023/08/ruza-a-traditional-water-harvesting-system-for-the-water-scarce-mountains/

Cheo-ozihi: The Mazi River passes through the Angami settlement of Kwigema in Nagaland Bhattacharya (2015). A very long canal carries river water downstream, feeding into a network of smaller channels that branch off from it. Bamboo pipes are often used to guide the water toward the terraces. One of these channels is called Cheo-oziihi, which translates to "water." Cheo, the person responsible for designing this 8–10 km waterway with its many offshoots, oversaw its design Das et al. (2023). Numerous terraces in Kwigwema and a few terraces in the nearby community are irrigated by this creek. The village water budget is distributed among the three khels. Drip Irrigation with Bamboo: The Meghalaya's Indigenous communities have an Indigenous Knowledge technique for tapping stream and spring water by utilizing bamboo pipelines to irrigate farms Kumar and Madhukar (2019). To ensure the water resources in the IHR remain sustainable, these time-honoured water management practices show a deep understanding of the area's hydrology and climate.

ROLE OF IKS IN SUSTAINABLE AGRICULTURAL PRACTICES

The Himalayan people depend on agriculture as a source of their livelihood, and the traditional methods of farming have been adapted to suit the varying heights, slopes, and climates of the region. Traditional farming methods refer to the earliest methods of farming that traditional farmers have been using for a long period of time. These approaches are aimed at satisfying the current demands, as well as keeping in mind the future generations. This is why the antique agricultural experience of the indigenous people, namely seed keeping, is highly essential to maintain the agricultural diversity in the region Maikhuri et al. (2001). The knowledge related to biodiversity of the indigenous people has a vital place in the regional food security, as shown by the diversity of crops and landraces used in different IHR agricultural systems Negi and Maikhuri (2013). Repeated crop rotation and mix cropping, to utilize land to the optimum level and enhance the fertility of the soil, the farmers of the Himalayas often grow numerous different crops, such as barley, millet, pulses, and maize. The application of organic manure and the use of crop rotation methods maintain the health of the soil and also help farmers to decrease the use of chemical fertilizers Kumar et al. (2023). The fact that the indigenous knowledge system sustains agrodiversity is significant because of (i) Enhancing productivity of each piece of land, (ii) enhancing soil

health by incorporating legumes, (iii) reducing the financial losses associated with the crop against peststicide, fertiliser etc. (iv) improving yields per hectare, (v) expanding food choices, and (vi) preventing soil erosion Semwal and Maikhuri (2015).

Figure 5

Figure 5 Terrace Farming as an Indigenous Agricultural Practice in the Himalayas
Source: https://timesofagriculture.in/terrace-farming-in-india-step-farming-india/

Within the Indian Himalayan Region (IHR), there are high slopes and limited flat surfaces for the same reasons, terrace farming is considered one of the best agricultural practices over there Rathore and Shashni (2023). Indigenous peoples have been doing terrace farming for a long time, in this method, they establish tiers of fields on steep slopes to prevent soil erosion and make sure that more land can be cultivated. The terraces help to retain the water, avoid runoff, and create microclimates that favor farming. The most common type of agricultural practices in Meghalaya is the terrace farming with bamboo drip irrigation, and Nagaland has the ZABO system as well as all-aldar-based farming Jeeva et al. (2006).

Figure 6

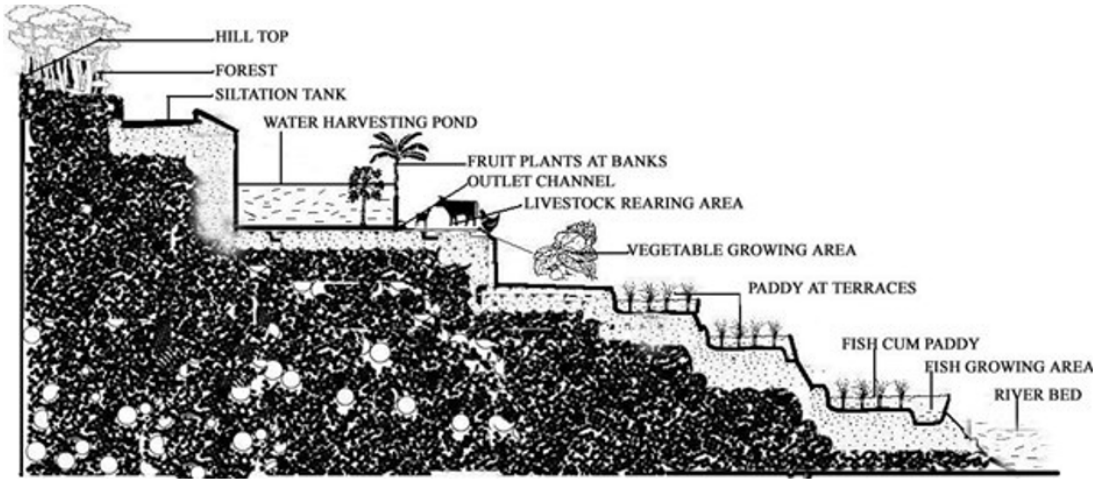

Figure 6 Illustration of Land Management in Zabo Farming System
Source: Singh et al. (2012)

The Apatani people practice an advanced agri-aquaculture system, which is typified by wet rice and pisciculture, which is cultivated at elevated altitudes alongside the valley landscapes (approximately 1600 m). The practice is based on the high level of annual precipitation in the area of 1700 mm and is supported by a complicated system of hydrological springs and streams Bhattacharya (2015). The Apatani keep the landscape very productive and ecologically balanced by sustaining gentle slopes so as to maximize water retention and nutritious flow Bhattacharya (2015).

Figure 7

Figure 7 Indigenous Apatani Fish–Paddy Sustainable Farming Practice, Arunachal Pradesh
Source: https://dics.co/current-affairs/arunachals-apatani-tribe

Many of the Indigenous communities in the Himalayas cultivate a wide variety of traditional crops, which are more adapted to the local climate. Preserving such varieties of crops can improve the agro-biodiversity of the region and also help people cope with changing weather conditions Rajpurohit and Jhang (2015). Forest litter is traditionally used as bedding in cow barns, and a combination of litter and bovine excrement is used as manure in agricultural fields Blume and Leinweber (2004). Jhum is an agricultural method that is practiced by tribal communities in some parts of the Eastern Himalayas, which involves the rotation of crops across various parcels of land that enables soil health to be rejuvenated when the areas are not under crop production Paul et al. (2017). In order to maintain the soil moisture and retain the natural soil structure, farmers in certain regions apply zero or low tillage to prevent the disruption of the soil, this ensures that the microbial activity of the soil remains intact and decreases soil erosion Singh et al. (2019). Himalayan farmers avoid the use of chemical pesticides to protect their crops against pests and diseases; they have alternatives that are made from natural products such as neem leaves, cow urine, and other treatments based on plants Das et al. (2019). The farmers also use agricultural waste, leaves, and plant remains as mulch to cover the soil. Mulching enhances moisture retention and decreases the growth of weeds and supplies organic material to the soil when it decomposes Singh et al. (2019). The Himalayan indigenous agricultural systems are very few, but very resilient and sustainable. They emphasize considerably the need to have a balance between the conservation of natural resources and the production of food.

CONCLUSION

The present rate of development has inflicted irreversible damage to the Himalayan ecosystems, which are no longer able to supply products and services for regional survival. Moreover, modern usage patterns have brought forth a new way of life that transcends numerous cultural and ethnic lines, most of which are exploitative in nature. The mainstream of people, without their knowledge, has increased the rate of homogeneity, and this has made our systems prone to abuse and eventual degradation of the natural resources in the future. The indigenous knowledge, which is grounded in cohabitation and communitarianism, has developed according to the climate and natural environments.

This study has demonstrated that far from being obsolete, IKS—such as the integrated rice-fish agriculture of the Apatani, terrace farming, the sophisticated Zabo water management systems, Gul or Kul for water harvesting in western Himalaya, Jhora, water channelling systems in Sikkim and Darjeeling, and the community-led biodiversity conservation within sacred groves, van panchayat of Uttarakhand, and Monpa Sorig (Sowa Rigpa) from Tawang, Arunachal Pradesh, and many more systems provide realistic, low-impact models for sustainable environmental governance.

IKS shown great character while coping with ecological degradation, but has still not been given proper space in the mainstream, so that slowly-slowly breakingdown these cultural frameworks that support them. Indigenous knowledge systems can play a key role in global sustainability efforts, that's why these systems need to be protected. When thinking about more affluent developmental paths, it means there is a need for a transdisciplinary synthesis that paves the way for deep collaboration between stakeholders, policymakers, and Indigenous knowledge-practitioners, and such a synthesized approach is necessary to arrive at truly effective environmental governance and sustainability.

REFERENCES

Aayog, N. (2018). Contributing to Sustainable Development in the Indian Himalayan Region. NITI Aayog.

Bhandari, S., and Kaur, H. (2023). Conservation Strategies for the Traditional Water Systems: A Case of Almora City, Uttarakhand. Journal of the Institution of Engineers (India): Series A, 104(4), 807–817. https://doi.org/10.1007/s40030-023-00759-0

Bhatt, H., Jugran, H. P., and Pandey, R. (2024). Cultural Ecosystem Services Nexus with Socio-Cultural Attributes and Traditional Ecological Knowledge for Managing Community Forests of Indian Western Himalaya. Ecological Indicators, 166, 112379. https://doi.org/10.1016/j.ecolind.2024.112379

Bhattacharya, S. (2015). Traditional Water Harvesting Structures and Sustainable Water Management in India: A Socio-Hydrological Review. International Letters of Natural Sciences, 37. https://doi.org/10.56431/p-a84p4z

Blume, H., and Leinweber, P. (2004). Plaggen Soils: Landscape History, Properties, and Classification. Journal of Plant Nutrition and Soil Science, 167(3), 319–327. https://doi.org/10.1002/jpln.200420905

Das, A., Gujre, N., Devi, R. J., Rangan, L., and Mitra, S. (2023). Traditional Ecological Knowledge Towards Natural Resource Management: Perspective and Challenges in North East India. In Sustainable Agriculture and the Environment (275–294). Elsevier. https://doi.org/10.1016/B978-0-323-90500-8.00019-1

Das, K., Sinha, T., and Prasad, S. N. (2019). Conservation of Plant Biodiversity Through Indigenous Knowledge in Rural Household: A Review. International Journal of Current Microbiology and Applied Sciences, 8(6), 1934–1943. https://doi.org/10.20546/ijcmas.2019.806.231

Gadgil, M., Berkes, F., and Folke, C. (1993). Indigenous Knowledge for Biodiversity Conservation. Ambio, 22, 151–156.

Germain, R., Ghosh, C., and Jayasuriya, M. (2018). Community Forestry in the State of Uttarakhand, India: Not Meeting the Needs of the Villagers. Small-Scale Forestry, 17, 225–242. https://doi.org/10.1007/s11842-017-9384-z

Ingty, T. (2017). High Mountain Communities and Climate Change: Adaptation, Traditional Ecological Knowledge, and Institutions. Climatic Change, 145(1), 41–55. https://doi.org/10.1007/s10584-017-2080-3

Jasmine, B., Singh, Y., Onial, M., and Mathur, V. B. (2016). Traditional Knowledge Systems in India for Biodiversity Conservation. [Journal information incomplete], 15(2).

Jeeva, S. R. D. N., Laloo, R. C., and Mishra, B. P. (2006). Traditional Agricultural Practices in Meghalaya, North East India. [Publication Details not Provided].

Joshi, M., Luitel, K., Barfal, S. S., Kuniyal, J., and Pande, K. (2023). Significance of Indigenous Knowledge Systems in Water Conservation and Management: A Study from Sikkim Himalaya. In Traditional Ecological Knowledge of Resource Management in Asia (159–174). Springer. https://doi.org/10.1007/978-3-031-16840-6_10

Junaid, D., Prajapati, V., Chauhan, R., Dhodi, K., and KC, J. (2024). Analysing Tourism Research in the Indian Himalayan Region to Identify Gaps and Propose Sustainable Development Strategies. Journal of Mountain Research, 19(1), 285–297. https://doi.org/10.51220/jmr.v19-i1.30

Kumar, A., and Madhukar, A. (2019). Management of Traditional Water System and Their Conservation in North Eastern Region Through Local Traditional Wisdom. AIP Conference Proceedings, 2142(1). https://doi.org/10.1063/1.5122648

Kumar, A., Saha, S., Layek, J., Babu, S., Kumar, R., Choudhary, A. K., and Das, A. (2023). Organic Farming in Indian Himalayan Region: Innovations for Sustainability. Indian Journal of Agronomy, 68, 36–51.

Kumar, P., Sharma, P. K., Kumar, P., Sharma, M., and Butail, N. P. (2021). Agricultural Sustainability in Indian Himalayan Region: Constraints and Potentials. Indian Journal of Ecology, 48(3), 649–661.

Magni, G. (2017). Indigenous Knowledge and Implications for the Sustainable Development Agenda. European Journal of Education, 52(4), 437–447. https://doi.org/10.1111/ejed.12238

Maikhuri, R., Rao, K., and Semwal, R. (2001). Changing Scenario of Himalayan Agroecosystems: Loss of Agrobiodiversity, an Indicator of Environmental Change in Central Himalaya, India. Environmentalist, 21, 23–39. https://doi.org/10.1023/A:1010638104135

Nagahama, K., Tachibana, S., and Rakwal, R. (2022). Critical Aspects of People's Participation in Community-Based Forest Management from the Case of Van Panchayat in Indian Himalaya. Forests, 13(10), 1667. https://doi.org/10.3390/f13101667

Negi, V. S., and Maikhuri, R. K. (2013). Socio-Ecological and Religious Perspective of Agrobiodiversity Conservation: Issues, Concern and Priority for Sustainable Agriculture, Central Himalaya. Journal of Agricultural and Environmental Ethics, 26, 491–512. https://doi.org/10.1007/s10806-012-9386-y

Negi, V. S., Kewlani, P., Pathak, R., Bhatt, D., Bhatt, I. D., Rawal, R. S., Sundriyal, R., and Nandi, S. (2018). Criteria and Indicators for Promoting Cultivation and Conservation of Medicinal and Aromatic Plants in Western Himalaya, India. Ecological Indicators, 93, 434–446. https://doi.org/10.1016/j.ecolind.2018.03.032

Negi, V. S., Pathak, R., Sekar, K. C., Rawal, R., Bhatt, I., Nandi, S., and Dhyani, P. (2018). Traditional Knowledge and Biodiversity Conservation: A Case Study from Byans Valley in Kailash Sacred Landscape, India. Journal of Environmental Planning and Management, 61(10), 1722–1743. https://doi.org/10.1080/09640568.2017.1371006

Negi, V. S., Pathak, R., Thakur, S., Joshi, R. K., Bhatt, I. D., and Rawal, R. S. (2023). Scoping the Need of Mainstreaming Indigenous Knowledge for Sustainable use of Bioresources in the Indian Himalayan Region. Environmental Management, 72(1), 135–146. https://doi.org/10.1007/s00267-021-01510-w

Niraula, R. R., and Pokharel, B. K. (2016). Community Forest Management as Climate Change Adaptation Measure in Nepal's Himalaya. In Climate Change Adaptation Strategies—An Upstream-Downstream Perspective (101–120). Springer. https://doi.org/10.1007/978-3-319-40773-9_6

O'Neill, A. R., Badola, H. K., Dhyani, P. P., and Rana, S. K. (2017). Integrating Ethnobiological Knowledge into Biodiversity Conservation in the Eastern Himalayas. Journal of Ethnobiology and Ethnomedicine, 13, 1–14. https://doi.org/10.1186/s13002-017-0148-9

Pande, S., Pande, D., and Pande, I. D. (2022). Van Panchayats of Uttarakhand as Role Model for Community Forest Management. [Publication Details Not Provided].

Paul, S., Tripathi, A., Burman, R. R., Panggam, M., Ray, S., Kalita, N., Vanlalduati, R., and Singh, A. (2017). Jhum Cultivation and its Consequences on Forest and Environment in Eastern Himalayan Tract of India: A Participatory Assessment. Range Management and Agroforestry, 38(1), 121–126.

Prasad, C., and Sharma, R. (2019). Water Resources and Their Traditional Management in Kedarnath Valley of Garhwal Himalaya, India. International Journal of Hydrology, 3, 194–203. https://doi.org/10.15406/ijh.2019.03.00180

Rajpurohit, D., and Jhang, T. (2015). In Situ and Ex Situ Conservation of Plant Genetic Resources and Traditional Knowledge. In Plant Genetic Resources and Traditional Knowledge for Food Security (137–162). Springer. https://doi.org/10.1007/978-981-10-0060-7_8

Ramakrishnan, P. (2007). Traditional Forest Knowledge and Sustainable Forestry: A North-East India Perspective. Forest Ecology and Management, 249(1–2), 91–99. https://doi.org/10.1016/j.foreco.2007.04.001

Rathore, S., and Shashni, S. (2023). Indigenous Knowledge System and Livelihood Option of Natives of Lahaul and Spiti District, Himachal Pradesh. In Climate Change Adaptation, Risk Management and Sustainable Practices in the Himalaya (213–235). Springer. https://doi.org/10.1007/978-3-031-24659-3_10

Rawat, A. S., and Sah, R. (2009). Traditional Knowledge of Water Management in Kumaon Himalaya. [Publication Details Not Provided].

Sah, R. (2023). Indigenous Water Knowledge: Religious Values and Cultural Practices. In Indigenous and Local Water Knowledge, Values and Practices (97–117). Springer. https://doi.org/10.1007/978-981-19-9406-7_7

Sati, V. P. (2023). Sustainable Forest Management in the Himalaya. Springer. https://doi.org/10.1007/978-3-031-21936-8

Semwal, R., and Maikhuri, R. (2015). Valuing Traditional Agrobiodiversity for Sustainable Development in Uttarakhand. In Ecosystem Services and its Mainstreaming in Development Planning Process (92–114). [Publisher Not Provided].

Sharma, A., Shashni, S., and Rathore, S. (2023). Traditional Knowledge System for Sustainable Agriculture Practices of Rural Communities of North-Western Himalaya, India. In Traditional Ecological Knowledge of Resource Management in Asia (191–210). Springer. https://doi.org/10.1007/978-3-031-16840-6_12

Sharma, S., and Kumar, R. (2021). Sacred Groves of India: Repositories of a Rich Heritage and Tools for Biodiversity Conservation. Journal of Forestry Research, 32(3), 899–916. https://doi.org/10.1007/s11676-020-01183-x

Shruthi Gopirajan, A. T., Kumar, P., and Joshi, P. K. (2022). Unraveling the Complex and Dynamic Himalayan Socio-Ecological Systems: A Systematic Review. Environment, Development and Sustainability, 24(2), 1532–1559. https://doi.org/10.1007/s10668-021-01527-5

Singh, N. C. (2023). Sustainable Natural Resource Management Through Traditional Ecological Knowledge: A Perspective on the Role of Apatani Tribal Women, Arunachal Pradesh. In Traditional Ecological Knowledge of Resource Management in Asia (239–259). Springer. https://doi.org/10.1007/978-3-031-16840-6_14

Singh, R. J., Deshwal, J., Sharma, N., Ghosh, B., and Bhattacharyya, R. (2019). Effects of Conservation Tillage Based Agro-Geo-Textiles on Resource Conservation in Sloping Croplands of Indian Himalayan Region. Soil and Tillage Research, 191, 37–47. https://doi.org/10.1016/j.still.2019.03.012

Singh, R. K., Hannah, K., Asangla, A., Bharali, R., and Borkotoky, D. (2018). Zabo: A Time-Tested Integrated Farming System Practiced by Chakhesang Tribe of Nagaland. Indian Journal of Hill Farming, 31(1).

Singh, R. K., Singh, V., Rajkhowa, C., and Deka, B. C. (2012). Zabo: A Traditional Way of Integrated Farming. In B. C. Deka et al. (Eds.), Resilient Shifting Cultivation: Challenges and Opportunities (114–117). [Publisher not Provided].

Singh, S., Youssouf, M., Malik, Z. A., and Bussmann, R. W. (2017). Sacred Groves: Myths, Beliefs, and Biodiversity Conservation—A Case Study from Western Himalaya, India. International Journal of Ecology, 2017, Article 3828609. https://doi.org/10.1155/2017/3828609

Subba, J. (2009). Ingenious Agricultural Heritage Systems and Sustainable Agricultural Ecosystems Management in Sikkim. In Bio-Cultural Diversity and Sustainable Development in North East India: Status, Vision and Challenges (86). [Publisher not provided].

Sundriyal, R. C., Upreti, T. C., and Varuni, R. (2002). Bamboo and Cane Resource Utilization and Conservation in the Apatani Plateau, Arunachal Pradesh, India: Implications for Management. Journal of Bamboo and Rattan, 1(3), 205–246. https://doi.org/10.1163/156915902760184277

Tsering, J., Gogoi, B. J., Hui, P. K., Tam, N., and Tag, H. (2017). Ethnobotanical Appraisal on Wild Edible Plants used by the Monpa Community of Arunachal Pradesh. Indian Journal of Traditional Knowledge, 16(4), 626–637.

Upadhyay, K. K., Japang, B., Singh, N. S., and Tripathi, S. (2019). Status and Socio-Ecological Dimensions of Sacred Groves in Northeast India. Journal of Applied and Natural Science, 11(3), 590–595. https://doi.org/10.31018/jans.v11i3.2121

Vidyarthi, S., Samant, S. S., and Sharma, P. (2013). Traditional and Indigenous uses of Medicinal Plants by Local Residents in Himachal Pradesh, North Western Himalaya, India. International Journal of Biodiversity Science, Ecosystem Services and Management, 9(3), 185–200. https://doi.org/10.1080/21513732.2013.823113