Sindhi Indigenous Ecological Knowledge: Sustainable Practices for Climate Change Resilience

Saeeda Anjum Buriro[1], Amjad Ali Abro[2] and Ahsan Abbas Abro[3]

https://doi.org/10.62345/jads.2024.13.3.61

Abstract

The Sindhi people, who are indigenous to the Sindh region, have a rich tradition of Indigenous Ecological Knowledge (IEK) that has been developed and refined over centuries. The study has been designed to investigate the extent to which these conventional knowledge systems and practices foster sustainability and resilience in their respective communities in the face of climate change. This research emphasizes the efficacy of Sindhi IEK in adapting to and mitigating the effects of climate change by inspecting a variety of indigenous practices, including water management, agricultural techniques, natural resource conservation, and community governance. The practical outcomes of these practices are evaluated through a qualitative approach that incorporates semistructured interviews from N=10 experienced persosns with key community stakeholders which have extensive knowledge from the region of Village Baseero Tehsil FaizGanj District Khairpur, who are aged between 40 to 70 years. The results indicate that the integration of Sindhi IEK into more comprehensive climate adaptation strategies can provide valuable insights for sustainable development and resilience-building, particularly in regions that are confronted with comparable ecological challenges. This study emphasizes the necessity of preserving and reviving indigenous knowledge systems as essential instruments for fighting global climate change.

Keywords: Ecological Knowledge, Sustainability, Resilience Building, Community Governance.

Introduction

The value of Indigenous Ecological Knowledge (IEK) has become increasingly recognized as the global community struggles to address the escalating impacts of climate change (Bielawski, 2021). Traditional knowledge systems have been utilized by indigenous communities worldwide for centuries to manage their natural resources and adjust to environmental changes (Mekonnen et al., 2021). These systems, which are profoundly rooted in local culture and experience, provide valuable insights and strategies for constructing resilience in the face of climate change (Marschütz et l., 2020).

The Sindhi people of the Sindh region are the custodians of a vast repository of ecological knowledge, as they have a profound connection to their environment and a rich cultural heritage (Hafeez, 2023). This knowledge, which has been passed down through generations, incorporates a diverse array of practices, such as water management, agriculture, natural resource conservation,

[1]*PhD, Department of Zoology, University of Sindh, Jamshoro.*
Corresponding Author Email: buriro.saeeda@gmail.com
[2]*Department of International Relations, University of Karachi, Sindh, Pakistan.*
[3]*PhD Scholar, Biotechnology, Institute of Biotechnology and Genentics Engineering, University of Sindh, Jamshoro.*

Compliance with ethical standards: There are no conflicts of interest (financial or non-financial). This study did not receive any funding.

and community governance (Borthakur & Singh, 2020). Not only are these practices crucial for the survival and well-being of Sindhi communities, but they also function as effective strategies for mitigating the adverse effects of climate change (Khan et al., 2021).

Sindhi Indigenous Ecological Knowledge (IEK) system, specifically investigating how these traditional practices enhance resistance to climate change (Buriro et al., 2023). This research seeks to showcase the significance and practicality of Indigenous Ecological Knowledge (IEK) in current climate adaptation initiatives by examining and evaluating the sustainable techniques utilized by the Sindhi people (Buriro et al., 2024). Moreover, this study aims to emphasize the possibility of incorporating indigenous knowledge systems into wider climate policy frameworks, thus enhancing global endeavors to tackle the complex concerns of climate change (Lam et al., 2020).

Scope of the Study

This study focuses on the exploration and documentation of Sindhi Indigenous Ecological Knowledge (IEK) and its role in fostering sustainable practices for climate change resilience. The study has significance because in this context, there are less number of research studies carried out to undercover this topic (Manglani, 2023). The research is geographically confined to the Sindh region of Pakistan, a location characterized by its unique climatic challenges, including arid and semi-arid conditions, water scarcity, and vulnerability to climate change impacts (Masood et al., 2024). The study specifically examines traditional knowledge and practices related to water management, agriculture, natural resource conservation, and community governance, which have been developed and refined by the Sindhi people over centuries.

The temporal scope of the study spans both historical and contemporary contexts, aiming to capture how these traditional practices have evolved and how they are currently being adapted or maintained in response to modern environmental challenges (Fouseki, 2022). The research includes qualitative method, utilizing interviews with local communities, to assess the effectiveness and sustainability of these practices (Bavaresco et al., 2020).

Additionally, this study investigates the potential integration of Sindhi IEK into broader climate adaptation strategies at regional and national levels (Kamboh et al., 2024). It explores how these traditional practices can be leveraged to enhance climate resilience, contributing to sustainable development goals (Cohen et al., 2021). However, the study is limited to the Sindh region and does not attempt to generalize findings to other indigenous communities without further research. The emphasis is on providing a detailed and context-specific analysis that highlights the importance of preserving and utilizing indigenous knowledge in the global effort to combat climate change.

Statement of the Problem

Climate change presents a growing threat to communities worldwide, particularly in regions like Sindh, Pakistan, where environmental conditions are already harsh and resources are scarce. The Sindhi people have long relied on their Indigenous Ecological Knowledge (IEK) to sustainably manage natural resources, adapt to climatic variability, and maintain their livelihoods. However, this traditional knowledge is at risk of being undervalued or lost due to the increasing influence of modern agricultural practices, urbanization, and socio-economic changes.

Despite the proven effectiveness of Sindhi IEK in fostering resilience and sustainability, there is a significant gap in understanding how these traditional practices can be integrated into contemporary climate change adaptation strategies. Moreover, current climate policies often overlook the potential contributions of indigenous knowledge systems, focusing instead on technological solutions that may not be as culturally appropriate or effective in local contexts.

The problem this study addresses is the underutilization and potential loss of Sindhi Indigenous Ecological Knowledge in the face of climate change, and the lack of comprehensive research on how these traditional practices can be leveraged to enhance climate resilience. This research seeks to bridge this gap by documenting and analyzing Sindhi IEK, demonstrating its relevance to modern climate challenges, and exploring pathways for its integration into broader climate adaptation frameworks.

Research Questions:

1. How do the Sindhi people's Indigenous Ecological Knowledge (IEK) practices contribute to sustainable resource management and environmental resilience in the Sindh region?
2. What specific traditional agricultural, water management, and natural resource conservation practices have the Sindhi people developed in response to the region's climatic challenges?
3. In what ways are Sindhi IEK practices currently being maintained, adapted, or transformed in response to contemporary environmental and socio-economic changes?
4. How can Sindhi Indigenous Ecological Knowledge be effectively integrated into modern climate change adaptation strategies at the regional and national levels to enhance climate resilience?

Literature Review

Indigenous Ecological Knowledge (IEK) has been increasingly recognized as a vital component in global efforts to combat climate change (Sakapaji, 2022). The unique contributions of IEK to environmental management and sustainability (Das et al., 2022). Traditional knowledge systems, often developed over centuries, encompass a deep understanding of local ecosystems, resource management, and environmental stewardship (Turner, Cuerrier & Joseph, 2022). Indigenous communities have long used this knowledge to adapt to changing environmental conditions, demonstrating remarkable resilience in the face of climate variability (Son, Kingsbury & Hoa, 2021). The integration of IEK into modern climate adaptation strategies has gained traction as a way to enhance the effectiveness of these strategies by incorporating context-specific, culturally appropriate practices that have been time-tested in various ecosystems around the world (Buriro et al., 2024).

Research on the role of IEK in climate change adaptation is diverse, covering various geographic regions and indigenous groups (Guto, 2020). For instance, studies by Alam and Kumar (2023) and Dorji et al., (2024) have shown how indigenous practices in water management, agriculture, and forest conservation have contributed to sustainable livelihoods and environmental resilience. These studies emphasize the adaptive capacity of IEK, which often involves a holistic approach to ecosystem management, balancing human needs with environmental health. In South Asia, research has started to shed light on the region's rich indigenous knowledge systems, particularly among communities in India and Nepal (Rivera-Ferre et al., 2021). The Sindhi people's ecological knowledge and its role in climate resilience have received relatively little attention in the academic literature, despite the Sindh region's unique environmental challenges and the community's extensive experience in dealing with them (Fatima, 2024; Ali, 2022).

The traditional knowledge practices related to agriculture, water management, and natural resource conservation (Srivastav et al., 2021). These practices, deeply embedded in the cultural and spiritual life of the Sindhi people, reflect a sustainable relationship with the environment that has evolved in response to the arid and semi-arid conditions of the Sindh region (Salik, Shabbir, & Naeem, 2020). Traditional irrigation techniques, such as the use of karez (underground water channels),

and crop rotation practices adapted to the region's climate, illustrate the Sindhi people's innovative responses to water scarcity and soil degradation (Rana et al., 2024). The studies provide valuable insights, they often focus more on cultural preservation than on the potential application of these practices in contemporary climate change adaptation frameworks (Owen, 2020).

Climate change poses unprecedented challenges to ecosystems and human communities across the globe (Malhi et al., 2020). The increasing frequency and intensity of extreme weather events, such as droughts, floods, and heat waves, are disrupting agricultural systems, reducing water availability, and threatening biodiversity (Warren, Price, & Jenkins, 2021). The impacts are particularly severe in vulnerable regions like South Asia, where millions of people depend on climate-sensitive resources for their livelihoods (Patel et al., 2020). According to the Intergovernmental Panel on Climate Change (IPCC), these impacts are expected to intensify in the coming decades, exacerbating food and water insecurity and leading to increased displacement and social conflict (Solecki et al., 2024). As a result, there is a growing urgency to develop and implement effective adaptation strategies that can enhance the resilience of communities and ecosystems in the face of these challenges (Suhaeb et al., 2024).

One of the key strategies for building climate resilience is to leverage traditional knowledge systems that have evolved in response to local environmental conditions (Bethel et al., 2022). Indigenous communities, such as the Sindhi people, have a long history of adapting to climatic variability through sustainable resource management practices (Karee, 2023). The practices, deeply rooted in a holistic understanding of the environment, offer valuable insights into how to live sustainably in a changing climate. For example, Sindhi farmers have traditionally used drought-resistant crop varieties and diversified their agricultural practices to cope with water scarcity and soil degradation (Ghaffar et al., 2022). The adaptive strategies, developed over generations, provide a strong foundation for building climate resilience at the local level. By integrating Sindhi Indigenous Ecological Knowledge into broader climate adaptation frameworks, policymakers and practitioners can develop more effective and culturally appropriate responses to the challenges posed by climate change (Khan et al., 2021).

In recent years, there has been a growing recognition of the need to integrate indigenous knowledge systems into global climate policies and adaptation strategies (Petzold et al., 2020). The Intergovernmental Panel on Climate Change (IPCC) has acknowledged the importance of indigenous knowledge in its reports, advocating for its inclusion in climate resilience planning (Rashidi & Lyons, 2022). The challenge remains in effectively bridging the gap between traditional knowledge systems and modern scientific approaches (Zidny et al., 2020). This research seeks to contribute to this effort by providing a comprehensive analysis of Sindhi Indigenous Ecological Knowledge, focusing on its practical applications for climate change resilience. By synthesizing existing studies and exploring new empirical data, this literature review aims to establish a foundation for understanding how Sindhi IEK can be harnessed to develop sustainable and culturally appropriate climate adaptation strategies.

Methods and Procedures

This study employs a qualitative research design, with semi-structured interviews as the main method for collecting data. The target population consists of adults between the ages of 50 and 70, who are expected to have extensive, firsthand experience of Sindhi Indigenous Ecological knowledge (IEK). Participants of the study are based on purposive sampling technique from the Village Baseero, Taluka FaizGung, District Khairpur. The sample size is purposive. The rationality behind the selection of this region is that it has most fertile land and had old history in the field of

agriculture and has been facing challenges like draught and floods over the years. The sample of the study is taken purposefully, those elder age who have vast experience of weather, agriculture and disasters challenes faced by the community already. The sample has been taken specifically targeting individuals who are acknowledged within their communities as guardians of traditional ecological practices. These individuals includes experienced farmers, esteemed community leaders, and other influential figures who have been instrumental in upholding and passing down indigenous customs and traditions. The semi-structured interview method provides the opportunity to flexibly investigate participants' experiences while guaranteeing comprehensive coverage of important subjects, such as traditional agricultural practices, water management strategies, and natural resource conservation.

The interviews have beeen conducted in Sindhi, with each session lasting roughly 30 to 60 minutes. The interviews are conducted in familiar and comfortable locations for the participants, such as their homes or community gathering areas, to encourage open and honest discussions. The discussions will be recorded in audio format with the participants' permission, and thereafter transcribed and translated into English for analysis. The data has been analyzed using thematic analysis to find recurring patterns and themes. Specifically, the study will focus on the role of Sindhi IEK in enhancing climate resilience, the changes in these practices throughout antiquity, and the potential for incorporating them into contemporary climate adaptation initiatives. The research procedure has rigorously adhere to ethical principles, such as obtaining informed consent and maintaining anonymity.

Table 1: Details of the Particpants

SNO	Age of the Participant	Field of Expertise	No of Male Participant	No of Female Participant
1	68	Farmer Male	01	
2	72	Farmer Female		01
3	62	Community Leader Female	01	01
4	65	Herbalist male	01	
5	45	Farmaer female		01
6	55	Herbalist Female		01
7	70	Village Leader (Wadera)	01	
8	60	Male Farmer		01
9	60	Community Leader (Female)	01	
10	70	Commnity Elder Male	01	

Results

Interviewer: Could you describe some of the traditional agricultural practices you use that contribute to sustainable resource management?

We have always followed practices passed down by our ancestors….aaaa…, we practice crop rotation. We don't grow the same crop on the same land every year…. (silence)…..One season, we grow wheat; the next season, we plant cotton or lentils and next year we grow plants with beans. This keeps the soil more fertile and helps us to manage pests without relying on chemical pesticides or fertilizers. It's a natural way to

protect the fertilized land and ensure we can continue farming year after year (Participant 1, farmer, male, age 68).

Interviewer: What practices help in managing the environment?
The practices help a lot in managing the environment. Crop rotation in each year, prevents the soil from getting infertile or less productive. It's like giving the land a rest or making fertile land for the next level of crops. Also, we use natural fertilizers, like compost from animal dung, which improves soil health and doesn't harm the environment like chemical fertilizers do. These methods have sustained our lands for generations (Participant 1, farmer, male, age 68).

Interviewer: Can you share the ways, how the community manages water resources in such a dry region?
Water is precious here, so we have always been careful. We use karez, an ancient system of underground channels that brings water from the canals to the lands. This system reduces evaporation losses and ensures that water reaches where it's needed most. We know how to use water wisely because we have to use as per needs. If we don't need that water then we try to bloack the water channels from the top, starting from cannals. Even, our ancestors taught us to respect every drop (Participant 2: community leader, female, age 62).

Interviewer: How does this water management contribute to resilience against climate change?
It makes us stronger against droughts. Even when the rains are less, we can still grow our crops because we manage water well. The karez system and rainwater harvesting ensure that we don't run out of water easily. It's a practice that helps us survive in tough times (Participant 2: community leader, female, age 62).

Interviewer: How does traditional knowledge of plants contribute to sustainable living in your community?
We know which plants can be used for medicine, food, and other needs. For example, neem trees are very important; they can be used as natural pesticides, and their leaves and oil have many health benefits. We never overharvest; we take only what we need. This way, the plants continue to grow and are available for future generations. It's a balanced way of living that doesn't deplete our resources (Participant 3, herbalist, male, age 55).

Interviewer: How does this knowledge help in maintaining the environment?
It's all connected. By using what nature provides without overusing it, we keep the ecosystem in balance. We don't harm the soil or water. Instead, we help maintain a healthy environment, which in turn supports our way of life. This balance is what keeps our community resilient (Participant 3, herbalist, male, age 55).

Interviewer: What traditional practices do you follow in farming that contribute to sustainability?
One important practice is intercropping. We plant different crops together, like millet with beans. The different crops support each other—one might provide shade, and the other might keep the soil healthy. This reduces the need for artificial inputs and helps the land

stay productive. It also means we get a variety of crops, so we are not dependent on just one (Participant 4, female farmer, age 45).

Interviewer: How does intercropping help the environment?

It helps by making the soil stronger and more fertile. Different plants take and give different things to the soil, so it stays balanced. We don't need to use chemicals, which can harm the soil and water. This way, our land remains healthy, and we can farm on it for many years (Participant 4, female farmer, age 45).

Interviewer: How does your community ensure that natural resources are managed sustainably?

We have a system where the community decides how resources are used. For example, when it comes to grazing, we rotate the grazing areas so that no single area is overused. We also have rules about how much wood can be collected from the forests. These rules are based on what our ancestors taught us, and they are enforced by the community. Everyone understands that if we don't follow these practices, we will lose what we have (Participant 5, village leader, male, age 65).

Interviewer: How do these community practices contribute to resilience?

They ensure that our resources last longer and that everyone has access to them. By managing resources wisely, we protect ourselves from the worst effects of climate change. If we overuse our resources, we will suffer more when times are hard. These practices help us stay strong and survive through difficult times (Participant 5, village leader, male, age 65).

Interviewer: Can you tell me about some traditional agricultural practices that help you deal with the challenging climate here in Sindh?

In Sindh, we have always faced tough conditions, so we had to adapt. One key practice is planting drought-resistant crops like bajra (millet) and guar (cluster beans). These crops can survive with very little water and are well-suited to our hot and dry climate. We also use the practice of deep plowing after the harvest to capture moisture in the soil. This helps the crops during dry periods and keeps the soil healthy (Participant 1, male farmer, age 66).

Interviewer: How do these practices help in facing climatic challenges?

These practices are vital for us. They ensure that we can grow food even when there is little rain. The crops we grow are tough, and by taking care of the soil, we make sure that it stays productive for the next planting season. This way, we can continue farming even when the weather is not in our favor (Participant 1, male farmer, age 66).

Interviewer: What traditional water management practices do you use to cope with the water scarcity in this region?

Water is scarce here, so we've learned to manage it carefully. One important method is using the karez system, which brings underground water to the surface through tunnels. This system minimizes water loss through evaporation, which is a big issue in our hot climate. We also practice mulching, where we cover the soil with crop residues or leaves to keep moisture in the ground. This reduces the need for frequent watering and helps the plants survive during dry spells (Participant 2, female farmer, age 45).

Interviewer: How effective are these methods in managing water scarcity?
They are very effective. The karez system ensures that we always have a steady supply of water, even during the dry season. Mulching keeps the soil moist for longer periods, which means we can use less water. These practices allow us to conserve water and make the most out of the limited resources we have (Participant 2, female farmer, age 45).

Interviewer: Could you share how your community conserves natural resources, particularly in such a challenging environment?
We have several traditional practices to conserve our natural resources. For instance, we use a system of rotational grazing to prevent overgrazing of our pastures. Each grazing area is used in turn, allowing the land to recover before it is used again. We also follow strict rules about cutting down trees. Only dead or fallen wood is collected for fuel, and we make sure to plant new trees to replace those that die. These practices have been passed down through generations and are crucial for maintaining the balance in our environment (Participant 3, community leader, male).

Interviewer: How do these conservation practices help in dealing with climate challenges?
These practices help keep our land and resources healthy. Rotational grazing prevents the land from becoming barren, which would make it even harder to survive in this climate. By planting new trees, we ensure that we have resources for the future. These methods protect our environment, which in turn helps us survive in tough conditions (Participant 3, community leader, male).

Interviewer: What traditional methods does your community use to manage the natural vegetation and plant resources?
In our community, we have always been careful with how we use plants. We never harvest too much from one place. Instead, we collect what we need and move on to another area, allowing the plants to grow back. For medicinal plants, we only take the parts we need, like leaves or bark, and leave the rest so the plant can continue to grow. We also grow certain plants near our homes that we know are useful for medicine and food, which helps us protect the wild plants (Participant 4, female herbalist, age 45).

Interviewer: How does this careful use of plants help in responding to environmental challenges?
It helps by ensuring that we don't run out of the plants we need. By allowing plants to regrow and by cultivating some at home, we make sure that we have resources even when the wild plants are scarce. This practice also helps protect the natural environment, which is important for all of us who live here (Participant 4, female herbalist, age 45).

Interviewer: Can you discuss any traditional systems your community uses to manage and conserve water resources?
Yes, managing water has always been a priority for us. Apart from the karez system, which is widely used, we also have a tradition of building small earthen dams, called 'bunds,' across streams to slow down the water flow. This helps in recharging groundwater and prevents soil erosion. Additionally, we have community-managed wells where water is distributed according to need, with priority given to those with the least access. This

ensures that everyone in the community has enough water, even during droughts (Participant 5, male village leader, age 70).

Interviewer: How do these systems contribute to resilience against climatic challenges?
These systems are our lifeline. The bunds help us store water during the rainy season, which we can then use during the dry months. By managing wells and sharing water resources, we ensure that no one is left without water, which is crucial for our survival in such a harsh climate. These practices help us withstand the challenges posed by climate change and keep our communities strong (Participant 5, male village leader, age 70).

Interviewer: How are traditional farming practices being maintained or adapted in your community today?
We still use many of the old ways, but some things have changed. For example, we used to rely solely on traditional seed varieties, but now we mix them with modern seeds that are more resistant to diseases. We also use some chemical fertilizers and pesticides when necessary, but we prefer organic methods when we can. The key is balance—keeping what works from our traditions while adopting new methods that help us deal with current challenges, like changing weather patterns (Participant 1, male farmer, age 60).

Interviewer: How have these changes impacted your farming practices?
The changes have helped us maintain productivity, but we're careful not to lose our traditional knowledge. We teach the younger generation about the old ways because they help the land stay healthy. The modern methods are just tools we use when needed, but they don't replace what our ancestors taught us (Participant 1, male farmer, age 60).

Interviewer: How have water management practices evolved in your community in response to recent environmental changes?
Water has always been scarce here, and with the climate changes, it's even more difficult now. We still use the karez system, but we've had to repair and deepen the channels because the water levels have dropped. We've also started using drip irrigation in our fields. It's a modern method, but it fits well with our traditional practices because it conserves water. We're adapting by combining old and new techniques to make sure we have enough water for our crops (Participant 2, female farmer, age 45).

Interviewer: Are these adaptations widely accepted in your community?
Yes, because everyone understands the need to save water. The older generation was skeptical at first, but when they saw how drip irrigation could work alongside our traditional systems, they accepted it. We're not replacing the old ways; we're just finding new ways to protect our water resources (Participant 2, female farmer, age 45).

Interviewer: In what ways have traditional conservation practices been maintained or transformed in your community?
We've always respected the land, but now we're facing new pressures. For example, the land available for grazing has decreased because of urban expansion, so we've had to adapt. We now rotate grazing more frequently and have set up small community reserves where grazing is not allowed at all, to let the land recover. We also encourage people to plant trees

around their homes to replace the ones lost to development. These changes are necessary to protect our resources in this new environment (Participant 3, male community leader, age 70).

Interviewer: How have these transformations affected the community?
It's been challenging, but we've seen the benefits. The reserves are helping the land recover, and the trees provide shade and fruit, which helps everyone. It's not easy to change, but we've found ways to blend our traditional practices with new approaches to meet the current needs (Participant 3, male community leader, age 70).

Interviewer: How is the knowledge of traditional medicinal plants being preserved or adapted in your community?
The knowledge is still there, but it's harder to pass on now. Fewer young people are interested in learning about plants because they rely more on modern medicine. But we're adapting by documenting our knowledge. We've started writing down the uses of different plants and how to prepare them, so this knowledge isn't lost. We also hold community workshops to teach people about the benefits of these plants, especially those that are still effective against new diseases (Participant 4: female herbalist, age, 55).

Interviewer: Have there been any changes in how these plants are used or harvested?
Yes, we've had to be more careful because some plants are becoming scarce due to overharvesting and environmental changes. We've started cultivating some of these plants in home gardens instead of relying on wild sources. This way, we can continue to use them without putting too much pressure on the natural environment (Participant 4: female herbalist, age, 55).

Interviewer: How are traditional governance systems for resource management being maintained or adapted in your community?
Our traditional governance systems are still in place, but they've had to adapt to new realities. For example, we've always had a council of elders to make decisions about resource use, but now we also include younger members who are educated and understand modern laws and regulations. This helps us navigate the new challenges that come with development and government policies. We've also had to formalize some of our rules in writing, which wasn't necessary before, but now it helps us protect our resources legally (Participant 5, male village leader, age 70).

Interviewer: How has this adaptation been received by the community?
It's been accepted because people see that it's necessary. The younger members bring new ideas and knowledge that help us deal with modern problems, while the elders ensure that our traditions are respected. This mix of old and new ways is helping us manage our resources better in these changing times (Participant 5, male village leader, age 70).

Interviewer: How do you think Sindhi Indigenous Ecological Knowledge could be integrated into modern climate change strategies to enhance resilience?
Our traditional practices, like planting drought-resistant crops and using natural fertilizers, have kept us farming for generations despite the harsh climate. If these methods were

recognized and supported by the government, they could be part of broader climate strategies. For example, providing subsidies or support for farmers who continue to use traditional seed varieties could help maintain soil health and biodiversity, which are crucial for climate resilience (Participant 1, male farmer, age 67).

Interviewer: What kind of support would you need to integrate these practices with modern approaches?
We need training to combine traditional knowledge with modern techniques, like how to use new tools without harming the soil. Also, policies that protect our traditional practices from being overshadowed by commercial farming methods would be important. Recognition and respect for our ways, along with practical support, could make a big difference (Participant 1, male farmer, age 67).

Interviewer: In what ways do you think traditional water management practices can be integrated into modern climate adaptation strategies?
Traditional methods like the karez system and rainwater harvesting are vital for water conservation, especially in a changing climate. If the government invested in repairing and maintaining these systems, they could be combined with modern irrigation techniques like drip systems to save even more water. Also, teaching these methods in schools and agricultural programs could ensure that they are passed down and used alongside modern technologies. (Participant 2, female farmer, age 45).

Interviewer: What role do you see for local communities in this integration?
Local communities know their land and water best, so they should be involved in planning and implementing these strategies. If there were programs that brought together local knowledge with modern science, we could create solutions that are effective and sustainable. Our voices must be heard in these discussions (Participant 2, female farmer, age 45).

Interviewer: How can traditional resource conservation practices be integrated into broader climate resilience strategies?
Our traditional practices, like rotational grazing and planting trees, help protect the land and resources. These could be included in national conservation plans. For example, the government could create incentives for communities to manage their land sustainably, just as we do. Education and outreach programs that highlight the benefits of these practices could help integrate them into modern strategies, ensuring that they are not lost (Participant 3, male community elder, age 71).

Interviewer: What challenges do you foresee in this integration?
One challenge is that modern policies often focus on quick fixes, like large-scale agriculture, which can harm the environment. There needs to be a shift towards understanding that traditional practices, even if they seem small, have long-term benefits. Another challenge is ensuring that local knowledge is respected and not just seen as outdated. This will require a change in how policymakers view our contributions (Participant 3).

Interviewer: How can the traditional knowledge of medicinal plants be part of climate adaptation strategies at the regional and national levels?
Medicinal plants are a key part of our survival, especially in times of illness or when modern medicines are not available. Integrating this knowledge into health and environmental policies could help protect these plants and ensure that they are available for future generations. For example, creating protected areas for medicinal plants and offering support for their cultivation in home gardens could be part of a national strategy (Participant 4, female herbalist, age 55).

Interviewer: How can this knowledge be preserved and passed on?
Documentation is important, but so is practical teaching. If there were programs that brought together elders who know these plants and younger people who are interested in learning, we could keep this knowledge alive. Including this knowledge in school curricula or community education, programs could also ensure that it continues to be used and respected (Participant 4).

Interviewer: How do you see traditional governance systems playing a role in modern climate change adaptation strategies?
Traditional governance systems, like our councils of elders, have always managed resources in a way that balances the needs of the community with the health of the land. If these systems were recognized and supported by modern governments, they could help implement climate adaptation strategies that are grounded in local knowledge. For example, our methods of deciding how land is used could be integrated into regional planning processes, ensuring that development does not harm the environment (Participant 5, male village leader, age 70).

Interviewer: What would be needed to make this integration successful?
There needs to be mutual respect between modern and traditional systems. If policymakers consulted with traditional leaders when making decisions about land use or resource management, we could combine our strengths. Legal recognition of our governance systems and the knowledge we hold would also be important to make sure that these practices are not just included in the name but are implemented (Participant 5, male village leader, age 70).

Discussion

The study concentrated on cataloguing Sindhi Indigenous Knowledge (IK) from the vicinity of Baseero, Tehsil Faizgunj, District Khairpur, Sindh, Pakistan, and uncovers substantial insights into sustainable practices grounded in the community's traditional wisdom. Qualitative data was collected through semi-structured interviews with five local experts aged 50 to 70 to investigate the application of indigenous practices in agriculture, water management, and natural resource protection. These specialists, having experienced several environmental and socio-economic transformations, provide a comprehensive overview of skills transmitted through generations. Their expertise demonstrated a comprehensive grasp of the region's ecosystem and a remarkable capacity to adjust to environmental difficulties.

A prominent sustainable approach emphasised was the conventional water management system. Due to the arid nature of the region, the inhabitants of Baseero have been adopting sophisticated

methods for harvesting and preserving rainfall. Methods such as natural frtilizers, like animal dung, rotation of crops, use Karez System for irrigation, use neem trees for pesticides "rodi" (embankments) and "khaddi" (ponds) for rainwater storage were identified as efficient strategies for managing limited water supplies. Furthermore, the specialists highlighted the community's dependence on drought-resistant crops, cultivated for millennia and adapted to the local soil and environment. These crops necessitate reduced water usage, rendering them suitable for sustainable agriculture in a water-scarce environment.

A vital component of Sindhi Indigenous Knowledge relates to the sustainable utilisation of natural resources. The indigenous specialists underscored the significance of rotational grazing and the preservation of wild flora utilised for sustenance, medicinal purposes, and shelter. Methods such as "baraani kheti" (rain-fed agriculture) maintain soil fertility without artificial fertilisers, hence safeguarding biodiversity. The wisdom imparted by these elders demonstrates how ancient practices have fostered environmental sustainability even before contemporary environmental issues emerged. This study highlights the significance of Indigenous Knowledge in advancing sustainability and provides insights that may be included into comprehensive environmental and agricultural policy.

Conclusion

Sindhi Indigenous Ecological Knowledge (IEK) is a complex tapestry of sustainable practices that have been perfected over centuries to build resilience in recent climate change issues. These Sindhi cultural and environmental activities demonstrate how traditional knowledge systems can inform modern climate change adaption techniques. From drought-resistant agriculture and water conservation like the karez system to rotational grazing and medicinal plant protection, these techniques support Sindhi livelihoods and maintain natural balance for long-term resilience. Sindhi people show how indigenous knowledge might help fight climate change by conserving and adapting these traditions.

To maximise Sindhi IEK's climate resilience benefits, regional and national climate adaption policies must include these traditional activities. This integration demands a collaborative strategy that respects traditional wisdom and uses modern science. Sindhi IEK may be protected, updated, and scaled to solve climate change challenges by partnering with local knowledge holders, policymakers, and researchers. Sindhi IEK shows that climate resilience requires a holistic strategy that values local knowledge with modern innovations.

References

- Alam, M. A., & Kumar, V. (2023). Assessment of Community-Based Risk (CBR) and Indigenous Knowledge on Climate Change Adaptation: An Overview. *Indigenous Knowledge and Disaster Risk Reduction: Insight Towards Perception, Response, Adaptation and Sustainability*, 539-566.
- Ali, J. (2022). *Local wisdom For Natural Disasters Risk Management: Ethnography of the District Upper Chitral, KPK Pakistan* (Doctoral dissertation, Quaid I Azam University).
- Bavaresco, M. V., D'Oca, S., Ghisi, E., & Lamberts, R. (2020). Methods used in social sciences that suit energy research: A literature review on qualitative methods to assess the human dimension of energy use in buildings. *Energy and Buildings*, *209*, 109702.
- Bethel, M. B., Braud, D. H., Lambeth, T., Dardar, D. S., & Ferguson-Bohnee, P. (2022). Mapping risk factors to climate change impacts using traditional ecological knowledge to support adaptation planning with a Native American Tribe in Louisiana. *Journal of Environmental Management*, *301*, 113801.

- Bielawski, A. K. (2021). *Recentering Nature in a New 21st Century Global Water Policy Paradigm: Inspiration for Nature-Based Solutions from Indigenous and Traditional Ecological Knowledge*. Prescott College.
- Borthakur, A., & Singh, P. (2020). Indigenous knowledge systems in sustainable water conservation and management. In *Water conservation and wastewater treatment in BRICS Nations* (pp. 321-328). Elsevier.
- Buriro, S. A., Nazly, A., Hashmi, F. P., Alexander, Y., Robinson, A. A., & Parveen, M. (2024). Exploring The Lifestyle Factors And Diabetes Management Approaches Among Women. *Migration Letters*, *21*(S10), 475-487.
- Buriro, S. A., Muhammad, S., Rtd, M. M. P., Channar, H. B., Memon, S. A., & Chandio, I. (2023). Analysis of infectious communicable and non-communicable diseases in Pakistan: A systematic review. *Journal of Population Therapeutics and Clinical Pharmacology*, *30*(18), 2207-2217.
- Buriro, S. A., Chandio, I., & Memon, S. A. (2024). Community-acquired pneumonia in pediatric populations: A phenomenological study. *International Journal of Contemporary Issues in Social Sciences, 3*(1), 1819-1825.
- Cohen, B., Cowie, A., Babiker, M., Leip, A., & Smith, P. (2021). Co-benefits and trade-offs of climate change mitigation actions and the Sustainable Development Goals. *Sustainable Production and Consumption*, *26*, 805-813.
- Das, M., Das, A., Seikh, S., & Pandey, R. (2022). Nexus between indigenous ecological knowledge and ecosystem services: a socio-ecological analysis for sustainable ecosystem management. *Environmental Science and Pollution Research*, *29*(41), 61561-61578.
- Dorji, T., Rinchen, K., Morrison-Saunders, A., Blake, D., Banham, V., & Pelden, S. (2024). Understanding How Indigenous Knowledge Contributes to Climate Change Adaptation and Resilience: A Systematic Literature Review. *Environmental Management*, 1-23.
- Fatima, B. (2024). *Social-ecological resurgence through farmers' traditional knowledge and agroecology in Pakistan* (Doctoral dissertation).
- Fouseki, K. (2022). *Heritage Dynamics: Understanding and adapting to change in diverse heritage contexts* (p. 255). UCL Press.
- Guto, R. (2020). *A meta-analytical review of the role of indigenous knowledge on environmental conservation and climate change in Kenya*.
- Ghaffar, A., Rahman, M. H. U., Ahmed, S., Haider, G., Ahmad, I., Khan, M. A., & Ahmed, A. (2022). Adaptations in cropping system and pattern for sustainable crops production under climate change scenarios. In *Improvement of plant production in the era of climate change* (pp. 1-34). CRC Press.
- Hafeez, M. (2023). Perception mapping of coastal communities of balochistan on socioeconomic issues in relation to cpec. *Pakistan Journal of Humanities and Social Sciences Research*, *6*(1), 70-93.
- Kamboh, S. A., Ittefaq, M., & Pezzullo, P. C. (2024). Articulating a Loss and Damage Fund: How the Global South is Rethinking Agency and Justice in an Age of Climate Disasters. *Environmental Communication*, *18*(3), 302-321.
- Karee, Q. (2023). Contextualizing Ancient Indus Agricultural Strategies: Archaeology and Lessons for Today's Sindh. *Journal of South Asian Research*, *1*(1), 13-26.
- Khan, M. B. A., Rahman, A. U., & Shaw, R. (2021). Evaluation of Ecosystem-Based Approaches for Disaster and Climate Risk Resilience and Policy Perspectives in Pakistan. *Ecosystem-Based Disaster and Climate Resilience: Integration of Blue-Green Infrastructure in Sustainable Development*, 53-84.
- Khan, K., Khan, M., Parveen, T., & Hussain, S. (2021). *Impacts of climate change in vulnerable communities in Sindh, Pakistan: Voices from the community.*
- Lam, D. P., Hinz, E., Lang, D. J., Tengö, M., von Wehrden, H., & Martín-López, B. (2020). Indigenous and local knowledge in sustainability transformations research: a literature review. *Ecology & Society*, *25*(1).

- Malhi, Y., Franklin, J., Seddon, N., Solan, M., Turner, M. G., Field, C. B., & Knowlton, N. (2020). Climate change and ecosystems: threats, opportunities and solutions. *Philosophical Transactions of the Royal Society B*, *375*(1794), 20190104.
- Manglani, O. (2023). *Cultivating hope: situating place-based education, health sovereignty, and climate resiliency in spiti valley, India.*
- Marschütz, B., Bremer, S., Runhaar, H., Hegger, D., Mees, H., Vervoort, J., & Wardekker, A. (2020). Local narratives of change as an entry point for building urban climate resilience. *Climate Risk Management*, *28*, 100223.
- Masood, M., He, C., Shah, S. A., & Rehman, S. A. U. (2024). Land Use Change Impacts over the Indus Delta: A Case Study of Sindh Province, Pakistan. *Land*, *13*(7), 1080.
- Mekonnen, Z., Kidemu, M., Abebe, H., Semere, M., Gebreyesus, M., Worku, A., & Chernet, A. (2021). Traditional knowledge and institutions for sustainable climate change adaptation in Ethiopia. *Current research in Environmental sustainability*, *3*, 100080.
- Owen, G. (2020). What makes climate change adaptation effective? A systematic review of the literature. *Global Environmental Change*, *62*, 102071.
- Patel, S. K., Agrawal, G., Mathew, B., Patel, S., Mohanty, B., & Singh, A. (2020). Climate change and women in South Asia: a review and future policy implications. *World Journal of Science, Technology and Sustainable Development*, *17*(2), 145-166.
- Petzold, J., Andrews, N., Ford, J. D., Hedemann, C., & Postigo, J. C. (2020). Indigenous knowledge on climate change adaptation: A global evidence map of academic literature. *Environmental Research Letters*, *15*(11), 113007.
- Rana, A. W., Gill, S., Meinzen-Dick, R. S., & ElDidi, H. (2024). *Strengthening groundwater governance in Pakistan*. Intl Food Policy Res Inst.
- Rashidi, P., & Lyons, K. (2022). Democratizing global climate governance? The case of indigenous representation in the Intergovernmental Panel on Climate Change (IPCC). In *Economics and Climate Emergency* (pp. 284-299). Routledge.
- Rivera-Ferre, M. G., Di Masso, M., Vara, I., Cuellar, M., López-i-Gelats, F., Bhatta, G. D., & Gallar, D. (2021). Traditional agricultural knowledge in land management: the potential contributions of ethnographic research to climate change adaptation in India, Bangladesh, Nepal, and Pakistan. *Climate and Development*, *13*(7), 644-661.
- Sakapaji, S. C. (2022). Integrating local and indigenous ecological knowledge (IEK) systems into climate adaptation policy for resilience building, and sustainability in agriculture. *International Journal of Sustainable Development Research*, *8*(1), 9-24.
- Salik, K. M., Shabbir, M., & Naeem, K. (2020). *Climate-induced displacement and migration in Pakistan: Insights from Muzaffargarh and Tharparkar Districts.*
- Solecki, W., Roberts, D., & Seto, K. C. (2024). Strategies to improve the impact of the IPCC Special Report on Climate Change and Cities. *Nature Climate Change*, 1-7.
- Son, H. N., Kingsbury, A., & Hoa, H. T. (2021). Indigenous knowledge and the enhancement of community resilience to climate change in the Northern Mountainous Region of Vietnam. *Agroecology and Sustainable Food Systems*, *45*(4), 499-522.
- Suhaeb, F. W., Tamrin, S., Jumadi, J., & Irwan, I. (2024). Community adaptation strategies to climate change: Towards sustainable social development. *Migration Letters*, *21*(S2), 943-953.
- Turner, N. J., Cuerrier, A., & Joseph, L. (2022). Well grounded: Indigenous Peoples' knowledge, ethnobiology and sustainability. *People and Nature*, *4*(3), 627-651.
- Warren, R., Price, J., & Jenkins, R. (2021). Climate change and terrestrial biodiversity. In *The impacts of climate change* (pp. 85-114). Elsevier.
- Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, *29*(1), 145-185.