Role of local place-based knowledges in sustaining locally-led adaptation to climate change in Northern Vietnam

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Recommended citation: Ho Ngoc Son, Bui Tuan Tuan, Nguyen Dang Cuong, Patrick Nunn, Binaya Raj Shivakoti, (2025). Role of local place-based knowledges in sustaining locally-led adaptation to climate change in Northern Vietnam, Proceedings of International Conference "Advancing solutions for climate change challenges in rural Vietnam", 4-7 November, 2024, Thai Nguyen, Vietnam, Science and Technology Publisher, Hanoi, page 269-281.

DOI: 10.15625/vap.2025.0117

Abstract

Global strategies for adaptation to climate change that are based on western scientific knowledge often encounter difficulties being adopted in non-western contexts in the Asia-Pacific region. In the face of climate change, locally-led adaptation (LLA) has emerged as a promising approach, emphasizing the importance of local knowledge systems in building resilience. Vietnam is one of the most vulnerable countries to climate change impacts. Local communitie, especially ethnic minority groups have long relied on place-based knowledge to navigate environmental changes. This paper explores the role of local place-based knowledge in sustaining locally-led climate adaptation efforts in Vietnam. Through a combination of case study and interviews with local communities in a rural area of Vietnam, this paper provides empirical evidence a case study in Vietnam to show that, if adequately supported, LLA could form the basis for developing sustainable pathways of adaptation to climate-driven environmental change. In the case study, the ways in which climate change is currently affecting local environments are detailed, together with the ways in which local knowledge is currently deployed to counter these effects. The findings highlight the significant role of traditional knowledge in resource management, agricultural practices, and disaster risk reduction. The study further explores the challenges of integrating local knowledge into formal adaptation policies and offers recommendations for enhancing the effectiveness of locally-led adaptation in the country.

Key words: Locally led adaptation, local knowledge, climate change, adaptation, Vietnam

1. INTRODUCTION

Over the past few decades, the effects of climate change on global systems, especially those of critical importance to sustaining human livelihoods, have become increasingly evident. Largely through the work of the Intergovernmental Panel on Climate Change (IPCC), the growing implications of projected future climate change on these systems have reached a point where scientists are detecting regime shifts and irreversible shifts in natural systems that have profound implications for the drivers of livelihood sustainability[1-3]. Much of this research has focused on ocean and polar environments where the visibility of anthropogenic climate change is often clearest but there are clear signs that other places, especially in the Asia-Pacific region, are being affected by climate change in ways that need realistic future plans to assure their sustainable futures[4-5].

The global scientific community has developed solutions, framed within the western scientific tradition, for various climate-change challenges. The IPCC has been at the forefront of developing these 'global' solutions which have been disseminated to almost every country on earth, their national design and implementation strategies sponsored by several global agencies including the Global Environment Facility and the Green Climate Fund as well as the Asia-Pacific focused Asian Development Bank. Downscaling such global solutions to particular places and communities is often difficult because of the science-based nature of these solutions and the absence of adequate local-area data in which to ground them[6-7]. In addition, many groups of people in the Asia-Pacific region, especially its more rural parts, do not uncritically privilege western science in the ways that the sponsors of these solutions do, instead favouring their place-based traditional knowledges that helped sustain their ancestors in these places, often for millennia[8-9].

The differences between western science-based knowledge and traditional knowledge arise largely from the contrast in worldview of the sponsoring groups[10]. Western-trained scientists privilege rationalist understandings of the world while people who favour traditional knowledges privilege non-western explanations, often expressed through spiritual beliefs. Both groups argue that their understandings have successfully sustained human livelihoods in the past and will do so in the future. Recent calls for the merging of these knowledges to produce sustainable pathways for future livelihood development, especially in response to climate change, are based on the idea that both types of knowledge are indispensable for this purpose[11-12]. One example of how merged knowledges might underpin practical adaptation is the concept of locally-led adaptation in which local people lead the

design and roll-out of adaptation pathways at the heart of which lies traditional and local knowledge[13-14].

Locally-led adaptation involves community-driven efforts to mitigate the impacts of climate change, drawing from local knowledge, skills, and cultural practices. Place-based knowledge, or local ecological knowledge, encompasses the understandings and practices developed through centuries of interaction with specific environments. This knowledge includes insights into weather patterns, soil health, water resources, and natural hazards, which are invaluable for crafting targeted, effective adaptation measures[14]. The concept of locally-led adaptation to climate change also emphasizes the empowerment of communities to design and implement adaptation strategies that are relevant to their unique local contexts. This approach is grounded in the understanding that climate change impacts are not uniform and that local communities often possess the knowledge and capacity to respond effectively to environmental challenges. The importance of LLA has been recognized globally, as it fosters community ownership, enhances sustainability, and ensures that adaptation measures are contextually appropriate[15].

Vietnam is one of the countries most affected by climate change, with rising sea levels, increased rainfall variability, and extreme weather events such as floods and droughts[16-17]. These climatic shifts pose serious challenges to the livelihoods of rural communities, particularly in the agricultural sector, which supports a large proportion of the population. In response to these challenges, locally-led adaptation has gained prominence as a means of fostering resilience at the community level. Vietnam is home to a diverse array of ethnic minority communities, many of whom have developed specialized knowledge systems to manage their environments. These knowledge systems have been shaped by centuries of adaptation to the local landscapes, from the highland regions of the north to the coastal zones in the south. Practices such as terracing, agroforestry, and the use of traditional weather forecasting methods are just a few examples of the ways in which local communities have adapted to their environments. Despite the richness of this knowledge, it is often undervalued or overlooked in national policy discussions, which tend to prioritize technological and scientific approaches.

At the heart of LLA is the concept of local place-based knowledge, which refers to the environmental, cultural, and social understanding that communities accumulate through generations of living in a specific place. This knowledge often includes traditional farming methods, resource management practices, and coping strategies that have evolved in response to local climatic and ecological conditions. In Vietnam, ethnic minority communities have

developed a deep understanding of their environment, and their knowledge systems have been central to their survival and adaptation in a rapidly changing climate.

However, the concept of LLA lacks sufficient case studies to make it a credible option for policy-makers at both global and national scales[15]. In response, this paper provides empirical evidence from a case study in Northern Vietnam to show that, where adequately supported, LLA can form the basis for developing sustainable pathways of adaptation to climate-driven environmental change. It also identifies the key challenges associated with climate change in Vietnam, together with the major solutions to these challenges that have been proposed. It unpacks the differences between global and traditional knowledges and reviews their implications for future livelihood sustainability.

This paper explores the role of local place-based knowledge in sustaining locally-led adaptation to climate change in Vietnam. Through qualitative and quantitative research, this study provides insights into how local knowledge systems contribute to climate resilience and highlights the challenges and opportunities of integrating this knowledge into formal climate adaptation frameworks.

2. METHODOLOGY

2.1 Study area

The study was conducted in Van Ho district of Son La province (Figure 1). Van Ho Model Case Site (MCS) is a place to pilot locally led adaption principles. Van Ho was selected as a case study site because it is the project area for several development projects funded by development agencies and implemented by the Thai Nguyen University of Agriculture and Forestry and its partners since 2017. Under those projects, many climate change adaptation actions have been supported to increase community resilience. This study is to document and analyse local place-based knowledge in climate change adaptation.

Son La is a mountainous province in the Central Northwest of Vietnam. Son La province is also a relatively poor and underdeveloped mountainous area. Son La province is located in the tropical monsoon climate, bearing the common characteristics of the Northwest mountains: cold and dry winters and hot, humid summers with lots of rain. In the past years, Son La is regularly affected by floods, flash floods and landslides and drought. Assessment of climate change in Son La in recent years shows that the average annual temperature in areas in the province fluctuates in the range of 21-23°C, the average temperature between years tends to increase. Rainfall in Son La is unusual and heavy rains have occurred and become difficult to predict. Extreme weather events occur with increasing frequency and

impact. Van Ho is one of 4 poor and mountainous districts of Son La with an area of 97,984.00 ha consisting of 14 communes at the elevation of 800-1000m asl.

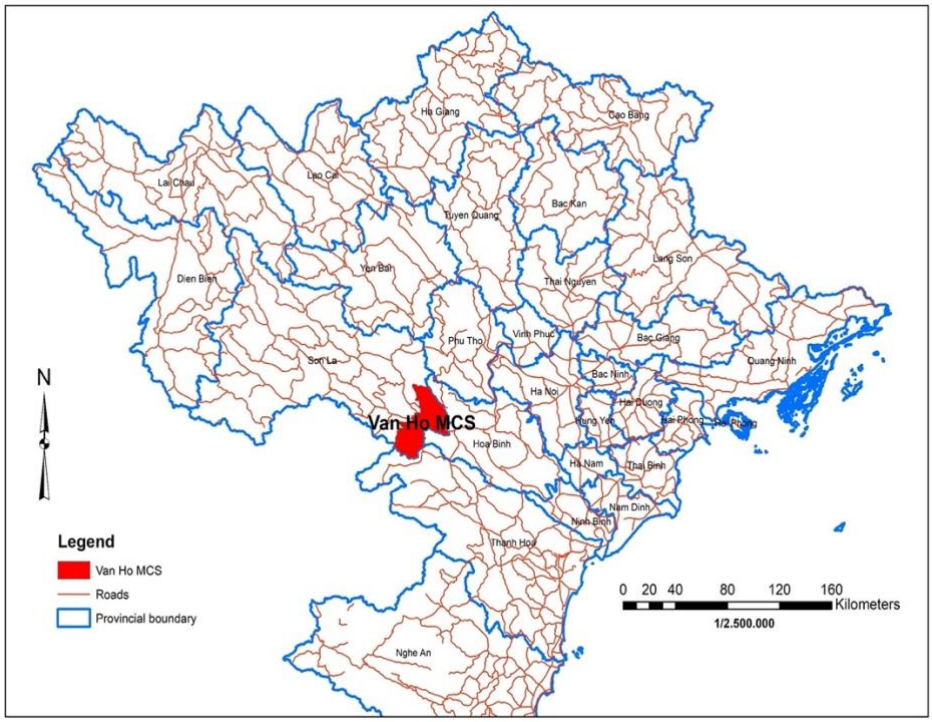

Figure 1: The map showing the location of Van Ho MCS

2.2 Data collection

Data were collected through a combination of interviews and focus group discussions with local farmers, community leaders, and local government officials in Chieng Yen commune, Van Ho district of Son La province from February to May 2024. The primary data collection methods included interviews and focus group discussions. In-depth interviews were conducted with 30 community leaders, local agricultural extension officers, and local knowledge holders. These interviews aimed to understand the ways in which traditional knowledge is used in climate adaptation and the challenges faced by communities in adapting to climate change. 05 focus groups of 7-10 persons were organized in each region to explore collective community-based strategies for climate adaptation and the role of local knowledge in these strategies.

2.3 Data analysis

Qualitative data were coded and analyzed thematically. Thematic analysis was employed to identify recurring patterns and key themes in relation to the role of local knowledge in climate adaptation.

3. RESULTS AND DISCUSSION

3.1 Climate risks and responses

Key concerns associated with climate change in the Northern Mountainous Region (NMR) of Vietnam are drought in dry the season (winter); soil erosion, landslides, and flooding in the rainy season (summer); and changing temperature regimes such as additional cold spells[17]. Climatic stresses most impact socially-marginalized and economically-disadvantaged communities, such as those in the upland areas of the Northern Mountainous Region (NMR)[18]. Ethnic minority residents of the Northern Mountainous Region comprise the majority of those living in poverty in this region. They typically live in the more remote areas, and their limited access to markets, services, and reliable transportation networks adds to their vulnerability[19]. Climate variability and weather extremes are already compromising efforts to improve living standards and to achieve millennium development goals set forth by the United Nations.

The main climate risks in the region are drought in the dry months (9-12), flood in rainy season (6-8), changing weather pattern causing difficulties in crop production planning. Changing weather patterns and increasing frequency of natural hazards such as droughts and storms are affecting local agricultural productivity. They are causing severe impacts on crops, livestock and fish and farm infrastructure and this significantly affects local livelihoods, food production and food security. The most vulnerable people in project area are the poor and ethnic minority people who expose to increasing climate risks and have limited adaptive capacity. In addition to climate stresses, the vulnerability of local communities is also determined by other social processes such as the poverty, inequality, unsustainable use of natural resources, poor infrastructure and pandemic such as Covid 19.

Given these challenges, adaptation strategies that draw on place-based knowledge are essential for developing responses that are not only effective but also sustainable in the long term. Livelihood diversification has been the main strategy adopted for living with climate variability and other stressors in the Van Ho area. The local population cultivates staple crops predominantly for their own consumption, but some also sell a proportion of what they produce. The diversity of economic portfolio gives greater flexibility to households for adjusting to change. In general, the biophysical factors of the mountainous environment have encouraged the local people to adopt multiple livelihood strategies and a variety of different agricultural production methods to support their subsistence.

For the majority of households in Van Ho District, mountain agriculture is their main source of income and sustenance. Farming practices have been adapted to the mountain

conditions and have shaped the environment to match livelihood requirements, as new fields were opened in the forests, hill faces were terraced, or fruit and forest tree plantations established. Our study found that the utilization of both timber and non-timber forest products provides a safety net and income for many households. They harvest wild fruits (e.g. Canarium and Dracontomelon), medicinal plants, and other non-timber forest products (e.g. honey) to sell to traders. Some people harvest herbal plants to sell to tourists who often stay in their villages. Forest products are extracted most during the off-peak crop season. Likewise, in times of crisis where drought or flood destroy crops and reduce household income, forest extraction increases significantly. Children and elderly people collect non-timber forest products regularly[17].

In addition, social cohesion, kinship, and social networks are strong in the rural areas of the NMR. These social networks are further tightened by the proliferation of local and non-governmental organizations and alumni associations. Nearly everyone in every village studied were related to each other in some way, on either the husband's or wife's side. Seeking help from relatives and neighbors is an effective mechanism to deal with idiosyncratic shocks such as the illness of a family member, accidents, or funeral costs[17].

3.2. Place-based knowledge and climate change adaptation in practice

3.2.1. Traditional agricultural practices

Agriculture in Van Ho district is shaped by the region's mountainous terrain and climatic variability. One of the most prominent place-based adaptations is terrace farming. By constructing terraces on mountain slopes, local farmers can reduce soil erosion, manage water resources more effectively, and prevent landslides. Terrace farming also enables the cultivation of rice and other staple crops, ensuring food security despite challenging environmental conditions. This practice is not only an adaptation to mountainous terrain but also a strategy for managing increasingly erratic rainfall patterns due to climate change. Local farmers in the study area also rely on some indigenous crop varieties such as local peanut, bean, pumpkin that are adapted to the region's conditions. These traditional varieties often have greater tolerance to drought, pests, and diseases compared to high-yield varieties. Maintaining and cultivating these crops allows communities to sustain agricultural productivity while conserving biodiversity. Such practices demonstrate the resilience that place-based knowledge brings to agriculture, especially in the face of climate uncertainties.

3.2.2. Community-based water management

Water scarcity is an escalating challenge in the northern mountainous region due to unpredictable rainfall and prolonged dry seasons. Local communities have developed place-

based water management practices that promote equitable distribution and efficient use of water resources. One such practice is the construction of small water storage ponds on terraced fields. These ponds collect rainwater during the wet season, providing a crucial water source during dry periods. The placement and maintenance of these ponds are informed by local knowledge of water flow, rainfall patterns, and soil composition, ensuring they are effective in managing water scarcity. Terrace farming is also widely used to maximize arable land on steep slopes while reducing erosion and preserving water. In addition, community-based water management systems are reinforced by social agreements on water sharing, where families and communities collectively manage and allocate water resources. Such systems prevent water-related conflicts and allow communities to adapt to changing water availability without requiring costly, external infrastructure. By fostering cooperation and resource-sharing, these traditional water management practices enhance resilience and promote social cohesion.

3.2.3. Forest and land conservation practices

For mountain communities in Vietnam, forests play a critical role in protecting against landslides, conserving biodiversity, and supporting livelihoods through non-timber forest products. Recognizing the importance of these ecosystems, local communities have implemented forest conservation practices based on traditional ecological knowledge. Thai ethnic groups in the region maintain sacred forests which are the areas of forest designated for spiritual practices and conservation. These sacred forests are strictly protected and often serve as biodiversity hotspots, preserving native plant and animal species that are essential for ecosystem health. They also practice agroforestry, food forests and mixed farming practices.

Farmers in the region are practicing agroforestry in different forms prioritizing local varieties and animal breeds for market preferences and biodiversity conservation purposes. Agroforestry, which is tree planting in combination with crops or pastures, is an integral part of nature-based solution approach. It is well known that tree planting can help restore biodiversity in agricultural landscapes, while increasing soil fertility by enhancing the accumulation of organic matter from decaying nature[20]. Agroforestry can also make agriculture more circular by reducing the dependency on chemical fertilizers and pesticides. As agroforestry reduces the need for inputs, it is more accessible for female farmers who often have less financial resources and limited access to credit, which can provide new opportunities for women's empowerment in the rural economy. In addition, the collection of firewood and fodder is primarily the task of women in rural areas around the world.

Agroforestry makes these products available on the farm and thus reduces the time spent by women on such activities, which can contribute to their empowerment. Farmers are trained to intercrop right species (tolerant crops, nitrogen fixing crops, medicinal plants) in the home gardens. For forest tree planting, projects led by Thai Nguyen University of Agriculture and Forestry support farmers to grow local species, multi-purpose trees such as Canarium, Cinamomum to maximize the benefits of the agro-forestry systems. By integrating trees with agricultural crops, agroforestry helps stabilize soil, regulate water flow, and enhance productivity, making it an effective adaptation strategy for mountainous regions.

In the Van Ho MCS, food forest models have been developed as nature-based solutions to food security and climate change resilience. Syntropic food forests have the potential to provide healthy food, sustainable livelihoods, quality environmental services, and spaces for education purposes, recreation and community activities[21]. Food forests are multifunctional agroforestry systems made of several plant layers of varying heights, including trees, shrubs, and groundcover plants. Syntropic farming adopts basic principles of carbon storage, microclimate regulation, biodiversity improvement, and creates livelihood opportunities. Unlike most modern agricultural systems that rely heavily on fossil fuels, herbicides, pesticides and fertilizers, the syntropic forest is a nature-based solution which is low-maintenance, helps to regenerate a natural ecosystem through combining forest trees with fruit, nut trees, shrubs, herbs and perennials in different layers. This combination creates a closed circulatory system, which does not need to add nutrients from the outside.

In the Van Ho MCS, households adopt mixed farming practices under food forest and agroforestry models. Particularly, farmers have been learned to intercrop maize and bean, growing red pea nuts in the one-crop rice land to adapt to drought and lack of water in the dry season. They also practice rice and duck farming systems. Experts from the Thai Nguyen University of Agriculture and Forestry guided farmers to mix different crops such as shade tolerant plants growing in the home gardens. Mixed farming implies a switch away from mono-crop agriculture to growing a set of interdependent crops where the cultivation of one creates favourable conditions for others. Crop diversity is seen as an effective strategy to improve soil fertility, enhance resilience of the production systems. Mixed farming that combines crop cultivation with animal husbandry offers additional opportunities to strengthen circular agriculture development.

In the Van Ho MCS area, households are supported to adopt circular agriculture practices which combine their local knowledge and scientific knowledge. Circular agriculture is an agricultural management concept that promotes the reuse of all resources that can be

used by the production system itself[22]. The integration of mixed crop-livestock and organic farming and agroforestry, is a key element of a circular agriculture model that aims to use natural resources more efficiently[23]. The transition to circular agriculture requires more emphasis on the promotion of smallholder farming, centred in organic, mixed-farming and agroforestry practices. In the Van Ho MCS, vermi-composting is practiced to support organic agriculture, pig raising, and fish raising. Many households practiced it in different scales, some households raised worm in 4-5 square meters to feed the chickens while some practiced in bigger area of more than 10 square meters. Businesses also co-invested in this farming practice. They expect to get products for use in their farms as well as selling to other pig farms nearby. Farmers reported that by applying circular agriculture model (vermicomposting, animal raising, growing crops) reduced at least 35% cost of animal raising while increase at least 15% revenue from selling products thanks to higher quality as a result of using vermicomposting for animal raising.

3.3. Discussion

Traditional and local knowledge are essential principles for communities to cope with climate variability and change in the Northern Vietnam. Through generations of observation and experimentation, the local people in the Northern Mountainous Region of Vietnam have developed complex farming systems, cultural practices and an indigenous knowledge base well-suited to their environments. Our study showed that local communities have different indigenous strategies including those focused on the management of resources related to water, land, crop, livestock, fisheries and other off- farm sources. For example, local communities were found to use small reservoirs and ponds and created dams to hold water on smaller streams. Villagers used combinations of these measures, often simultaneously. In the case of land management, strategies including manuring, mulching, ploughing in crop-residues, and fallowing. In crop management, strategies included planting native varieties, timing of planting, crop diversification and crop rotation. In agricultural production, local knowledge-based responses include using local drought- resistant crops and switching from rice to other cash crops. Numerous native crops and animals are cultivated in the home gardens or farms. These include hilly sticky rice, green bean, white bean, yellow soybean, red peanut, persimmon and tangerine. The varieties cultivated are understood to be more resistant to drought and suffer less from pest and disease pressures. Farmers also save seed, which reduces costs and permits the selection of plants more productive under local conditions. In addition to the cultivation of native crops, farmers were found to be using native livestock and fish breeds including black pig, mudfish and barbel chub. Produced in the area for over

fifty years, many are better adapted to the local environmental conditions and diseases. Fish management strategies include the collection of eggs of wild native fish species from smaller rivers and streams to grow out in their ponds[17].

Local people also have valuable experience in predicting rainfall, the change in weather patterns and the onset of drought in their community. Almost all experiences are based on monitoring and observing the stages in the life cycle of the plant and the behaviours of animals. They also have experience in forecasting seasonal calendars to schedule specific events in the planting of crops, agroforestry and animal husbandry. Based on the use of native plants and animals, it supports maintaining the natural ecosystem and increasing the resilience to climate change. In turn, this reduces vulnerability in the community[18]. These examples illustrate the importance of local knowledge and experience for communities in coping with and adapting to climate change impacts.

However, this knowledge tends to be more recognized and used among the elderly. Younger people showed little enthusiasm for using and conserving traditional knowledge and skills, and tend to be more interested in scientific knowledge and modern technology. Many are also becoming less connected with farming practices, and typically seek wage work in cities whenever they have the opportunity. Therefore, land-based skills among young people are being eroded. For example, only a few young people knew which plants or herbs could be used as medicine for common injuries or illnesses. The erosion of traditional and local knowledge is likely to undermine the future adaptive capacity of local communities. As such, the integration of local knowledge into adaptation planning can help promote and thus conserve this useful knowledge[18].

In the region, the presence of social networks and support is seen as a critical resilience factor across many villages. Such ties increased the responsiveness of local institutions and larger organizations at all levels. The pre-existence of larger organizations (e.g. the Farmer's Association, Women's Union, or Youth Union) helped to mobilize people and resources more effectively. Households contributed money to funds held by these organizations, which were redistributed to those most in need. Villagers held meetings to establish methods for coping with crises and helping one other. The village and commune organizations were also active in organizing mutual support. Following a crisis, community spirit grew as organizations helped households rebuild their livelihoods. The importance of having a social network for support provided by family, friends, or from networks based upon cultural or economic interests, was strongly emphasized as a foundation of both community and individual resilience[17].

Locally-led adaptation emphasizes community involvement in designing and implementing adaptation strategies, harnessing local knowledge and resources to address unique environmental and cultural contexts. Place-based knowledge comprises the practices, beliefs, and insights communities develop through long-term interactions with their local environment. In the mountainous areas of Northern Vietnam, where communities are highly dependent on natural resources, place-based knowledge provides critical insights into environmental changes and sustainable resource use. By leveraging local knowledge, communities can adapt in ways that are cost-effective, culturally appropriate, and ecologically sustainable, enhancing the effectiveness and longevity of adaptation efforts.

Place-based knowledge systems are embedded in the culture and values of Northern Vietnam's communities, which fosters a deep sense of ownership and commitment to these practices. Unlike top-down adaptation approaches that may be perceived as foreign or disruptive, place-based adaptations resonate with community identities and traditions. This alignment fosters community ownership, ensuring that adaptation measures are accepted and sustained. When communities lead adaptation initiatives, they are more likely to be committed to their success.

Adaptation strategies based on local knowledge often require fewer external resources, making them more accessible and affordable for rural communities with limited financial means. For example, terrace farming and agroforestry use locally available materials and do not rely on expensive technologies. By relying on community knowledge and resources, these strategies reduce dependency on external aid and increase community resilience.

Place-based knowledge has developed through generations of coping with environmental changes, providing communities with insights that are inherently adaptable. By preserving and adapting these traditional practices, Northern Vietnam's communities build resilience in a way that aligns with the natural environment. The collective nature of local knowledge also fosters a sense of social responsibility, strengthening community cohesion and facilitating the sharing of resources and information during times of crisis. Government agencies can work with local leaders to refine these practices, strengthening national adaptation strategies.

3.3.3. Challenges and policy recommendations

The study has highlighted the growing recognition of indigenous knowledge as a valuable asset for climate adaptation. However, challenges remain in effectively integrating this knowledge into national and global climate adaptation policies.

While local knowledge holds valuable insights for adaptation, it is often overlooked in favor of standardized, top-down approaches. Integrating place-based knowledge into national adaptation frameworks requires a policy shift that recognizes and funds locally-led adaptation initiatives. This involves engaging community leaders, traditional knowledge holders, and local organizations in planning and decision-making processes.

The oral transmission of place-based knowledge means that it can be easily lost, especially as younger generations migrate to urban areas. Initiatives to document traditional practices and engage youth in adaptation projects can help preserve these valuable knowledge systems. Universities and research institutions can play a role in cataloging and validating local knowledge, making it accessible for future generations.

Successful locally-led adaptation requires strong partnerships between communities and government agencies. Governments can provide financial and technical support to enhance local efforts, while communities contribute insights and innovation. Establishing community-based adaptation funds and technical support networks can empower local adaptation actions and facilitate knowledge sharing across regions.

While place-based knowledge provides a solid foundation for adaptation, additional resources and training can enhance its effectiveness. Government and NGO support for community-led initiatives, through funding or capacity-building programs, can empower communities to expand and refine their adaptation strategies. Establishing community-based adaptation funds and technical support programs would enable Northern Vietnamese communities to lead in developing locally appropriate solutions to climate change.

4. CONCLUSIONS

As climate change increasingly threatens the livelihoods and well-being of rural communities in Northern Vietnam, locally-led adaptation based on place-based knowledge offers a powerful approach to building resilience against climate change. Local place-based knowledge plays a significant role in sustaining locally-led adaptation to climate change, particularly in agriculture, resource management, and disaster risk reduction. Traditional ecological knowledge provides context-specific solutions that are sustainable, culturally relevant, and community-driven. From terrace farming and community water management to forest conservation, traditional practices offer insights that are environmentally sustainable, culturally relevant, and resilient to climate shocks. By recognizing and integrating place-based knowledge into formal adaptation frameworks, policymakers can support sustainable development and enhance resilience in Northern Vietnam. By valuing and integrating local knowledge into adaptation frameworks, policymakers can foster resilient, adaptable

communities equipped to face the challenges of a changing climate. The lessons from Vietnam underscore the broader potential of locally-led adaptation as a pathway to sustainable, inclusive climate resilience across the globe. This paper underscores the potential of place-based knowledge in sustaining locally-led adaptation efforts, highlighting lessons that can inform adaptation strategies in similar regions worldwide.

Efforts should be made to document and preserve local knowledge through community-driven initiatives, including oral histories and participatory mapping. National and regional climate adaptation plans should incorporate local knowledge as a key component of adaptation strategies, alongside scientific data and modern technologies. Facilitate knowledge exchange between traditional knowledge holders, local communities, and policymakers to ensure that local knowledge is incorporated into decision-making processes. Programs that educate younger generations about the value of traditional knowledge and provide training on sustainable adaptation practices should be promoted.

Acknowledgements

This work was conducted as part of the projects at Thai Nguyen University of Agriculture and Forestry, Vietnam. Projects were supported financially by the funding from the Asia Pacific Network for Global Change Research through a project to Ho Ngoc Son under grant CBA2022-08MY-HoNgoc and a project to Binaya Raj Shivakoti under grant AOA2022-01MY-Shivakoti.

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