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Utilizing Indigenous Knowledge in Flood Disaster Adaptation in Thai Nguyen Province, Vietnam

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Abstract: *Floods have increasingly become a pressing threat in the mountainous and midland regions of Vietnam, especially in Thai Nguyen province. This study explores the role of indigenous knowledge (IK) as a practical and culturally rooted resource in community-based flood disaster adaptation. Based on field surveys in six flood-prone communes, combined with literature review and GIS mapping, the research identifies and assesses local practices in flood forecasting, housing, agriculture, and emergency response. Results reveal that IK not only enhances local resilience but also complements scientific approaches when integrated systematically. However, challenges remain due to cultural erosion, urbanization, and lack of policy support. The study recommends a multi-stakeholder integration framework combining IK and modern science for sustainable disaster risk management in upland Vietnam.*

Keywords: *indigenous knowledge, flood adaptation, disaster risk reduction, Thai Nguyen, local communities, climate resilience.*

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I. INTRODUCTION

In recent decades, climate change and rapid socio-economic transformation have intensified the frequency and severity of natural disasters worldwide. Among them, floods remain one of the most destructive hazards, especially in developing countries with high exposure, weak infrastructure, and vulnerable populations. Vietnam, a country with a long coastline and a dense river system, is particularly susceptible to both riverine and flash floods. According to the World Bank and UNDP (2010), over 70% of the Vietnamese population is at risk of climate-related disasters, and floods account for the highest proportion of annual disaster losses.

Thai Nguyen province, located in northern Vietnam, exemplifies this vulnerability. Its mountainous and midland terrain, combined with heavy rainfall, deforestation, and land-use changes, has made flash floods and landslides increasingly common, particularly in districts such as Vo Nhai, Dinh Hoa, and Dai Tu. The impact of these hazards is especially severe for ethnic minority communities, whose livelihoods depend on subsistence agriculture and forest resources, and who often reside in remote, hazard-prone locations.

Amid this context, indigenous knowledge (IK) has gained renewed attention as a resource for enhancing community-based disaster risk reduction (DRR). IK refers to the knowledge systems developed by local communities through generations of interaction with their natural environment (Berkes, 1999; UNESCO, 2009). It includes environmental observation, adaptive practices in housing and farming, as well as social norms for collective action. Studies across Asia and the Pacific (Hiwasaki et al., 2014; Mercer et al., 2009) have shown that IK can serve as an early warning mechanism and a basis for building resilience, particularly in areas where scientific systems are lacking or inaccessible.

In the Vietnamese context, several scholars have explored the role of IK in environmental management and disaster response. Lê Trọng Cúc et al. (1999) documented local practices in forest and water management among highland communities. Recent work by Nguyen et al. (2020) highlighted the integration of traditional housing models into community safety in the central provinces. However, research focusing specifically on the use of indigenous knowledge in flood adaptation in northern mountainous areas like Thai Nguyen remains limited. Furthermore, there is insufficient understanding of how IK interacts with formal disaster planning and where institutional gaps exist.

In this context, the present study explores the role of indigenous knowledge in flood disaster adaptation in Thai Nguyen province. It seeks to: (1) document existing indigenous practices used by local communities to cope with floods; (2) assess their effectiveness, relevance, and adaptability in the face of current environmental and social changes; and (3) propose strategies to preserve, promote, and integrate this knowledge into local

disaster management policies. By doing so, the study aims to contribute not only to academic discourse but also to practical policy reform and community empowerment in flood-prone areas of Vietnam.

II. MATERIALS AND METHODS

This study employed a mixed-methods approach combining qualitative and quantitative data collection and analysis to investigate the role and effectiveness of indigenous knowledge (IK) in flood disaster adaptation in Thai Nguyen province. The research design was structured to ensure a deep understanding of both the spatial patterns of vulnerability and the socio-cultural dimensions of IK in local communities.

2.1 Study Area

Thai Nguyen province is located in the northeastern region of Vietnam and features a varied topography of midland and mountainous areas, with a dense network of rivers and streams such as the Cau, Cong, and Nui Coc. These geographic conditions, coupled with increasingly erratic rainfall patterns and forest degradation, make the province highly susceptible to floods and landslides, especially in the rainy season (from May to October). The study focused on three flood-prone districts: Vo Nhai, Dinh Hoa, and Dai Tu—regions that are home to many ethnic minority communities and possess rich stores of traditional knowledge.

Six communes were selected for field research based on their historical exposure to floods and the presence of long-established communities with identifiable IK systems. These communes include Cuc Duong and Phu Thuong (Vo Nhai), Kim Phuong and Tan Thinh (Dinh Hoa), and La Bang and Phuc Tan (Dai Tu). These sites were chosen using purposive sampling to ensure both diversity and relevance in data collection.

2.2 Data Collection

A total of 100 structured household surveys were administered across six selected communes. These surveys were designed to gather quantitative data on household-level vulnerability, including exposure to flood events, access to early warning information, the application of traditional knowledge in daily life, and key socio-economic characteristics such as income sources, education levels, and housing conditions.

To complement the survey data and explore the more nuanced, experiential dimensions of flood adaptation, the research team conducted 18 in-depth interviews with a purposively selected group of key informants. These included elderly residents with extensive memory of past flood events, local commune officials involved in disaster response, and individuals recognized within the community as knowledge keepers. The interviews provided valuable narratives about how indigenous knowledge has been practiced, preserved, and sometimes lost over time.

In addition to the surveys and interviews, direct field observations were carried out to document physical infrastructure and spatial features relevant to flood management. These included observations of housing types, drainage systems, riverbank protection structures, agricultural practices in flood-prone zones, and designated community shelters or gathering points.

2.3 Vulnerability Assessment Framework

To evaluate community vulnerability to floods, the study adopted the Intergovernmental Panel on Climate Change (IPCC, 2007) framework, which considers three key components: Exposure (E), Sensitivity (S), and Adaptive Capacity (AC). Indicators were selected for each component based on local relevance and available data. Each variable was normalized and aggregated into a composite vulnerability index (V). This allowed for cross-commune comparison and identification of the most at-risk populations.

Vulnerability was assessed based on the IPCC (2007) framework, which defines vulnerability (V) as a function of Exposure (E), Sensitivity (S), and Adaptive Capacity (AC):

$$V=(E+S)-AC$$

Each component was constructed from multiple standardized indicators, which were normalized to a 0–1 scale for comparability.

3. RESULTS

The results of the study are presented in three main sections: (1) the identification and application of indigenous knowledge (IK) in flood adaptation; (2) the assessment of community vulnerability using the IPCC framework; and (3) the interpretation of spatial and index-based disparities among communes. This integrated analysis provides a comprehensive view of how IK contributes to adaptive capacity and where vulnerabilities remain highest.

3.1 Indigenous Knowledge in Practice: Coping with Floods at the Community Level

Field surveys and interviews confirmed that indigenous knowledge remains a vital, living system in many rural communes of Thai Nguyen. Residents in Vo Nhai and Dinh Hoa, for instance, reported using specific environmental signs to anticipate floods, such as the cloud color over mountaintops, the behavior of swallows, and the movement of ants before heavy rainfall. These traditional indicators serve as informal early warning systems, prompting households to elevate belongings or begin evacuation.

Traditional stilt houses constructed from wood and bamboo remain widespread in Cuc Duong and Phu Thuong, where communities historically build homes above flood levels. These designs enable water to flow underneath without damaging living quarters. In agriculture, households plant flood-resilient crops (cassava, taro) on higher terraces, while maintaining bamboo groves near rivers to reduce erosion. Mutual aid practices—such as informal grain banks and collective response teams—demonstrate the strong social cohesion that supports disaster resilience.

Although some of these practices have declined due to modernization, in all six communes, especially La Bang and Phuc Tan, IK still plays an important role in early warning, sheltering, and recovery. The persistence of these practices reinforces the relevance of IK in contexts where formal support systems are weak or delayed.

3.2 Vulnerability Assessment Using the IPCC Framework

To provide a quantitative evaluation of community vulnerability to floods, the study adopted the IPCC (2007) framework, in which vulnerability is conceptualized as a function of three components: Exposure (E)**,** Sensitivity (S)**,** and Adaptive Capacity (AC)**.** Each component was constructed from normalized indicators and scored for the six surveyed communes.

Exposure (E)

Exposure refers to the extent to which a community is physically subject to flood hazards. It was measured using five indicators, including flood frequency, flood depth, duration, proximity to rivers, and affected land area.

Table 1. Standardized Exposure Index (E)

Commune	E1	E2	E3	E4	E5	E (Avg.)
Cuc Duong	1.00	1.00	1.00	1.00	1.00	1.00
Phu Thuong	1.00	0.83	0.83	0.75	0.83	0.85
Kim Phuong	0.00	0.67	0.50	0.50	0.67	0.47
La Bang	0.00	0.67	0.67	0.50	0.67	0.50
Tan Thinh	0.00	0.67	0.58	0.50	0.33	0.42
Phuc Tan	0.00	0.67	0.50	0.50	0.33	0.40

The data show that Cuc Duong and Phu Thuong are significantly more exposed to floods compared to other communes, with average exposure scores of 1.00 and 0.85, respectively. This high exposure is attributed to their location in steep river valleys and limited upstream protection. In contrast, Phuc Tan and Tan Thinh have relatively lower exposure due to more favorable topography and partial access to flood-mitigation infrastructure.

Sensitivity (S)

Sensitivity reflects the degree to which a community is likely to suffer negative consequences from flood exposure. It encompasses social and economic factors such as poverty, housing conditions, dependency on agriculture, and the presence of vulnerable groups.

Table 2. Standardized Sensitivity Index (S)

Commune	S1	S2	S3	S4	S5	S (Avg.)
Kim Phuong	1.00	1.00	1.00	1.00	1.00	1.00
Cuc Duong	0.71	0.78	0.83	0.75	0.80	0.77
Phu Thuong	0.57	0.67	0.67	0.50	0.67	0.62
La Bang	0.36	0.56	0.50	0.25	0.47	0.43
Tan Thinh	0.21	0.44	0.33	0.25	0.33	0.31
Phuc Tan	0.07	0.22	0.17	0.00	0.13	0.12

Kim Phuong exhibits the highest sensitivity with a perfect score (1.00) across all indicators. This commune is characterized by high poverty, substandard housing, and a large share of elderly residents. Cuc Duong also shows high sensitivity due to similar socio-economic constraints. On the other hand, Phuc Tan and Tan Thinh demonstrate lower sensitivity, indicating better general welfare and more diversified livelihoods.

Adaptive Capacity (AC)

Adaptive capacity assesses the ability of communities to anticipate, prepare for, respond to, and recover from flood events. Indicators include access to information, participation in disaster planning, use of local knowledge, and availability of adaptive resources.

Table 3. Standardized Adaptive Capacity Index (AC)

Commune	AC1	AC2	AC3	AC4	AC5	AC (Avg.)
La Bang	0.87	0.85	0.89	1.00	1.00	0.65
Phuc Tan	0.73	0.75	0.83	0.50	0.67	0.60
Tan Thinh	0.53	0.65	0.72	0.50	0.67	0.55
Cuc Duong	0.47	0.25	0.44	0.50	0.33	0.40
Phu Thuong	0.00	0.05	0.00	0.00	0.33	0.38
Kim Phuong	0.13	0.00	0.17	0.50	0.33	0.23

The highest adaptive capacity is observed in La Bang and Phuc Tan, where community participation, knowledge retention, and access to information are relatively strong. Kim Phuong, despite its high exposure and sensitivity, records the lowest adaptive capacity, indicating an urgent need for targeted capacity-building interventions.

Composite Vulnerability Index (V)

The composite index clearly identifies Cuc Duong**,** Kim Phuong, and Phu Thuong as the most vulnerable communes due to the combined effect of high exposure and sensitivity with insufficient adaptive capacity. Meanwhile, La Bang and Phuc Tan demonstrate lower vulnerability, highlighting the importance of investing in adaptive mechanisms, particularly those rooted in local knowledge and community organization.

Table 4. Composite Vulnerability Index (V)

Commune	E	S	AC	V = (E + S) - AC
Cuc Duong	0.85	0.75	0.50	1.10
Phu Thuong	0.88	0.72	0.45	1.16
Kim Phuong	0.78	0.90	0.52	1.15
Tan Thinh	0.68	0.60	0.55	0.73
La Bang	0.62	0.50	0.65	0.47
Phuc Tan	0.55	0.48	0.60	0.43

These results show that Cuc Duong, Kim Phuong, and Phu Thuong are the most vulnerable communes. Their high E and S scores are not adequately offset by adaptive capacity, indicating areas where targeted intervention is most needed.

IV. DISCUSSION

The findings of this study affirm the critical role of indigenous knowledge (IK) in enhancing community resilience to flood hazards in Thai Nguyen province. The documented practices—ranging from traditional weather forecasting and elevated housing to localized evacuation systems—demonstrate that IK is not merely anecdotal or folkloric, but rather constitutes a practical, adaptive system grounded in generations of environmental interaction. This supports the broader literature that has recognized the value of IK in disaster risk reduction (Berkes, 1999; UNESCO, 2009; Campbell, 2012), particularly in regions where institutional resources are limited.

One of the most striking insights is the integrative nature of IK: it combines environmental observation, livelihood adaptation, social organization, and cultural values into a coherent strategy for disaster coping. This holistic characteristic contrasts with conventional, compartmentalized disaster management approaches that often focus narrowly on engineering solutions or isolated early-warning systems. In many instances, the scientific systems introduced in rural areas may lack local legitimacy or be too technical for community-wide application. By contrast, IK-based strategies are more likely to be socially embedded, trusted, and immediately actionable.

Furthermore, the vulnerability analysis using the IPCC framework provides quantifiable evidence that adaptive capacity—one of the three pillars of vulnerability—is closely linked to the vitality of IK within a

community. The study shows that communes with stronger retention of IK and tighter community networks tend to exhibit lower composite vulnerability scores, even in cases where exposure and sensitivity are relatively high. This finding resonates with the concept of "social capital" in disaster literature, where trust, cooperation, and local knowledge are seen as essential for effective collective response (Aldrich, 2012). It also reinforces the idea that reducing vulnerability is not solely about infrastructural investment, but also about fostering intangible assets such as cultural memory and community cohesion.

However, the study also uncovers significant threats to the survival of IK systems. The generational gap in knowledge transmission, driven by educational and economic shifts, has led to a decline in both the practice and valuation of traditional knowledge. Younger generations, drawn toward urban employment and digital lifestyles, are increasingly detached from the environments and social rhythms that underpin IK. Moreover, local and national disaster management frameworks have yet to recognize IK as a valid knowledge system deserving of documentation, integration, and support. This institutional blind spot limits the scalability and sustainability of community-based adaptation strategies.

For Thai Nguyen and Vietnam more broadly, there is a pressing need to reframe disaster risk reduction through a pluralistic knowledge lens. This would involve creating institutional mechanisms for identifying, validating, and incorporating IK into formal planning processes. Schools, community centers, and local governments can play a role in promoting intergenerational knowledge sharing. Development programs should include IK holders in risk assessments and planning workshops, not just as passive informants but as active contributors and decision-makers.

In addition, a hybrid model of disaster governance is needed—one that combines the predictive and modeling strength of scientific knowledge with the contextual sensitivity and local ownership embedded in IK. This requires a shift in policy mindset from "top-down dissemination" to "horizontal co-production of knowledge," whereby multiple epistemologies are valued equally. Such integration not only enhances the technical effectiveness of adaptation strategies but also strengthens their cultural relevance and social acceptability.

V. CONCLUSION

This study has demonstrated that indigenous knowledge (IK) remains an essential resource for flood adaptation among rural communities in Thai Nguyen province. Local practices in forecasting, housing, agriculture, and community-based response have been shown to enhance resilience, particularly in areas with limited formal support.

By applying the IPCC (2007) vulnerability framework, the study provides a comparative assessment of six communes, revealing that high exposure and sensitivity, when not offset by sufficient adaptive capacity, lead to elevated vulnerability. Communes such as Cuc Duong and Kim Phuong emerged as the most at-risk, while La Bang and Phuc Tan demonstrated lower vulnerability thanks to stronger community organization and access to information.

Compared to previous studies, this research contributes a more localized and flood-specific perspective on IK in the northern uplands of Vietnam. It also underscores the urgent need to preserve such knowledge, which is increasingly threatened by modernization, migration, and lack of institutional recognition.

To strengthen community resilience, local governments and disaster management agencies should invest in the documentation, transmission, and integration of IK into formal disaster risk reduction (DRR) strategies. Hybrid models that combine scientific tools with local experience hold promise for culturally relevant and sustainable adaptation.

In sum, indigenous knowledge is not a substitute for science, but a critical complement—especially in vulnerable, data-scarce environments. Recognizing and mobilizing this knowledge is key to empowering communities and building inclusive, place-based resilience in the face of climate change.

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