Indigenous Knowledge in Soil Erosion Control: Practical Experiences from Ethnic Minority Communities in the Northwest Region of Vietnam

Le Tien Duy[1], Le Thi Lien[2]
[1]Faculty of Land Management, Hanoi University of Natural Resources and Environment
[2]Faculty of Natural Resources and Environment, Hanoi University of Natural Resources and Environment Branch in Thanh Hoa province.
DOI: 10.56201/ijaes.vol.11.no10.2025.pg85.93

Abstract
This study aims to document, systematize, and deeply analyze the indigenous knowledge system of the H'Mong community in managing and controlling soil erosion in the mountainous Northwest region of Vietnam, an area at severe risk of land degradation. Employing a qualitative case study approach in Mu Cang Chai district, Yen Bai province, the research conducted in-depth interviews, focus group discussions, and participant observation with experienced farmers to understand their perceptions and practices. The research findings reveal that the H'Mong possess a complex knowledge system where perceptions of land and erosion are interpreted through vivid local terminologies and intertwined with the spiritual value of "ancestral land." This system is manifested through a combination of sustainable agricultural practices, including sophisticated terracing techniques, diverse agroforestry and intercropping models, and the philosophy of "clothing the soil" by maintaining vegetation cover. Notably, the study highlights the role of community conventions in protecting watershed forests, an effective erosion control measure at the landscape scale. These findings affirm that indigenous knowledge is not an outdated experience but a practical, dynamic, and effective scientific system. Therefore, the study proposes significant policy implications regarding the necessity of recognizing, conserving, and integrating indigenous knowledge into agricultural development programs, promoting co-management models between scientists, managers, and the community. The novelty of this study lies in its comprehensive systematization of erosion control practices, not only at the technical level but also through a deep analysis of the epistemological foundations and the social institutions that operate it, while also identifying contemporary challenges threatening the existence of this knowledge heritage.

Keywords: *Indigenous knowledge, soil erosion, ethnic minorities, Northwest Vietnam, sustainable agriculture, land management.*

1. Introduction

The Northwest region of Vietnam, characterized by its highly dissected topography, steep slopes, and a rainfall regime concentrated in a high-intensity monsoon season, is one of the areas most at risk of severe soil erosion in the country. Studies indicate that the average soil loss due to erosion on sloping lands can range from 50 to over 100 tons/ha/year, especially in upland cultivation areas without protective measures (Sakurai et al., 2004; Tran & Lei, 2017). This situation, combined with increasing pressure from population growth and agricultural expansion, has led to a vicious cycle of land degradation, reduced soil fertility, and declining crop yields. The consequences of erosion are not limited to the field level but also cause off-site impacts such as the siltation of reservoirs, rivers, and streams, and an increased risk of

flooding in downstream areas (Mai et al., 2013; Huynh et al., 2020). This directly and severely affects the livelihoods of ethnic minority communities, whose lives depend mainly on agriculture and who have poverty rates higher than the national average (Baulch, 2010; Tuyen, 2016).

To address this challenge, many modern technical solutions, often referred to as soil and water conservation measures, have been introduced and promoted, including the construction of terraced fields, contour planting, and the use of cover crops. However, the adoption rate of these measures in practice is often low and unsustainable. The reasons include high investment costs, complex technical requirements, and especially, incompatibility with local socio-economic and cultural systems (Cramb, 2005). In this context, the indigenous knowledge system, which has been accumulated and tested over many generations of cultivation on sloping lands, is considered a valuable but underappreciated resource. Indigenous knowledge, or traditional ecological knowledge, is defined as a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment (Berkes, 1999). These knowledge systems have been proven to play an important role in the sustainable management of natural resources in many parts of the world (Berkes et al., 2000; Rambo, 1984). Although the role of indigenous knowledge is increasingly recognized, studies in Vietnam, particularly in the Northwest region, still lack systematic works and in-depth analyses of specific erosion control practices, as well as assessments of their scientific basis and their potential for integration into contemporary development programs.

Therefore, the main objective of this paper is to document, systematize, and analyze the experiences and knowledge of the H'Mong ethnic community in the Northwest region of Vietnam in managing and controlling soil erosion. To achieve this objective, the research will focus on answering three main questions: (i) How do ethnic minority communities in the Northwest perceive soil erosion, and what specific practices do they use to manage it? (ii) How is this knowledge system maintained and transferred across generations? (iii) What economic, social, and environmental factors are threatening the existence of this knowledge system?

2. Research Methods

2.1. Research Approach

To answer the research questions, this study applies a qualitative research approach, which allows for an in-depth understanding and interpretation of the community's knowledge, perceptions, and practices within their cultural-social and natural ecological context. Specifically, the case study method was chosen as the primary research design. This method is particularly suitable for exploring a complex contemporary phenomenon like "indigenous knowledge of erosion control" within the real-life context of the H'Mong community, where cultural, economic, and environmental factors are closely intertwined and inseparable.

2.2. Selection of Study Site and Participants

The study site was purposively selected to be the two communes of La Pan Tan and Che Cu Nha in Mu Cang Chai district, Yen Bai province. This choice was based on three main reasons: (i) This is an area with highly dissected topography and an average slope of over 35 degrees, representing a typical high-mountain region with a very high risk of soil erosion in the Northwest; (ii) The H'Mong community accounts for over 90% of the population and still maintains many traditional cultivation practices on upland fields, creating favorable conditions for observing and documenting the indigenous knowledge system; and (iii) This area is under great pressure from crop structure transformation, especially the expansion of commercial

maize cultivation, providing an ideal context to analyze the factors threatening the existence of traditional knowledge.

The research subjects were H'Mong households directly engaged in agriculture. The study used a combination of purposive sampling and snowball sampling methods. Initially, we approached and selected "local experts"—elderly farmers (over 50 years old) with more than 20 years of farming experience, village heads, and reputable women in the community who often hold knowledge about crop varieties and home gardens. Then, from these initial participants, we asked them to recommend other individuals in the community who were also recognized as having a deep understanding of land and farming techniques. A total of 45 people (28 men, 17 women) participated in interviews and focus group discussions.

2.3. Data Collection Tools and Process

Field data collection was conducted from September to December 2024. The study used a multi-tool methodology to collect data, ensuring the comprehensiveness and reliability of the information through triangulation. The main tools included:

Semi-structured in-depth interviews: This was the primary data collection tool, conducted with 30 individuals, with each interview lasting from 45 to 60 minutes. The interview guide was flexibly designed around the topics of: (1) People's perception and interpretation of the erosion phenomenon (signs, causes, consequences); (2) The history of land use of the family and community; (3) Specific farming techniques for soil conservation (land selection, land preparation, crop arrangement, water management, fertility maintenance); (4) How knowledge is taught and learned across generations; and (5) Changes in farming practices and the challenges being faced.

Focus Group Discussions: Three focus group discussions (each group with 6-8 people, divided by gender and age) were organized. The purpose was to cross-verify information obtained from individual interviews and to stimulate discussions about the community's common conventions and customary laws in managing land and forest resources.

Participant Observation and Transect Walks: The research team walked with farmers from the village to the upland fields at different altitudes and terrains. This activity allowed for direct observation of the farming techniques applied in the field, while also listening to the people explain their choices and decisions in their real context. Field notes, photographs, and diagrams were made during this process.

2.4. Data Analysis

All interviews and group discussions were audio-recorded with the participants' permission, then transcribed verbatim. The data were analyzed using thematic analysis. The analysis process included the steps of: (1) Reading and familiarizing oneself with the entire dataset; (2) Generating initial codes from text segments relevant to the research questions; (3) Searching for, synthesizing, and grouping related codes into potential themes; (4) Reviewing and refining the themes; (5) Defining and naming the main themes. This process helped to systematize disparate practices and perceptions into a structured, logical analytical framework that directly answers the paper's research questions.

2.5. Ethical Considerations in Research

The research strictly adhered to ethical principles. Before conducting any data collection activities, the principle of Free, Prior, and Informed Consent (FPIC) was applied. The objectives, content, research process, as well as the rights of the participants (including the right to refuse or stop participating at any time) were clearly explained in the local language with the assistance of an interpreter. The anonymity and confidentiality of participants' personal information were ensured by coding names and identifying information during the analysis and

publication of results. Respect for local culture, beliefs, and customs was a guiding principle throughout the entire fieldwork process.

3. Research Findings

3.1. Indigenous Epistemology of Land and Erosion

The analysis shows that the H'Mong community in Mù Cang Chải possesses a complex epistemological system regarding land and the natural processes that occur on it. This system is not based on modern scientific terminology but is built from practical observation experience over many generations, closely linked to subsistence farming. The interconnected practices form a holistic landscape management strategy aimed at controlling erosion and ensuring sustainable livelihoods (Figure 1).

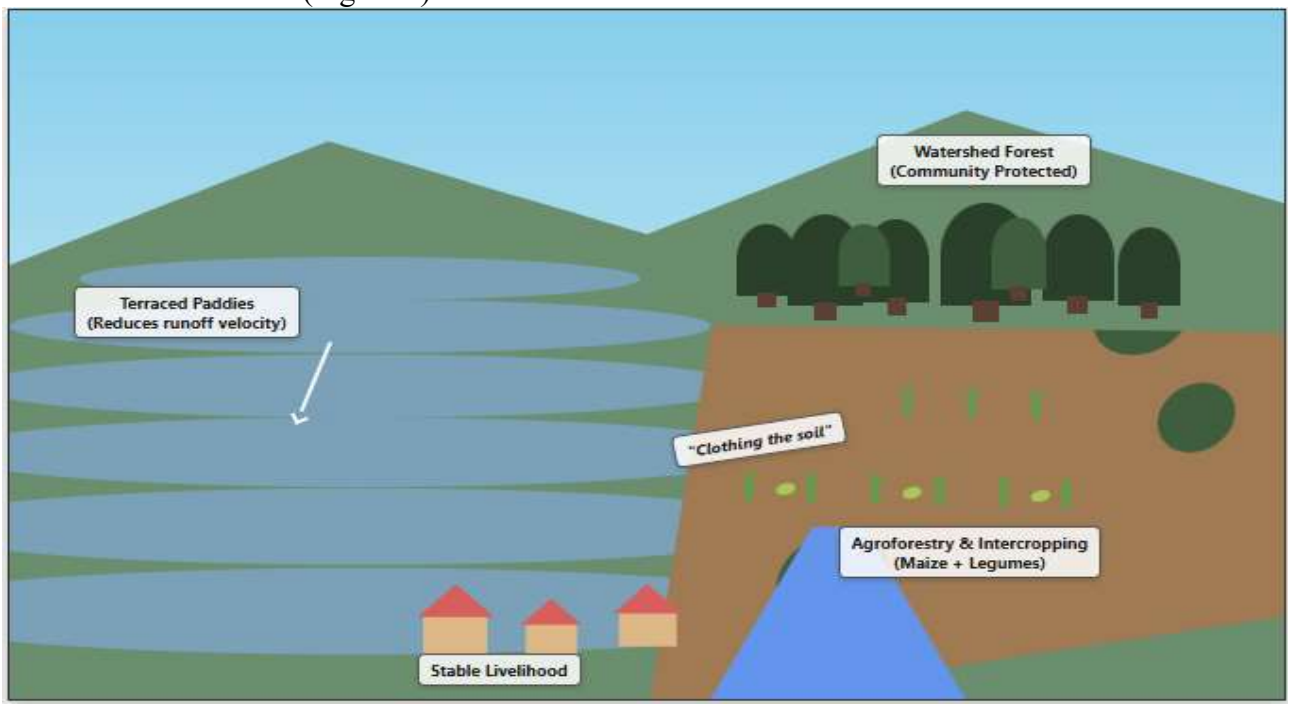

Figure 1. An illustrative diagram of the H'Mong's integrated indigenous knowledge system for soil erosion control, showing the synergy between protected watershed forests, terraced paddy cultivation, agroforestry practices, and the philosophy of maintaining soil cover.

The people classify soil mainly based on sensory indicators such as color, texture, moisture, and indicator vegetation. "Good soil" is described as dark black or dark brown, friable, good at retaining moisture, and often having many earthworms. Conversely, "bad soil" is red or pale yellow, hard when dry and sticky when wet, and often mixed with a lot of gravel. A village head shared his experience in selecting land for a field: *"Good soil is black soil, when you hold it in your hand it feels soft and porous, whatever you plant will grow. As for the red soil mixed with rocks, it's arid, you can only plant cassava, and even that won't be good. You have to look at the grass and plants growing on it; where the grass is lush and the trees are big, the soil underneath has strength."*

The perception of erosion is also incredibly specific and vivid. The people do not use the term "erosion" but accurately describe this phenomenon through phrases like the soil being "washed away," "losing its color," or "the top layer being washed away." They recognize the signs of land degradation by observing the change in water color after rain, the appearance of small rills (which they call "water flow marks"), and finally, deep gullies ("cut into ravines"). A farmer explained: *"After a heavy rain, you go to the field and see the water flowing turbidly,*

the soil on the high ground gets thinner and thinner, exposing the gravel. People call that soil 'faded.' With soil like that, the corn can't grow big."

More importantly, for the H'Mong, land is not merely a means of production. It carries a deep spiritual meaning, considered a sacred heritage – "the land of the ancestors." This relationship creates a sense of moral responsibility to protect the land. Allowing the land to degrade and erode is not only an economic failure but is also seen as an act of disrespect towards ancestors and the supernatural forces that govern the land. An elder in the village emphasized: *"This is the land left by our grandparents, we must preserve it for our children and grandchildren. To ruin the land, to let it wash away, is to commit a sin against the house spirits, against the ancestors."* This holistic epistemology, where practice, experience, and spirituality are intertwined, is the philosophical foundation for their erosion control practices.

3.2. Diverse Agricultural Practices in Erosion Control

Based on that profound epistemological foundation, the H'Mong have developed and maintained a complex of diverse and highly adaptive agricultural practices to control erosion and maintain soil fertility. These techniques are not isolated actions but are combined into a holistic farming system.

The most prominent and widely known practice is the technique of making terraced paddy fields for wet rice cultivation. Field observations in La Pán Tẩn and Chế Cu Nha show that this is not simply land leveling. It is a complex knowledge system, starting with the selection of mountain slopes with moderate steepness and a natural water source. The farmers then calculate to create terraces with relatively flat surfaces and sturdy earth bunds. These bunds are often reinforced with stones or planted with native grasses with strong root systems to enhance stability. An experienced farmer shared: *"Making terraced fields requires knowing how to read the terrain, you have to follow the slope, not destroy it. The bunds must be built firmly to hold water, only then will the rice grow well and the soil not be washed away. The water must flow from the upper field to the lower field slowly."* This system not only creates a cultivation surface but also acts as a series of small dams, reducing the velocity of surface runoff, enhancing water infiltration, and retaining the fertile topsoil.

On upland fields where terraces cannot be made, agroforestry and intercropping models are flexibly applied. Interviews and field observations recorded the prevalence of intercropping maize with legumes such as soybeans or black beans. The logic behind this practice was clearly explained by the people. A woman participating in a focus group said: *"When planting corn, you must intercrop it with soybeans. The soybean roots have nodules, they make the soil looser and better for the next crop. Planting only corn for several seasons will quickly degrade the soil."* In addition, they also maintain large trees and fruit trees scattered on the fields or plant them as green fences along the edges of steep slopes. These trees act as living "anchors," using their root systems to hold the soil, and their canopies help reduce the impact of raindrops falling directly on the ground.

Besides, the technique of managing vegetation cover on the ground plays an extremely important role. Contrary to the practice of clean tillage, the H'Mong often maintain a cover on their upland fields year-round. After harvesting, the stubble of upland rice or the stalks of corn are left in the field. The weeding process is also selective clearing, removing only the plants that directly compete with the main crop, while the rest are cut and spread right on the ground. An elder explained this philosophy: *"After harvesting rice and corn, you must leave the stubble. If the soil is left bare, one rain will wash all the color away. It must have something to cover it, like putting clothes on the soil."* This layer of organic material not only protects the soil from rain and wind erosion but also decomposes slowly, returning nutrients and improving soil structure.

3.3. The Role of Forests and Community Conventions

The H'Mong's land management system is not limited to the scope of their fields but extends to the landscape scale, in which community forests play a central role and are protected through strict social conventions. Interviews and focus group discussions revealed the existence of "sacred forests" and "watershed forests" in the community's consciousness and resource management practices. These are forests that are almost absolutely protected, where all acts of exploitation, logging, hunting, or cultivation are strictly forbidden. The protection mechanism is not based on state law but on customary law and spiritual beliefs. A village head explained: *"That forest over there is a spirit forest, no one is allowed to enter to cut a single tree or break a single branch. Anyone who desecrates it will be punished by the forest spirits, causing their family members to fall ill and their pigs and chickens to die."* Respect and fear of supernatural forces have become an effective enforcement tool, ensuring the integrity of these forests over many generations.

Ecologically, the strict protection of these forests, especially watershed forests, serves as an indirect but extremely effective large-scale erosion control measure. The people are well aware of the hydrological role of the forest. An elderly farmer shared the knowledge passed down: *"You must preserve the forest at the head of the stream. If you cut it down, there will be no water to use in the dry season, and in the rainy season, the water will come down with great force, sweeping away all the fields."* These unwritten conventions, though not directly aimed at combating erosion, operate as a large-scale resource management mechanism. The dense forest canopy intercepts the force of raindrops, the thick litter layer on the ground acts like a giant sponge to enhance infiltration and regulate runoff, and the intricate root systems of the forest trees bind the soil and rock, effectively preventing landslides and surface erosion on steep slopes.

3.4. Knowledge Transmission and Contemporary Challenges

This indigenous knowledge system is not documented in writing but is mainly maintained and transferred across generations through oral tradition and direct practice. Knowledge is passed from parents to children during daily labor in the fields. Field observations show that children follow adults to the fields from a young age, learning by observing, imitating, and participating in tasks from simple to complex. An elder in the village shared: *"We don't have any books. We just take our children to the fields. They watch us select the land, watch us build the bunds, and then they learn by following. The knowledge goes from the eyes to the hands and into the head, not from written words."* This "hand-holding" process ensures that knowledge is naturally absorbed and linked to the specific ecological context.

However, this fragile transmission mechanism is facing serious challenges from contemporary socio-economic changes. Pressure from the market economy, especially the shift to monoculture of commercial maize, is eroding traditional practices. A middle-aged farmer said: *"Now, planting hybrid corn makes money faster, so people don't want to intercrop with beans anymore. They use herbicides to clean the land, even though they know doing so makes the soil wash away faster."* Furthermore, the allure of modern lifestyles and non-agricultural job opportunities in urban areas makes the younger generation increasingly less interested in following in their parents' footsteps. This creates a generation gap, threatening to break the chain of knowledge transmission. Finally, development policies and agricultural programs from the outside, sometimes introduced without a deep understanding of the local context, also inadvertently create conflicts, devaluing the relevance and suitability of indigenous techniques.

4. Discussion

4.1. "Dialogue" between Indigenous Knowledge and Modern Science

The research results show a remarkable similarity between the H'Mong's erosion control practices and modern scientific principles, although they are interpreted through different epistemological paradigms. The intercropping of maize with legumes, explained by the people as "making the soil looser and better," is essentially the application of the principle of biological nitrogen fixation and soil structure improvement. Similarly, the philosophy of "clothing the soil" by maintaining vegetation cover and crop residues on the fields corresponds perfectly with scientific recommendations to reduce the impact of raindrop energy, limit surface runoff, and increase soil organic matter content. Even the sophisticated technique of terracing is a testament to a deep understanding of hydrology and soil mechanics, aimed at reducing the length and gradient of the slope, thereby controlling the energy of the runoff. This indicates that indigenous knowledge is not an outdated experience, but a scientific system forged from centuries of experimentation, a form of science of the concrete, verified and refined with each growing season.

4.2. Indigenous Knowledge as a Dynamic Adaptive System

It must be emphasized that the H'Mong indigenous knowledge system is not a static, unchanging system. It is a dynamic system, constantly being adjusted and adapted to cope with changes in environmental and social conditions. Their history of cultivation on sloping lands is a long process of trial, selection, and accumulation of the most suitable and effective practices. The flexibility in combining crop types, or adjusting cultivation techniques based on the characteristics of each specific plot of land, has shown the high adaptability of this knowledge system. However, the biggest challenge today lies in the speed of change. The pressure from the market economy, the introduction of new crop varieties and agrochemicals, and the shift in the values of the younger generation are occurring at an unprecedented rate. This speed threatens to exceed the inherent self-regulation and adaptive capacity of the traditional knowledge system, which is based on transmission and verification over many generations.

4.3. Policy and Practical Implications

The findings of this study offer important implications for sustainable agricultural development policy and practice in the highlands. First and foremost, it shows the urgent need for policy mechanisms to recognize and institutionalize the role of indigenous knowledge in land resource management. Instead of being seen as backward experiences, these knowledge systems should be viewed as valuable social and ecological capital. Accordingly, agricultural extension and rural development programs need to shift from a top-down technical imposition approach to one of integrating, dialoguing with, and promoting locally-tested indigenous practices. This opens up a path for building co-management models, where scientists, policymakers, and local communities collaborate on an equal footing. In these models, modern scientific knowledge and indigenous knowledge can complement each other to jointly analyze, test, and scale up sustainable farming solutions that are both economically efficient and compatible with the specific ecological and socio-cultural context of the locality, contributing to food security and environmental protection.

4.4. Limitations of the Study and Future Research Directions

This study has certain limitations, mainly that its scope is focused only on the H'Mong community in two communes of Mù Cang Chải district, so the results cannot be generalized to all other ethnic groups in the Northwest region. Therefore, future research directions should be expanded, including quantifying the effectiveness of indigenous farming systems in reducing

erosion and maintaining fertility for a scientific comparison with modern models, as well as conducting comparative studies of indigenous knowledge among different ethnic communities to obtain a more comprehensive picture.

5. Conclusion

This study has contributed to documenting, systematizing, and deeply analyzing the indigenous knowledge system of the H'Mong community in Mù Cang Chải in managing and controlling soil erosion. Through understanding their epistemology, specific farming practices, and social institutions, the paper has shown that this is a complex knowledge system, built on a foundation of keen observation, long-standing experimental experience, and a profound spiritual worldview. Techniques such as terracing, agroforestry, maintaining vegetation cover, and protecting watershed forests are not just isolated solutions but are constituent parts of a holistic strategy, demonstrating a deep understanding of ecological and hydrological processes on sloping lands.

Thus, the paper reaffirms the central thesis that indigenous knowledge is a significant, effective, and highly adaptive scientific resource. Neglecting or ignoring this knowledge source is not only a great waste of intellectual resources but also undermines efforts towards sustainable agricultural development in regions with harsh conditions. In the context of globalization and climate change posing unprecedented challenges, the existence of these knowledge systems is under serious threat. Therefore, taking action to conserve, restore, and respectfully integrate indigenous knowledge into contemporary development strategies is an urgent requirement, to ensure that this knowledge heritage is not lost but will continue to be a pillar for the resilient and sustainable development of mountain communities.

References

Baulch, B. (2010). Ethnic minority poverty in Vietnam. *Chronic Poverty Research Centre Working Paper, (169)*.

Berkes, F. (1999). Sacred ecology: traditional ecological knowledge and resource management Taylor and Francis. *London Science and the St Elias, 203*.

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications, 10*(5), 1251-1262.

Cramb, R. A. (2005). Farmers' strategies for managing acid upland soils in Southeast Asia: an evolutionary perspective. *Agriculture, ecosystems & environment, 106*(1), 69-87.

Huynh, C. V., Pham, T. G., Nguyen, T. Q., Nguyen, L. H. K., Tran, P. T., Le, Q. N. P., & Nguyen, M. T. H. (2020). Understanding indigenous farming systems in response to climate change: An investigation into soil erosion in the mountainous regions of Central Vietnam. *Applied Sciences, 10*(15), 5091.

Mai, V. T., van Keulen, H., Hessel, R., Ritsema, C., Roetter, R., & Phien, T. (2013). Influence of paddy rice terraces on soil erosion of a small watershed in a hilly area of Northern Vietnam. *Paddy and Water Environment, 11*(1), 285-298.

Rambo, A. T., & Sajise, P. E. (1984). *Introduction to human ecology research on agricultural systems in Southeast Asia*.

Sakurai, K., Kawazu, H., Kono, Y., Yanagisawa, M., Van Tiem, L., Thanh, L. Q., ... & Chau, T. N. (2004). Impact of agricultural practices on slope land soil properties of the mountainous region of northern Vietnam: a case study in bac Ha District, Lao Cai Province. *Japanese Journal of Southeast Asian Studies, 41*(4), 503-518.

Tran, X. M., & Lei, G. (2017, December). Sustainable Use and Management of Sloping Fields in the Mountainous Area of Vietnam: Present Situation and Solution. In *3rd International Conference on Economics, Management, Law and Education (EMLE 2017)* (pp. 316-322). Atlantis Press.

Tuyen, T. Q. (2016). Income sources and inequality among ethnic minorities in the Northwest region, Vietnam. *Environment, Development and sustainability, 18*(4), 1239-1254.