Socioecological Linkages for Sustainability: The Traditional Ecological Knowledge of the Hmong People of Dong Van Karst Plateau, Ha Giang Province, Vietnam

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Abstract

This study focuses on the system of traditional ecological knowledge (hereafter called TEK) of the Hmong people living in Dong Van Karst Plateau, Ha Giang, Vietnam. Dong Van Karst Plateau is well-known for the extreme harshness of its living conditions characterized by the severe climate and the serious shortage of arable lands and potable water. Notably, the Hmong have managed to overcome the difficulties of living on the Karst Plateau area by generating a system of TEK to adapt to the rocky environment. In this study, I employ the TEK theory of Berkes (2008), an approach to TEK of many analysis levels. The research suggests that TEK is not simply a body of knowledge on rock resource usage and management, but also a knowledge that evolves, integrates, and crystalizes in the social mechanisms of Hmong society. There is a "socioecological linkage" arising from the reciprocal interactions between TEK and such social mechanisms as knowledge transmission, cultural internalization, and Hmong cosmology. It is the socioecological linkage that contributes to maintaining sustainability in the way that the Hmong utilize and manage rock resources. It is important to note that in 2010, Dong Van Karst Plateau was designated by UNESCO as an official member of the Global Geoparks Network, a designation that brought about environmental stress to the Hmong community with its restrictions on all exploitation and utilization activity of rock resources for the protection of the natural landscape. However, thanks to the socioecological linkage, Hmong people could adapt and overcome the stress in a sustainable manner. Finally, the research considers TEK from a "cultural resource management" perspective and proposes methods to preserve and promote TEK in the contemporary context.

Keyword

Hmong people, traditional ecological knowledge, sustainability.

持続的発展のための社会と環境のリンク：ベトナム・ドンヴァン・カルスト高原に暮らすモン族の伝統的環境知識についての研究

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要旨

この研究は，ベトナム・ハザン省ドンヴァンカルスト高原に暮らすモン族の人々がもつ伝統的環境知識（以下，TEKと表記する）のシステムについて考察する。ドンヴァンカルスト高原は気候が厳しく，農地として利用できる土地と水が非常に乏しいという，極端に過酷な生活条件の地として知られる。注目すべきことに，モン族の人々はここで岩ばかりの環境に適応するためにTEKのシステムを構築し，カルスト高原ならではの生活上の困難をすべて克服してきた。

この研究の中で，私は多くの分析レベルのコンプレックスの中でTEKにアプローチしたBerkes (2008) の理論を用いる。調査が示唆しているのは，TEKは石という資源の利用と管理に関する知識の単なる総体ではなく，さらに進んで，モン社会のメカニズムの中で生じ，統合され，明確な形となるものだということである。知識伝達のメカニズム，文化の内面化メカニズム，そしてコスモロジーを含む，モンの社会のメカニズムとTEKの間で互恵的な関係が続く中で，「社会と環境のリンク」が生まれた。この社会と環境のリンクがあるからこそ，モン族の人々は石という資源を利用し管理するというやり方で持続可能性を維持できている。ここで言及するべきことは，2010年にドンヴァンカルスト高原がユネスコによって，グローバルジオパークネットワークの正式なメンバーとして認定されたことである。グローバルジオパークの自然景観を保護するために，石を資源として開発し利用することがすべて制限され，モン族のコミュニティに環境のストレスがもたらされた。社会と環境のリンクのおかげで，モン族の人々は持続可能な方法でストレスに適応し，克服することができたのである。最後に，この研究はTEKを「文化資源マネジメント」という観点から考察し，現代的な状況の中でTEKを保護し活用する方法を提案する。

キーワード

モン族，伝統的環境知識，持続可能性

1. Introduction

Approximately three centuries ago, Hmong ethnic group which originated from the South China, emigrated to and resided in the Northernmost part of Vietnam. Among those high regions where Hmong people resides, Dong Van Karst Plateau of Ha Giang province which includes four mountainous districts of Meo Vac, Dong Van, Quan Ba, Yen Minh is considered as the first destination in the history of the Hmong's migration into Vietnam. Dong Van Karst Plateau is well-known for the extreme harshness of living conditions such as the severe climate, the serious shortage of farmable lands and water, and the difficulty in transportation. Noticeably, Hmong group had managed to adapt well to the rocky environment by generating a system of traditional ecological knowledge (here after called TEK). Living in such a harsh environment where people have nothing but rocks, 'live in the rock, being buried in the rock', TEK is undoubtedly the key for the survival and sustainable development of Hmong community here, that can be seen in almost all aspects of their life. By conducting the research on the TEK of Hmong people in Dong Van Karst Plateau, the first objective of this study is to identify the adaptation of Hmong people to the rocky environment based on the TEK system. Secondly, the study focuses on the 'socio-ecological linkage' which had arisen during the interaction between TEK and social mechanisms in Hmong society. Both TEK and social mechanisms contribute to maintain the sustainability in the rock resource usage and management of Hmong people in karst plateau.

2. Theoretical framework

The research on TEK has a rich history. The interest in TEK had been growing in 1980s-1990s and it had developed "as a field of study, complete with theory, research approaches, models and potential applications" (McGregor 2004). Surprisingly, until now, there had been no universal accepted definition of the term TEK. Nakashima (1993: 99) simply suggested that TEK is "the knowledge of native people about their natural environment". Menzies (2006: 6) supposed "TEK is the term used to describe the knowledge and beliefs that indigenous peoples hold of their environments that is handed down through the generations". Berkes, a leading researcher on TEK studies, (1993: 3) claimed that: "TEK is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial or less technologically advanced societies, many of them indigenous or tribal". This definition afterward continually had been supplemented by Berkes himself (2008: 7) 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". This definition can be considered as a significant evolvement in comparison with the definition from his earlier works since Berkes considered TEK as a dynamic process, building on experience and adapting to changes. It is an attribute of societies with historical continuity in resource use on a particular land. TEK here referred to the ways of knowing (process), as well as to information (knowledge as the thing known).

When it comes to TEK analysis, there are many theories which suppose that TEK should be considered at multiple layers of levels. Lewis (1993) claims that TEK begins with knowledge at the level of taxonomic systems and then proceeds to the knowledge of processes or functional relationship. Orlove and Brush (1996) develop the system of three levels of TEK including indigenous environmental knowledge, management practices and religious beliefs about rituals uses of plants and animals. As for my study, I apply the theoretical framework developed by Berkes (1993, 2008) that analyzed TEK in the complex of four interrelated levels: 1) Local and empirical knowledge on species identification and taxonomy, life histories, distributions, and behavior. 2) The resource management system includes an appropriate set of practices, tools, and techniques. 3) Social institutions: sets of rules-in-use, norms and codes of social relationships. 4) Worldview shapes environmental perception and gives meaning to observations of the environment.

In my research, I determine and sort levels of TEK analysis in a different way since my research does not focus on TEK and resource management only but it also aims to study the linkage between TEK and social mechanisms.

The figure 1 illustrates the socio-linkage between traditional ecological knowledge and social mechanisms in the adaptation to the rocky environment of Hmong people. The circle of TEK includes two part: the body of TEK and the management of rock resources, people, then I analyze the utilization of TEK in daily life. Finally, the management of rock resources which is an important aspect of TEK is mentioned.

4.1. The management of limited farmable land in the rocky plateau

As for Hmong people living in karst plateau, the land for cultivation is of great essence and consideration. That the majority of area is covered by limestone resulted in the serious shortage of land for cultivation. As a result, local Hmong people have applied a number of methods to agricultural production in order to solve the problem of the cultivated land shortage. Firstly, the utilization of all available land for cultivation has always been maintained as the management principle regarding the problem of limited land by Hmong people at Lung Hoa B village. The majority of farmable land has been exploited for cultivating corn since it is the annual primary crop. In addition, they plant fruit-trees and some vegetables in the garden. Even barren lands at roadside also are utilized to plant elephant grass for feeding livestock. The maximum utilization of cultivated land can be best observed in corn cultivation. Aside from corn fields located in valleys that are quite flat with few large rocks and a lot of soil, Lung Hoa B villagers have sustained two more categories: rocky fields and rock-niche fields. Regarding the first type named rocky fields, local people set up terrace fields with a view to utilizing the area on mountain sides with the moderate slope and plenty of soil with the help of a number of rock embankments to reduce the erosion. To build up the embankment for rocky fields, villagers firstly collected many rocks from surrounding areas or had to break the mountain for rocks sometimes. Afterwards, they used a hammer and a chisel to eliminate sharp edges and make rocks become flatter. The flatter edges rocks had, the more solid the embankment became. Rocks were then arranged into the embankment with the principle that big rocks would be stand at bottom to establish a solid background, and small ones are upper. Finally, all the gaps among huge rocks were filled up and sealed with small pieces of rocks. Noticeably, even though no agglutinative substances were applied, all rocks were firmly attached and bound together thanks to the skillful arrangement of local people.

Besides, the technique of setting the latter category of rock-niche field is quite impressive. To set up a rock-niche field, local people often find niches enclosed by rock edges that could prevent strong wind, add soil to niches, and then sow corn seeds in. They have to carry soil up from lower lands and add to the niche so that the corn tree can stand firm and grow.

Intercropping and crop rotation are traditional techniques of Hmong people to solve the problem of limited arable land in karst plateau. They usually intensively intercrop corn as the main crop with other crops such as amaranth, pumpkin, green pea, edible canna, mustard green, and so on. After soil preparing, they start sowing the seed of corn, vegetables and beans on the field. In addition, Hmong people at Lung Hoa B also rotate corn with soybean and buckwheat.

4.2. Farming on rock

Dong Van Karst plateau is the world's only geopark with residents living with unique farming systems on karst rock (FAO 2015). To cultivate on rocky terrain of Karst Plateau, Hmong people have developed a system of traditional knowledge that includes knowledge on different phases of agricultural cultivation, among which are the experiences to build rocky fields. In addition, the knowledge on soil preparation, traction maintaining, specialized tools making as well as rocky field ploughing techniques should be mentioned. To begin a new crop, soil preparation is of great essence and is considered as one of the hardest work. After the New Year holiday (around February), Hmong people at Lung Hoa B village start to prepare soil for the new crop. The first task is to carefully remove all big rocks out of the field, and then collect them in piles. We can frequently see such kinds of rock-clearing piles at rocky fields of Hmong people in Dong Van plateau. For local people, these rock-clearing piles serve as a rock saving source for building rock banks delimiting the agricultural plots, and maintaining terrace support of rocky fields. Rock banks, rock-clearing piles, and terrace fields supported by rock embankments are the typical signs of the agricultural landscape in karst areas (Ezio Burri et al., 1999: 36-37).

Once the phase of cleaning the land is finished, villagers use the hoe and knife to clear the weeds, then dry and burn the weeds to ash, and spread it on the field as fertilizer. Afterwards, the task of ploughing field starts. It has always been emphasised by local people that ploughing rocky field is thought to be an easy work, but it is actually quite challenging to anybody. A number of factors are required in this work, including a good pulling-plow cow, a specialized ploughshare, and most importantly a skilled plougher. Only Hmong men can undertake the task of ploughing field, since it is a laborious work. They, men, must be strong enough to firmly hold the ploughshare as well as control the cow to go in the right direction. Particularly, the controller supposedly pays full attention in case the ploughshare is stuck by underground rocks. The ploughshare would be easily broken if the controller does not stop ploughing just in time to avoid underground rocks.

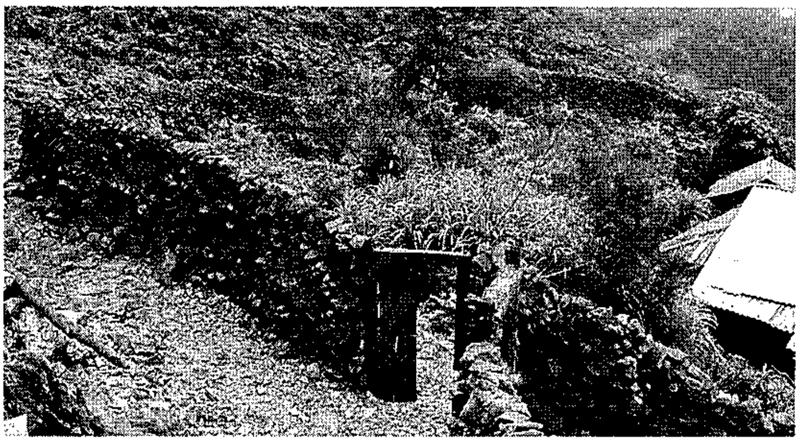
In Dong Van area, cows play a critical role in agricultural cultivation, since it offers an essentail source of muck as well as the fact that it is the dominant animal used to draw a plow. Hmong people in Dong Van choose breeding cows instead of buffaloes for the main traction because cows have a substantial resistance to the coldness of karst climate. Local people had gained experience on choosing suitable cows for agricultural cultivation through their appearance. A cow which is considered to be excellent at pulling ploughs must have such characteristics as short body, wide shoulder, rather big legs, brawny chest, tall figure, shining and short hooves, big mouth, small teeth, and a big hump to set a plough. Specially, in order to draw a plow on rocky fields, cows must go through a proper training. When a cow reaches the age of one year old, local people would take the cow to the field for training. At the begining, they choose quite flat fields with a few rocks to be the traning ground. Because untrained cows often disorderly jump and run, the first step is on training the cow to go in the right direction. They control the cow with a rope which threaded on cow's nose associated with commands to orient the cow to go, stop, and turn left or right as they wish. Afterwards, the owner has to train the cow to stop on time when the ploughshare is stuck by rocks, which is the most important for ploughing rocky field. After the training, the cow would be ready to work on rocky fields.

A number of specially dedicated tools which can be made only by Hmong people are required during the farming on rocks. Hmong people in

Dong Van area are also very pretigious for the ability of forging and casting agricultural tools, especially the ploughshare casting. Nowadays, there are only a few Hmong blacksmiths who master the techniques of casting the ploughshare. The Hmong ploughshare has the shape of isoscels triangle. Its blade is slightly curve with the obtuse and heavy head. The main material for making the Hmong plowshare is cast iron. However, the ploughshare used to work on rocky fields would be alloyed with steel in order to maintain the durability. In addition, it was revealed by a blacksmith that mixing oak ash with cast iron would also strengthen the ploughshare. The ploughshare becomes so strong and durable that it can hardly be damaged even when struck with big rocks.

4.3. The knowledge on utilizing rocks in daily life

The most popular rock utilization by Hmong people is in construction such as rock fences, or rock graves, and so on. In order to arrange a rock fence, Hmong people at Lung Hoa B firstly dig a drain as deep as 20-30cm, and then placed very big rocks inside to make a foundation. The foundation must be thick with 1-3 layers of rock depeneding on the height of each fence. The thicker the foundation of the fence is, the taller the fence can be. Making a sturdy foundation is of great importance so that the whole fence can stand firmly for a long time. After that, smaller rocks are formed on the foundation to shape the fence up to the height of approximately less than 2m. The rock fence which is 1.2-1.3m in height must have the foundation as thick as 40cm. For the rock fence as high as 1.6-2.0m, the foundation must be 60cm in thickness. During the process of arranging rock fences, no agglutinative substances are employed. The native people estimate and sellect suitable rocks with their eyes only, then tightly fit rugged and angular rocks together. Rock fences is of great significance in the life of Hmong people. First and foremost, only when Hmong people decide to set up a house do they start the arrangement of a rock fence to mark the boundary of their living space. It also plays a vital role in the protection of the house, the garden as well as the cattleshed from thieves and wild animals. Rock fences acompanied with the traditional rammed earth house have become a unique



Source: The author

Figure 4. A rock fence

cultural landscape of Hmong people in karst plateau.

'Living in the rocks, being buried in the rocks", goes a universal saying about the hard life of Hmong people in the rocky plateau. The native has held a close and eternal attachment to rocks. A Hmong person comes into being, grows up with the rocks, and it is a rock grave that he is buried in when he passes away. According to local people, rock covers the majority of the surface of karst terrain; as a result, when villagers dig about 1-2m only deep into the ground, they would reach the hard rock layer. Consequently, Hmong people in karst plateau ordinarily have their own graves shallowly dug. After lowering the coffin into the grave, Hmong people fill up the grave with soil, then cover the whole grave with rocks. The layer of rocks here protects the grave and especially prevents the erosion that can wash the soil out and lead to the exposition of the coffin.

4.4. Management mechanism of rock resource

In Hmong society, their own traditional mode of management was adopted in order to administer rock resource. Viewing from the map, the area of Lung Hoa B village falls into two categories: the first is resident areas and the second category is natural. The management of rock resources in these two categories were quite different. According to traditional mode of management, rock resource in the residential area was considered as the private property, and villagers were allowed to exploit rocks in their private land without any prohibition. Meanwhile, rock resource in the natural area officially was the collective property of the entire village, so villagers all had the responsibility to protect the rock resource there. However, aside from the exploitation of rock resource in private land, it appears that villagers did exploit rocks at surrounding natural areas which were close to their houses and their corn fields. There was ambiguity and loose terms in the traditional management of rock resource at Lung Hoa B village in the old days. Villagers exploited rock resource spontaneously even in natural areas without the close control from the community. However, villagers more or less had a sense of management and protection towards their rock resource since it was a crucial resource to them. Especially, the traditional management of rock resource in the old days was a local community-based mechanism which was mainly established on Hmong household scale. In addition, due to the nature of Hmong kinship, members of a Hmong clan were concentrated into clusters; it is to say that the rock resource management here should also be based on kinship. Clans' members shared the rock resource and took the responsibility to monitor and protect rock resource at their private land and natural surrounding areas.

The designation by the UNESCO as one official member of Global Geoparks Network in 2010 marked the considerable transformation in management mechanism of rock resource. There were a number of peremptory policies were promulgated by the government in the hope that geological heritages and natural landscapes are protected and preserved. This has had a considerable influence in the exploitation and utilization of rock resource of local Hmong people. Consequently, the traditional mode of management sustained by Hmong community has changed while the new mechanism of management that combined the both government and local community emerged.

After the designation, almost all the exploitations of rock resource at the village now have to be put under the strict supervision of the local authorities. At every important natural landscape was set a prohibition notice of rock resource exploitation. Obviously, the situation of rock exploitation in natural areas which was quite spontaneous before must cease immediately while the rock exploitation in private lands now is also restricted. Villagers even cannot break big rocks at their own land whenever they wish like before. In accompany with the restriction of exploitation, some staff are assigned by the local government to regularly visit the village and directly monitor the actual situation of natural landscapes and timely preventing unauthorized exploitations which can cause damage to natural landscapes. Nevertheless, rock exploitation is a habitual practice which villagers had sustained for hundreds of years. As a result, there were certain inevitable contradictions between local authorities and local people at first. Initially, villagers took little notice of the policies of the government, and the concept of Global Geopark was quite unfamiliar to them; so they continued to exploit rocks to fulfil their requirements. It was the staff of local government and the head of village who made the contribution to gradually solve the problem. The staff of the local government was very active in propagandizing new policies to people at village. They even came from house to house to convince villagers to follow the policies if necessary, meanwhile, the head of village was an actual bridge connecting the local government and villagers. The head of village must have a thorough understanding of policies from the local government, then express in a simple and comprehensive way, so villagers could easily grasp the main content of policies.

Thanks to the effort of local government, there has now been a considerable improvement in the awareness of villagers at Lung Hoa B village on managing rock resource. In their minds, rock resource was once an unbounded resource in the past has now been transformed to the limited and exhaustible one. As a result, villagers have developed a deeper sense of protection rock resource than before. At present, villagers strictly monitor the rock resource and do not allow other people (even close siblings like their own brother or sister) to take rocks from their private land without their permission. In case their family need rocks to build something, instead of breaking big rocks, rock-tops or cliffs that might cause damage to the natural landscape, they hoard rocks by diligently collecting small rocks on mountain or at their land. Villagers also keep their eyes on the natural landscape at their village beside watching on their private land.

Naturally, the remarkable change that the contemporary mode of rock resource management has now become more well-organized than in the past is very easily seen. The mode of management at the village now consists of two stakeholders who are the local government and villagers. There is a close association between stakeholders that reinforces the effectiveness of resource management. Local government is supposed to have control on the overall process of management with the helping hands of the staff and the head of village. In the meanwhile, villagers might make adjustments to their practices so that they would fit in the new situation. Villagers have generated a thorough understanding about rock resource in the context of Global Geopark, then have come up with a reasonable and self-conscious way of exploitation and management. Local government, on the one hand, promulgated the policies that strictly prohibited all exploitations of rock resource in order to protect the natural landscape of the geopark. On the other hand, they had a complete comprehension of the important role of rock resource in daily life of local people. The communities of Hmong people and other ethnic groups in Dong Van Karst Plateau exploited rocks for hundreds of years, and this activity has become an indispensable custom in their life. The very strict prohibition by local government could lead to the severe conflict, so local government they had to loosen the regulation to some extents. They gave permission to local people to come further into the mountainous areas which are far from the main road for rock exploitation, however, only in small scale and served for household demands such as building rock fences or rocky fields. Such activities as detonating a mine to break mountain or big exploitation that might cause serious damage to the natural landscape are strictly prohibited. As a result, Lung Hoa B villagers can continue utilizing rock resource in a sustainable and environment-friendly manner. In general, the event in which Dong Van Karst Plateau was entitled a global geopark might be considered as a disturbance having a big influence on the community of Hmong people at Lung Hoa B village. Fortunately, villagers manage to overcome the disturbance smoothly thanks to the self-adjustment within their community and the flexible management mechanism of local government.

5. Social mechanisms behind the traditional ecological knowledge

In accompany with the ecological knowledge system, many specific social mechanisms including knowledge transmission, cultural internalization, and worldview also had been established in order to sustain and preserve this knowledge system. In this section, I focus on the three crucial mechanisms closely related to TEK in Hmong society. At first, I illustrate the process of knowledge transmission as a very important mechanism that preserves TEK through generations. After that, the cultural internalization which is expressed in rituals and traditions is mentioned to see the integration of TEK into Hmong belief system, and finally, the expression of TEK that is integrated in Hmong cosmology is analyzed.

5.1. The transmission of traditional ecological knowledge

Hmong people in Dong Van Karst Plateau had sustained their own model to transmit the system of traditional knowledge from one generation to the next. It is a multidimensional process that consists of many specific activities that allow them gradually integrate and adapt to natural environment. The process of knowledge transmission can be divided into three continuous stages that include different features in terms of age, gender as well as the transmission model.

The first stage - The initial accustoming to rocky environment

The first stage normally is proportional to the period of 0-5 years old of Hmong people. This is the period when Hmong children initially get accustomed to the environment and acquire the first ecological knowledge. Noticeably, this stage begins from very early, even since the child was only few months old. Probably, many people will doubt about the learning ability of few months old children since they are too small for learning anything, however, the transmission of ecological knowledge actually does begin when parents unintentionally make children familiarize with the rocky environment by bringing them along to the field.

When the Hmong children are in 2−5 years old, the involvement of parents as the transmitter has not actually started and they mainly let their children continue to familiarize with rock environment but in a higher level. Children now have become mobile enough so they can play by themselves at the field, climb up big rocks and even go far to surrounding areas. It can be said that the field, the garden and surrounding areas have become the playground of children in which they can freely discover the natural environment and perceive primary ecological signals to some extents. In rocky fields, it's undoubtedly that rocks are the popular toy of Hmong children since colorful rocks such as white rock, red rock, blue rock, and so on always attract the children's attention. Parents can take chance to teach them by using rocks for learning the vocabulary on rocks because in this period, children start learning language. The first stage is the beginning of knowledge transmission process which is characterized by the initial self-awareness, self-discovery of each Hmong child about the rocky environment.

The second stage - Learning through practical activities

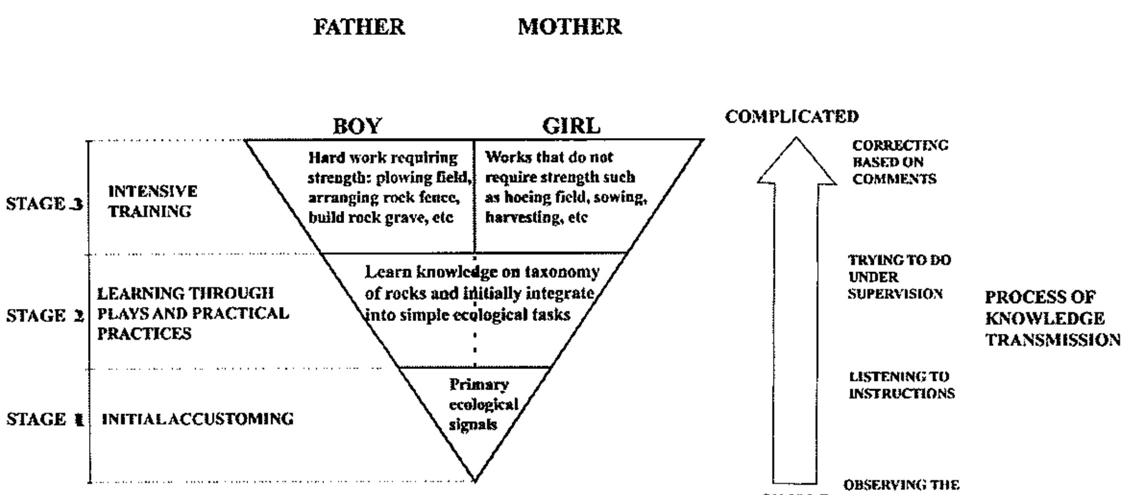
The period of 6−10 years old is considered as the second stage when children are mobile and verbal enough to be taught much more complicated tasks. In this period, the self-awareness of Hmong children continues happening by the 'learning through play' model, meanwhile, the process of knowledge transmission also is characterized by the gradual learning of specific ecological knowledge, through the step by step involvement in practical activities under the instruction of the predecessor. Hmong parents have gradually proved their worth as the main teacher to kids. Hmong parents now deliberately bring kids to the field for observing, getting accustomed to practical activities and kids can help their parents to some extents. They also have a clear sense of engaging their children in specific works at the field or in the garden. Moreover, they start to actually teach ecological knowledge to kids, of course, which is simple and appropriate to their age and gender. At that time, instead of playing at the field only, kids must undertake such tasks as collecting detritus to clear the field, or removing weeds and bushes out of the field. The second period is characterized by the simultaneous occurrence of the self-learning and the transmission from the older generation to the next one, which all have influenced equivalently on the knowledge acquirement of kids. The knowledge transmission starts to be gender specific in this period, however, not so distinctly since knowledge as well as practical activities transmitted are rather simple.

The third stage - The intensive training

The third stage is the period of 10−15 years old, marking the mature age on which Hmong children can acquire and master almost all ecological knowledge, then utilize it in daily life. Hmong kids now have improved themselves in terms of physical body as well as intellect, and are well trained enough to integrate in the whole works. In this period, ecological knowledge is much more complicated than in the second stage, so the process of knowledge transmission primarily depends on the channel of the older generations. The emphasis now is placed on the process of observing the whole work-listening to the instruction-trying to do under the supervision-correcting based on comments. Regardless of the complex of knowledge to be transmitted, the transmitter, ordinarily parents, firstly must conduct the task once or twice so the learner can observe, remember and model on. The transmitter then explains in detail the whole task from the simple step to the more complicated one, and answer the question from the learner, if any. After that, the learner must try to do the task under the supervision of the transmitter who will give comments to correct the learner's work. Finally, the overall task is learned, so the learner can officially participate in the work in accompany with the transmitter. At that time, only occasional verbal correction is needed and the role of transmitter gradually is eliminated when learner totally can master the whole ecological knowledge.

It can be said that, the third period is considered as the most important among three periods of knowledge transmission. Hmong kids in this period are taught almost all necessary ecological knowledge which help them survive in rocky environment. Kids now are ready for utilizing perceived knowledge to deeply engage in all daily tasks just as the adult generations.

The figure 5 illustrates the basic stages in the process of knowledge transmission, which allows Hmong people gradually approach the system of traditional ecological knowledge, then progress to master and utilize knowledge in reality. In general, the process of knowledge transmission among Hmong community is influenced by many socio-cultural factors. If the custom of taking kids along to go to work creates the opportunity for Hmong kids approaching ecological knowledge quite early, the close kinship brings about many information transfer channels by clan members such as cousins, uncles, and so on, to kids aside from parents as the main transmitter. The transmission process is specific with three separate stages which correspond with the age ranges: 'few months to 5 years old', '6 to 10 years old', and '11 to 15 years old' relatively. There are specific knowledge and tasks which the learner can approach in each stage. The higher stage they



Source: The author

Figure 5. The model of knowledge transmission of Hmong people

are, the harder knowledge and tasks they can acquire. On the other hand, we can realize the gender distinctness which has become clearer and clearer over three stages. The first stage of knowledge transmission does not show any sign of gender distinctness while the second stage starts to be slightly gender specific. The third stage proclaims the most obvious gender difference in many features of knowledge transmission. In the third stage, Hmong boys and girls will approach different knowledge which is transmitted by people of the appropriate sex. Ordinarily, boys have to learn such hard knowledge and tasks as plowing field or arranging rock constructions from the father while girls focus on learning more simple tasks that do not require strength, for instance, hoeing field, sowing, or harvesting from the mother. Worth mentioning is that the process of transmission always associates with specific places corresponded with specific knowledge.

5.2. Rock-related ritual and traditions

Rock-related ritual and traditions are the expression of cultural internalization which is the next category following the knowledge transmission in the hierarchy of social mechanisms. Meanwhile, the mechanism of knowledge transmission plays an important role in transferring traditional ecological knowledge from generation to generation, rock-related rituals and traditions raise ecological knowledge from a simple body of empirical knowledge to a higher level as an important position in the belief system of local Hmong people.

Hmong people in Dong Van area strongly believe in the existence and the power of the rock spirit that has deep influence on their spiritual and physical life. Their belief at first goes along with the reverent awe of the rock spirit that had made Hmong people here must be relatively cautious and have generated many taboos in order to harmoniously interact to the rock spirit. They are especially afraid of inadvertently violating the rock spirit's personal space or bumping into a rock spirit. On the other hand, Hmong people have a strong sense of asking for the protection from the rock spirit. The belief in worshiping the rock spirit is very popular in this area with many expressions. For example, before Hmong people exploit rock on the mountain, they do not forget praying to the rock spirit and the god of mountain for the fluent work without accidents such as the rock pulls their legs or sharp pieces of detritus cut their limbs. The rock spirit even is invited to become the adoptive parents who covers up the sick Hmong children. This unique custom originated from the belief of Hmong people in the power of rock spirit as well as the hardness of rock symbolizing the great strength. As for Hmong families having a sick child, they come to the three-way crossroad and find a tall, big, hard rock standing alone that they called the 'birth rock' to be the adoptive parents of the sick child. They hold a ritual by tying red threads on the 'birth rock', then praying to the birth rock so that the rock can transmit its power to those threads. After that, they tie those red threads on the limbs or neck of the sick child and tell the child that 'The adoptive rock parents give red threads to you, which will support you to have a good health and good fortune'. The child must always wear those thread with the belief that he/she is being protected by the rock spirit. Furthermore, the belief in rock spirit is practiced in the ritual of worshiping the big rock as the guardian rock (somewhere called the 'ancestor rock' or 'grandparents rock'), which is very popular and can be seen at almost all

Hmong families and villages in Dong Van area. Thus, ecological knowledge for adapting the rock environment has significantly influenced the belief system of Hmong people in Dong Van Karst Plateau. To some extents, ecological knowledge contributes to establish and uphold a series of rituals and traditions related to rock resource. On the contrary, thanks to the annual practice of these ritual and traditions, ecological knowledge gradually had been crystallized and engraved into the consciousness of each Hmong person.

Furthermore, owing to the regular practicing rituals and traditions, Hmong people can remember and interpret ecological signals from the environment appropriately. Of course, not all rituals and traditions are explainable in ecological terms, nor should they be. But obviously, we can learn much of ecological adaptive experience is contained and preserved in the system of rituals and traditions, only that ecological knowledge now had been are modified to other forms that were deeply imbued in the mind of Hmong people. On the other hand, rock-related-rituals and traditions convey respect and help Hmong people remember the importance of the rock resource, as a result, they raise up the sense of managing and preserving the rock resource among Hmong people.

5.3. Worldview and Cultural values

The last category of social mechanisms includes world views and cultural values of Hmong people in Dong Van Karst Plateau. This category rounds out the knowledge-practice-belief hierarchy that describes traditional knowledge. World view or cosmology consists of essential beliefs mainly contributing to structure observations that bring about ecological knowledge.

In the belief system of Hmong people, the ecological system is a 'community of beings' in which humans are part of an interacting set of living things. Aside from humans, there are many other living things such as animals, plants, and even natural factors like rock, soil, and so on, that have spirits and being sentient. They all can be watchful and aware of people's behavior. In rocky ecological system of karst plateau like Dong Van area, the belief which characterizes the Hmong belief system is the belief in rock spirit persisting within Hmong community and it shapes the Hmong worldview.

In the consciousness of Hmong people living in karst plateau, the rock is not a simple natural factor but it is considered as a being just like humans. They believe that rocks also have to follow the life cycle the same as humans of coming into being-growing up-being dead. They generated a set of their own jargons by which it seems that rocks are truly living their own life. 'Parent rocks' give birth and nourish 'living rocks' by their own body, so living rocks have to be cemented to parent rock in order to 'grow up'. Living rock even can 'shed tears', can 'sweat', and finally, when living rocks are separated from parent rocks, they become 'dead rocks'.

Hmong people consider rocks as an important partner in process of adapting to ecological system of karst plateau. Living in such an extreme harsh environment as karst plateau where has nothing but rocks, surprisingly, Hmong people here do not have one iota of disgracing or refusing rocks, on the contrary, they believe that rocks are the sprout of life by which they can depend on to overcome the difficulty of living environment. Hmong proverbs and fairy tales can reveal many unique viewpoints of Hmong cosmology on the position of rocks as the foundation of life. As a Hmong proverb said:

"The wealth lies on the rock
The hard working brings about the prosperity"
(Le Trung Vu 1994: 23)

A number of unique viewpoints on Hmong cosmology on the position of rocks as the foundation of life are revealed in Hmong fairy tales. In these Hmong fairy tales, the image of the rock appears frequently which symbolizes the everlasting stableness. Hmong people believe that, at the beginning of the world, the earth was only a block of thin mud which was very weak. There were two gods namely Mr. Tray and Ms. Tray who created rocks and plants, then by which they strengthened the earth. Since that time, the earth became solid. The land was stable thanks to the rock. Rocks were only materials which was solid forever. Rocks were strong. Rocks did not lose its shape so it was everlasting (Nguyen Manh Tien 2014: 41).

Especially, the image of rock caves on the mountain containing a lot of wealth is very popular which proves the Hmong unique belief that people can depend on rocks to achieve the prosperity. The tale of '*Mr. Cu and Mr. Cau*' talks about a Hmong boy who does a favor for a green dragon, so the dragon give him the rock cave where it stores its wealth (Duong Thi Phuong et al., 2014: 18-24). Meanwhile, the tale of '*Grandmother and two grandchildren*' talked about a sacred cave on the mountain containing many foods and drinks where Hmong people can enter and eat those foods and drinks (Le Trung Vu 2010: 171-175). We also can see the similar motif in other tales such as '*The orphan and sister*' (Duong Thi Phuong et al., 2014: 14-17), '*One good turn deserves another*' (Duong Thi Phuong et al., 2014: 40-43), and so on.

Obviously, Hmong fairy tales prove the unique belief of Hmong people that rocks are the sprout of life. Because of the significant role of rocks, Hmong people acknowledge an obligation to show respect to the rock to ensure a sustainable development. Hmong people in karst plateau show their respect to the rock resource by maintaining the attitude of humility when exploiting rock resource. They have to pray to the rock spirit and ask permission before exploiting rocks. They also hold rituals by which they make offerings in order to show their respect to rocks.

Aside from the worldview, the generating of the TEK also had created prominent cultural values that even though are outside the sphere of ecology, are relatively relevant to TEK. As for the case of Hmong people living at Lung Hoa B village, 'sharing' and 'reciprocity' are the most outstanding values that had deeply rooted into their mind. The value of sharing guarantees the harmonious exploitation of the rock resource within the Hmong community. After 2010, Dong Van Karst Plateau became the official member of Global Geopark network and had created a slight environmental stress within the local Hmong community in karst plateau. The rock exploitation had been tightened because the rock resource used to be an unbounded resource in the past which now had been transformed to a limited one. As a result, the much more restrictive exploitation led to the shortage of rock materials in many Hmong families. In such a difficult situation, the value of 'sharing' increasingly proved its worth as a simple method, but very effective to alleviate the shortage of materials. Families who had the needs for rock materials but the rock resource in their land could not satisfy, they could ask for the support from their neighbors or relatives who were always generous and willing to share their resource to people in need.

Aside from 'sharing', 'reciprocity' is an important cultural values that is relevant to the system of traditional knowledge. It is the 'sharing' that creates the major premise to establish and maintain the value of 'reciprocity'. 'Sharing' itself is one expression of 'reciprocity' since "sharing may carry an expectation of return (reciprocity) and can serve as somewhat of an insurance policy against future shortages" (Sutton and Anderson 2014: 115). Along with 'sharing', 'reciprocity' helps to maintain social ties within the whole community, consequently, that bring about a collective source of power to adapt the harsh rocky environment. In practicing and managing traditional ecological knowledge, the value of reciprocity is manifested clearly among villagers at Lung Hoa B, especially among clans' members. Villagers do not only share the resource but they also reciprocate each other's support. In most cases, such ecological works as ploughing rocky fields, arranging rock fences, building houses, or making rocky graves all are the hardest, and villagers often depend on the support of neighbors and relatives who are always enthusiastic and willing to help as much as possible. There are many cases that even though the host does not call for the help, others still volunteer to come and assist the host in finishing the work.

6. Discussion and conclusion

In general, the system of traditional ecological knowledge of Hmong people in Dong Van Karst Plateau includes sets of empirical knowledge and information about the living environment that are generated and accumulated by long-term factual observations and the trial-and-error experimentation. Moreover, it has been continuously reinforced by accounts of TEK holders. There is much ecological knowledge and information that is personal knowledge originally, and then is enriched and validated through social interactions. Aside from factual observation, TEK is also generated in the accumulation of facts through trial and error experimentation. The custom of using rock to arrange the fence of Hmong house may be an example. As said by local Hmong people, at first Hmong ancestors used such materials as wood or bamboo to make the fence. However, the soil layer in the surface of karst plateau was quite thin so that it was hard to drove stakes deeply into the ground to ensure the firmness of the fence. Cattle often broke the fence not to mention the fact that wood or bamboo was not durable enough and easily became rotten. As a result, they changed to using rocks to make fences which were much more firm, more durable and very effective for preventing thieves and keeping cattle inside. The present structure of Hmong crop plants in Dong Van area is also the result of the long-term process of trial-and-error experimentation. Living in karst plateau in which is always shortage of water, therefore, Hmong people have to consider about the natural conditions and they probably went through many experimentations in order to come up with a set of plants such as corn, pumpkin, soybean, and so on, which are drought-resistant and can grow in exhausted fields here.

Generally, traditional ecological knowledge enables Hmong people to adapt quite harmoniously to the karst environment. However, the system of TEK is not infallible and has its own problems.

At first, the rock resource is very necessary for the Hmong and the activity of exploiting rock has become a traditional custom of Hmong people here. Over hundreds of years, they have ceaselessly exploited the rock resources to satisfy their needs. Rocky fences, rocky graves, rocky banks at corn fields, and so on, all were built from the rock materials exploited from the mountain. However, the rock resource is a non-renewable resource so that this custom has gradually damaged the natural landscape of karst plateau. Especially, in the old days, the situation of exploiting rocks was very spontaneous and uncontrolled. Hmong people with the thought that the rock resource was so abundant that it seemed to be unbounded, in accompany with the traditional management mechanism allowed local people freely access to the resource, that all, obviously, had seriously broken the natural landscape. In addition, many ecological practices of local people seem to be harmless at first, actually can have serious influences on the karst environment. Karst plateau is particularly prone to soil erosion because of shallow, erodible soils on surface (Beynen 2011: 110), so that the practice of chopping down trees on mountains for firewood, regular clearing land for cultivation has gradually made the vegetation cover on karst surface become thinner and thinner that results in the erosion. Moreover, Hmong people with custom of the making maximum use of farmable lands due to the shortage of lands can be considered as an overuse of soil to some extents that also can cause the erosion. Another issue is that karst plateau is quite susceptible to groundwater pollution because the layer of soil on surface of karts plateau which plays the role as a natural filter layer often is not thick enough, not to mention the natural cracks, swallow holes, and sinkholes enable surface water directly link to groundwater. As a result, such activities as rotting manure, fertilizing, human wastes, etc. can easily contaminate the groundwater.

Traditional ecological knowledge closely associates with the long history and culture of Hmong people. In accompany with the generation of TEK, there are many special social mechanisms such as mechanism for knowledge transmission, mechanism for cultural internalization, and worldviews and cultural values, were established in order to sustain and preserve TEK. Among mechanisms, knowledge transmission is the most important since this mechanism ensures that TEK can be passed from the generation to the next. Mechanisms of cultural internalization makes people can remember TEK which is crystalized and transformed to ecological signal bearing sacred colors, and through regular practice of these rituals and traditions, TEK can be embedded into Hmong mind. Finally, worldview contributes to the establishment of respectful relationship between human and natural environment. It gives human beings special responsibilities to the land where they are embedded in. The socio-ecological linkage here maintains and contributes to the sustainable development of the system of traditional ecological knowledge.

Traditional ecological knowledge is the way of Hmong life and closely links to social history of Hmong people. Undoubtedly, TEK is considered as a cultural identity of Hmong culture, as a result, TEK becomes a cultural resource by which Hmong people not only can survive but they also can 'bloom'. From my point of view, tourism is the most effective method to utilize TEK as a cultural resource. Dong Van Karst Plateau is rich in touristic potentials and has become a very famous touristic destination which attracted more and more tourists to visit. In accompany with beautiful natural landscape, ethnic cultural identities are also a significant touristic attraction, that are advantage to develop cultural tourism by which local people can utilize well TEK. However, the utilization of TEK for developing tourism among local Hmong communities is quite poor that is not appropriate to its potential. As for Lung Hoa B village, after 8 years since 2010 when Dong Van Karst Plateau was designated by the UNESCO as a Global Geopark, villagers almost have not done so much to utilize their own cultural resource to develop tourism. This poor development of tourism here has many reasons but in my opinion, the biggest problem here is that, local people do not know how to utilize their own cultural capital. In other words, they do not have a strategy for tourism development. On the one hand, the weak utilization of cultural resource for developing tourism is a wasteful and proves the slow transformation in socio-economic situation of Hmong people in Dong Van Global Geopark. On the other hand, this state, from my point of view, can be an advantage of Dong Van area since local government has the opportunity to learn from experience of other places where tourism already developed and build up a sustainable tourism development strategy for this area.

Traditional ecological knowledge is very meaningful to local communities in many aspects and ignoring TEK almost ensure failure in development (Brokensha et al., 1980). T' Seleie (1975: 16-17) used the metaphor of water to talk about what TEK means to the people.

> "It has been flowing before any of us can remember. We take our strength and our wisdom and our ways from the flow and direction that has been established for us by our ancestors we never knew, ancestors of a thousand years ago. Their wisdom flows through us to our children and our grandchildren to generations we will never know. We will live out our lives as we must and we will die in peace because we will know that our people and this river will flow on after us".

When we apply this metaphor to the case of traditional ecological knowledge in this study, it can be seen that, TEK is the source of the highly specific and detailed knowledge that local people require in order to survive in rocky environment. It enables local people to interpret ecological signals from natural environment appropriately, then they can respond by strategies that ensure the sustainable use of the rock resource. This survival has a physical basis (TEK for substance), spiritual (TEK defines the role of human being in the world) and emotional (providing strength and resilience) aspects (adapted from McGregor 2004).

Especially, traditional ecological knowledge has a strong potential to contribute to more effective and sustainable management of the natural resource with the model of local community-based management. At present, the mechanism of managing rock resource in Lung Hoa B village is the combination between local government and local community. On the one hand, local government keeps close control of the rock resource, on the other hand, they use as much local-level management as possible by handing over certain authority to Hmong community by which local people can access and manage the natural resource in a self-disciplined manner.

Finally, yet important, even though traditional ecological knowledge is crucial for the survival and development of local Hmong community, it does not always remain undamaged through time not to mention that it is facing the danger of extinction. This danger resulted from many reasons: characteristic of TEK itself, the influence of modern education, and the change in the way of life of Hmong community. At first, the characteristic that TEK is not in written form and TEK is transmitted through generations by words of mouth can become a weakness making it easy to face being lost due to the lack of records. In addition, the formal education at school unfortunately is one reason for the loss of TEK since young generations nowadays spend much of their time at school where teachers offer them modern knowledge instead of TEK. This situation can somewhat lead to the little appreciation of young generations on the TEK system. In accompany with two causes, the change in the way of life and the thought of local people has also accounted for the loss of TEK. In brief, the danger of being loss of TEK is not a far perspective but it has happened among Hmong communities. Due to its role as the key for the sustainable development and as a Hmong cultural identity, paying the attention to preserve TEK is an urgent task. In order to solve the weakness of lacking of TEK records, it is necessary to collect and build up a collection of written TEK of Hmong people in Dong Van Karst Plateau which my research hopefully can be a contribution. Only by this work, can we organize TEK, and especially make it usable and accessible to Hmong community as well as others. In addition, the task of propaganda also should be promoted by which local government makes local Hmong people realize the value of TEK as well as acknowledge the importance of TEK preservation. They must first and foremost control their own knowledge. Nevertheless, that simply collecting and documenting TEK is somehow counter-productive; therefore, social mechanisms that support TEK also should be in the concern because the socio-ecological linkage between TEK and social factors is the corner-stone leading to the sustainable preservation. I believe that TEK deserves to have a rightful place alongside scientific knowledge. The holders of TEK should cooperate with modern scientists to preserve and connect both bodies of knowledge as means to manage natural resources and to develop communities in an ecological sustainable manner.

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