

**MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
INSTITUTE OF METEOROLOGY, HYDROLOGY
AND CLIMATE CHANGE**

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**KNOWLEDGE OF ETHNIC MINORITY
COMMUNITIES IN LAI CHAU IN RESPONDING TO
CLIMATE EXTREMES AND NATURAL DISASTERS,
TOWARDS EFFECTIVE CLIMATE CHANGE ADAPTATION**

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**SUMMARY OF THE THESIS
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- Vietnam National Library.
- Library of Hydrometeorology and Climate Change Institute.

**LIST OF SCIENTIFIC ARTICLES OF THE AUTHOR
RELATED TO THE THESIS**

1. Vu Van Cuong and Tran Thuc (2017), *Indigenous knowledge in adaptation to climate change*. Journal of Climate Change Science, No. 2, 6/2017, pages 25-29
2. Vu Van Cuong, Tran Thuc, Đinh Thai Hung (2018), *Knowledge, natural experiences of the ethnic minority Community to cope with disaster and adapt to climate Change in agricultural production of lai chau Province*. VietNam Journal of Hydro – Meteorology, No. 696, 12/2018, pages 20-26
3. Vu Van Cuong, Tran Thuc, Đinh Thai Hung (2019), *Investigating and casting the knowledge of the community ethnic minority in lai chau province response To natural disaster and extreme climate*, VietNam Journal of Hydro – Meteorology No. 699, 1/2019, pages 13-19.

INTRODUCTION

1. Research reason

Local/indigenous knowledge developed by ethnic minority communities through the long history of interaction with natural environment, helps them to build their resilience against environmental changes. According to the governmental policies, application of knowledge and experience of ethnic minority communities to prevent climate extremes and natural disasters is considered one of solutions to achieve the objectives regarding to climate change response at the local level.

The dissertation entitled “Knowledge of ethnic minority communities in Lai Chau in responding to climate extremes and natural disasters, towards effective climate change adaptation ”, thus aims to provide a scientific and practical basis for applying the role and value of indigenous knowledge of ethnic minority communities in the province of Lai Chau

In addition, the results of the thesis will be references for the authorities at all levels to develop policies and plans responding to natural disasters and climate change adaptation in the future.

2. The research objectives:

(i) To assess the climate extremes and natural disasters and its impacts on people’s lives and production of the ethnic minorities in the province of Lai Chau ;

(ii) To analyze and draw lesson learnt from the knowledge system of ethnic minority communities in Lai Chau applied for responding to climate extremes and natural disasters;

(iii) To propose measures in order to promote the knowledge system of ethnic minority communities in Lai Chau for climate change adaptation.

3. Research subject and scope

- Research subject: Community knowledge system on cultivation and animal husbandry; exploitation and management of water resources and forest resources; protection of human health of property. This knowledge system has been used by ethnic minority communities in Lai Chau in responding to climate extremes and natural disasters.

- Scope of the research: The thesis studies and surveys in Thu Lum commune, Muong Te District; Ta Leng, Ho Thau, Ban Bo and Na Tam communes, Tam Duong District.

4. Research hypothesis

- Ethnic minority communities in Lai Chau recognize clearly the manifestations of climate change and the impacts of extreme climate and natural disasters on socio-economic aspects at their communities.

- Ethnic minority communities have used the knowledge, experience and technical systems of individuals, families and communities to adjust their practices for minimizing risks due climate extremes and natural disasters for their production and resource management. .

- It is possible to promote the knowledge systems of ethnic minority community for effective climate change adaptation .

5. Research questions

- How do climate extremes, natural disasters and climate change affect the lives and production of ethnic minority communities in the province of Lai Chau?

- What kind of knowledge, experience and techniques are used by ethnic minority communities in Lai Chau to mitigate the risks of climate extremes and natural disasters to their lives and production.

- How do we do to promote community knowledge of ethnic minorities to adapt effectively to climate change at the community level in Lai Chau province?

6. The contents of research

To answer these research questions, the thesis implements the following research contents:

(i) Assessing of the climate extremes and natural disasters and its impacts on the lives and production of ethnic minority communities in Lai Chau;

(ii) Investigating, analyzing and summarizing practical knowledge systems of ethnic minority communities in Lai Chau which have been applied in response to the climate extremes and natural disasters;

(iii) Assessing the impact of climate change on the lives and production of ethnic minority communities in Lai Chau;

(iv) Developing measures to promote the knowledge system of ethnic minority communities in Lai Chau for climate change adaptation;

(v) Proposing contents of community knowledge that need to be integrated into policies and plans for development and climate change response in the province of Lai Chau.

7. Research methods:

(i) Literature review; (ii) Participant observation; (iii) Individual semi-structured interview; (iv) Delphi method.

8. The original contributions of the thesis

- Through sociological investigation and surveys, the thesis has revealed and acknowledged the knowledge of the ethnic minority communities in Lai Chau in responding to climate extremes and natural disasters in the past.

- The thesis has exposed positive values and difficulties for replication and application of knowledge systems of the ethnic minority communities in Lai Chau for climate change adaptation.

- The thesis has proposed measures to promote the knowledge system of ethnic minority communities for developing climate change adaptation in the Lai Chau Province.

9. Scientific and practical contribution of the Thesis

- *Scientific contributions:* (i) The Thesis analyzed and clarified the role and value of knowledge of the ethnic minority communities in Lai Chau; (ii) The thesis has structured community knowledge on cultivation; animal husbandry; and management of forest resources, water resources management, and community shelter houses. These community knowledges are valuable in dealing with climate extremes and natural disasters in the past, and support potentially communities in climate change adaptation in the future; (iii) The Thesis has applied an interdisciplinary approach in assessing the role and value of community knowledge in climate change adaptation.

- *Practical contributions:* (I) The thesis's findings help the ethnic minority communities to realize the values of the knowledge that their community has accumulated and produced. They, then help the ethnic minority communities continue to develop and replicate these knowledges for climate change adaptation; (ii) Research results of the Thesis's findings are good references for local authorities in developing and implementing policies and plans for socio-economic development

and climate change adaptation in the province of Lai Chau.

10. Thesis overview

Apart from the Introduction, Conclusion and Recommendations, the thesis consists of the following chapters: Chapter 1: Literature reviews of international and domestic studies; Chapter 2: Theoretical considerations, the study area, and methodology; Chapter 3: Practical value of knowledge of the northern ethnic minority community in responding to climate extremes and natural disasters; Chapter 4: Promoting of the knowledge system of ethnic minority communities in Lai Chau for climate change adaptation.

CHAPTER 1: LITERATURE REVIEW OF INTERNATIONAL AND DOMESTIC STUDIES

1.1. Overview of foreign studies

Reviewing the studies of foreign scholars regarding to community knowledge, thesis notices two main periods. The first one is about prior of the year of 2000. At this time, the research and studies focused on community knowledge applied for management of natural resources, sustainable ecosystems and served for sustainable development at the community level. The second period, being from 2000 onward, scholars focused on studying the application of community knowledge to clarify the climate change manifestations, its impacts, and solutions for climate change adaptation at the community level. Reviewing these two periods, it is shown that research and application of community knowledge in community development can become an effective solution that can be alternative for scientific one in specific conditions.

1.2. Overview of domestic studies

In recent decade, some scientists and organizations have researched and applied the value of knowledge of ethnic minority communities in Vietnam to improve the capacity and participation of local people in climate change response. They focused on developing on-site response experience and the role of authorities at all levels; Developing and diversifying livelihoods in regions and localities to support climate change adaptation in the line with varying vulnerable levels; Promoting the use of knowledge of ethnic minority communities in responding to climate change, especially in developing new livelihoods related to low-carbon development. Reality shows that if community knowledge is fully applied and combined with modern technology and techniques, it will help to save effectively huge funding. From an overview of domestic and foreign studies, the thesis draws some limitations and shortcomings of previous studies. First, approaches and research methods of reviewed foreign and domestic studies are mainly single-discipline, which are applied for particular sectors and aspects. Second, cultural and community knowledge are formed by geographical conditions, natural environment, socio-economy. The impact of extreme climate and natural disasters on each ethnic group, each geographical region are at different frequency, intensity and scope. It is impossible apply strictly the community knowledge system of an ethnic minority specified for particular area to those of other areas. Therefore, it is necessary to research and summarize the system of knowledge that has support significantly ethnic minority communities respond effectively to climate extremes and natural disasters in the past, which would continue to help them adapt to climate change in the future.

Conclusion of Chapter 1

The community knowledge system plays an important role in the process of survival and development of the ethnic minority community. It serves as a basis for people to solve socio-economic issues and respond effectively to climate extremes and natural disasters in their community.

The community knowledge system is determined by the natural, economic and cultural conditions of a specific ethnic minority community. The system of community knowledge only can achieve its highest value in certain cultural space conditions. Therefore, it is very difficult for applying ethnic minority communities in Lai Chau to for those living outside of Lai Chau province to effectively respond to natural disasters and climate change without tests and selection.

The knowledge system of ethnic minority communities in responding to climate extremes and natural disasters in the past, are applicable to climate change adaptation at the community level. Therefore, it is necessary to promote the benefits of each community knowledge system in the combination with with scientific knowledge and other development activities, in order to enhance the value of community knowledge. This also create solutions for climate change adaptation in accordance with socio-economic conditions and people's culture at the community level.

The single-discipline approaches are mainly applied for the studies of community knowledge. The thesis, thus applies multidisciplinary approach based on some scientific disciplines.

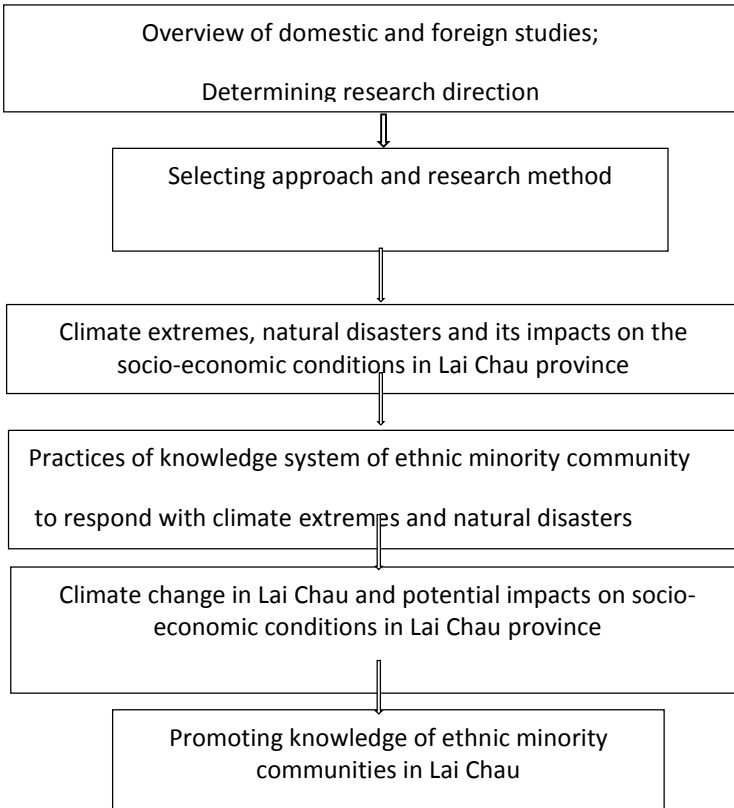


Figure 1.1. The thesis diagram

CHAPTER 2: THEORETICAL CONSIDERATIONS, THE STUDY AREA, AND METHODOLOGY

2.1. Theoretical considerations

2.1.1. Concepts/technical terms

According to literature review, the concept of "community knowledge" used in the thesis is considered the entire knowledge and understanding of the people belonging to a specific, ecological and socio-cultural space. Community knowledge are manifested in production practices, behaviors in managing and exploiting natural resources, and the practices of culture and beliefs in the community. Knowledge of the community are constantly accumulated, revised, and transferred among generations through verbal explanation, and the practices of production and social behaviors in the community. Community knowledges are means and tools helping people behave and adapt to natural and social conditions within history of existence and development of each ethnic minority community.

2.1.2. Characteristics and values of ethnic minority community knowledge

(i) Locality: ethnic minority community knowledge reflects people's perceptions and insights on the natural environment and ecosystem in a specific area or territory where they live. For example, people who live in forest areas can understand thoroughly the forest fauna and floral systems.

(ii) Practicality: Knowledge of ethnic minority community is created from living practices within specific conditions and spaces. It also was not produced by one person, but rather by many generations in the lineages and communities over thousands of years. It had gone through thousands of "True" and "False" tests within their production

practices and dealing with the natural environment. Practicality is also a constraint in replicating and applying the knowledge of the ethnic minority community in other areas.

(iii) **Dynamicity:** community knowledge is created from practical activities, production and behavior with the natural environment. It is constantly supplemented, re-evaluated and developed to become suitable with natural and social changes.

(iv) **Verbal learning:** The knowledge of ethnic minority communities is documented very less. This knowledge is memorized, and manifested in cultural and belief activities. As a result, it was transferred to the next generations mainly through verbal learning and practicing cultural and belief activities in the community.

2.1.3 Characteristics of climate change adaptation solutions

The climate change adaptation solutions are (i) loss acceptance; (ii) loss sharing; (iii) danger reduction; (iv) impact prevention; (v) changing the ways for using resources; (vi) changing places; (vii) researching and applying sciences and technology; (viii) educating, informing and encouraging behavior changes:

2.1.4. Applied theories

1) **Cultural ecology:** Cultural ecology clarifies the relationship between culture and physical environment. According to the viewpoint of this theory, people can survive and adapt to the physical environment by adjusting cultural behaviors.

2) **Human ecology theory:** This theory clarifies mutual relationship and the interaction among people within the living environment, and the relationship between social environment and physical environment within the tolerance.

3) Agricultural human ecology: Traditional agricultural ecosystem is close to the natural ecosystem. The main modes of agricultural human ecology are the technique of "intercropping" or "multi-crop", "agroforestry", and "shifting cultivation".

2.2. Study area

Lai Chau is border mountainous province, located in the northwest of Vietnam, with geographical coordinates being 21⁰51' 'to 22⁰49' Northern latitude; and 102⁰19' - 103⁰59' East longitude. It faces the Yunnan Province in the North (China); the province of Lao Cai in the East, and Yen Bai Provinces; Dien Bien and Son La Provinces in the South. Lai Chau is 450 km far from Hanoi capital in the southeast (according to national highway 4D, 70, 32). Its population consists of 20 ethnic minorities living together. Ethnic groups are divided into different groups such as Tay - Thai language group including Thai, Tay, Nung, Giay, Lao and Lu ethnic groups; Vietnamese - Muong language group consists of ethnic Vietnamese and Muong people; Mon - Khmer language group has Khomu, Mang and Khang ethnic groups; The Tibetan - Burmese language group has the Ha Nhi, Cong, La Hu, Si La, Phu La and Lo Lo people; Hmong language group - Dao has Hmong and Dao ethnic groups.

2.3. Research methods

The thesis uses different approaches including systematic approach, interdisciplinary approach and participatory approach. Methods are as following:

(i) Desk study method. It reviews and assesses available data and documents published by individuals and organizations. Data can come from papers, monographs and specialized reports;

(ii) Participatory observation method: This method approaches individuals and communities via joining activities with participants. For example, the researcher eat, stay and work with participants, then he or she observe and record participants' activities within their production processes and daily lives in the research area;

(iii) Individual semi-structured interviews: The researcher will meet, exchange and record information from deep-understanding individuals in the community regarding to particular issues and interested topics of the thesis;

(iv) Delphi method: this method is the consultation process to achieve consensus of experts in terms of issues of research interests.

Conclusion of Chapter 2

The thesis has analyzed and applied the cultural ecology, human ecology theory, and agriculture human ecology. Culture, both within production and daily life of ethnic minorities is always adjusting and changing by itself to adapt to the changes of the natural environment. These changes are reflected in the adjustment of cultural behaviors, transformation and renovation of physical environment within the threshold for rehabilitation and production of ecosystems, in order to meet the physical needs of people and the society development.

The topography of Lai Chau Province consists of many sub-climate regions, and many ethnic minority communities. In order to ensure the representativeness of the climate regions, there are varying research subjects at different scopes. They include ecological belt area being higher than 800m (above the sea level), and the research subjects are the knowledge system of Hmong and Ha Nhi ethnic groups; The ecological zone between 500-800m high, with the the community

knowledge system of the Dao people; The ecological belt area being lower than 500m high, with the Thai and Lao ethnic groups.

The Thesis uses several methods to collect information and data, including: (i) Literature review; (ii) Participant observation; (iii) Individual semi-structured interview; (iv) Delphi method . By using simultaneously multiple methods, the collected information sources and data are complementary, objective and reliable, which supports significantly the analysis and assessment processes. From the theoretical considerations, the thesis offers an analytical framework illustrated in the Figure. 2.2.

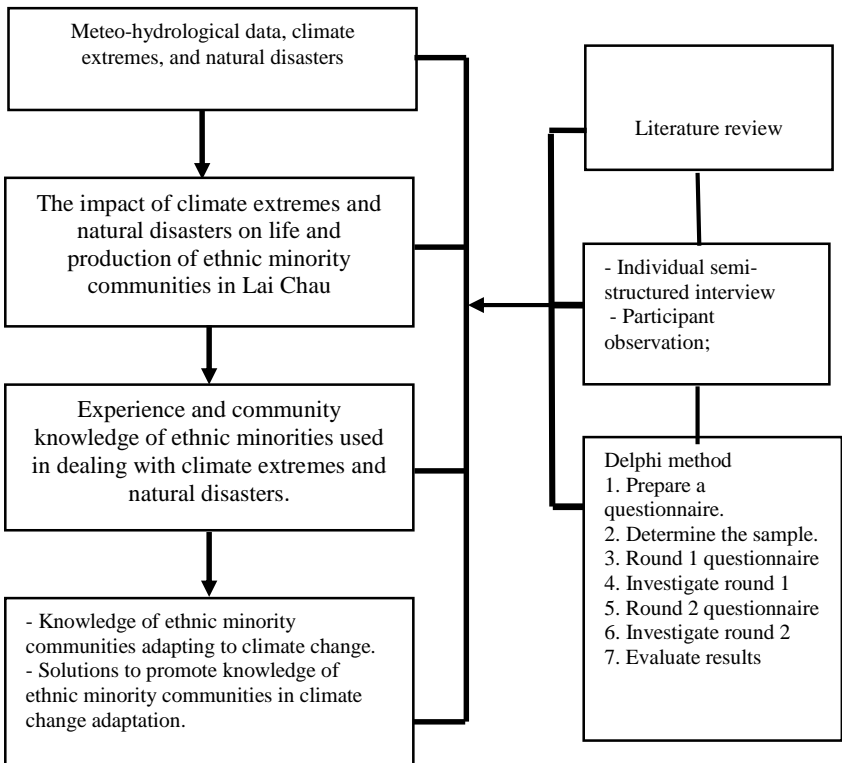


Figure 2.2. Analytical framework for carrying out the thesis

CHAPTER 3: PRACTICAL VALUE OF KNOWLEDGE OF THE NORTH ETHNIC MINORITY COMMUNITY IN RESPONDING TO CLIMATE EXTREMES AND NATURAL DISASTERS

3.1. Climate extreme and natural disasters and in Lai Chau

3.1.1. The trend of climate extremes and natural disasters in Lai Chau

The observed meteorological data during the period of 1961 -2014 in Lai Chau showed that the average annual temperature, those of winter, and those of summer increase by 0.2 -0.3⁰C per decade in winter and 0.1 -0.2⁰C per decade in summer throughout Lai Chau Province. The annual rainfall and the maximum daily rainfall decrease on the stations located in Lai Chau Province. The fastest decrease rate is at 4.2mm per year and the slowest one is about 0.19mm per year.

3.1.2. Impact of climate extremes and natural disasters on socio-economic conditions in Lai Chau

From 1961-2010, the Province has 1.4 flash floods and landslides annually. Flash floods and landslides destroyed 13 irrigation facilities, traffic works and economic loss in the Province with an estimated 275.7 billion VND per year. During the period of 1961-2015, there are average 5 people were killed and an average of 476 houses damaged annually.

3.2. Community awareness about the impact of climate extremes and natural disasters.

According the analysis results from local responses, the figure 3.7 has shown the extent and scope of impacts of natural disasters and climate extremes on socio-economic conditions of the ethnic minorities community in Lai Chau Province.



Figure 3.7: Assessment of the impact of natural disasters, climate extremes on life and production of ethnic minority communities in Lai Chau

It is affirmed that natural disasters such as floods, flash floods and landslides are natural disasters that seriously affect human health, lives, houses and properties. Climate extremes, heat waves and droughts affect greatly forest resources. The livestock and farming sectors are affected by cold and very cold spells.

3.3. The community knowledge system used in response to the climate extremes and natural disasters

The survey results in Round 1 show that there are 8 out of 21 solutions to respond to climate extremes and natural disasters, are selected by experts, that is lower than 70%. These solutions are appropriated to the actual socio-economic conditions in the studied areas. The measures selected in Round 1 are used for fixed questions for Round 2, divided into 5 topics. These areas consists of (i) life and property protection (there are 4 measures regarding this topic namely from S1 to S4); (ii) Cultivation (there have 6 measures denoted from T1 to T6); (iii) The livestock sector (it has 5 measures symbolized from C1 to C5); (iv) Water source protection (there are 3 measures namely from N1 to N5); (v) Forest protection sector (there are 3 measures denoted as R1 to R3). Indicators are graded on a scale of 1 to 5. (the options of *very disagree/ no impact* is for scale of 1; and those of *totally agree/having serious* is considered at scale of 5).

3.4. Limitations and difficulties in replication and application of community knowledge to respond to climate extremes and natural disasters

There are some economic, cultural and social difficulties. The intellectual property rights has not acknowledged for community knowledge. There is a lack of financial, scientific and technological resources to support the development of community knowledge. The mechanisms and policies are not yet adequate. There are some limits of the community knowledge system, which causes difficulties in replicating and applying it to respond to the climate extremes and natural disasters.

Conclusion of chapter 3

The these studies on climate change, impacts of climate change on socio-economic sectors in Lai Chau, and reviews and acknowledges the community knowledge system used by people to respond to extreme climate and natural disasters in the region, this chapter draws some conclusions:

In the period of 1961 - 2014, mean temperature in increased from 0.2 to 0.3⁰C, and 0.1 to 0.2⁰ C per decade, respectively to the winter and summer. Annual rainfall decreased from 0.9 to 4.2 mm per year observed at almost stations in Lai Chau Province.

Floods, flash floods, whirlwinds, hail, cold, cold weather are climate extremes and natural disasters that occur frequently in Lai Chau Province. They have impacted and caused serious damage to life and people's property, food production, animal husbandry, infrastructure, and economy of ethnic minority communities.

The community knowledge system of ethnic minorities in Lai Chau protects health, life and property. They have applied earth-wall houses and stilt houses to adapt cold conditions of the highlands, floods flooding flood in low areas.

Regarding agriculture production, community knowledge is used to cope with climate extremes and natural disasters via Intercropping, rotating crop, planting tea trees instead of unproductive food plants, planting the native plants. The techniques / modes of production that people have been applying are the production methods of the traditional agricultural human ecosystem. This method has been able to maintain crop productivity, also to ensure sustainable agricultural ecosystems and to meet people's food needs.

Regarding to animal husbandry, traditional grazing methods have been transformed into free-range that is captive breeding in combination with free grazing. Grass has been planted, agricultural by-products has been collected, which leads to proactively supplement food sources. The change in livestock mode reflects the co-evolution of the social and the natural systems, which helps people adapt to changes in the environment, and to minimize risks for livestock in the cold weather conditions.

For exploiting and managing water resources and forest resources, the community has been aware of the abilities of natural conditions that they can relied on. They thus created techniques for water extraction, for example “Cồn nước/water mill”. Using the self-governing community method and designing the water diversion system suitable to local conditions and circumstances. Using customs and beliefs to protect watershed forests and sacred forests, thus maintaining the water-holding capacity of forests, and conserving biodiversity. Forest resources and water resources are managed and exploited by local people in a sustainable way, providing a safe living environment, ensuring livelihoods in extreme climatic conditions and increasing natural disasters.

There are some economic, cultural and social difficulties. The intellectual property rights has not acknowledged for community knowledge. There is a lack of financial, scientific and technological resources to support the development of community knowledge. The mechanisms and policies are not yet adequate. There are some limits of the community knowledge system, which causes difficulties in replicating and applying it to respond to the climate extremes and natural disasters.

The economic, cultural - social difficulties of the community, intellectual property rights for community knowledge have not been established. There is a lack of financial, scientific and technological resources to support the development of community knowledge.

The mechanisms and policies are not yet adequate. There are some limits of the community knowledge system, which causes difficulties in replicating and applying it to respond to the climate extremes and natural disasters for cultivation, animal husbandry, forest resource management, water resources and protecting the health of people .

CHAPTER 4: PROMOTING OF THE KNOWLEDGE SYSTEM OF ETHNIC MINORITY COMMUNITIES IN LAI CHAU FOR CLIMATE CHANGE ADAPTATION

4.1. Climate change and its impacts on Lai Chau province

According to RCP 4.5 scenario, the average annual temperature in Lai Chau Province increased by about from 1.6 to 1.8⁰ C compared to those of the base period, in the middle of the century. By the end of the century, it is expected to increase about from 2.2 to 2.4⁰ C. According

to the RCP8.5 scenario, the mean of annual air temperature in Lai Chau Province will possibly increase from 2.2 to 2.3⁰ C. Those at the end of the century, will be expected to increase by nearly 4⁰ C compared to those of the base period.

According to the RCP4.5 scenario, the amount of annual rain in Lai Chau Province probably increase by about 10-15% compared to those of the base period, by the end of the century. Regarding to the RCP8.5 scenario, the annual rainfall will increase by 10-20% by the end of the century. The rainfall in the southern region will be expected to increase faster than those of the Northern area of the Province. The daily rainfall have a trend to increase similarly to the annual rainfall, but there are different at intense. the daily rainfall will probably increases about 20-50% compared to those of the base period, according to the RCP4.5 scenario, and about 40-70% regarding to the RCP8.5 scenario. by the end of the century.

Extreme rain, flooding, flash floods and landslides, heat, extreme cold will occur with more serious intense in the future, which causes adverse impacts on the sectors. The most affected sectors include: (1) cultivation for food production; (2) Forest development; (3) Livestock; (4) Infrastructure and people's lives and health. As a result, ethnic minority communities will face more difficulties in their life and socio-economic production.

There have been policies on socio-economic development for ethnic minority communities in Lai Chau. These policies have been effective in responding to the climate extreme and natural disaster for ethnic minority communities in Lai Chau. However, these policies have not considered adequately the contributions of ethnic community's culture and their adaptive capability. The policies supporting seed

sources have not focused on native plant and animal breeds. They also have not yet paid attention for training and campaigning for the value of the community knowledge system that local people are using.

4.2. Promoting community knowledge in adapting to climate change

Climate change will increase the intensity and scope of the its impacts on the socio-economic conditions of ethnic minority communities in Lai Chau In the future. The community knowledge of ethnic minorities in Lai Chau is precious, which needs to be promoted to adapt effectively to the potential impacts of future climate change. The potential solutions are in the Table 4.2.

Table 4.2. Difficulties and shortcomings and solutions to promote community knowledge for climate change adaptation

No	Difficulties and shortcomings in applying and replicating community knowledge to respond to the climate extremes and natural disasters	Measures for promoting knowledge community in the climate change adaptation
1	The ethnic minority community has not yet fully aware of the value of the community knowledge system	campaign for raising the awareness of the community about the value of community knowledge.
2	Governmental agencies have not recognized the role and value of community knowledge	Governmental agencies need to assess properly and develop intellectual property rights for the community knowledge system, and

		teaching these knowledges for the ethnic minority communities.
3	There is a lack of resources for promoting community knowledge	Develop financial support policies, encourage application of community knowledge
4	Community knowledge has not been fully integrated scientific and technological advances applied in the local context.	Integrating community knowledge into the development policies and the climate change response plans.
5	There are some limits of the community knowledge system	Sciences and technology should be applied to overcome these limits and to enhance the value of the community knowledge system

4.2.1. Campaigning to raise the awareness of the value of community knowledge

One of the difficulties for replicating and applying community knowledge is that the community of ethnic minorities and authorities at all levels are not fully aware of the role and value of community knowledge in climate change adaptation at the community level. Therefore, it is necessary to improve the campaign that raises awareness about the value of community knowledge.

4.2.2. Establish intellectual property rights for community knowledge

Local authorities should recognize the value of community knowledge and support the community to establish intellectual property rights over valuable community knowledge especially community knowledge capable of creating value. This encourages the community

to maintain and promote their community knowledges, for example, planting high-value commercial and drought-resistant varieties. Some content of community knowledge recognized and established intellectual property rights should be considered in teaching environment of ethnic minority communities.

4.2.3. Support resources for developing community knowledge

Local governments and communities need financial support to complete the cultural institutions and infrastructure, and to maintain operations. At the same time, it is needed to maintain and implement well the subsidy policy for reputable people, village patriarchs, heads of clans in the community. There should have funds for activities that restore traditional festivals and beliefs, which brings creative spaces for exchanging and learning community knowledge systems

4.2.4. Integrating community knowledge in socio-economic development policies and climate change response plans

Lai Chau Province has action plans to respond to climate change and provincial socio-economic development plans, in which the Provincial Agriculture Restructuring Project is directly related to life and production of ethnic minorities. The effectiveness of these policies depends very much on identifying, applying and promoting the community knowledge system. The integration, therefore, is very important and decisive for the success of policies.

4.2.5. Application of science and technology

In fact, not all community knowledge is worth responding to extreme climate and natural disasters in the past, are still valuable in climate change adaptation. Therefore, local authorities need to support the community of ethnic minorities to apply science and technology to support and improve the values of community knowledge in extreme

climate conditions and increasing natural disasters due to Climate change.

Conclusion of Chapter 4

Researching climate change trends, its potential impacts and researching on the measures for promoting the systems on community knowledge of ethnic minority communities in Lai Chau Province, the thesis has some conclusions

According to climate change scenarios, there will probably increase in frequency and intensity for natural disasters such as floods, flash floods, landslides, droughts and cold spells. The increase of natural disasters will strongly impact on people's lives and health, production of food, animal husbandry, water resources and forest resources of ethnic minority communities in Lai Chau.

There have policies on socio-economic development for ethnic minority communities in Lai Chau. These policies have been effective in responding to climate extremes and disaster risk reduction for ethnic minority communities in Lai Chau.

However, these policies have not adequately considered cultural contribution and adaptive capability of ethnic minority community to climate change. The policies supporting seed sources have not focused on native plant and animal breeds, and not paid attention to training and campaign of the value of the knowledge system of the community that people are using.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

There are many researches both international and domestic on community knowledge for climate change adaptation. However, they often focused on particular sectors, locations, country, and community. It is difficult to apply these researches in other places which have different conditions in terms of nature, culture, socio-economic systems, and the climate change impacts. It is, thus necessary to implement the research that reveals and acknowledges the community knowledge of ethnic minority community for adapting to climate extremes and natural disasters. From this, there are some lessons learnt and valuable contents have been integrated into climate change policies.

Climate extremes and natural disasters often affect lives and production of the ethnic minority communities in the province of Lai Chau. In addition, there is limited funds and resources from government for climate change adaptation and the community knowledge has not been recognized and utilized properly. The thesis has revealed, acknowledged and promoted the community knowledge in climate change adaptation, which brings appropriate solutions for the ethnic minority communities.

Based on the research on the impacts of climate extremes and natural disasters in Lai Chau, there are floods, flash floods, thunderstorms, hail, extreme cold spells caused serious damage to the lives, infrastructure, assets and production of ethnic minority communities.

The community knowledge systems have been effectively applied by local people in response to climate extremes and natural

disasters in the past. They have been utilized for (i) protecting local lives and properties, (ii) producing food, (iii) breeding livestock, (iv) managing and exploiting water resources, (v) managing forest resources. There would have increase trend in frequency and intense of climate extremes and natural disasters due to climate change, which causes more risks and difficulties for the ethnic minority community in the province of Lai Chau.

The thesis has revealed and acknowledged community knowledge that has been valuable for adapting to adapt to climate extremes and natural disasters. The potential solutions, thus should include (i) campaigning the community awareness about the value of community knowledge; (ii) Establishing intellectual property rights of the community knowledge system; (iii) Support Financially, encouraging the maintenance and development of community knowledge; (iv) Integrating community knowledge into provincial development policies and climate change response plans; (v) Applying science and technology to improve and enhance the value of community knowledge.

2. Recommendations

1), There are 20 ethnic minorities living together, In Lai Chau Province; while the author only researches and summarizes community knowledge in responding to extreme climate and natural disasters of 5 ethnic groups, namely the Hmong, Ha Nhi, Dao, Thai and Lao ethnic groups, due to the scope of a doctoral thesis. The thesis thus proposes that there should have further research on the community knowledge of the remaining ethnic communities, which would contribute more effectively to the development of climate change adaptation policies and actions of Lai Chau Province.

2) The Thesis has revealed and acknowledged the community knowledge system that enable local people to cope with natural disasters and adapting to climate change. However, to promote the value of community knowledge in responding to climate change, it is necessary to adopt the results of the thesis to build a model of community adapting to climate change, such as "ecological village" and community-based climate change adaptation.

3) The Thesis has assessed the role and value of community knowledge of ethnic minorities in responding to natural disasters and climate change. This has also proposed to contents of community knowledge that need to be integrated into development policies of the provincial. Therefore, it is necessary to study the shortcomings of the current provincial development policies especially the ones related to ethnic minority communities, and take into account the community knowledge of ethnic minorities for policy making process in the future.