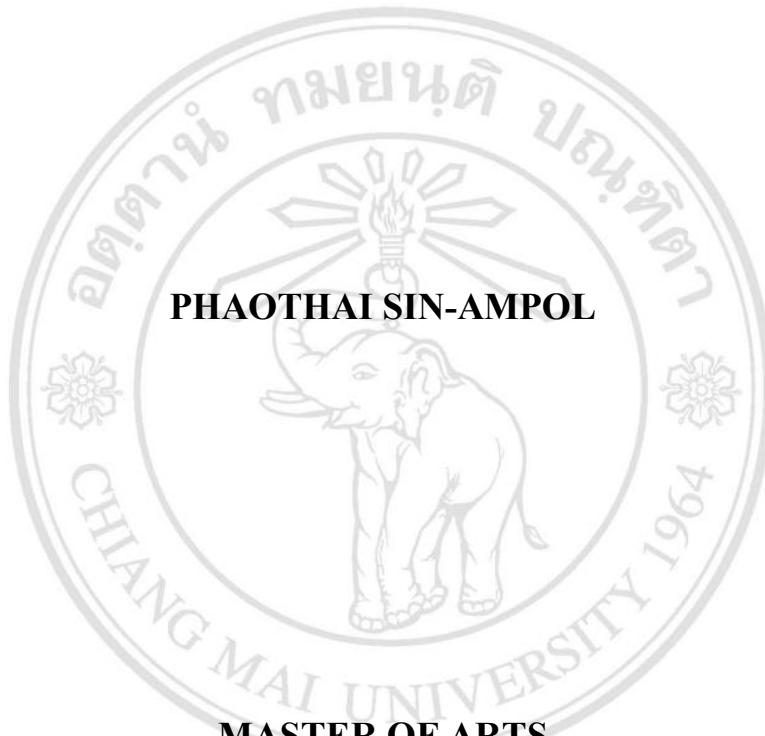


**MOBILITY OF FISH CAGE FARMERS IN THE
PING RIVER BASIN AS AN ADAPTATION
TO CLIMATE-RELATED AND
SOCIO-ECONOMIC RISKS**



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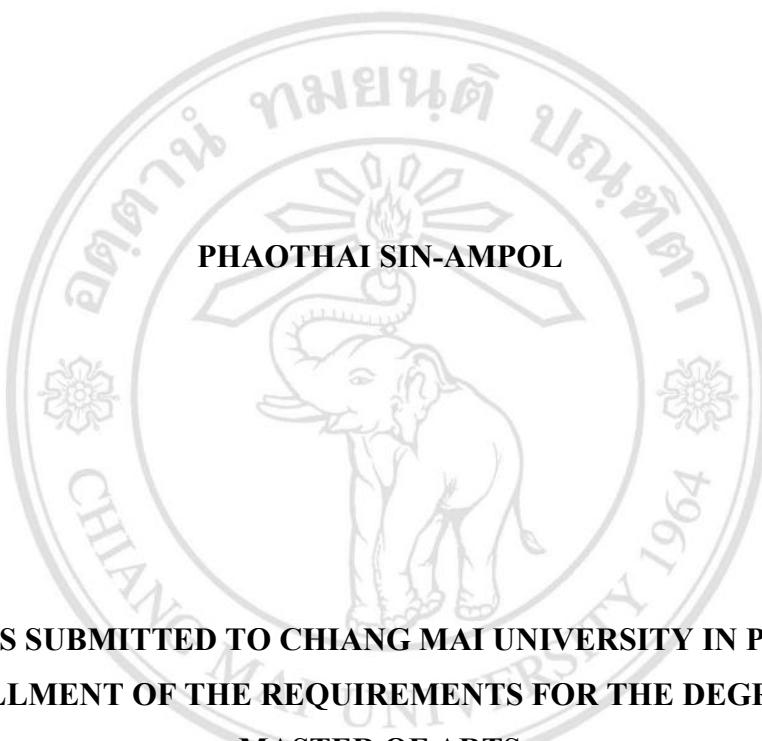
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AND SOCIO-ECONOMIC RISKS**



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SEPTEMBER 2014**

**MOBILITY OF FISH CAGE FARMERS IN THE PING RIVER
BASIN AS AN ADAPTATION TO CLIMATE-RELATED
AND SOCIO-ECONOMIC RISKS**



**A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS**

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**GRADUATE SCHOOL, CHIANG MAI UNIVERSITY
SEPTEMBER 2014**

**MOBILITY OF FISH CAGE FARMERS IN THE PING RIVER
BASIN AS AN ADAPTATION TO CLIMATE-RELATED
AND SOCIO-ECONOMIC RISKS**

PHAOTHAI SIN-AMPOL

THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS
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30 September 2014

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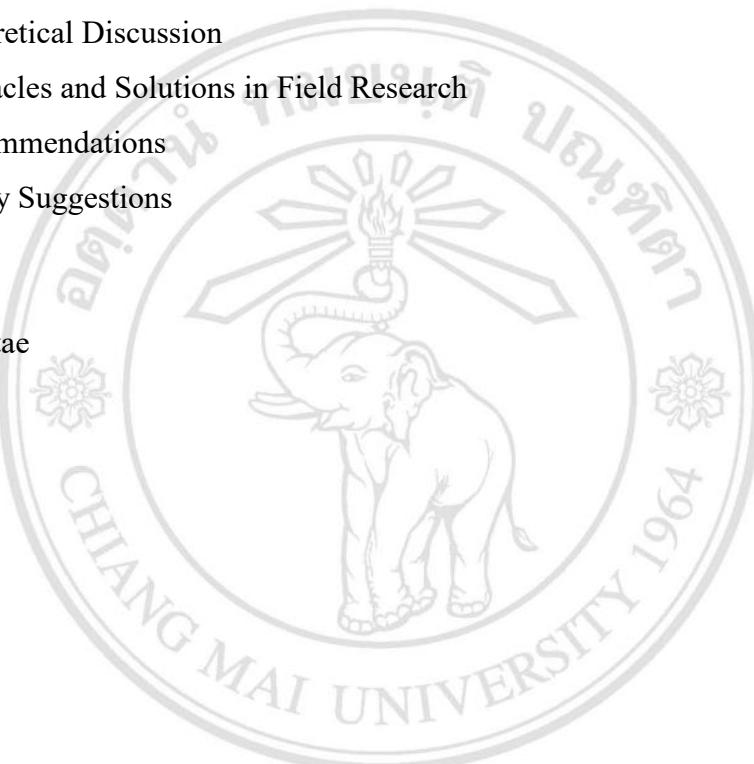
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Thesis Title	Mobility of Fish Cage Farmers in the Ping River Basin as an Adaptation to Climate-related and Socio-economic Risks
Author	Mr. Phaothai Sin-ampol
Degree	Master of Arts (Social Science)
Advisory Committee	Lecturer Dr. Santita Ganjanapan Advisor Assistant Professor Dr. Chusak Wittayapak Co-advisor

ABSTRACT

Mobility of Thai aquaculture society as adaptation has not been studied much as of yet. This thesis, thus, studied mobility as an adaptation to risk in the Ping River Basin, both climate-related factors and socio-economic factors which has been challenged by rural changes noticed for decades in Thailand by using three conceptualizations – vulnerability and adaptation to risks in human-environmental systems, a new rural place, and mobility: drivers, remittances, and access to capitals. This research applied qualitative analysis through in-depth semi-structured and life-history interviews, participant observation, comparison techniques, field note taking, and transcription. Data was collected in the summer, first rainy peak, second rainy peak and winter of 2013-2014 from 42 fish cage farming households from four villages in upstream, midstream, and downstream sections. Each village and household unequally received risks both aspects of multiple risks in fish farming. Climate-related risks, especially drought, were affected by irregular low level of water storage and runoff, extreme events in rainfall amount and temperatures from regional to local level, as well as cage location. Socio-economic risks, meanwhile, were mainly impacted by market equilibrium failure, price fluctuation, and increased production factors' prices under distinctive production systems in contractual relations. Production failure, illustrated as massive fish death and financial loss, was the main effect of multiple risks. Most households in upstream and downstream villages were affected by moderate to high risks, while midstream villages encounter moderate-low risks.

Analyzing multiple household vulnerability by production sizes, large-scale farming households tended to have lower vulnerability than other households explicitly, and this had a direct relationship with levels of mobility. This research found that households which had high multiple vulnerability experienced more dependency burdens which were the main obstacle to diversify occupations and access to financial, social, and cultural capitals from other jobs. Although risk perception in climate-related term is irrelevant to production sizes, vulnerability may be eliminated if households occupy larger production sizes. This debate, anyway, cannot always be descriptive of midstream and downstream sections in which production sizes among farmers in villages were not quite different.

Mobility is as an adaptation to household livelihood subsistence. The efficiency of mobility and remittances was motivated by the differences of distance, time duration, frequency, mobile person, and types of jobs. Major volumes of remittances were obtained from periodic mobility in the pre-farming period. Most of the large-scale farming households evidently obtained these more than others because of long-distance mobility with a longer period of time and frequency, and being of skilled labor. Cultural remittances including working skills and occupational experiences, thus, are the most essential entity to diversify jobs by moving in a short distance as episodic mobility or operating a new immobile occupation, as well as applying learning methodologies and skills in reducing fish cage farming risks. Large-scale households thereby had a moderate to high capacity to adapt. Most of the medium and small households having lower levels of mobility and lacking effective utilization of remittances carried a moderate-low adaptive capacity. Downstream households, besides, had the lowest adaptive capacity.

In conclusion, adaptation to multiple risks by mobility had occurred across time and space through various household activities including production, basic livelihood existence, and life foundation setting in the past until the fish cage farming era at the current time. The outcome of utilizing remittances for long-term adaptation is reflected in the locale itself – livelihood of fish cage farming households. This thesis also suggests way to reduce risks by stressing the importance of access to climate information, developing qualified fingerings, increasing the concerns from authorities, promoting knowledge exchange among farmers, and building a farmers' network across communities.

หัวข้อวิทยานิพนธ์	การปรับตัวด้วยการเคลื่อนย้ายของเกษตรกรผู้เลี้ยงปลากระชังใน ลุ่มน้ำปิงต่อความเสี่ยงด้านภัยมิอาภาพและสังคม-เศรษฐกิจ		
ผู้เขียน	นายแผ่น ไทย สินคำพล		
ปริญญา	ศิลปศาสตรมหาบัณฑิต (สังคมศาสตร์)		
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บทคัดย่อ

การเคลื่อนย้ายในสังคมผู้เพาะเลี้ยงสัตว์น้ำของไทยยังไม่ได้รับการศึกษาค้นคว้ามากนัก วิทยานิพนธ์นี้ จึงได้ศึกษาการปรับตัวด้วยการเคลื่อนย้ายต่อความเสี่ยงและความเปราะบางด้านภัยมิอาภาพและสังคม-เศรษฐกิจซึ่งถูกทำลายด้วยการเปลี่ยนแปลงชนบทไทยที่เกิดขึ้นมาหลายครั้ง โดยใช้แนวคิดความเปราะบางและการปรับตัวต่อความเสี่ยงในระบบมนุษย์และสิ่งแวดล้อม แนวคิดสถานที่ชนบทแบบใหม่ และแนวคิดเรื่องการเคลื่อนย้าย: แรงขับเคลื่อน สิ่งส่งกลับบ้าน และการเข้าถึงทุน การศึกษานี้ใช้วิธีการเชิงคุณภาพผ่านการสัมภาษณ์เชิงลึกแบบกึ่งโครงสร้าง การสัมภาษณ์ประวัติชีวิต การสังเกตแบบมีส่วนร่วม การเปรียบเทียบ การบันทึกภาคสนาม และการถอดความ ข้อมูลในงานวิจัยถูกเก็บรวบรวมในช่วงฤดูร้อน ต้นฤดูฝน ปลายฤดูฝน และฤดูหนาว ในปี พ.ศ. 2556 – 2557 จากครัวเรือนเกษตรกรผู้เลี้ยงปลาในกระชัง 42 ครัวเรือนใน 4 หมู่บ้านลุ่มน้ำปิงตอนบน ตอนกลาง และตอนล่าง แต่ละหมู่บ้านและครัวเรือน ได้รับความเสี่ยงทั้งสองด้านในระดับที่แตกต่างกัน ความเสี่ยงด้านภัยมิอาภาพโดยเฉพาะจากภัยแล้งเกี่ยวกับพืชผักและน้ำท่าที่ต่ำกว่าปกติ รวมกับสภาพสุดขั้วของปริมาณน้ำฝนและอุณหภูมิตึ้งแต่ระดับภัยมิภายนอกจนถึงระดับท้องถิ่น ตลอดจนทำเลที่ตั้งกระชัง ในขณะที่ความเสี่ยงด้านสังคม-เศรษฐกิจเกิดจากความล้มเหลวของดุลยภาพตลาด ความผันผวนของราคา และราคายังคงการผลิตที่เพิ่มสูงขึ้นภายใต้ความแตกต่างในการผลิตแบบมีพันธุ์สัญญา ความล้มเหลวในการผลิตจากการตายของปลาในปริมาณมากและการขาดทุน เป็นผลกระทบหลักจากความเสี่ยงแบบทวีคูณ ครัวเรือนผู้เลี้ยงปลาส่วนมากได้รับความเสี่ยงในระดับค่อนข้างสูง โดยเฉพาะหมู่บ้านตอนบนและตอนล่างของลุ่มน้ำ ในขณะที่หมู่บ้านตอนกลางของลุ่มน้ำมีความเสี่ยงในระดับค่อนข้างต่ำ

เมื่อวิเคราะห์ความเปรียบเทียบวิถีชีวิตของครัวเรือนจำแนกตามขนาดประกอบการพบว่า ครัวเรือนที่มีขนาดประกอบการใหญ่มีความเปรียบเทียบต่ำกว่ากลุ่มอื่นอย่างชัดเจน และยังแปรผันตรงต่อระดับการเคลื่อนย้ายด้วย งานวิจัยชินนีระบุว่าครัวเรือนที่มีความเปรียบเทียบสูงมีภาระพึงพิงมากซึ่งเป็นอุปสรรคหลักต่อการสร้างความหลากหลายในอาชีพและเข้าถึงทุนทางการเงิน ทุนทางสังคม และทุนทางวัฒนธรรมจากอาชีพอื่นๆ แม้ว่าการรับรู้ความเสี่ยงด้านภัยมิอาศาจะไม่สัมพันธ์กับขนาดประกอบการ แต่ความเปรียบเทียบในอาชีพเลี้ยงปลาอาจถูกขัดไปได้ถ้ามีขนาดประกอบใหญ่ แต่บริบทนี้ไม่สามารถใช้อธิบายได้ในหมู่บ้านกลางและปลายน้ำซึ่งมีความแตกต่างของขนาดประกอบการระหว่างผู้เลี้ยงปลาไม่มากนัก

การเคลื่อนย้ายจัดได้ว่าเป็นการปรับตัวอย่างหนึ่งเพื่อการดำรงชีพของครัวเรือน ประสิทธิภาพในการเคลื่อนย้ายและสิ่งส่งกลับบ้านที่ได้รับถูกผลักดันด้วยความแตกต่างด้านระยะทาง ระยะเวลา ความถี่ บุคคลที่เคลื่อนย้าย และสถานะหน้าที่การทำงาน สิ่งส่งกลับบ้านส่วนมากได้รับจากการเคลื่อนย้ายเป็นครั้งคราวในช่วงก่อนเลี้ยงปลา ครัวเรือนที่มีขนาดประกอบการใหญ่ส่วนมากได้รับสิ่งส่งกลับบ้านมากกว่าอย่างชัดเจนมากกว่าครัวเรือนอื่นๆ เนื่องจากเคลื่อนย้ายทางไกล ใช้ระยะเวลาและความถี่สูง และเป็นแรงงานที่มีทักษะ สิ่งสำคัญที่สุดที่ช่วยในการปรับตัวคือ ทุนทางวัฒนธรรม อันได้แก่ ทักษะในการทำงานและประสบการณ์จากการประกอบอาชีพ ซึ่งช่วยสร้างความหลากหลายในการประกอบอาชีพด้วยการเคลื่อนย้ายแบบไม่ประจำในระยะทางสั้นๆ หรือโดยการประกอบอาชีพแบบที่ไม่ต้องเคลื่อนย้าย ตลอดจนการประยุกต์วิธีการเรียนรู้และทักษะเพื่อลดความเสี่ยงในการเลี้ยงปลา ดังนั้น ครัวเรือนที่มีขนาดประกอบการใหญ่จึงมีความสามารถในการปรับตัวในระดับปานกลางถึงสูง ในขณะที่ครัวเรือนที่ประกอบการในขนาดกลางและเล็กส่วนมากมีการเคลื่อนย้ายน้อยกว่า อิกทั้งยังไม่ได้ใช้ประโยชน์จากการสิ่งส่งกลับบ้านอย่างมีประสิทธิภาพ จึงมีความสามารถในการปรับตัวปานกลางถึงก่อนเข้าสู่ตัว นอกจากนี้ ครัวเรือนที่อยู่ติดกันล่างของกลุ่มน้ำมีความสามารถในการปรับตัวต่ำที่สุด

โดยสรุปแล้ว การปรับตัวต่อความเสี่ยงด้วยการเคลื่อนย้ายเกิดขึ้นในสภาพข้ามพื้นที่และเวลา ผ่านกิจกรรมที่หลากหลายของครัวเรือนนับตั้งแต่การผลิต การดำรงชีพพื้นฐาน และการสร้างความมั่นคง ในการดำรงชีพในอดีต จนกระทั่งถึงยุคของการเลี้ยงปลาในปัจจุบัน ผลลัพธ์ของการใช้ประโยชน์จากสิ่งส่งกลับบ้านเพื่อการปรับตัวระยะยาวถูกสะท้อนกลับมาอย่างพื้นที่เกิดเหตุ ซึ่งเป็นวิถีชีวิตของครัวเรือนผู้เลี้ยงปลา วิทยานิพนธ์นี้ยังให้ข้อเสนอในการลดความเสี่ยง โดยเน้นความสำคัญของการเข้าถึงข้อมูลด้านภัยมิอาศา การพัฒนาลูกปลาที่มีคุณภาพ การเพิ่มความใส่ใจจากหน่วยงานรัฐ การส่งเสริมการแลกเปลี่ยนความรู้ระหว่างเกษตรกร และการสร้างเครือข่ายเกษตรกรระหว่างชุมชน

CHAPTER 1

Introduction

1.1 Rationale

Mobility, generally, has been an integrated geographical, social, economic, political and environmental strategy in responding to livelihood insecurity, natural disasters, unequal development, and power relations for mankind for a long period of time. It is not only human movement in a spatial sense, but also emphasizes the transaction of non-human entities such as money or ideas across spatial scales. These movements of people and things actualize the dissolution of a bounded local community and are transformed into a boundless form of a global-local village. Mobility is decided collectively by a mobile and immobile population in a social unit involving remittances, materials, symbolic flows, and networking outside of the traditional form of community based on geographical and social space interaction (Greiner and Sakdapolrak, 2013; Pries, 1999). Household relations, as a fundamental social unit, thus, are not localized in face-to-face relations, but altered to trans-boundary of life and capital flows (Castree, 2003). Besides the household decisions to move, other various factors also force people to relocate elsewhere.

Mobility in any time-space conditions is usually caused by some repelling or attracting factors for social, economic, psychological, or personal reasons. Socio-economic causes, to identify, are likely to be one of the important drivers after international labor exchanges had been established. In Thailand, the government has encouraged international labor migration particularly in the Middle East and East Asian regions for several decades in accordance with regional industrialization and commercialization (Department of Employment, 2013; Chammaratana, 2011). The fourth social and economic national development plan encourages domestic labor demand thanks to regional and provincial industrialization and urbanization. Labor movement in local areas, therefore, has been observed for a period of time due to smaller land size held by the offspring generation

from their antecedents (NESDB, n.d.). Those procedures have altered offspring social values to diversify production systems. Mobility, on the one hand, is likely to be greatly forced by socio-economic pressures from global to local scales. On the other hand, environmental changes may also influence mobility in similar features.

Environmental factors have been dynamic following global and regional changes by natural and human actions for thousands of years. Several negative phenomena of environmental changes have been experienced in the last three decades thanks to the awareness of environmental sustainability for development (United Nations, 1987). Through the lens of mobility/migration and environments, various studies have reflected different environmental drivers to propel mobility including unequal power to access natural resources, resource depletion, marginal environments, and climate-related disasters. Agriculture, as a major occupational group, is directly affected by those problems especially climate-related disasters which tend to change in every scale. Several physical failures in agricultural production can be represented such as massive yield decline, pest invasion, and unidentified death of plants and animals. Many farmers, thus, decide to move as an alternative adjustment in that context to economically survive. Aquaculture, as one of the sectors in agriculture, has been damaged as well.

Many researches in aquaculture and mobility have declared that migration/mobility of natural fishery/agricultural-based households were accepted as livelihood strategies to deal with climate change, natural hazards, and livelihood insecurity. Those movements, to be specific, reacted chiefly to the exploitation and depletion of aquatic environments which are influenced by anthropogenic climate change, dysfunctional regulation systems, and overpopulation. Fish farmers had also lost their natural, physical, economic, social, and technological capitals to cope with the situations (Badjeck *et.al.*, 2009; Kheang, 2013). Resettlement of fishery villages, in other words, was also promoted as an adaptation policy and implementation to encourage adaptive capacity of natural-captured fishery households in climate change (Martin, 2010; Martin, 2010). It is quite clear that mobility as livelihood strategies in climate and environmental inducements have been researched in natural-fishery based society. Although a study from Vietnam compared different adaptation strategies between fishers in the Phuoc Lap commune and

aquaculturalists in the Mai Duong commune in lagoon culture by non-climate factors of income diversification and the element of migration (Hanh, 2011), the relationship among mobility, risks, and vulnerability in intensive cage aquaculture in a river system, particularly in Thailand, have not been studied extensively.

Fish cage farming is one of the intensive agricultural activities which are practiced throughout Thailand. At the country level, Thai people consume fresh fish at around 32 kilograms per year per person. According to this ratio, three quarters of the fish (24 kilograms) are received as marine fish, while only a quarter (8 kilograms) is freshwater fish. Freshwater fish, thereby, have been widely bred to satisfy market demand and substitute the decrease of captured freshwater fish. In all types of aquaculture production, tilapia is the most popular aquatic animal in Thailand which is mostly harvested in pond and cage aquaculture (Department of Fisheries, 2011). Following King Bhumibol's proposal to improve the tilapia breed in 1989, however, the red hybrid tilapia [*Oreochromis mossambicus* (Peters, 1852) × *Oreochromis niloticus* (Linnaeus, 1758)] has been completely developed since early 1997 by Charoen Pokphand Foods (CPF) to replace the traditional breed of black tilapia. Red tilapia production has been initiated as fish cage agri-business in 1996 (Ban Mueng Newspaper, 2009). In the Ping river basin, red tilapia intensive production was established for the last 15 years. The rise of fish cage farming in Thailand is likely to be caused by higher fish demand particularly in this basin (Lebel, 2008). To respond to the total red tilapia demand in market spheres, environmental and socio-economic stability are very essential for intensive production.

Climate-related factors obviously have an environmental impact on fish cage farming in the river ecosystem as an open system. Climate-related factors are likely to be recognized by the interaction of climate and water resources – rainfall, temperature, runoff, water depth, current velocity, local wind circulation, water pollution, turbidity, sediments, and suspensions (Kundzewicz *et.al.*, 2008; El-Sayed, 2006). Fish cage farming is also exposed to the dynamics of time and space differentials and from dual manipulation of natural processes and anthropogenic actions that also accelerate more severity in duration, frequency, intensity, and period of occurrences (Burton *et.al.*, 1978) particularly in water resources – the most significant resources for fish cage farming.

River water, theoretically, is a common-pool resource which everyone can access, utilize, and manage together (Brun *et.al.*, 2005). Water resources are therefore managed by the Royal Irrigation Department, Marine Department, Department of Fisheries, and used by local communities, as well as fish cage farmers. Although many participatory processes in water resource management are advocated by RID in different fields of operation, this unit often exerts itself as a leader for particular objectives in benefiting from water resources. According to the definition of public irrigation, it has been defined clearly as “the activity held by RID which purposes for water storage, control, allocation, or drainage for agriculture, energy generation, infrastructure, or industry. The definition also covers water-related disaster prevention and water transportation in irrigated areas as well (Public Irrigation Act Issue 4, 1975).” Royal Irrigation Department (2013), moreover, explains that irrigation must be held by water irrigation units to allocate irrigated water for planting. The state, besides, also recently established a special organization in flood prevention, preparation, response, and recovery by integrating all irrigation-related authorities after Thailand’s massive flood in 2011 (Office of the National Water and Flood Management Policy, 2012). Following state-initiated water resources management for various purposes, physical-human interactions in this sense have demonstrated severe threats to fish cage farming that fish cage farmers must seriously consider. They, further, do not encounter physical-human effects in climate-related variability as such, but socio-economic stress is another factor in production systems nowadays.

In socio-economic perspectives, originally, most of fish cage farmers were likely to be joined in contractual relations (Lebel, 2008). In developing countries, it has become one of the changing production processes especially in food consumption leading to extremely complicated procedures of exchange and distribution (Echanove and Steffen, 2005). Business agreements in contractual relations have to be held vertically as a pathway to promote farmers to gain production factors (particularly in variable factors), cultural elements (techniques, methodologies, knowledge, and proficiency), and social collaboration with state and private institutions from the company. Farmers, besides, have to accept contractual agreements in producing crops at any time, price, and quantity required by the company, as well as cooperate with market distribution in vertical integration among companies, retailers, producers and buyers (Sivramkrishna and

Jyotishi, 2008; Oya, 2012; Singh, 2002; Key and Runsten, 1999). As production relations in contractual relations depend extremely on the dynamics of market demand, contract alteration, price fluctuation, and restrictive policies controlling fish cages in the river by legal authorities, the inequalities of financial, social, and cultural capitals of each cage producers are multiplied as socio-economic factors.

The household, which is a unit making the decision to participate in fish cage farming, invariably shoulders the burdens in the production from climate-related variability and socio-economic stresses as risks related to various environments and stakeholders. When household exposures from the above risks are multiplied, human-related factors including financial capitals, knowledge, experiences, social relations, occupations, and labors related to household production are likely to change being sensitive to the fact that when a household has not enough capacity to gain those capitals. Climate-related vulnerabilities from different adjustments appear in each cage location. Fish cage farming, however, is just a part of the household occupations in recent years because there are other economic activities both in farming and non-farming activities enhanced by the developmental streams of industrialization and urbanization. Rural villagers have to rather distinguish themselves and temporally, spatially, and purposefully migrate in order to diversify the livelihood sustainably and expand the opportunities in economic, social and cultural access to capitals (Rigg, 2001). When fish cage farming is an exact form of sustaining a livelihood, fish cage farmers cannot deny the fact that this occupation does not interact with other livelihood subsistence pathways and is also related to household mobility.

From the recent developments in Thailand, several distinct social pressures have motivated more consumerism in living expenses and values leading to skeptical outlook on livelihood security in both the original and destination place. A mobile person, or a remitter, is extremely impacted by the remittance sent back to their homeland and this is related to part of the decision making process in beginning household economic activities. Mobility, therefore, is not a one-way relation received from a remitter, but it becomes a two-way interaction between a migrant/remitter and the local household who do fish cage farming and sustain other members' livelihood following the corporation among mobile population, immobile population and remittances (Greiner and Sakdapolrak, 2013).

The main thesis of this study is to ascertain whether or not mobility of fish cage farming households is an effective way in responding to risk and the vulnerability of climate-related and socio-economic risks in different physical and social exposures. In this study, mobility in space during the pre-farming and post-farming period is considered as a way of adaptation to the multiple risks and vulnerability within different social and geographical scales as well as changing temporal contexts.

1.2 Research Questions

This study focuses on the adaptation of households which culture fish in cages in the Ping River. The main relationship of interest is whether or not mobility of members in a household is an effective adaptation to the climate-related and socio-economic risks under differing conditions.

- 1.2.1 How do fish cage farmers experience climate-related variability and socio-economic stresses as risks?
- 1.2.2 How do different levels of mobility and production sizes affect vulnerability to climate-related and socio-economic sensitivity of households?
- 1.2.3 In what ways do remittances from mobile members contribute to household adaptation to climate-related and socio-economic risks?

1.3 Research Objectives

Following the main research questions posed, three research objectives will be pursued:

- 1.3.1 To study the individual and interactive effects of risks from climate-related variability and socio-economic stresses on fish cage farming households.
- 1.3.2 To compare vulnerability to climate-related and socio-economic sensitivity of households with different levels of mobility and production sizes
- 1.3.3 To investigate how remittances from mobile members contribute to household adaptation to climate-related and socio-economic risks particularly in fish farming related activities

1.4 Operational Definitions

Fish Cage Farming is red hybrid tilapia feeding in cage culture systems in the Ping river basin

Fish Cage Farmers are the farmers who operate red tilapia fish cage farming in the Ping river basin either as a main or minor occupation

Household describes the persons normally living together or fragmented unit composed of at least one member with blooded, kin, or non-blooded relations sharing familial, reproduction, financial, production burdens, or emotional sense of being a household

Pre-Farming Period is a period of time before starting fish cage farming in the Ping river basin

Post-Farming Period is a period of time after starting fish cage farming in the Ping river basin

Risk is the interaction of climate-related variability and socio-economic stress coming from both external hazards and internal exposures in fish cage farming

Vulnerability is the state of lacking adaptive capacity in fish cage farming households in adjusting to climate-related and socio-economic risks. Vulnerability, in this research, is affected by sensitivities of current household demographic structure, occupational diversification, risk perception, and access to capitals and techniques in fish cage farming.

Adaptation reflects various strategies of personal income and remittances for household members from mobility activities in reducing risks and vulnerability within fish cage farming households in short and long durations.

Mobility refers to periodic and episodic movement in any scale of place among individual members in fish cage farming households working as migrant labors or household activities involving relocation in pre and post-farming periods.

Periodic Mobility is a continuous mobility of any household members in local, provincial, regional, and international levels for work as an everyday practice. This is differentiated into three categories by different time and space relationship – daily routine mobility, internal mobility, and overseas sojourner.

Episodic Mobility is an intermittent mobility that is encouraged voluntarily or involuntarily by unsafe conditions for social, economic, political, and environmental reasons. This can be described in two patterns – leisure mobility and mobility in hazardous events.

Remittances demonstrate the attainment of financial, social, and cultural capitals returned from a mobile person in any mobility activity used for building up a life foundation, existing daily living, doing other occupations, and investing in fish cage farming and other occupations.

1.5 Review of Theories, Concepts, and Related Studies

1.5.1 Vulnerability and Adaptation to Risks in Human-Environmental Systems

Three determinants of risk are defined in socio-ecological systems – hazard, exposure, and vulnerability. Hazards, to declare, from potential changes in frequency, intensity, and duration, as well as vulnerability and exposure should be realized as causes of climate risks affecting human society. To define, disaster risk is the feasibility of adverse effect occurrences which aim at dysfunctional risk management from exposed social units and physical environmental variability regarding life, social capacity, and financial losses. Hazard refers to possible adverse effects from natural or human inducements impacting on a vulnerable or exposed system. Exposure, next, describes hazardous occurrences by some motivators in the area in which population and economic resources are located. Some areas may be exposed but not vulnerable if structural or behavioral mitigation strategies are well deployed (Cardona *et.al.*, 2012).

Vulnerability is the most important mediator to bridge the analysis of risk reduction and adaptation together. It profoundly relates to human-environmental interaction, hazards and disasters, sustainable livelihoods, and socio-ecological systems (Adger, 2006). In the climate change perspective, it describes the degree to which susceptibility of groups or individuals suffer. Although vulnerability refers to various meanings and causes, it is recognized that communities are not homogeneous leading to different degrees of vulnerability because various societies and people may value different significance of impacts and vulnerability on human and natural system. Key vulnerabilities assessment

is also illustrated by global social systems, regional systems, global biological systems, geophysical systems, and extreme events. (Daze *et.al.*, 2009; Schneider *et.al.*, 2005).

In academic understanding, vulnerability analysis is divided into six major schemes (Adger, 2006; Cardona *et.al.*, 2012) including human-stimuli and social vulnerability from resource entitlement (Olmos, 2001; Brooks, 2003); likelihood of occurrences and intensity, climate extremes, and individual-collective perception (IPCC, 2001; Schneider *et.al.*, 2005; Burton, 1978; Walmsley and Lewis; 1984); human/social/political ecology and double exposure from development and physical variability (Hewitt, 1983; Hewitt, 1994, 1997; Handmer, 2003; Leichenko and O'Brien, 2009); pressure-and-release model (PAR) (Blaikie *et.al.*, 1994, cited in Wisner *et.al.*, 2003); vulnerability of social-ecological system (Adger *et.al.*, 2004; Adger, 2006; Turner II *et.al.*, 2003); and holistic approach reflected by economic stresses, gender inequality, dependency of aging, lack of social networks, poverty, communication deficit, and social construction of risk leading to future vulnerability faced by various social groups unequally (Cardona *et.al.*, 2012).

The first scheme seems to describe extremes in social and human vulnerability and their opportunity deficit without concern about physical stresses. The second scheme, meanwhile, profoundly focuses on the magnitude and likelihood of hazards, macro-scale influence to local community participatory processes as top-down action and the perception of humans. But, this approach seems to focus on the dichotomy – analyze climate variability from a macro picture without any human concerns and on the contrary interested in humans as an individual unit explicitly affected by psychological matters from one's interpretation and the collective forces from humans without power relations and surrounding environments. The third scheme, likewise, discusses the issues of vulnerability in the interaction of social scales from local to international level especially during development and conflict in a very broad sense and with the likelihood of the abandonment of real local community in power fields. The fourth theme, the PAR model, seems to be static in real explanation because it lacks everyday livelihood and practice concerns. The sixth theme, however, seems to move beyond the area of this analysis especially in risk communication strategy. To deal with this research, therefore,

vulnerability to social-ecological systems is likely to cover the analysis of fish cage farmers to deal with climate-related and socio-economic risks.

Many natural extremes are more hazardous and spread out to various areas and societies unequally both in losses of life and material wealth – becoming as a disaster. Although several hazards are independently manifested naturally, social systems are also involved in economic, social, and aesthetic transformation. This research has therefore selected a framework for vulnerability analysis in sustainability science by Turner II *et.al.* (2003) to actualize the multiple risks. This framework is described as; discerned causes of vulnerability from two directions based on entitlement, coping through diversity of social unit, and resilience as a part of livelihood sustainability. The RH (risk-hazard) model, firstly, focuses on sensitivity of climatic disturbances and exposure to hazards. The PAR (pressure-and-release) model, secondly, turns to the exposed unit in each social group (individual or human groups) which is vulnerable to risks from unsafe conditions in social perspectives. Following the description, RH and PAR model integration is very useful to fulfill research gap as RH does not pay attention to any social consequences, while PAR also lacks biophysical operation affecting the disaster.

To support the interaction of RH and PAR models, a number of scholars illustrated several climatic and non-climatic conditions over spatial and temporal criteria to understand how do hazards occur and measure the effects on mankind from magnitude, frequency, duration, areal extent, speed of onset, persistence and reversibility of impact, spatial dispersion, distributional aspects of impacts and vulnerability, potential for adaptation, and the probability of dangerous physical and environmental hazard occurrences (Burton *et.al.*, 1978; Daze *et.al.* 2009; Handmer, 2003; Schneider *et.al.*, 2005). Climate effects on a nested global-local relationship are not only proven by natural climate and its analysis from scientific claims, but are also engaged with humanity, social science, cultural, and geographical perspectives. In addition to physical assessments, natural disasters widely cover environmental, social, economic, political, and cultural issues including the increase of climatic extremes frequency and world population particularly in poorer areas, and areas of rapid socio-economic changes, and the expansion of urbanization, economic

globalization, and environmental degradation (Handmer, 2003). Those factors inducing climate damages have been controlled and organized by human actions for a long time.

Human action is compared as a potential accelerator of new hazards not manifested by intrinsic natural disasters that lead to technological, social or anthropogenic hazards. Pseudo-natural hazards, further, also originate from the manipulation of natural or modified ecosystems which are equal to the combination of disaster risk and adaptation to climate under development requirements. For instance, the overpopulation in downstream necessitates more water demand and flood controls for economic activities in urban areas leading to dam construction. Those actions affect social, economic, and ecological vulnerability. Above all in regard to poverty areas, disaster risk can impact the vulnerability of daily life as mentioned:

“Disaster risk is but one component of the risk faced by society. But, disaster risk is many times constructed on the basis of everyday or life-style risk typified by conditions of malnutrition, ill health, unemployment, lack of income, social and family violence, drug addiction and alcoholism, lack of education and opportunity, etc. (UNDP, 2002: 234).”

In terms of the relationship between climate and society, humans have negatively manipulated several effects to foster climate variability. Many scientific academics have declared that climate change is a suitable term to define the feasibility of climate shift features and oscillation from the past to the future. This definition, however, is too universal to ascribe to different places, times, and people because it removes the cultural understanding of people from climate mainstream knowledge. Climate in physical terms, in this sense, should be encapsulated in the cultural memory and knowledge of people from the past until now (Hulme, 2008). The study about the cultural context of a conservation area and its relationship to climate change perception in Nepal (Becken *et.al.*, 2013) also suggested that daily life issues that each person experiences are a fundamental composition to perceive and evaluate climate change magnitude even if scientific knowledge of climate change is necessary to understand current situations of environmental problems. People’s common sense, attitudes, and behavior supported by experience and personality dispositions in daily life can encourage decisions in coping

with damages from climate-related disasters. Socially constructed risk of the community also differs in the perception of climate change effects and is based on values and beliefs, social roles, cultural practices, demographics, household size, education, income, and livelihood (Becken *et.al.*, 2013; Bubeck *et.al.*, 2012).

The integration of risk-hazard and pressure-and-release perspectives, then, is analyzed by place-based methodology coupled with human-environmental systems either external or internal pressures to represent household vulnerability. As seen in the figure 1.1, multiple perturbations and stresses are influenced by human and environmental factors and variability from external pressures particularly on a regional and global scale. In a defined micro-scale unit (a household), to start with, internal exposure of components (individual, household, classes, firms, states, flora and fauna, ecosystems) and their characteristics (frequency, magnitude, duration, etc.) of human-and-environmental damages affect changes in vulnerability.

Sensitivity, in other words, explains the degree to which a community is affected by climate stresses. Household sensitivities in social/human capitals and natural endowments are also included. Linking with those capitals and endowments, biophysical vulnerability is used to explain the likelihood of hazardous occurrences (physical manifestation of variability events in terms of absolute changes from the averages) and the severity and probability of such hazards. Information and likelihood of hazardous occurrences forecasting are quite essential to decrease biophysical vulnerability because it is one of the coping strategies dealing with such physical manifestations which affects the global environment on the one hand (Brooks, 2003). The vulnerability of individuals and of societies in social perspectives, on the other hand, is understood in dimensions to which individual and group entitlements have called on resources. Development processes which are affected by the dynamics of political institutions and economy are considered as major determinants on social vulnerability (Olmos, 2001).

The resilience of a system is reflected by the system capacities to cope or respond, restructuring of the system (adjustment or adaptation), and nested scales (world, region, and place) and scalar dynamics of hazards inside a particular place, and lastly, leads to further adaptation in the regional and global scale. In the level of household, physical,

natural, social, human, and financial capitals can encourage or decline stresses from environmental effects (Deshingka, 2012). Adaptation, in other words, is a great component to understand ways of reducing risk and vulnerability.

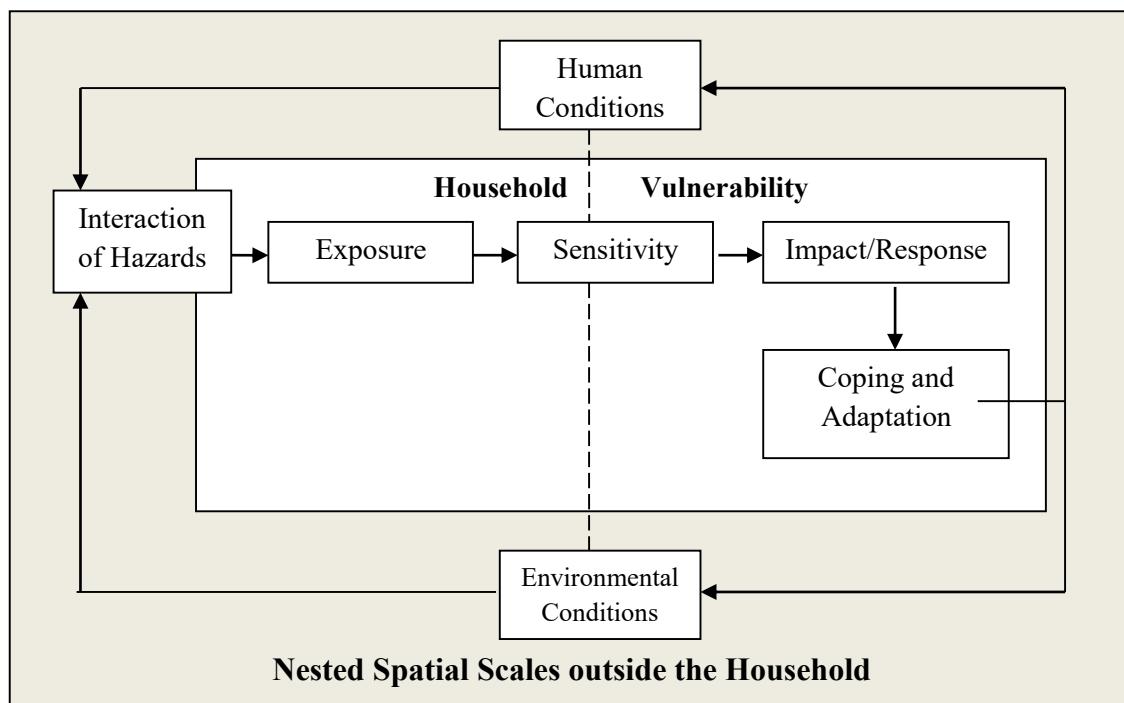


Figure 1.1 Vulnerability framework in sustainability science
 (modified from Turner II *et.al.*, 2003: 8076)

Adaptation, previously, has been used only in Darwinism evolutionary theory and avoided by social scientists. Adaptation in human aspects is quite different from previous ideas of scientific evolution theory according to this notion:

“An important distinction, however, is that humans possess the ability to plan and manage adaptation. Thus, while the responses of biological systems to perturbations are entirely active, the responses of human systems are both reactive and proactive, incorporating environmental perception and risk evaluation as important elements of adaptation strategies (Smithers and Smit, 1997: 19).”

Current studies of adaptation, nonetheless, have followed up IPCC’s definition of adaptation (2008: 869) as “adjustments in natural and human systems in response to actual expected climatic stimuli or their effects, which moderates harms or exploits

beneficial opportunities.” (Daze *et.al.*, 2009; McBean and Rodgers, 2010). Another meaning of adaptation is also interpreted from a quote by Freire (1969, cited in Pelling, 2012) that it is the pathway to survive better in the same environment compared with the past due to social and political constraints shaping our livelihood. Adaptation is described along with vulnerability and resilience. Adaptation, moreover, is now being used widely in climate change studies to describe long-term adjustment by humans to changing climate situations different from mitigation or adjustment which is proscribed in only the short-term and will become chronic problems later because it is just an urgent solution for any flash hazards (Burton *et.al.*, 1993).

Olmos (2001) explained adaptation to climate change in manifold issues. People can reduce several adverse effects of climate on their health and well-being through the adaptation process. Adaptation, besides, encourages people to reduce and enhance viability of social and economic activities to deal with climate vulnerability in the long run. Anticipatory or planned adaptation in behavior or economic structure, thus, is the strategy of long-term planning to cope with and protect against the negative effects in societal perspective from climate change as a practice. Adger (2003), in addition, described that determinants of adaptation to increase the capabilities of resilience to climate change situations including social capital, flexibility and innovation in institutions of government and private sector, health status, and individuals and groups well-being are faced with climate change impacts. Accordingly, adaptation must respond to structural and environmental consideration in an adaptive landscape including the dynamics of social structures (roles, routines, organizations), human agency (corporation of individual and collective actors), and biophysical, social, economic, political, and discursive environments (McLaughlin, 2011).

Adaptive capacity, generally, plays a great role in decreasing vulnerability from risks and hazards of climate change both in susceptibility and through exposure by applying anticipatory or planned adaptation as a main target. Daze *et.al.* (2009: 5) clarified from the third assessment report of IPCC that adaptive capacity has been defined as “the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the

consequences.” Access and control over natural, human, social, physical, and financial resources are the most important factors shaping adaptive capacity of individuals, households and communities. Adaptive capacity can be varied by external factors such as policies, institutions and power structures based on temporal and spatial zones in relation to particular hazards. The major purpose and outcome of adaptation is to adjust to climate stimuli, build adaptive capacity and transform decision-making leading to attitude changes both of short and long-term benefits in demographic, cultural, economic changes, information technology, global governance, social convention and globalizing flow of capital and labor (Adger *et.al.*, 2004). It can foster the future capacity to enact and practice adaptive action to climate change’s underlying institutions either by top-down pressure or local expression from a community. Short-term planning, anyway, tends to protect against climate hazards more than long-term planning in the future (Adger *et.al.*, 2004).

Yohe and Leichenko (2010) suggested from a risk-based approach that adaptation policy should be flexible with changing situations and must be involved in short-term mitigation. In planning perspectives (figure 1.2), using mitigation in adaptation policy can alleviate near-term effects from disaster risks while most of adaptation policies usually focus on long-term adjustment. Mid-course corrections and iterative processes in flexible adaptation with mitigation policy, indeed, should be reconsidered in order to recalibrate and revise more appropriate plans for climate and environmental change preventions from up-to-date information, modern technology, and new policies. Unlike other adaptation patterns neglecting flexibility or mitigation (orange and yellow line), anticipated results of a flexible adaptation pathway with mitigation (green line), ultimately, can maintain the level of affected risks to remain under acceptable risk over time.

The qualified ideas from various literatures that research has extracted on risk, vulnerability, and adaptation is that climate-related and socio-economic effects illustrate a close relationship to each other in influencing the multiple risks to fish cage farming. Our ecosystems nowadays are obviously represented through human-environmental systems. Importantly, it is very difficult to reject social/human capitals or environmental/natural endowments in the analysis of vulnerability to climate change. To resolve risk and vulnerability, adaptation should be a focal point of climate and socio-

economic methods either in the short or long term to reassess surrounding situations carefully. As this research pays an attention to household vulnerability and adaptation in social perspectives, changing rural contexts following the occurrence of the modern community and its networks should be clarified in more details.

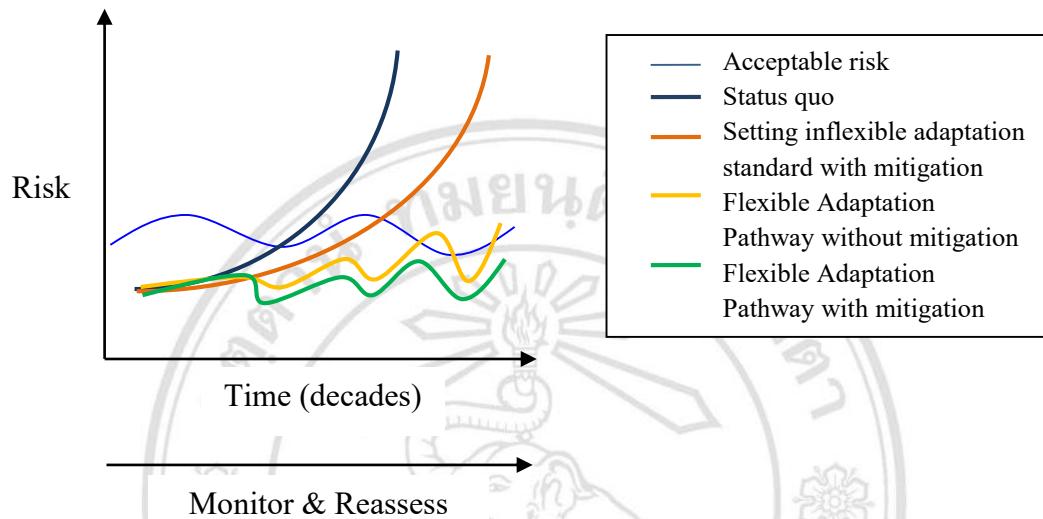


Figure 1.2 Flexible adaptation and mitigation pathways
(modified from Yohe and Leichenko, 2010: 2)

1.5.2 A New Rural Place

Although space and place seem to have the same definition in everyday use, human geographers separate the two as different concepts. Both space and place, yet, are defined as cultural artifacts made by people, practices, languages, and representations. Place, nowadays, is prominent for comprehending of the world with time-space compression although Manuel Castells raised the concept that globalization influences can actualize the end of a static place and transforming it into a space of flows as well as more a homogeneous world (Castree, 2003; Hubbard, 2005).

The meaning of place in human geography, thus, has been redefined by John Agnew (1994, cited in Castree, 2003) in three directions – place as location, sense of place, and place as locale. At the beginning, Hartshorne proposed that place is a location composed of three elements – systematic, chronological, and idiographic – leading to a unique location. Several problems from this explanation, yet, have been proven regarding a broad

description on a specific depiction in a given place in three aspects. Geographers, first, cannot understand areal contexts in details. The weakness of the discipline, second, was apparent. And, thirdly, there are no neatly articulated areas as mosaics in real situations because all boundaries are not defined naturally (Castree, 2003). In the second displacements era, scientific and quantitative revolution was popular under the umbrella of spatial science. Researches in this period, however, were heavily criticized because there is no human engagement in the interaction of place. Following researches saw humans as little more than dots on the map/equation – geography without man whereas sense of place, to date, is a main theme of rehumanizing the individual and group lifeworlds. According to many problems from the minutiae of local attachments and experiences, recent studies have investigated place as a locale – both face-to-face interaction and subjective settings developed and expressed emotionally. It, thus, has been influenced by local (localities) and global connection in two issues – how locals control their own lives and how they connect with each other.

Globalization in economic, political, cultural, environmental, and social issues is considered popular from the global scale to local community. One description has been defined by Beckford (2003:119, cited in Turner, 2010) that globalization is the increase of interrelationships across time and space of cultures, commodities, information, and peoples by using information transmission technologies to connect such components in a “global village” in the sense of technological development. In the sense of society, globalization effectively advocates new patterns of institutions, consumption and social movements to generate new social expression challenging the old society and construct new types of global ideologies. A basic idea of a local and translocal community, further, demonstrates that the social world changes in interrelations of social space, place and identity. Division of space, in fact, reflects heterogeneity of society and culture. Based on the definition of local community, it often emphasizes tradition, solidarity and value in face-to-face relations. Community studies, the study of homogeneity, abandoned all population inflows and outflows processes (Peleikis, 2003).

Linking with a modern comprehension of place, the connection between global and local space overcomes the impasse of determination and voluntary action of people to flow

across space by uneven development from global interlinkages, and local inequalities as heterogeneity. This phenomenon, thereby, defines place as locale following the definition of Agnew (1987, cited in Castree, 2003: 167) – “a setting and scale for people’s daily actions and interactions”. A progressive sense of a porous place as locale reconstructs “glocal identities” to unblock movements of people, goods, information, and images in different local areas in order to challenge a locale controlled by class, race, gender, family background, etc. (Castree, 2003). According to global technological communication, Appadurai (1995, cited in Pelekis, 2003) stated that virtual neighborhoods are able to exchange ideas, opinions and create social linkages in manifold methods beyond the boundaries. Villagers have moved between the boundaries in different places as a ‘translocal village-in-the-making’ based on economic, political, social and psychological resources. People, hence, always fit their background – gender, age and class as well as social and economic environment – on specific places linked to migration experiences including the perception of place on each entity.

The concept of translocality was further reviewed by Greiner and Sakdapolrak (2013) from spatial, social, and mobility theories. The concept was defined from various scholars as relations that “extend beyond the village community” (Tenhunen, 2011: 416, cited in Greiner and Sakdapolrak, 2013), as a constructional space of post-national identity, and as a total set of circulations and transfers. Translocality, to illustrate, can be exemplified as a challenging concept to deal with place analysis of grounded movement. It also demonstrates two different arenas dealing with material and physical senses of place, while the others show the making of meanings, identities, imaginaries, narratives, symbolic representations, and practices of spatial places. Notwithstanding, these two arenas have been merged in Gidden’s Structuration Theory to illuminate “locales” from the practice of different social interactions to physical environmental manifestations and “trans-locales” originated from routine activities in time-space trajectories. This concept, therefore, is related to the interconnectedness of the production and reproduction in multiple spatial scales under the engagement of actors, institutions, and their habitus in each area, particularly in mobile and immobile connection negotiation which is affected by different capacities to gain capitals under “power geometry of time-space compression” that surmount the dichotomy of “here” and “there”, or “rural” and “urban”.

Peri-urban frontiers, or *chaan-meung*, spatially, become areas of rural-urban livelihood and identity rearrangement according to economic growth in Thailand. It can basically be observed by less available vacant land and farm plots. Another action is the movement among rural villagers particularly in the younger generation which is connected with immediate changes from land conversion of residential and industrial land use (Hirsch, 2009). The integration of rural and urban spheres is also explicit in Chiang Mai, Khon Kaen, and Had Yai cities (Glassman and Sneddon, 2003). Rigg (2001) also elucidated about rural changes in Southeast Asia in the past when agriculture, farmers, and rural areas were integrated as an identical image which represented society and science, cultural and economy, and politics and production collaboration on place. Rural villagers, besides, seem to cluster as house groupings are docile to social norms, rely on self-sufficiency, live tranquilly, and carry on with the rural idyll. The rural community at this moment is observed instead as composed of area, people, and production, however, not bound as a static unit, but as cross-scale interactions to urban areas and global place. The emergence of extended metropolitan regions (EMRs) has also blurred a boundary between rural and urban areas, as well as the influence of industrialization. De-agrarianization of Southeast Asia, thus, has been illustrated profoundly by occupational readjustment, income-earning reorientation, social re-identification, spatial relocation, and spatial interpenetration in the countryside for decades.

New political economy of agriculture of human agency by means of industrial change to farming, transnational agricultural investment in agro-food systems to provide the outcome for rural areas, and rural differentiation is due to the distinguished aspects of industrialization and counter-urbanization. New agrarian questions have emerged predicting an investigation of rural areas production systems, and the involvement of local people in the global economy, Fordism, and post-Fordism processes in order to disintegrate the median of industrial and agricultural ideas. Agro-industrialization, thus, obviously deals with familial farming changing to become more industrial, capital-based, and flexible due to finite resources and the increase of production. The idea of rational peasant suggested by Popkin (1979, cited in Rigg, 2001) also argued that farmers try to optimize for their own sake rather than share the community's benefits. Roles of the state, meanwhile, dominate rural villagers' life via administrative and market systems. In sum,

the term post-peasant can redefine and conjugate current and historical practices among rural villagers and related stakeholders in socio-economic terms (Rigg 2001; Rigg, 2005)

It can be believed that rural changes become outstanding characteristics to dissolve rural and urban division due to delocalization of rural people in spatial and sectoral-occupational terms. An additional argument regarding rural changes that correlates with agro-industrialization, by the way, was also suggested that one of the most essential schemes is the “de-linking” of land and poverty in household livelihoods. More significant than the basic analysis of land-induced poverty, particularly in land size and tenure, is the diversification of income and occupation, as well as intensification of farm production which is a former operation of a household and should also be reconsidered even though it is quite difficult to assess (Rigg, 2005).

Agricultural decline in rural households is actualized by the plantation supported by modern agricultural mechanization, environmental-related disturbances from the expansion of infrastructure, land conversion, and industrial development policy replacing agricultural production. Younger generations both men and women, interestingly, are influenced a lot because some of them define him/herself as an educated person who does not work on the farm at all and has no ability to do farming. The return to farm production mixed with non-farm activities, however, is recognized by rural people who are becoming more urban in both consumption behaviors and residence when the income from in-situ non-farming work is not very high. Livelihood in the countryside, noticeably, becomes hybrid in household characters, job opportunities, and areal differentiations (Rigg, 2001).

In terms of capitalism and agricultural production penetration, this has been challenged by industrialization, urbanization, and global inter-development pervading the local community across spaces. In those processes, both farm and non-farm production must be accounted for in the analysis of household dynamics. In the view of a generalized typology of agrarian change in South East Asia, poor farmers might be gradually changing themselves to an urban proletariat. Most of the farmers in this region still remain as semi-subsistence (commercially agriculture with village-based livelihood) or pluriactive post-peasant (commercially agriculture with non-farm and mobility activities). At present, several farmers participating in high-input production may also be

professionals who have enough capacity to cooperate with the national/international market, and can turn back to work on the farm as a single occupation. In the near future, plurality of occupation will be advanced by being part-time farmers and traders in one aspect, and integrated into other occupations again as postproductive or neopeasant to obtain better chances of sustaining a livelihood (Rigg, 2005). Richer farmers, herein, will survive as capitalist farmers in a competitive market and succeed in power relations in class distinction. Assets of farm production and production technologies are also involved with these phenomena. Non-farm production and income, moreover, are very important in the analysis of household subsistence from the rural changes in the Southeast Asia region as it can create some differentiations among farmers themselves in sustaining livelihoods from the integration of rural life to labor markets (Kelly, 2011; Rigg, 2005).

Migration/mobility in Southeast Asia has also been a part of rural strategies to generate remittances to support agricultural production, facilitate rural inequalities and cultural changes, establish migration institutions to drive some activities in the homeland, and reconstruct new political ideas in rural villages (Kelly, 2011). Elias and Scotson (1965, cited in Peleikis, 2003) also declared that mobility/migration rather than fixed staying has been practiced by pre-industrial villagers for a long time following social relationship on defined place and location. Amidst the modern society, individual and social mobility on a local level can represent the capacity of locality – daily working and consumption.

The interface of modernity and tradition in rural locale areas enforces many people to shift to a modernization of their personal paradigm to be modern either going outside or staying at home to receive remittances. Rural changes from mobility, however, are not always illustrated as consumption behaviors as such, but it deals with changes of production structures from agricultural to non-farm practices. Mobility, thus, is an important principle to widen deeper perception of consumption preferences, transformation of ideas and information streams challenging socio-cultural norms and alter status symbol in a locale.

1.5.3 Mobility: Drivers, Remittances, and Access to Capitals

Mobility is seen as a holistic view of moving across scales rather than specific issues particularly in transportation geography (Cresswell, 2011). Although some academics

(Lee, 1966; Wilson, 1968) stated earlier that migration of people has many repulsive (push-negative) and attractive (pull-positive) factors in designating an origin and a destination (from areal differentiation, ethnic diversity, household life cycle, economic progressive, transportation and communication development) along with an intervening set of obstacles (such as law enforcement), psychological motives, emotional behaviors, and accidental occurrences as irrational causes, it is not sufficient enough to describe current situations where an actant in the actor-network theory also plays a great role in improving the local community seen as locale. Adey (2011) expanded the idea of mobility which focuses on how mobility works and connotes the meaning in different ideas and approaches in cultural, anthropological, sociological, political, and subjective means based on the application of geographical concepts. The concept of mobility is illustrated as a lived relation among people, objects, things, and places in relation to something (events) or someone (Cresswell, 2011). Mobility, in this meaning, resembles pathways of communicating meaning, significance, and determination of people and things. Rather than distance, mobility promotes the construction of imagination spaces to establish new social relations in the field of attaching some symbolic meanings. In addition, an actant (non-human actor) has been concentrated as byproduct of social relations and innovation leading to human interactions in the mobility process. Mobility, thus, accepts a non-representative approach combined with a representative approach in order to describe globalization of mass movement.

In political concerns, mobility can be proven in three directions. Ideology, first, has an impact on uninhibited mobility under the regulation and policy based on national benefits. Mobility in participation and civil society, second, identifies how people and things move around various spaces as a the way to challenge public and personal value systems in economic, political, and social life inclusion and exclusion of the community. Mobility under this scheme encourages the construction of public space to communicate one's voice, erode sense of place, and destroy bounded space from temporariness in social structures of both public and personal value system. Power balance and differences in capitals (economic, social, cultural, and symbolic) affected by political influences, third, represent the exclusion and marginality of powerless actors from the elite. Those issues

define motility – the intention and ability to access to opportunities for mobility – to different actors in the field of power relations (figure 1.3).

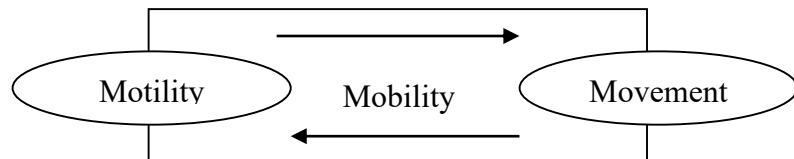


Figure 1.3 Motility and Mobility (After Canzler, Kaufmann and Kesselring, 2008 orig.fig. 1.1, cited in Adey, 2011: 102)

Mobility patterns are visible in flexible citizenship (access to global mobility) and displacement of people, resources, and ideas from development that may be caused by natural anomalies (e.g. disasters, disease), resettlement and so on. Many large-scale developments tend to greatly affect in forced resettlement against marginalized groups although some smaller-scale developments are also in the developmental process. Mobility – based on flexibility, inequality, and attachment of social relations – is also impacted by power and meaning contestation among people. Diffusion of byproduct from mobility – money, people, machinery, images, ideas, and innovation diffusion – may advocate new social arrangements and phenomena to motivate new cognitive perception.

Migration/mobility at community level is recognized as a part of adaptation pathways to climate change (McLeman and Smit, 2006). This action, however, must be considered as the capacity of a community to adapt. Households will make an explicit decision to migrate when a community does not have enough alternatives via other pathways except mobility as a way of adapting. Capital endowments of a household are the most important indicator to define whether or not migration is the best way to adapt. In case that mobility is the best alternative, the population structure of the community will be changed from out-migration of villagers and instead may be composed of in-migration from the outside when an insider has moved before comes back to the hometown.

When debating on the decision-making of mobility from both household and external pressures, inconsistency of individual and collective decisions to choose mobility is emanated by the influence of gender and generational power. Many young people, to illustrate, make a decision to move outside because they feel bored from the already-set

frame from their parents (Rigg, 2001). Furthermore, women who are the main workforce in industrial society and usually earn a lower income than men due to the existence of a patriarchal society, also consider the benefits of relocation (Fulcher, 2004). Although social networks and norms are major entities shaping such decisions, individuals or groups of individuals may make own decisions based on their own particular perspective. Patterns of mobility in the local society, therefore, are not observed similarly and are not exclusively linear. Various models of migration and mobility, indeed, always appear in accordance with methodology and channels of communication with other ‘neighborhoods’ throughout the world (Peleikis, 2003).

Households and surrounding people, anyway, still extremely advocate or obstruct mobility actions. Mobility, an important process of translocality in both internal and international level movements, must be related to all stakeholders as “translocal spaces are constantly co-produced by mobile and immobile populations” (Greiner and Sakdapolrak, 2013: 8). Suggestions from family, friends, or the influence of the social values of the community to remain at the home place occur at the same time as adverse environmental effects empirically emerge and impact their life, thus, illustrating an immobility paradox (Findlay 2011). Primary adaptation of the household and community, by the way, is implemented by sending one of their members to other places “to diversify income, gain knowledge, spread risk, and gather capabilities to sustain a community, including assets to insure against future shocks and stresses” (Scheffran *et.al.*, 2012: 120).

Socio-economic development imparts massive impacts on mobility/migration especially international migration. Poverty and misery from global inequality become fundamental reasons in mobility decisions. Each mobility/migration, to identify, must be encouraged by the analysis of costs, risks, knowledge, social networks, and individual aspiration. International migration, interestingly, is considered as a South-North relationship from unequal development rather than a global interconnectedness (de Hass, 2005). Job demand, in other words, particularly in economic restructuring is one of the socio-economic reasons to require labor in different gender and generational qualifications (Rigg, 2001). After the Second World War, Fulcher (2004) argued that mobility is not merely from the intention of an individual as such because mobility of labor and capital

has spread everywhere and become more dynamics. International division of labor has been provoked by multi-national corporations (MNCs). Using MNCs as a mediator of international labor division can reflect the weakness of labor unions and low wage labor in some regions. In Asia, there are three generations of labor use under MNCs (Thailand is in the second generation after 1980s). On the other hand, using international labor loosens labor relations and disrupts the union mechanism because it is very difficult to manage labor livelihood all over the world. Delocalization of life and living, on the other hand, has also appeared in social and economic turbulences in an agricultural perspective especially with land plots owned by offspring generation from the inheritance system are smaller than the last 35 years (Rigg and Salamanca, 2011).

In addition to socio-economic stresses, climate/environmental disturbances are also integrated with mobility responses to risks and shocks. Drought, desertification, land degradation, extreme weather events, and sea level rise affects mobility decisions of people (Tacoli, 2009). Some decisions are partially forced following distressed diversification from agricultural failures and marginal environments, thus illustrating the idea of people threatened by negative ecological, climatic, and natural hazard extremes together with the lack of economic development in that area. A natural repulse of people is to flee from an origin to a new destination in order to escape from those interferences. While richer households obviously decide to work in a non-farm sector for future wealth, poorer households are driven to non-farm jobs as a survival strategy. (Rigg, 2001; de Sherbinin *et.al.*, 2012; Scheffran *et.al.*, 2012).

Another study in Niger also declared that both environmental factors such as drought, soil degradation, and the shrinking of lakes and economic factors affect migration. The interaction of the two major drivers can be noticed as “environmentally-induced economic migration” (Afifi, 2011). In case of Northeast Thailand, after the first development era or “*samai pattana*” in 1961, a proportion of migration gradually increased and became extremely high in external relations in the 1970s after urban development policy and crop failure periods. In addition, in the 1990s consumptive imaginings from television media and education also changed the paradigm of rural villagers as they become more consumptive and this having a casual linkage with mobility

from the countryside. At the same time, the northeast area was still the region of plentiful resources deficit, marginal environments, and low income status. Due to an outstanding of this feature, many scholars during that era endeavored to study migration behaviors from population-environment relations (Rigg and Salamanca, 2011).

To argue, environmental change is likely to induce mobility of shorter distances and at the beginning of climate stress, in short and immediate periods, particularly circular mobility (Tacoli, 2009). Later, a transnational social field will exert a lot of influence on the next movement. To define their preferred destination to live from the drivers of migration, it may depend on by environmental, technical, and political challenges. Most of the people moving short distances rather than long distances are likely to be affected by restrictive policies of migration across borders. Potential migrants end up moving to a closer area rather than the most attractive possible destination because they prefer to avoid an intervening confrontation. Uneven attraction of places within a transnational social field leading to migration, besides, is also represented by pre-existing social and cultural connections (Findlay, 2011).

Mobility/migration, what is more, can be done more than one time. Previous employment, social relationship, kinship, and community membership are all significant for mobility in forms of migrant networks to fulfill the process of sending and receiving social, economic, and cultural remittances, to and from the origin and destination community (de Hass, 2010). Temporary and permanent mobility activities within a country affected by the intensification of environmental and socio-economic drivers, temporal changes of resource access and utilization, and cognitive responses to risks, are able to restrain climate-related extremes and provide a search engine for new chances in life. Social networks of earlier generations, basically, may foster the forthcoming mobility activities of the next group of mobile persons (Bradsley and Hugo, 2010).

According to rural change in Southeast Asia, mobility/migration acts as a driver of this phenomenon. Mobility/migration has been established in transcontinental permanent flows, regional temporary flows, intra-national rural-urban movements, national and cross-border rural-rural flows, as well as everyday mobility. Legal authority from state bureaus, modern communication systems, and information transfer are significant in

creating the mobility volume of each country. In Thailand, mobility to overseas regions in 2010 had appeared at a regular rate compared to other countries particularly Vietnam and the Philippines. Migrants tended to move to Europe, United States of America, and Oceania areas as diaspora, and have migrated as regional temporary flows to Singapore, Taiwan, and East Asia particularly in Israel for construction and industrial work. More than four-fifth of Thai international migrant laborers, statistically, are men. In intra-national rural-urban movements, the increase of urban population in Thailand, which is one of indicators to discern rural-urban movement, is not as obvious compared to many Southeast Asian countries especially after the 1980s (from 20.9 percent in 1970 to 34.0 percent in 2010) although there was a striking escalation of urban population in 1970-1980 (from 20.9 to 26.8 percent). In contrast, Thailand has the highest ratio of total road networks (149.5 percent) with an excessive rate of vehicle ownership by individuals (from 4 to 127 per 1000) in a 30-year period which promotes everyday mobility among Thai villagers to the city (Kelly, 2011).

In the modern era, the collaboration of transportation-communication systems and rural industrialization can reduce the time and distances spent in mobility as well as construct a more diversified livelihood. Modern transportation and communication systems are important equipment in spreading development ideology, ease rural people's access to more opportunities outside the village, alleviate poverty, and build more resilience in livelihood. In contrast, we can see a lot of insecurity, inconvenience, and deficit opportunity for poorer people and less developed areas of physical transportation systems which constrain their life of mobility for work and other purposes (Bryceson *et.al.*, 2003; Rigg, 2001). In another sense, rural industrialization represented by pieceworkers, cottage manufactures, and village factories, can become ruined rapidly according to employment failure in industrial and agricultural sectors. Rural industry requires little capital investment and technology, but it still faces external forces from export market, big company demand, and currency fluctuation. These pressures are also multiplied by a good transportation system, financial access, and state extension. In the case of a northeastern province in Thailand, local industrialization has been promoted for a few years and has motivated people to be commuters by using motorcycles as transport for work particularly in the offspring generation (Rigg and Salamanca, 2011).

Mobility, by the way, leads to spatial fragmentation of the household (Podhisita, 2011), and changes to co-residential dwelling units dictated by different roles and reproduction burdens – *baeng kan pai haa ngaan* and *liang lan*. Many households become extended units or skip-generation which diversify crop production and transform occupational identity as non-farmers. However, households having pre-school children will be fixed in their location and mobility becomes difficult (Rigg, 2001). Disembedding of households and families occurs with fragmental residences but still retain a sense of household bonding because of remittances received in all forms (Rigg and Salamanca, 2011).

According to this dislocation, household characteristics can be classified into six types (Nipon, 2011) by the roles of each member in their different functions (elderly people, labor force, and child). These include unrelated individuals, unrelated household, couple household (with additional person), nuclear family household (with children and/or additional person), extended household (with children and/or additional person), and skip-generation household. Those characteristics are standardized by demographic classification thanks to the socio-economic development in the last five decades.

Household structures in Thailand, according to the results, have totally changed from the previous decades following the highest economic growth period in the last two decades especially in family size (Sittitrai *et.al.*, 1991). Family size diminishing reflects three challenges in family well-being along with economic growth – educational achievement to promote better life opportunities in the future, needs of more material wealth from the offspring, and increases in women's role in working opportunity due to less reproductive burdens. The aging society in Thailand, finally, is enormously evident particularly in Northern Thailand due to the decline of population projection ratio, the increase of elderly people, and the feminization of the older population. Elderly people are also faced with limited financial support to accomplish their needs and demands (UNFPA, 2006).

Although mobility (and migration) is likely to be a normal phenomenon in responding to environmental and non-environmental factors by means of livelihood sustainability and income diversification, it seems to be problematic for policy makers from a paradigm of sedentary living, which concerns the gravity of the urban area as an attractive unit for rural people trying to seek better opportunities in their life. Also, though environmental

stresses and climate change make many people migrate outside of their homeland to the outside, it is not a primary mechanism of coping and risk mitigation strategy to rainfall-related events, as portrayed in a case study of four villages in Lamphun. Following many socio-economic changes in rural life, moreover, rice production is not a definite answer for them whether they can sustain themselves with the gradual erosion of sustainability and sufficiency or not. To argue, various policies and prevention strategies fail to understand the cause-effect relations of migration regarding climate change adaptation. Mobility, thus, is a core pathway of adaptation that has occurred among rural Thai communities for a number of years. Their material, functional, emotional, and imagined relations within this process can empower social resilience to an exposed household. (Rigg and Salamanca, 2011; Sakdapolrak *et.al.*, 2013; Tacoli, 2009). In addition, mobility in translocality does not only focus on population flow, but also pays attention to remittances, materials, and symbolic flows as translocal imagination and networking are established across barriers (Greiner and Sakdapolrak, 2013).

Noticeably, remittance is one of the most important byproduct of mobility used for livelihood enhancement at the level of household and others. Many scholars studied about remittance in the mobility process in two major directions. Firstly, remittance has been defined as purely financial remittances sent back to the hometown from social exchanges and networks between remitters/migrant workers and immobile person/household to subsidize their consumption or investment (Gentry and Mittelstaedt, 2010). It is also very outstanding for the household that migration is one of the way to accumulate self-financial security and encourage capital intensification in agricultural production (Deshingka, 2012). Types of immigrants or remitters can be suggested into three groups regarding the willingness of mobility. The expatriate, first, is the provider of remittances sent back for altruistic reasons and represents a sense of obligation of the remitter who may not come back to the homeland and so far has permanently migrated. The sojourner, second, is related to the expectation of the household of origin that the remitter is coming back to the hometown after finishing his/her work. This will occur when the family tries to add to its total income or diversify its economic risk. However, remitters/sojourners still keep an exclusive relationship with other sojourners in the host country. The pathfinder, third, finds better pathways for the family's life in a new place in dual actions – both in

remittances sent back to the hometown and pursuing the opportunity of investment in the host country both tangible and intangible (such as education) ways. Financial remittances, besides, can be utilized for improving basic infrastructures and life quality of households such as clean water and sanitation systems (Adida and Girod, 2011).

Remittances, on the other hand, are also a combination of financial remittances and human-social capital that migrants can access during their working and when coming back to the hometown and using this to adapt and change their livelihood (de Hass, 2010; Findlay, 2011; Rigg *et.al.*, 2012; Scheffran *et.al.*, 2012). For example, the concept of migration-for-adaptation is an empowering process in dealing with climate change by returned migrants who transfer and gather remittances, knowledge, technical and institutional innovations to and for the homeland. Returning migrants, following this action, are likely to well understand their local socio-ecological conditions which lead to various improved pathways such as disaster management, energy, crop and resource diversification, technological transfer, and co-development of natural resources and agricultural systems.

In the case of Thailand, dissociation of the village community in rural society, to show, is socially distinct from the urban community rather than occupationally distinct. The new pathway of a sufficient economy is linked socially to new local values to sustain the community in the long term rather than geographical residences. Migrants come to their hometown with socio-cultural values and practical skills. Moreover, new economic activities culled from the new aspirations of migrants lead the rural people to join them with the help of the convenient mobile system and market motivation. Reversed activities have appeared in both rural and urban villagers. Rural people become the urban consumers while urban villages become “hobby” farmers as has been noted around Chiang Mai (Tubtim, 2012 cited in Rigg *et.al.*, 2012). They, unfortunately, encounter debt, illness, and environmental degradation.

Mobility/migration is often considered by different thresholds of climate, cultural, and economic perception when looking for a solution in various extreme climatic events. Realizing that only mobility/migration, however, cannot cover all spatial actions of people living with unstable climate. Black *et.al.* (2013), thus, provided distinctive actions

of voluntarily migration, forced displacement, and trapped population or immobility affected by manifold causes of major climate disasters, while many studies touched superficially on displacement as subsequent actions of immediate disasters. According to the results, scholars debated based on their reviews that onset and intensity of disasters tend to exert their effects with multi-causal structural drivers in motivating migration in a crisis. Wealth accumulation also fostered relocation, while some may be trapped in their location because of low social, economic, and political capitals. Short-term displaced people experiencing various major disasters, anyway, tend to be vulnerable from structurally induced failure rather than environmental effects. This study also suggested in terms of policy implementation that the right to move or stay of immobile population should be protected, while the viewpoint about displaced and migrated groups should be changed from the consequence of policy failure to anticipatory adaptation.

Although mobility is excessively illustrated as an adaptation from multiple risks in various dimensions, some people apply immobility as a livelihood strategy instead. In the case of Australian wheat farming households in the Wheat Belt in New South Wales, they did not move or relocate to rainfall areas as an anticipated adaptation to climate variability as the farmers had already made a decision based on individual psychology, embodied experience, and additional information from media. They, in fact, attempted to reduce damages from extreme drought compared to previous years by strategic (long-term) and reactive (short-term) *in situ* adaptation in more-than-climate issues including geographic, climatic, agronomic, marketing, institutional, financial, technological and innovation, regulation, human resources, and family issues (Head *et.al.*, 2011).

To handle mobility as an adaptation to multiple risks as conceptualization in this research, it has to be scrutinized along with the effects from remittances as byproducts of mobility and access to financial, social, and cultural capitals in different directions made by mobile and immobile decision. This analysis is influenced by rural changes in dimensions of national and international development policy, urbanization, industrialization, environmental turbulences, actors in decision-making, household fragmentation, and transportation infrastructure. To classify levels of mobility, drivers, distances, time durations, types of jobs, and purposes of mobility are analyzed with immobile actions.

1.6 Conceptual Framework

Following the literature reviews, the overview of this research tends to focus on multi-scalar analysis in the intra-household level and out-of-home level including village, provincial, inter-regional, and international levels as designed in the conceptual framework. Three essential components confluent with the interaction of time and space are multiple risks, multiple household vulnerability, and mobility as an adaptation.

Initially, multiple risks and vulnerability, which are important causes for adaptation, are divided into two major issues – climate-related and socio-economic factors. Multiple risks in fish cage farming, on the one hand, are investigated in two parts. External hazards, first, occurs from externalities related to natural and anthropogenic climate-related risks illustrated as natural climate and disaster patterns, irrigation systems, and flood prevention policy. In another aspect, socio-economic externalities are manipulated by the community, market spheres, and state bureaucracies. Internal exposures, on the other hand, highlight on the possibility of household levels is exposed to multiple risks by cage location and the contractual relations system. These two factors of risk are correlated by qualitative methods to evaluate the level of risks in village and household levels.

In regard to the second research question, multiple household vulnerability is scrutinized from both fish cage farming and non-fish activities by realizing the adjustment of fish cage farmers to climate-related risks and the fundamental socio-economic characteristics which are different in each household. To understand vulnerability in the climate-related arena, this research tends to recognize risk perception. Interestingly, fish cage farming is not the single activity of a household. This research, thus, has to analyze current household demographic structure and occupational diversification from the influences of rural changes. Access to capitals from different livelihood patterns and access to techniques in fish cage farming in adjusting to climate-related risk perception are important to define vulnerability in financial, social, and cultural capitals.

Adaptation to multiple household vulnerability and risks in fish cage farming, ultimately, are examined by periodic and episodic mobility during two periods of time – pre-farming and post-farming periods – to understand the different patterns of distances, time durations, frequency, mobile person, and drivers in each mobility activity. Multi-scalar

analysis, following factors of mobility, is utilized explicitly in this part. Rural changes, to date, can be reconsidered in order to link socio-economic restructuring among spatial scales through the years. The outcome of mobility for constructing adaptive capacity in a household as a locale is demonstrated through financial (money and assets), social (social networks), and cultural (working skills, experiences, knowledge) remittances (figure 1.4).

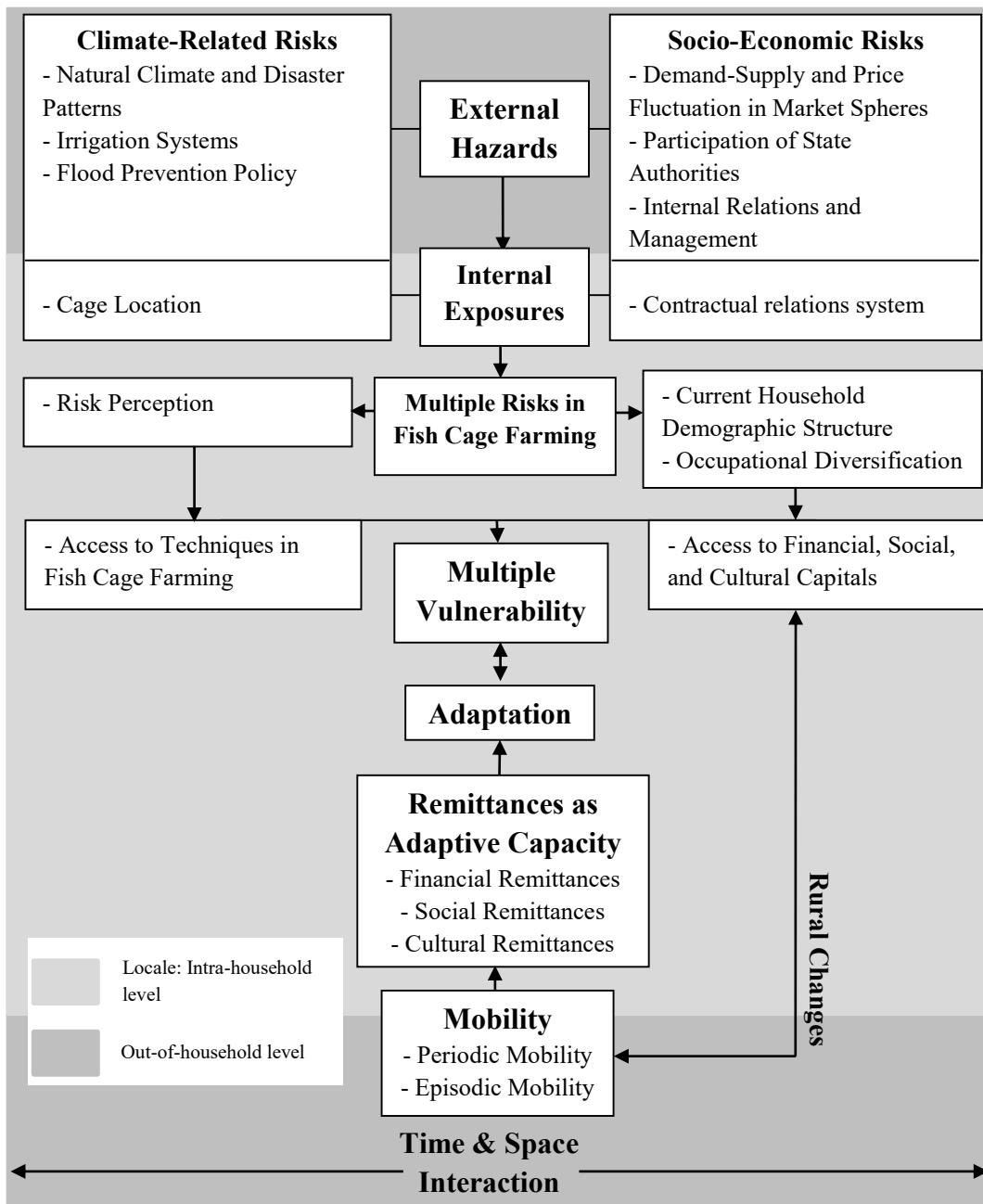


Figure 1.4 Conceptual framework

1.7 Research Methodology

1.7.1 Research Sites

As this research focuses on mobility, multi-sited and mobile ethnography are considered as mobile methodologies to investigate the results in various sites and their movement in spatial terms (Cresswell, 2012). Research sites were selected to provide levels of hazard and exposure to climate-related and socio-economic risks relevant to fish cage farmers along the sub-basin areas – upstream, midstream, and downstream sections.

Social and economic characteristics in the Ping river basin have also been transformed following the 4th national economic and social development plan (1977-1981) which defined goals of urbanization, industrialization, and commercial agriculture. Chiang Mai (and Lamphun as a satellite town) is a target of Northern Thailand for prosperity distribution from the capital primate city to decrease unequal development and immigration. Urbanization-related policies in this region encouraged land-use zoning, infrastructure development, and employment policy by concentrating more on industrial, commercial, and service investment especially the northern areas such as Lamphun, and the second Lamphun real estate establishment as an exporting transition zone. Ten years later, the collaboration of urbanization and industrialization of the upper Ping river basin in the development stream has dramatically risen in Chiang Mai and Lamphun since the 1990s which has been reflected through Gross Provincial Product (GPP) statistics in the manufacturing sector. Agricultural revenues of the two provinces, on the other hand, are still represented at an equal rate as they were twenty years ago (World Bank, 2005).

According to supplementary general data, the first and second research sites are located in Chiang Mai-Lamphun Basin, the upper part of the Ping river basin in Northern Thailand. The average altitude of this basin is around 270-300 meters above the mean sea level, and has a lower slope ratio compared with other parts of this region. To narrow down the scope, this research chooses to study fish cage farming households in the second part of the Ping river basin under the control of three large irrigation systems – Mae Ngad Somboon Chol dam, Mae Kuang Udom Thara dam, and Mae Tang irrigation unit. Two study areas in Chiang Mai province were selected – Ban Koh and Hua Kuang villages.

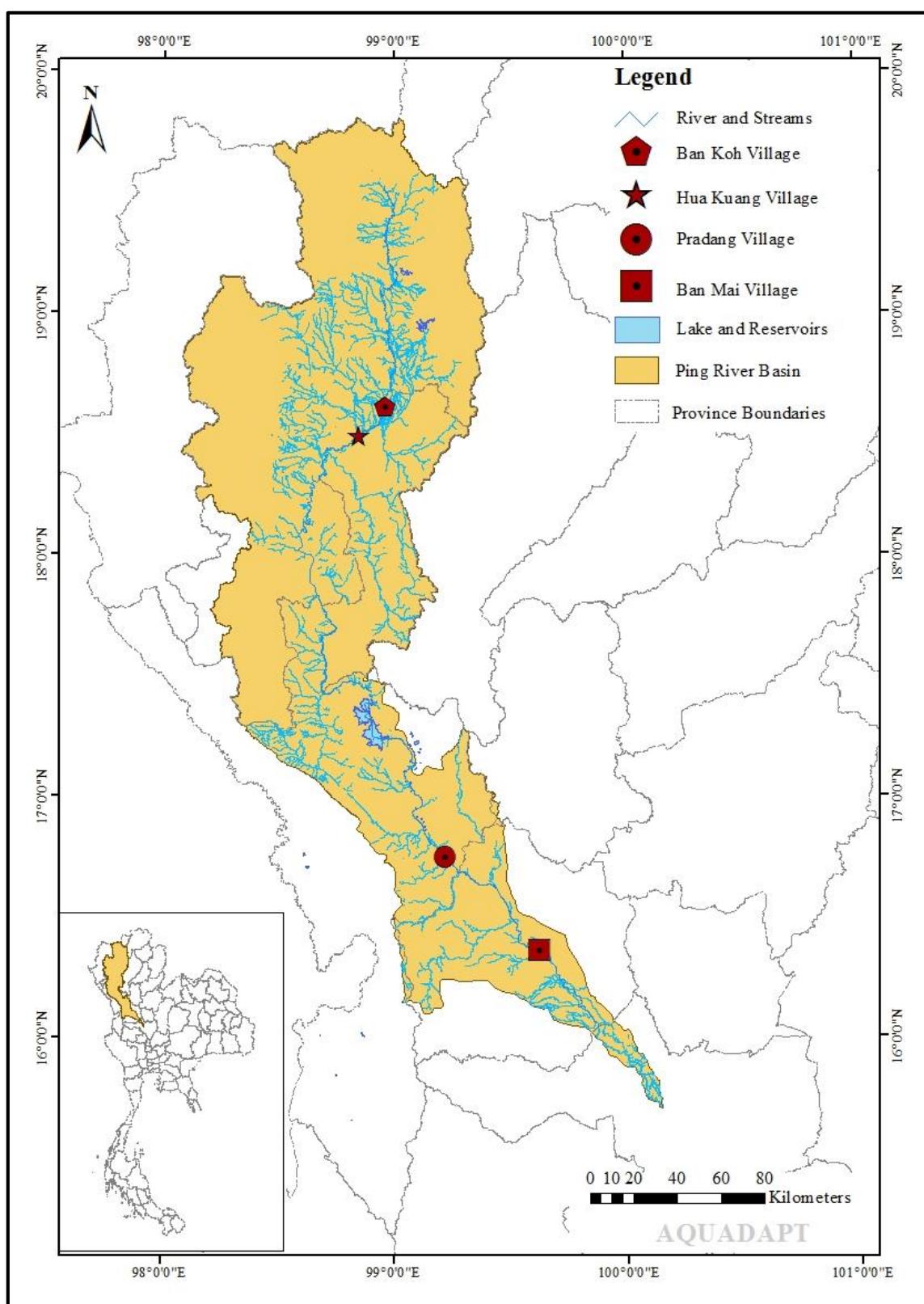


Figure 1.5 Location of research sites in the Ping river basin (Santita, 2014a)

As a representative of urban influenced areas, Ban Koh is located in Nong Tong Pattana Municipality, Hang Dong district. The occupation of people in the village is composed of daily wage labor, local technicians, farmers, or fishers. In the meantime, villagers in Hua Kuang village located in Doi Lor district are engaged in agricultural production and daily wage labor in a construction sector as main occupations.

Pradang village in Wang Chao District, Tak Province is the third research site located in Western Thailand and in the east (floodplain) side of province. The average altitude of this basin is around 90 meter above the mean sea level. This village is settled in the midstream section – the fourth part the basin in the Ping river basin – under the Bhumibol dam, the first multi-purpose concrete dam of Thailand, which is directly influences total production in the provincial level. It is not surprising that the GPP amount in agricultural sectors is the highest apportion and is equal to 24 percent of all production in 2004 after mining and quarry activities decreased in the late 1990s (World Bank, 2005). Tak province, besides, is categorized as an economic crop production area for commercial prospects. Agro-industrial crop plantations (cassava, sugar cane), however, which began in the 1970s as well as longan orchards and rice cultivation, have created an important change in Tak economic structures with an increase in commercial practices. Major plants in this province are maize, wet rice, banana, chickpea, orange, soybean, and longan. As Tak province has a lot of natural resource, many industries are based here due to the close proximity of minerals found there namely zinc, garment, and granite. In an urban perspective, this village is 20 kilometers from Tak city. However, it has no urban planning policy from the state to develop this province as do principle cities in the western region.

The fourth area of the lower Ping river basin is Kamphaeng Phet Province located downstream below five medium to mid-large irrigation projects. The average altitude of this basin, physically, is lower than 50 meter above the mean sea level. Unlike Tak Province, manufacturing production has become the main revenue which was more than half of the provincial GPP. In 2007, however, around 45 percent of the industry was agro-industry and food industry in small and medium sizes based on economic crop production (rice, sugar cane, soybean, maize, cassava, cotton, and banana). The labor ratio in the agricultural sector, moreover, stayed at the highest rate (approximately 60 percent)

compared with other production sectors. The two provinces, likewise, are not a major target of urban development and real estate establishment (World Bank, 2005; Ministry of Industry, 2007). The study area, Ban Mai village, is around 20 kilometers to the south of Kampheang Phet. This area is classified as a rural area and performing agriculture as the main occupation. The location of this village, moreover, is southward of the Wang Bua Irrigation system.

Table 1.1 Research sites

Research Sites	Weir / Dam (North to South)	Location
Ban Koh	Chollakhan Phinit, Tha Mako, Sob Rong	Chiang Mai, Upstream
Hua Kuang	Nong Saleek, Doi Noi, Wang Pan	Chiang Mai, Upstream
Pradang	Bhumibol Dam	Tak, Midstream
Ban Mai	Wang Bua	Kamphaeng Phet, Downstream

1.7.2 Units and Levels of Analysis

This research aims to highlight on fish cage farmers in the level of household. Household in this research refers to living-together or a fragmented unit composed of at least one member with blooded or non-blooded relations sharing familial, reproduction, financial, or production burdens as well as an emotional sense of being part of a household. To understand mobility, the individual unit is necessary together with household level in the analysis because mobility usually is done practically by individuals although sometimes comes from household co-decision. In this research, climate-related and socio-economic risks, vulnerability, mobility, and remittances are therefore analyzed by different scales.

Risks of fish cage farming households are recognized as the interaction of climate-related variability and socio-economic stresses from external hazards and internal exposure. Each community is a target of risk assessment from external climate-related hazards either physical (rainfall and temperature variability) or human inducements (disaster prevention, irrigation system, river improvement, and pollution). Also, socio-economic external

hazards include demand-supply and price fluctuation in market spheres, participation of state authorities, and internal relations and management. Risks, however, do not occur solely from the outside. Internal exposures, besides, are experienced by each household both by climate-related and socio-economic exposures. Likewise, vulnerability of fish cage farmers is represented by sensitivity from risk perception in a climatic term; and socio-economic sensitivity from rural changes illustrated in current household demographic structure and occupational diversification. Access to capitals from occupational diversification and techniques in fish cage farming influenced by risk perception are major contexts to evaluate vulnerability along with levels of mobility.

In the household unit, this study explores mobility to understand the diffusion of household members as labor migration and relocation of activities to other areas. Mobility of both labor migration and relocation of activities will be historically and currently analyzed from occupational or economic activities along with drivers (environmental and non-environmental drivers) by different household members in various distances (intra-village, provincial, inter-region, or overseas areas), time durations (seasonal, temporary, or permanent), types of jobs, and purposes (building up life foundation, existing daily, doing other occupations, and investing in fish cage farming and other occupations) of mobility. Also, constructing adaptive capacity of fish cage farming household in this research can be understood through the result of mobility reflected by remittances used for fish cage farming, livelihood-related activities, or consumption.

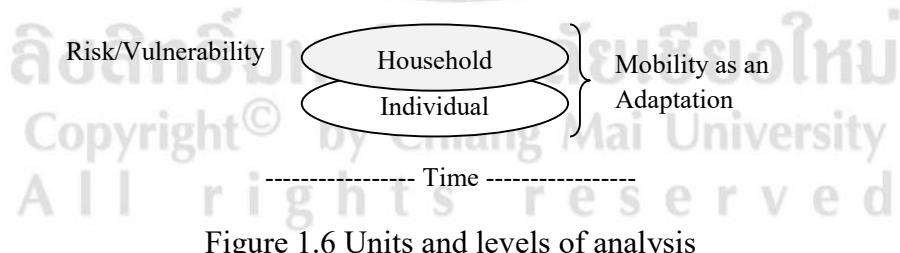


Figure 1.6 Units and levels of analysis

1.7.3 Data Collection

Various types of methodologies in data collection are respectively required to fulfill the contexts, analysis, and synthesis processes of this research. Two major modes of data collection, thus, are already employed.

This research definitely needs primary data to understand the actual circumstances that occur to fish cage farmers and other stakeholders in engagement. Time scope for the research has been provided from pre-farming and post-farming periods regarding the starting time of fish cage farming in each household. A range of time, in other words, to collect data and study in field research were held from April 2013-2014. By using general interviews with both individual and focus groups accompanied with participant observation in the four research sites, these methods became useful to find out some basic ideas about research questions and objectives. Collecting information in each household by various patterns is more effective and suitable to different kinds of information.

To gather deeper information, formal and informal interviews are the most significant techniques to gain research findings. In-depth semi-structured interviews as non-directive and probe interviews include household demographics, fish cage farming production systems, livelihoods and occupations, climate-related hazards, and mobility experiences are required following conditional events. Field note-taking technique is also included to summarize several significant matters from fieldwork each time. Life-history interviews, in addition, besides revealing personal information, can also provide a historical timeline of events happening in fish cage farming. Participant observation, in other words, is crucially applied to understand another side of social interactions in every level of analysis as possible. In order to sufficiently comprehend climate-related and socio-economic risks and vulnerability, in-depth and up-to-date data collection should be apprenticed in four durations owing to different characteristics and its variability of risks – summer (April-May), early rainy season (June-July), second rainy season (September-October), and winter (January-February).

To design primary data collection effectively, I had to educate myself and search for secondary data from manifold sources and bureaus. Climate and water resource statistics can be accessed from Meteorological Office, Irrigation office I (Chiang Mai), Hydrological and Water Resource Management Center I (Chiang Mai) and Center II (Phitsanulok) from e-databases and reports collecting sequenced data. GPS information and remote-sensory images from Space Technology and Geo-informatics Center at Northern Region, besides, are very necessary in analyzing with the statistics of land use

changes, terrain features and elevation, water tributary system, and village location. Fish cage statistics and other agricultural production in the research sites from the Fisheries District Office, Agricultural District Office, and demographic information from the District Office are required in order to understand basic contexts of each area. Moreover, monographs and other academic papers used in this research have been found at both online database systems and in books belonging to Chiang Mai University Library and outside.

1.7.4 Population and Sampling Techniques

This research starts from the classification of four research sites to conduct the population. The targeted population of this research covers fish cage farming households in the Ping river basin according to research sites. However, I had to select some samples to fulfill this study by using various techniques. All of the sampling techniques in this research, however, were conducted under non-probability sampling. In the first step, to know who the fish cage farming household is, accidental sampling had been adopted in the case of facing them directly. Another technique had been practiced by accumulating sampling techniques accepted by using a gatekeeper in one community. This method could be used when I have contacted the leaders of the community or network or government officials in the scope of cage extension or a private company employee who has already connected with a household. Afterwards, the second stage, I had to utilize some households as samples by using purposive sampling techniques based on climate-related (cage location, channel characteristics, climate and water stresses) and socio-economic (sizes of operation, contractual relations, household livelihoods, and mobility patterns) exposures in research sites. In sum, there are 42 fish cage farming households in four research sites with different production sizes – 11 fish cage farming households in Ban Kon, Hua Kuang, and Pradang villages, and 9 fish cage farming households in Ban Mai village.

1.7.5 Research Techniques

According to the research objectives posed, several data analysis techniques are recognized chiefly by non-statistical analysis because most of the data are collected by qualitative techniques as mentioned above. To clarify, transcription, triangulation, and comparison analysis from individual profiles are the main techniques. Basic methods of

descriptive statistics by average, ratio, and scoring system, however, are still applicable to figure risk and vulnerability among farmers who have different capacities to adapt.

Transcription is handled along with non-directive, in-depth interview to define settings, acts, activities, relationships, participation, and meaning of the interviewee and other related actors, places, institutions, and behaviors. To ease this analysis, individual profiles of fish cage farming households are prepared for comparison and triangulation. Comparison technique, additionally, is very beneficial to compare and assess risks and vulnerability among households from different backgrounds. Triangulation, finally, is also adopted to accumulate the different voices of interviewee with other samples in each season, and develop an analysis of secondary documents before writing the thesis. Different analytical methods are applied in each research objective as illustrated below.

An assessment of climate-related and socio-economic risks is defined by two major directions. Climate-related variability information, firstly, is gathered by external hazards from physical and anthropogenic changes (rainfall, temperature, seasonal variability, disaster prevention policy, irrigation system, and river improvement), and internal exposures (cage location, channel characteristics, and feeding season). The issue of socio-economic stresses, similarly, is also recognized by external factors including state advocacy, market demand, price fluctuation trends, and community in-situ management, as well as its exposures from contractual relations with firms, production patterns, and relations to official units and community in each household. Those issues of multiple risks must be compared, analyzed, interpreted, and triangulated among farmers' memorandum as primary data from manifold interviews, and field note-taking, observation, documentary and statistical analysis, as well as reliable articles under the umbrella of fish cage farming in research sites as secondary data.

Comparison analysis is the main methodology to compare multiple household vulnerability from current household demographic structures, occupational diversification, risk perception, and access to capitals and techniques in fish cage farming by dividing the samples into three levels of mobility – high, moderate, and low – to ascertain the relationship between multiple household vulnerability and levels of mobility which will be the foundation for the analysis of the next chapter. In addition to qualitative

techniques, basic quantitative techniques are also applied namely average, ratio, and scoring system.

Likewise the second stage, mobility experiences have been traced back to previous profiles and the participation of each household member to support household adaptation viewed again in the current period. This stage is achieved by comparison analysis of different financial, social, and cultural remittances, as well as levels of mobility from semi-structured interviews, probes of life-history, and participant observation in constructing adaptive capacity to deal with risk and vulnerability nowadays. Different levels of mobility and remittances are identified by different drivers, household members, time durations, types of jobs, and purposes of mobility.

1.8 Thesis Organization

This thesis can be categorized into six chapters to illustrate distinctive issues and answer in appropriate pathways in response to dealing with the main argument.

Chapter 1 Introduction is composed of the general rationale of the study, research questions, research objectives, operational definitions, review of related concepts and studies, conceptual framework, and research methodology – to reveal general themes and understanding of the research before in-depth details in the next chapters.

Chapter 2 Research Sites in Changing Contexts provides general information of all research sites including locations, demographic structures, physical characteristics, historical profiles of villages, backgrounds in fish cage farming, climate-related trends, irrigation, and participating authorities, to understand and compare surrounding situations in the dynamics related to risks, vulnerability, and adaptation.

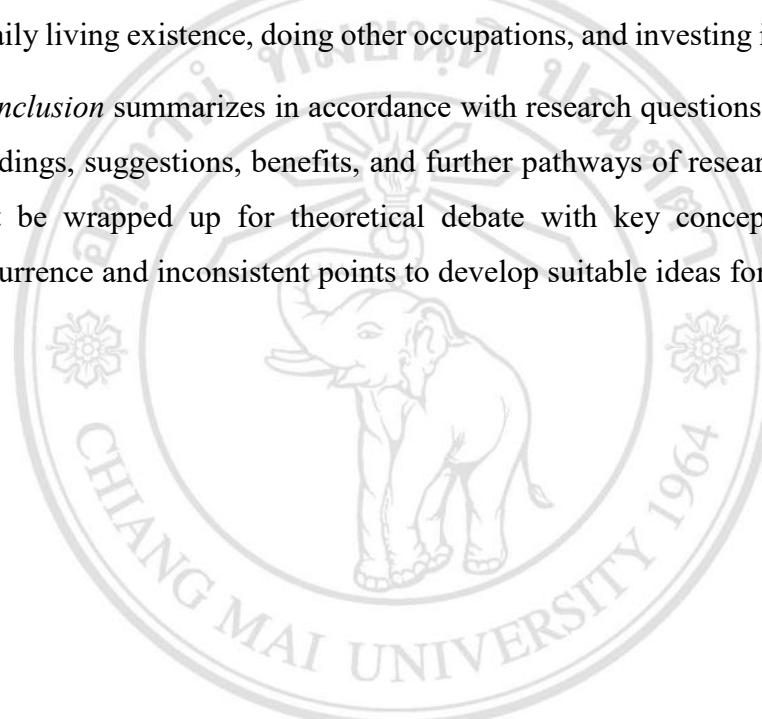
Chapter 3 Multiple Risks in Fish Cage Farming studies the interactive effects of climate-related and socio-economic risks both external hazards which occurred in the level of village and those consequences received by households from internal exposure. The results are fundamental to vulnerability analysis in a household level.

Chapter 4 Multiple Household Vulnerability compares vulnerability to multiple risks with different characteristics of fish cage farmers' household from four sensitivities including current household demographic structures, occupational diversification, risk perception,

and access to capitals in occupational diversification and techniques in fish cage farming from distinctive levels of mobility.

Chapter 5 Mobility as an Adaptation to Multiple Risks investigates how remittances from mobility activities composed of different household members, drivers, purposes, distance, frequency, and time durations contribute to household adaptation by both short-term mitigation and long-term adaptation to climate-related and socio-economic risks and vulnerability particularly in fish farming related activities including building up a life foundation, daily living existence, doing other occupations, and investing in fish farming.

Chapter 6 Conclusion summarizes in accordance with research questions and objectives to provide findings, suggestions, benefits, and further pathways of research. All results, besides, must be wrapped up for theoretical debate with key conceptualizations to examine concurrence and inconsistent points to develop suitable ideas for exploration in the future.



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CHAPTER 2

Research Sites in Changing Contexts

This chapter is necessary to provide and trace back preliminary contexts related to fish cage farming in physical, social, and economic dimensions. Realizing the origin of fish cage farming as an alternative intensive aquaculture and its development, suitable requirements in climatic sequences and socio-economic linkages, as well as structural changing of research sites in demographic and occupational senses can explicitly illuminate manifold understandings to the research before analyzing various critical situations under the umbrella of risk, vulnerability, and adaptation in a defined time scope.

2.1 Development of Hybrid Red Tilapia

This section, generally, aims at describing several introductions related to red tilapia species and its business and basic statistics of fish cage farming in order to grasp an overview of red tilapia fish cage farming in the Ping river basin.

Red tilapia is a hybrid breeding from the Nile tilapia (*Oreochromis niloticus*) which originated in the Northern Africa region and has been found in several tropical and sub-tropical areas in last the 4-5 decades (Petchjul, 2004). In Thailand, King Bhumibol Adulyadej had first received 50 tilapia fingerlings from Japan by His Imperial Majesty Akihito on March 25th, 1965. Afterwards, the Nile tilapia or *Pla Nil* became widespread throughout Thailand as the most famous economic fish for consumption thanks to the highest produce in one year (200,000 tons). King Bhumibol Adulyadej, by the way, had encouraged new pathways in developing tilapia species in 1989 because freshwater and marine fishes from all natural sources tended to drop significantly and it was a suitable time to develop a more attractive species to serve massive consumption in the near future. Following the royal thought, CPF Public Company had started a tilapia reproduction development project by hybridizing *Oreochromis niloticus* from England,

United States of America, Israel, and Taiwan making the crossing with natural non-GMOs methods. The hybrid red tilapia has an outstanding red-pink color on its fish scales and body from the crossing of a Florida Red and an Israel species which has a great threshold of disease resistance in Thai environments from the Chitrada (Thai) species which had been developed into a new species and can be nurtured in freshwater and brackish water, and saline water. Later, a new tilapia species had been named and introduced by the king as *Pla Tubtim* (means ruby fish) in 1998. This new species, red tilapia, is chiefly developed for intensive production and promoted as an occupation because a farmer only needs to feed 4-5 months per crop and will receive sufficient income if fish cages are located in good water quality and spacious feeding areas. According to the stage of new species' development, CPF began fish cage farming as the first agri-business production in Thailand in 1997 for farmers to secure an income and also benefit for consumers including fresh markets, restaurants, and self-employed operations in the food sector (Lebel, 2008; Ban Mueng Newspaper, 2009).

Following the statistics of freshwater aquaculture from Department of Fisheries (2011), the area of all freshwater aquacultures covered of an area of approximately 900,685 rai with 492,396 farmers throughout the country. Although cage aquaculture has the lowest cumulative share (0.86 %) in a 13-year period among all aquaculture systems by numbers of cage farms (95.66 % in pond, 2.35 % in paddy-cum-fish, and 1.13 % in ditch), the expansion of cage aquaculture in Thailand has been observed respectively from 0.30 precent (721 farms) in 1999 to 1.31 precent (6,448 farms) of all aquaculture farms in 2011, or nearly ten times in numbers of farms (Figure 2.1).

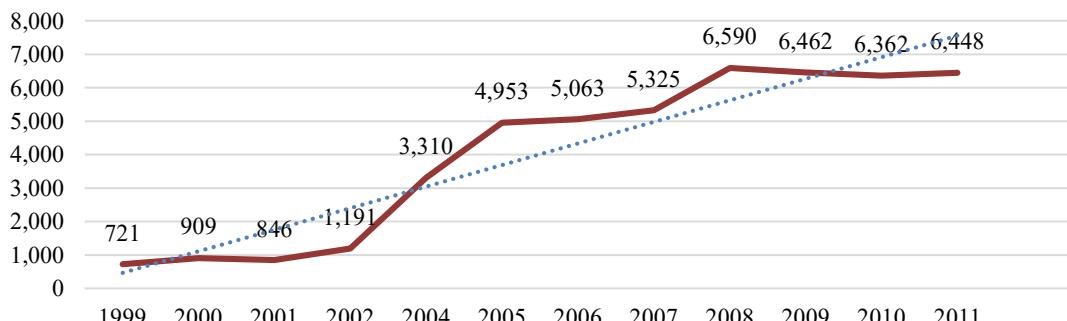


Figure 2.1 Number of cage culture farm from 1999 to 2011

(Source: modified from Department of Fisheries, 2011 by Santita, 2014b)

The relationship of the amount of production per unit, on the other hand, is also another significant issue. Although cage aquaculture covers the smallest area throughout the country, production ratio of fish cage farming demonstrated at the highest peak (53.66 tons/rai) more than 100 times compared with other sorts of aquaculture (0.25-0.42 tons/rai) according to the statistics in 2011. It could be assumed that fish cage farming represents the greatest capacity of freshwater aquaculture in the perspective of the worthiness of area used and production amount.

To classify the production amount of fish cage farming by fish types, tilapia (including red tilapia) has had the highest proportion since 2000. It, moreover, has been higher than 90 percent since 2005. Tilapia in fish cage farming, however, decreased slightly (lower than 90 percent) from 91.62 percent (36,494 tons) in 2010 to 87.87 percent (29,517) in 2011. Fish production from tilapia cage farming, nowadays, costs at least 1.6 billion baht per year. In the meantime, around 10 percent of fish production in last ten years came from catfish, giant gourami, striped catfish, and other kinds of fish. Fish production in 2011 including tilapia, however, was obviously declining for the first time in the 13-year period (figure 2.2).

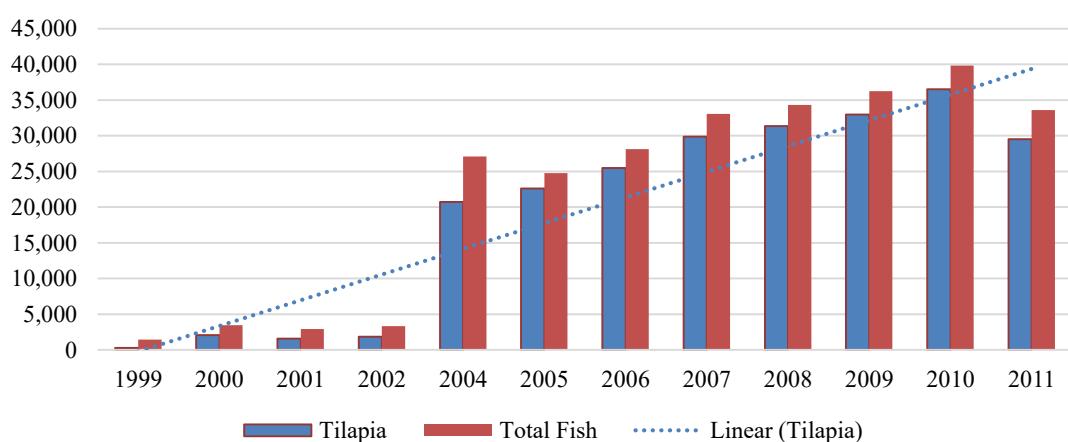


Figure 2.2 Comparison of tilapia and other freshwater fish production in cage aquaculture (ton), 2011 (Source: modified from Department of Fisheries, 2011)

Tilapia fish cage farming, provincially, in research site provinces is valued at around 80-90 million baht per year and shared approximately 4 percent of all tilapia fish cage farming production amounts in the country. Chiang Mai province had the highest

produce compared to Tak and Kamphaeng Phet. Tilapia production by value in Tak and Kamphaeng Phet province, however, tends to be increasing over the years, while it had decreased from nearly 90 million baht in 2008-2009 to 65-73 million baht in the following two years in Chiang Mai province. (Figure 2.3).

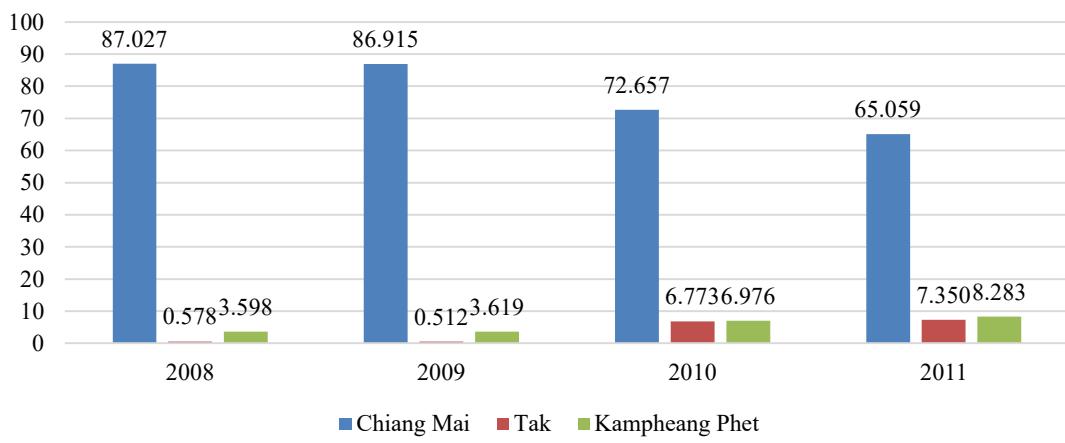


Figure 2.3 Annual value of tilapia fish cage aquaculture by province (million baht) from 2008 to 2011 (Source: modified from Department of Fisheries, 2011 by Santita, 2014b)

Cage farming, to assume primarily, tends to have been much favored in the aquaculture sector in last decade because it requires no land plots to operate and producers can gain higher produce per area compared to other aquaculture systems. Tilapia production, including red hybrid tilapia, has attained the highest share among other aquatic animals since 2004. Total production amount in 2011, however, slightly decreased which is significantly related to production decline in Chiang Mai province, the largest producer in the research sites. This skeptical data is the first information to open room for debate with other issues in fish cage farming.

2.2 Suitable Requirements for Tilapia Fish Cage Farming

Several suitable requirements for fish cage farming are very important in controlling and influencing to the growth rate, fish production quality and quantity, disease, and fish killing. In freshwater aquaculture, physical factors (water depth, flow and velocity, dissolved oxygen rate, water temperature, light intensity, pH, chemical substances, and turbidity), components for fish cage farming (cage shape, depth, size of net hole,

fingering density, cage position, and feed frequency), and production patterns (traditional, semi-intensive, and intensive) are included in the analysis (Department of Livestock Development, 2012; Huai Hong Krai Royal Development Study Center, 2012; Masser, 1997; Petchjun, 2004).

2.2.1 Physical Requirements

Major requirements in physical perspectives constitute eight factors related to water qualification and its substances. Two-meter depth from the water surface, firstly, is the most oxygen dissolved area. Having optimum water depth in the river can benefit fish survival. However, feeding fish in a bottomless area will cause oxygen deficit. It is also affected by irrigation storage and management in a particular area, and rainfall amount and frequency in the upstream. The optimum rate of water velocity, secondly, is 6-7 meters per second. This factor is varied by cage characteristics including size of net hole, cage shape, and cage location, as well as drainage from irrigation system and seasonal variability. Stagnant water is likely to occur in dry season, while overflow or strong flow tends to be found in rainy/monsoon season. Oxygen stress, thirdly, is the most frequent serious problem faced by producers especially a dissolved oxygen (DO) rate. Suitable dissolved oxygen should be sustained at 4 mg/l for healthy fish and feed conservation. The highest dissolved oxygen rate appear in the daytime. However, dissolved oxygen rate should be maintained at least 3 mg/l to prevent fish stress which essentially affects the growth rate. Besides, dissolved oxygen rate is significantly decreased at approximately 30-50 percent in the area which is below two-meter in depth level. Water temperature, fourthly, is very influential on the fish, being a cold-blooded animal. Optimum temperature helps to sustain fish consumption at a good rate and decrease fish conversion. Although tilapia can well adapt to tropical environments and tolerate extreme temperatures between 10-40 degree Celsius, the optimum temperature with the highest dissolved oxygen which is vital for fish growing is between 25-30 degrees Celsius. This range of temperature can significantly reduce fish killing, stress, and shock. Interestingly, water depth has an absolute impact on the variation of water temperature particularly in winter and summer. Less water depth will lead to extreme variability of water temperature.

Water plants and tree shadows, another important factor, have several impacts on light intensity in river water. Excessive shade from all plants can reduce light intensity which has a capacity to increase dissolved oxygen rate at the water surface. Phosphorus and nitrogen, besides, exert their role on abundant growth of water plants and phytoplankton affecting the pH rate and chemical contamination by physical processes. The pH, sixth, is related to uptake and release of carbon dioxide during respiration and photosynthesis. Rate of suitable pH is 6.5-8.5 which can be dropped to the lowest near dawn and climbed up to the highest in mid-afternoon. Besides, a change in the pH rate depends on the amount of water plants and phytoplankton. To focus on chemical substances, seventh, ammonia and nitrite toxicity occurs from protein digestion, fertilizer runoff and soil erosion from rain, inorganic fertilizer, plant decomposition, die-off plankton, and uneaten feed transforms into ammonia. Turbidity, finally, is caused by suspended soil and detritus (muddy color). High intensity of suspension (e.g. clay, mud) during heavy rains leads to gill clogging and development of secondary diseases. If visibility in water is less than six inches or more than 24 inches in depth from the water surface measured by a secchi disc, it is very critical for fish survival. A suitable turbidity rate should be assessed at 15-24 inches or 30-60 centimeters from the water surface.

2.2.2 Components for Fish Cage Farming

Six essential components for fish cage farming should be prepared to prevent unintended consequences. Quadrangle and rectangle cage shape, most importantly, are usually used for fish cage farming because they have more surface areas which can receive water stream and its circulation continuously. Fish cage is divided into two types – fixed cage and floated cage. Fixed cage is often used for fingering breeding in the shallow area (less than two meters of depth). Floated cage is beneficial for deeper areas (more than two meters) which can be tied to a pillar or a tree to situate and move easily. Each cage, additionally, should be situated over river base flow at least 50 centimeters to facilitate water circulation. Laying down fish cages in very deep areas, however, is not suitable because the dissolved oxygen rate may decline. Each cage, the third factor, should be at least three meters apart from each other to prevent spaces between cage corners which lead to the decrease of dissolved oxygen rate and facilitate

water flow. Size of net holes, fourth, should be smaller than fingering sizes in order to prevent fingering losses, but tiny net holes are not efficient for water circulation. Another controlling factor is fingering density. It may vary by fingering sizes from the company and expected fish sizes for selling. In fact, the optimum rate of fingering density is around 50-100 fingerings per cubic meters. Fish cage farmers, at last, should feed by small amounts around 4-5 times per day because tilapia do not have a stomach to digest feed. If fish farmers feed too much per time, residue feed grains will be fermented at river base flow and create toxic water in the feeding and surrounding areas.

2.2.3 Production Patterns

Production patterns in fish cage farming can be categorized into three patterns – substantial, semi-intensive, and intensive production. Each production pattern is different in forms of fingering density, water quality control, feed quality, management system, and purposes of operation related to life subsistence and profit-oriented/commercial needs. Substantial production pattern, basically, aims at the consumption in households which does not require too much production. Semi-intensive production, in other words, combines substantial and intensive production together with less restriction about fingering density, sex ratio of fingerings, and fish sizes. Intensive production, the most famous pattern in fish cage farming, attempts to respond to market demand and customer needs. Male tilapias are popular in intensive production because they have no reproductive stage which leads to weight losses. Farm management system, besides, is associated between fish farmers, market representatives, fish companies, and customers and a high quality of production factors especially fingerings and feeds. Most fish cage farmers, nowadays, choose to produce by intensive production as an alternative occupation to earn sufficient income. It, also, is pointedly related to the use of limited aquaculture area as fish cage farmers may anticipate higher produce per area. In this part, the major concern is fish cage farming under intensive system requires elevated stability in all physical requirements and components responding to market demand. Intensive production currently, in addition, is often tied with contractual relations who encourage fish cage farmers to access various socio-economic benefits following the agreement.

2.3 Contractual Relations in Fish Cage Farming

Contractual relations or contract farming provided by fish companies is usually practiced as alternative agri-business in fish cage farming. Profit in the production, generally, is directly varied by risks. When farmers encounter high risks, they tend to earn high profit; however, low risks in the production may lead to low profit received by farmers (Hardaker, 2000 cited in Benjapan *et.al.*, 2011). Although fish cage farmers can sometimes earn short-term revenue from fish production (Benjapan *et.al.*, 2011), the relationship between individual fish cage farmers and fish companies tends to be unequal in the arenas of risk management, financial security, aggregation, and the adoption of social capital to reduce risks and market negotiation because they still lack state extension to create other alternatives to the production (Busara *et.al.*, 2006; Ponte, 2000). Fish cage farming in most areas, therefore, is still subscribed to contractual relations with a fish company which is related to production factors, financial systems, and market systems with its distribution.

2.3.1 Production Factors

Many studies reveal that contractual relations in fish cage farming provide production factors including medical supplies and feed, distribution system to the market by purchasing on financial credit or insurance to the company including loans to establish the operation and rearing of fingerlings to feed (Lebel *et.al.*, 2013), knowledge, and techniques in the production. Production factors, nevertheless, can be divided into two categories.

Variable production factors, the first category, primarily include fingerlings, feeds, and medical supplies and are always invested in the crop as short-term production factors. After subscribing to contractual relations, a fish company usually mobilize those factors especially fingerlings and feeds to fish farmers. They have to pay a financial credit called insurance in advance before starting the production in each round which is varied by a different financial system of fish companies. However, a few farmers purchase for variable production factors by cash and get a discount in feed prices because the insurance cost of feed is excluded. In the case of medical supplies, farmers can choose to purchase by cash or have it included in a financial credit. Nowadays, feed price,

firstly, costs around 550-690 baht per bag (20 kg) varying by brands and financial credit system. Fingerings, secondly, have many sizes. Fish cage farmers can sometimes select and buy from fish companies. Three-inch fingerings cost approximately from 5 to up to 8 baht per fingering, and tiny fingerings cost at least 0.65 baht per fingering. Medical supplies, lastly, are not static and vary by disease situations and the decision of farmers to make use of them. Totally, the cost of variable production factors is mainly changed upon the numbers of fingerings which are fed per crop.

Fixed production factors, secondly, are assembled as long-term production factors. They are not much relevant to contractual relations, except there are some farmers who access to loans under the patronage of fish companies to establish the operation and invest in fixed production factors at the beginning. The basic fixed production factor is cages. Individually, each farmer can select different types and quality of materials to build cages namely, iron, bamboo, buckets, nets, and other accessories. Besides, some farmers purchase some machines in fish farming depending on the necessity in each area and the self-attitude of farmers to equipment use such as engines, water pumps, aerators, pipes, water dispensers, and water turbines. At least 10,000 baht must be prepared for the investment in fixed production factors at the beginning.

2.3.2 Financial Systems

Three main financial systems in intensive production are remarked. Farmers who adopt a full cash system, first, have to absolutely purchase all production factors by cash. Although a massive financial fund must be saved for purchasing, they can earn feed price discounts as a company excludes an additional price for the credit/insurance system. Farmers who accept the partial credit system, second, must deposit some money before starting each crop and need to receive excess profit after selling fish in each crop. If any crop faces production failure and financial losses, most of the fish companies will allow fish farmers to continue the next round and cut future profit that may be earned to repay the loan. Generally, farmers have to purchase fingerings by cash and insure some money for fish companies for feed which is calculated by the number of fish (set a definite price of insurance per fish) or a percentage system (e.g. purchase one-fifth of total feed used in each crop estimated from the number of fish by the company). The

full credit financial system, third, is quite similar to the partial credit system. Farmers, nonetheless, are not necessary to pay for fingerings with cash. All variable production factor prices excluding medical supplies are included in the financial credit/insurance which is usually measured by the number of fish in a crop.

2.3.3 Market System and Distribution

Fish companies usually handle the responsibilities to distribute the product to the market as in terms of agreement. They will contact merchants in the market to catch the fish by themselves. After the fish have been sent to the market, it is the role of a company to distribute the product to fresh markets, discount stores, enterprises, restaurants, and so on. Fish prices, however, is not equal and follows the difference of price determination from each fish company. Besides, the demand-supply relationship has a great impact on the fluctuation of fish price and the amount of fish catching per time. Fish price will be dropped in excessive supply situations on the one hand, while it will be escalated when the demand of consumers is enlarged on the other hand. Market sources cover mainly within the province and region, including outside the region sometimes particularly in *Talad Thai* in Pathum Thani province, one of the largest agricultural produce markets in Thailand. Sizes of fish and market sources, significantly, have a close relationship to each other because the consumer in each area has different fish consumption behaviors. Actually, a popular fish size is between 600-900 grams per fish which is cultivated approximately 4-5 months if the water is sufficient enough for the production in both qualitative and quantitative aspects.

2.4 General Roles of State Authorities Related to Fish Cage Farming

Above the requirements of physical environments, and relationship of intensive production in commercial terms, state authorities have great impacts on supporting or retarding fish cage farming in aquaculture, water resources and their management, and rights over operational areas depending on the departments' missions.

2.4.1 Department of Fisheries (DoF)

Historically, the act about fishery and its equipment was not released officially until the first act in 1901 was mandated in order to provide sufficient aquatic animal production

for the Thai people, produce aquatic animals as a national income, and collect an aquatic animal tax. After the first national economic and social development plan had been declared, fishery burdens in Thailand were reconsidered as they could not reach the target of national development. Thus, the department of fisheries promulgated a new decree on February 7th, 1975 to expand its role. It covers research affairs related to aquaculture quest and experiment, aquatic species maintenance, statistics, knowledge collection, aquatic resources conservation, equipment, aquatic productions, and aquatic industries, the survey of fishery sources, aquaculture and natural catching extension, and other related fishery activities in accordance with the national plan for competition in national and regional fishery markets.

According to the announcement of Department of Fisheries (2006), the establishment of the fishery district office has been provided to assist in the burdens of the fishery provincial office at the level of district and nearby areas which do not have a fishery district office. This local authority has several duties about aquatic research and development, standardization, technical extension, fishery database, and information provision under the regulation of the department. Besides, each province and district has fishery volunteers to collaborate in fishery-related burdens from the department.

The fishery volunteer project (*Pramong Asa*) was launched in 2003 in order to develop the volunteers as official assistance to foster the trust of local communities with the department for real problems and obstacles, and to publicize the information from the department to communities. The will of the department aims at building social networks and multilateral collaborative actions among the department, officer, volunteer, and fish farmers, as well as helping fish farmers to consult and exchange various issues related to fishery affairs with a volunteer in each community as mediators to contact a fishery officer. Nowadays, there are 14,000 volunteers throughout the country or at least 30 volunteers in each province. Most of the old volunteers are selected voluntarily from the department to inherit the assignment and to empower their networks and enforce more potential in fishery extension through annual meeting. Besides this multilateral association, the department has allowed the registration of aquatic farmers under the agreement as one of pathways to provide the coverage to all farmers.

One of the significant roles of the fishery office is to facilitate the registration of aquatic farmers. Following the department's statute about the registration (2013), aquatic farmers have a responsibility to register with the provincial fisheries department. In the registration rules, they have to firstly declare rights over the land which is allowed from related authorities in case those fish farmers use public areas to operate fish farming. Fish farmers must provide general information of aquaculture including types of aquaculture (pond, cage, cement pond, plastic pond, paddy cum field, ditch, allowed land), amounts of feeding illustrated as land areas, numbers of cages, and so on, types of aquatic animals and their amount, numbers of crops per year, and approximate value earned from the production. The registration is triennial, and each farmer has to continue again after the termination. The main purposes of the registration are to collect aquaculture and production statistics as well as the related operators in the aquatic animal sector, use those bits of information to reassure effective fishery-related management, and provide several financial and managerial assistances particularly during disaster events to aquatic farmers.

In conclusion, it can obviously be discerned that the department of fisheries has made various attempts to develop and exchange further assistances, knowledge, techniques, and methodologies to the fishery and aquaculture sector from the past until now. Multi-scale collaboration, noticeably, can be investigated at such periods of time to promote better understanding of aquatic-related affairs in order to build a great foundation to expand the interaction on a national scale. By the way, the mission of the department of fisheries is not limited only inside the fishery arena, but also engages with other departments and bureaus in national, regional, and local scales.

2.4.2 Marine Department (MD)

According to the 11th national plan, the marine department has proposed six major targets to accomplish their mission – develop and maintain basic infrastructure to support logistic systems, improve and connect basic infrastructure for transportation, provide the security for water transportation, enforce the capacity in information technology to manage transportation networks, build networks from related stakeholders to engage in various participations, and foster other important operations

of the department. Although all missions of the department aim at improving water transportation on both domestic and international levels, fish farming is also involved with this department following the 16th navigation in Thai water act released in 2007 and the fisheries act in 1947. It is the responsibility of the marine department, following the article 85/1, to employ an officer authorized by the provincial governor or the local administrative organization, who has full rights to declare river, canal, lake, or sea areas as a prohibitive area for anchoring of a boat or raft. Thus, the department of fisheries has set a regulation to control the allowance of aquaculture, especially for fish cage farming in public water areas that all aquatic farmers must ask for permission from the marine department before enrolling in the fishery registration.

2.4.3 Royal Irrigation Department (RID) and Related Organizations

RID has several major responsibilities about the development of water sources following the potentiality of the river basin, the allocation of water resources to all stakeholders with equality, justice, and sustainability, the promotion of integrated stakeholders' participation in all scales, and the prevention and relief of water-related disaster consequences. According to the definition of public irrigation, it has been defined clearly as "the activity held by Royal Irrigation Department which purposes for water storage, control, allocate, or drainage for agriculture, energy operation, infrastructure, or industry. The definition must combine water damage protection and water transportation in irrigated areas as well (Royal Irrigation Act Issue 4, 1975)". RID (2013), however, explains that irrigation must be held by a water irrigation unit and chiefly uses that irrigated water for planting.

In the perspective of fish farming, irrigation management following the policies of the department entails the infrastructure and its water resources management. To start with, irrigation infrastructures can be classified by size – large, medium, and small – with different purposes both within and across the department including irrigated water allocation, electricity generation, ecological conservation, and disaster prevention. Each irrigation project, especially large and medium-scale projects, creates a lot of consequences on fish cage farming in upstream, midstream, and downstream areas.

Two large irrigation systems have significant tasks to control and manage water resources in sub-basin areas. Mae Ngad Somboon Chol Dam is one of the important dams in Northern Thailand and located in the upstream area of the Ping river basin, Mae Tang district, Chiang Mai province. Before building this dam, many villagers in nearby areas had suffered from the massive flood in 1973 and the local weir was destroyed. Thus, this dam has been constructed by a royal suggestion to support agricultural irrigation, prevent flood disasters both upstream and downstream areas, generate electricity in local areas, advocate natural fishery and aquaculture, and promote tourism. This earth fill dam was inaugurated on February 22nd, 1986 with 265 million cubic meters of reservoir storage capacity. The dam will support agricultural production and disaster mitigation in 26,810 rai of the Ngat sub-basin area. Besides, this dam is a definite source of water resources to the Mae Faek irrigation project covering an area of 44,360 rai, Old Mae Ping irrigation project covering an area of 49,000 rai, as well as the public weir irrigation of villagers in 16 places covering an area of approximately 39,000 rai. The target population under the all of the irrigation projects is around 140,000 persons. Farmers in irrigated areas can cultivate various plants twice a year. Moreover, this dam also has benefits for flood prevention in Chiang Mai city, aquatic food sources for villagers, and fish cage farming freshwater aquaculture (Mae Faek – Mae Ngad Irrigation and Maintenance Project, 2014).

Bhumibol Dam is the first multi-purpose concrete arch dam in Thailand and was constructed on the Ping River in Sam Ngao district, Tak province, the midstream area of the Ping river basin. The storage capacity of the reservoir is around 13,462 million cubic meters which is the second largest dam in Thailand. Bhumibol Dam is mainly administrated by the Electricity Generating Authority of Thailand (EGAT). It has been running all operations including electricity generation and irrigation since 1964. Irrigation management, however, is divided from EGAT and abides under the administration of Royal Irrigation Department. The target of Bhumibol Dam is to allocate water resources for agriculture, consumption, transportation, tourism to Tak, Kampheang Phet, Nakorn Sawan, and other provinces in the downstream especially Chao Praya river basin, and generate electricity thanks to the plan of Royal Irrigation

Department. Particularly, irrigation water from the dam can support an area of approximately 9.5 million rai in Tak province (Bhumibol Dam, 2014; EGAT, 2014).

Several medium irrigation systems also serve the large irrigation systems' burdens. In the upstream section, Chollakhan Phinit (Old Mae Ping) Weir is a medium irrigation project under Lamphun irrigation project located in Saraphi district, Chiang Mai province, the upstream area of the Ping river basin. This irrigation project has been transformed into a public irrigation system for decades. It covers 29 villages in 4 sub-districts of Saraphi district and 42 villages in 7 sub-districts of Muang Lamphun district (Information System for Chiang Mai Public Irrigation Projects, 2014). The allocation of water resources is totally controlled by Mae Ngad Somboon Chol Dam as a fixed river water capital to these areas.

Nong Saleek Weir is a medium irrigation project under Lamphun irrigation project located in Pa Sang district, Lamphun province, the upstream area of the Ping river basin. To provide general information, this is a 3.8-meter concrete weir with a 1.5-meter rubber ridge and two water gates. Drainage capacity is 1,290 cubic meters per second in maximum. Benefit areas cover 10,000 rai in rainy season and 2,000 rai in dry season.

Doi Noi Weir is a medium irrigation project under Chiang Mai irrigation project located in Doi Lor district, Chiang Mai province, the upstream area of the Ping river basin. This weir was constructed in 1987 to store water for 9,555 villagers in Doi Lor and Chom Thong district covering an area of approximately 17,000 rai. It, unfortunately, collapsed from the erosion of strong water current since the massive flood in Chiang Mai in September 20-30, 2011. Recently, Irrigation Office I has proposed a reconstruction plan of Doi Noi weir under the northern development strategic plan and was accepted since in January 2012 (Royal Irrigation Department, 2013).

In the downstream section, Tho Thong Dang Irrigation and Maintenance Project: is the medium irrigation project under Kamphaeng Phet irrigation project located nearby the Ping River in Muang Kamphaeng Phet district, Kamphaeng Phet province at the boundary between midstream and downstream area of the Ping river basin. This irrigation project, historically, has had several irrigational backgrounds since the Sukhothai Kingdom era until the early Ayutthaya era following historical evidence.

Afterwards, this project was revised again by royal thought and constructed as an irrigation and maintenance project and has been in use since 1985. It covers irrigational, non-irrigational, and beneficial areas of approximately 383,800 rai in Muang Kampheng Phet, Pran Katai, and Sai Ngam district in Kampheng Phet province, as well as Khirimat and Kong Krailat district in Sukhothai province (Tho Thong Dang Irrigation and Maintenance Project, 2013).

Wang Bua Irrigation Project, Water Allocation Office I is under the administration of Kamphaeng Phet irrigation project located in Thep Nakorn sub-district, Muang Kamphaeng Phet district, Kamphaeng Phet province, the downstream area of the Ping river basin. It is a 4.5-meter high and 450-meter long gabion-and-motra ridge weir along the Ping River and was constructed in 2004. It covers an irrigational area of 402,047 rai in Kamphaeng Phet and Phichit province (Irrigation Office IV, n.d.)

2.4.4 Office of the National Water and Flood Management Policy

Office of the National Water and Flood Management Policy (ONWFMP) had been established in February 2012 as a unit under the direct administration of the prime minister after the 2011 massive flood in several parts of Thailand, which destroyed thousands of people's life, assets and caused many injuries, as well as create negative massive consequences in national economic development. The important missions in upstream-to-downstream administration are to release a national plan for water and flood management with related departments, compensate money to flood victims who are affected by the organization's policies, propose the work of state authorities and organize and administrate water resources and effective flood readiness, as well as offer a cabinet to promulgate budget setting or loan mobilization in relation to water resources and flood management. In case of immediate actions in flood events, this organization has an expressed authority to control water resources in all dams and irrigation systems.

2.5 River-Based Livelihood and Fish Cage Farming in Research Sites

The Ping river basin covers an area of approximately 33,896 square kilometers (Royal Irrigation Department, 2012). In land use perspectives, forest is the major share of land use in the basin especially in the mountainous areas. It covers an area of approximately 77.42 percent which can be categorized as wildlife sanctuary areas (11.42 percent), national parks (14.91 percent), and forest conservation areas (73.66 percent). In regard to the statistics about agricultural land use, 50.81 percent of all agricultural areas especially in flat areas which are quite far from the river are used for crop production, ordered by coverage areas. The second is rice cultivation (42.01 percent) particularly in Chiang Mai – Lamphun basin and the lower part of Kamphaeng Phet and Nakorn Sawan province. There, also, are 6.71 percent of land plots for orchard and perennial plant plantation.

In the hydrological dimension, this river originates from Phi Pan Nam range in Chiang Dao district, Chiang Mai province, flows southward in the basin and reaches to the great Chiang Mai plain. The Kuang River, further south, meets the west side of the Ping River in Lamphun province. The Ping River continues until stored in the reservoir at the Bhumibol Dam, flows from here to meet the Wang River in Tak province, runs through the great floodplain in Kamphaeng Phet and Nakorn Sawan province, and finally merges with the Nan River at Pak Nam Po, Nakorn Sawan province. The Ping river basin covers five provinces – Chiang Mai, Lamphun, Tak, Kamphaeng Phet, and Nakorn Sawan (HAI, 2012).

In another perspective, Thailand has been an agricultural-based country for decades. All research sites have also depended on farming production and water use for a long period of time. The changing of various economic yields being planted in paddy fields, crops, and orchards, notwithstanding, can be observed by the increase in natural resources users and the area's socio-economic transformation into the new stream of development in last four to five decades. Manifold types of secondary and tertiary production in non-farm sectors, besides, have emerged and infiltrated as new alternatives for rural villagers. In the later period, intensive commercial influence was not only limited to the factory or business in the city, but also began challenging production patterns in

farming and self-employed enterprise in situ. Each village, however, is based on different physical, social, economic, and political environments leading to its distinctive general characteristics.

As all research sites are situated near the Ping River, villagers who do both farm and non-farm production tend to be familiar with the river. They have to depend on the river water for four basic functions – consumption, agricultural use, management system, and transportation. In a consumption perspective, previously, most of the villagers used river water for daily life activities such as washing and taking a bath. Each sub-basin area (upstream, midstream, and downstream), nevertheless, still has different applications to river water in agricultural use, management system, and transportation generating a distinctive river folklore from its past history.

In upstream areas, river water is very important for all agricultural types both in direct and indirect ways. Rice production in all seasons (both *na pi* and *na daw/na prang*) must use a lot of river water in the planting, growing, and pre-cultivation stages. Other farm production especially longan, the most productive plant in Northern Thailand, meanwhile, has to use river water, as well as groundwater or pond water which vary by water table to assist in the growing at least once a month. Following the demand for water in farming production, Vanpen (2005) demonstrated that each local community has an outstanding traditional system to manage and control water resources during all seasons. A communal water resource management system called *muang fai* has been apprenticed for seven hundred years in Lanna Thai history before the modern irrigation system of the Thai State. Local people in Northern Thailand released several agreements in water resources allocation in each community which chiefly contributed to agricultural practices. Everyone engaging in *muang fai* must preserve and be responsible in maintaining *muang fai* by following the rules.

After the implementation of the national development plan 50 years ago, farmers' livelihoods have been dramatically changed by water resources management especially agricultural production systems. Under state authorities, water resources management has been one of the development plans in the Ping river basin. All of the large, medium, and small irrigation projects including massive dam construction, irrigation systems,

reservoirs, and waterways have been established in each river basin to reach socio-economic targets related to crop production, household consumption, industrial manufacture, electricity generation, and natural disaster prevention.

Rights of management in water resources, currently, have been overlapping between actual rights of local community to access water sources, use, management participation, information, and the regulation of state authorities in every scale of management. Although *muang fai* system has enough capacity to allocate water resources in each particular community, water resources allocation particularly of river water is evidently controlled by the state from headwater to downstream areas. The implementation of water management projects especially small-scale projects, besides, is the representative of state authorities to administrate and control water resources through various policies by establishing many local officials to receive and practice the policies following the order of the Royal Irrigation Department and other state authorities. Such small projects including reservoirs, waterways, swamps, and wells which can be built in less than a year and have no compensation on land expropriation have been widely constructed. In the basin, 669 projects have covered the irrigation area of approximately one million rai. All small irrigation projects along the waterways are mainly utilized for consumption and agriculture (HAI, 2012).

Along with this, water transportation has been very popular in central Thailand including the midstream and downstream areas for at least the last 50 years. To date, many commercial activities have appeared in the villages due to the interaction of strangers and villagers inside and outside the village. In the village, a lot of merchants piloted their ships to sell many products such as torch and rubber oil along the river. Some villagers built a boat in the village and floated to the south to sell products. Some of them used a boat or walked across the river to meet cousins on the opposite riverside and communicate with other people in nearby communities. Importantly, it can be recognized that the daily life of local villagers is very much embedded in the river. Anyway, modern transportation systems especially by the vehicle transformed a lot of the patterns of physical communication.

Fish cage farming, nowadays, is an obvious picture of the interaction between fish cage farmers and the river. This activity can revive river-related folklore of fish cage farmers because river water is the most significant factor for production and their lives totally rely on river water, as well as provide a gainful occupation and that earns enough income to subsidize the household. Using river water to operate fish farming directly is explicitly affected by natural and anthropogenic actions of climate-related variability. Dealing with how fish cage farmers live with the river water in the state of risks, vulnerability, and adaptation in the red tilapia aquaculture is one of important challenges in this research.

Each research site also has a different background of fish cage farming in the perspectives of time of beginning, participant stakeholders, internal management, and production systems with their techniques. To provide basic information about intensive aquaculture, commercially, many fish cage farmers have subscribed to a contractual company in fish cage farming by purchasing on financial credit to access to variable production factors including feed and fingering while farmers themselves have to invest in fixed production factors namely cages and other necessary machines such as water pumps and turbines to foster the production.

According to the distinctive characteristics in hydrological terrains, river-based livelihood, basic contexts of livelihood, and fish cage farming operations, four research sites in the Ping river basin are the main target areas of the research and are located in three different sub-basin sections – upstream, midstream, and downstream.

2.5.1 Upstream Section

The second part of the Ping river basin covers an area of approximately 1,524.72 square kilometers or 952,949 rai (4.41 percent of Ping river basin area) in some parts of Chiang Mai and Lamphun provinces including Hang Dong and Doi Lor district (HAI, 2012). It consists of many fish-cage-farming villages alongside the Ping River. However, two research sites operating a lot of fish cage farms – Ban Koh and Hua Kuang village – had been selected.

The first research site, Ban Koh village, is in the Nong Tong Pattana Municipality area which covers an area of approximately 14 square kilometers. Ban Koh village is around 28 kilometers from Chiang Mai taking 35 minutes travelling to the city (Nong Tong Pattana Municipality, 2012) and around 9 kilometers from Lamphun taking 12 minutes travelling to the city. The absolute location of Ban Koh village is at 18 degrees 37 minutes 10.0704 seconds latitude and 98 degrees 57 minutes 16.3434 seconds longitude. It is bordered by Ban Tha Kwai, a Nong Tong sub-district to the north, Ban Pa Lan, a Nong Tong sub-district to the south, the Ping River and Muang Lamphun district to the east, and Ban Nong Tong, a Nong Tong sub-district to the west. The important weir and irrigation systems in nearby areas are Chonlakhan Phinit (Old Mae Ping) and Tha Mako weir to the north, and Sob Rong weir to the south.

Ban Koh village is a village located in the Nong Tong sub-district, Hang Dong district, Chiang Mai province and being administrated by Nong Tong Pattana Municipality. Following the symbol of this municipality, the village provides plentiful agricultural yields and farm produces and the prevention of floods in rainy season have been fostered by a local check dam. In the level of township, besides, commercial activities have been prosperous since the past until now with a convenient land and water transportation system (Nong Tong Pattana Municipality, 2012). It is quite obvious to assume that this area has been an agricultural-based village for a long period. Likewise, in the past, rice production in Ban Koh village was the most popular farm-based occupation thanks to an appropriate physical terrains and soil types with an optimum supply of water resources. Longan production had later been introduced for the last 30 years has become the main farming activity replacing most paddy fields due to higher income earned as intensive production and floods causing severe damages in rice production. Most of the planting areas in Ban Koh village are now being covered by longan orchards, while paddy fields have declined from hundreds of plots to only one plot (3 rai) now. Land conversion from the influence of urbanization thanks to principle city development from the 4th national economic and social development plan, in the meantime, is another aggravating force reducing agriculture and changing villagers into a workforce for the industrial and service sectors instead. Some of villagers have settled down in the village and produce flying lanterns as a self-employed operation.

Fish cage farming was introduced in 1992 as a group operation funded by the government via Nong Tong Municipality aimed at improving rural livelihoods to be more secure and also motivating the local-scale economy. It, initially, was operated in natural local canals (*muang*) before starting in the Ping River in five years later by using another red tilapia species (*Pla Nil Dang*) to feed. Each member of the group received 10,000 baht to begin the individual operation and was responsible for taking care of the groups' cages. This group distributed feed to all members as well as share knowledge and exchange information among members similar to the fish pond association in Northern Thailand nowadays. At least 50 members at that time subscribed to the fish cage farming group and set up individual operation as well. Following the great income which fish cage farmers earned from group and individual operation, competition and exploitation among farmers together with financial fraud in the group occurred leading to inequality of access to benefits among the members. Those problems were chronic for such a long time that is resulted in the group termination for six or seven years ago. Meanwhile, fish cage farming in Ban Koh village had been operated by individual households for 10 years before the group collapsed and all of the farmers tended to expand and manage their own cages rather than operate within the group.

Although fish farming has been driven by the household itself, access to loans from the Bank for Agriculture and Agricultural Co-operatives (BAAC) was actualized by four community enterprises (group 1, 2, 3, and 5) with at least five members per group. Financial capital from this source had an essential role in launching fish cage farming again. Currently, all groups in the village stopped the financial collaboration among themselves at least five years ago, but most of the members have still operated their production until now. Fish cage farmers, to date, are likely to help each other in their group before assisting other fish farmers in different groups in cultural and workforce aspects such as passing the information about the latest news related to fish farming, releasing the fingerlings, catching fish for selling, and moving cages during hazardous events. However, selection of company, investment decision, and time duration for feeding concerns of the individual household itself. In the meantime, a fish cage farming group has again been established and funded by the community and village development project (SML) which is required financial capital from the government and

the villagers' share and provides excess profit back to villagers again. To administrate the SML fish farming group, the committee has been formed from fish cage farmers in the village.

Reasonably, fish cage farming in Ban Koh village still has some collective actions in forms of helping each other in the exchange of labor, knowledge, and techniques. Nevertheless, financial management is in the level of household thanks to the state of lost trust and also competition among farmers who attempted to gain a higher income by themselves. Unfortunately, the number of fish cage farmers, statistically, essentially declined from 50 to nearly 20 farmers owing to internal turbulences and conflicts in financial and administrative systems since the period of group operation, as well as climate-related and socio-economic disturbances which will be explained in the following chapters.

Hua Kuang village, another research site, is one of villages in Song Kuae Municipality area, Doi Lor district which covers an area of approximately 8.5 square kilometers (Song Kuae Municipality, n.d.). Hua Kuang village around 40 kilometers from Chiang Mai taking approximately one hour travelling to the city. The absolute location of Hua Kuang village is at 18 degrees 29 minutes 26.379 seconds latitude and 98 degrees 50 minutes 33.5142 seconds longitude. It is bordered by Ban Song Kuae, Song Kuae sub-district to the north, Ban Pa Lan, Song Kuae sub-district to the south, the Ping River and Tha Tum sub-district, Pa Sang district to the east, and Santisuk sub-district to the west. The important weir and irrigation systems in nearby areas are the Nong Saleek weir to the north, and the Doi Noi weir to the south.

Hua Kuang village in Song Kuae Municipality, Song Kuae sub-district, Doi Lor district, Chiang Mai province is the second research site and has a long history of farming activities. The villagers, besides, have been employed in either non-farm or farm activities for several decades. Many of them, both men and women, are wage and monthly laborers in the construction sector, bakery factory, and industrial estate. Moreover, several male labors have had experience as laborers in overseas regions especially in the Middle East and East Asia thanks to the promotion of Thai labors exportation to various regions as workforces for the last 40 years. This has also been

precipitated by the major flood. Changes in occupational structures to non-farm working has been chiefly impacted by the 4th national economic and social development plan which promoted city, and industrial development to challenge production structures in regional communities including the Chiang Mai – Lamphun area. Intensive agricultural production, however, is a great share of the proportion of the main occupation in this village. Rice and longan plantation, as well as fish cage farming have been the most popular occupations and have a long history in the village. In the past, rice cultivation was the main agricultural production which was usually done in rainy season only. Farmers, currently, always cultivate their rice two times a year – rainy (*na pi*) and winter-hot (*na prang* or *na daw*) season according to financial attraction from the rising demand for rice. Longan orchards, meanwhile, have been gradually replacing the paddy fields for the last 30 years owing to drought, lack of water for rice cultivation, and a higher price for longan than rice.

It can be inferred that all fish cage farmers have a foundation from those occupations mentioned earlier. Fish cage farming has been first started in 1999 by individual households. At least three or four farmers firstly decided to subscribe to contractual relations with a fish company. Afterwards, the number of fish cage farmers sharply increased to 60 farmers located in only one village. Each one, further, owned ten fish cages or more and earned profitable revenue for many years. Thus, Hua Kuang village has been one of the major fish production areas to support market demand for a long time with massive production and a high number of fish cage farmers. In the beginning, their investment had been divided into two parts – fixed cost and variable cost. Fixed cost includes producing cages and purchasing basic farm machines and tools such as water pumps, pipes, and so on. Meanwhile, variable cost is under contractual relations to the fish company who provide feeds, fingerings, and medical supplies as well as advice and concern after fish cage farmers signed formally and informally to the agreements and purchased their first pledge money to receive production factors. According to the contractual agreements from a private company, fish cage farmers themselves must be completely responsible for risk burdens from every direction.

Fish cage farming in Hua Kuang village was normally operated all year round because of optimum quality and quantity of water to feed. The most essential factor to boost their production comes from the storage of the Doi Noi weir southward of the village. As all farmers realized, Doi Noi weir is very useful for fish cage farming and other agricultural production. Plentiful water resources in this village can perfectly serve the production. According to the capacity of Doi Noi weir with lower variable cost at that time, fish cage production, in the first several years, made fine revenue for farmers and provided better economic status in only a short period. Under contractual relations that needed massive financial capital to start, borrowing money from bank for agriculture and agricultural co-operatives (BAAC) together with savings from agricultural and non-farm activities in the past were very significant and became the main burden of fish cage farmers to compensate. However, they were able to earn a lot in a few years and refund loans to the bank. Later, Doi Noi weir was destroyed by two floods in 2005 and 2011. Unfortunately, the massive flood in 2011 destroyed most of concrete structures at Doi Noi weir and made the weir incapable of storing water resources for fish cage production and agricultural activities. As the great turning point from the weir failure, various consequences both of qualitative and quantitative aspects have been explicitly voiced from many of the fish cage farmers. Statistically, around half of them (30 farmers) stopped their fish cage farming immediately and permanently and turned back to previous jobs. Although some farmers have still operated their production, they have to reduce cage numbers to avoid production failure and the imbalance of revenue and expense.

2.5.2 Midstream Section

The fourth part of the Ping river basin covers an area of approximately 3,011.60 square kilometers or 1,882,250 rai (8.72 percent of Ping river basin area) in some parts of Kamphaeng Phet, Lamphun, Lampang, and Tak provinces including Wang Chao district (HAI, 2012). It consists of three fish-cage-farming villages alongside the Ping River. However, Pradang village in Wang Chao district, Tak province has been chosen. Pradang village has a cultivation area of at least 3,000 rai for agricultural production. This village is around 22 kilometers from Tak taking approximately 20 minutes

travelling to the city (Community Department Development, 2011). The absolute location of Pradang village is at 16 degrees 44 minutes 49.4052 seconds latitude and 99 degrees 13 minutes 3.4134 seconds longitude. It is bordered by Nong Bua Tai sub-district, Muang Tak district to the north, Chiang Thong sub-district to the south, the Ping River and Wang Hin sub-district, Muang Tak district to the east, and Na Boat sub-district to the west. The important dam and irrigation system is Bhumibol Dam to the north which are around 80 kilometers from the village.

Pradang village is located in Pradang sub-district, Wang Chao district, Tak province. This village was established and settled down at least a century ago near the Ping River. The village name is derived from the natural gully which means “surging” because the strong overflow in this gully in monsoon season flows directly into the Ping River to the mountain opposite the village with massive forces impacting many ships travelling to Tak, Kamphaeng Phet, and Nakorn Sawan which have to anchor at the village to avoid the danger. Later, the village name was distorted to the current name (Community Department Development, 2011). Formerly, a deciduous forest covered all areas including the village and a logging concession was given to many villages and investors to utilize forest production to cut timber, and build boats and wood furniture as a major occupation. According to the physical terrain of this village which has limited plain areas, most of villagers hold small land plots and practice subsistence agriculture as a minor activity to subsidize daily living and food security. After the logging concession tended to decrease thanks to degraded forests and restrictions from the government for at least 25 years, crop plantations (maize, cassava), lemon and longan orchards, and rice cultivation had been promoted. Some people, by the way, decided to move outside the intra-village to the overseas level to find job opportunities and income abroad because of having less farming skills. There, significantly, are only a few employed villagers doing wood furniture production or carpentry now in this village following the extreme limitation of tree resources in surrounding areas.

Pradang village is the newest village compared to all of the other research sites which had started fish cage farming for four to five years ago from the establishment of local SML group funded by the community and village development project to advocate local

business operations and rural development. The representative of Tak Provincial Administrative Organization (PAO) who is a villager living in Pradang village is a significant actor in coordinating the budget. Most of villagers decided to start fish cage farming by using the financial sharing system. Villagers who have responsibilities for fish cage farming have to share finances, take care of the fish following the schedule, and earn excess profit after selling the fish to the company. This fish cage farming group is seen as a preliminary school or learning center for fish cage farmers in the first and the next generations to gain collective knowledge, techniques, and learning systems. Later, some farmers in the first generation have begun individual household farming after the group was started two to three years ago because of the individual will to earn self-income and some internal conflict issues which occurred in the group. Two fish cage farming groups, however, have been established in recent years by both the PAO and another financial source (from the Ministry of Social Development and Human Security). Nowadays, there are three fish cage farming groups in Pradang village with around 15 participants who share in the production. Profit sharing of the fish farming group in Pradang village, essentially, is quite different from the operation in Ban Koh village. Rights to earn excess profit from the production are reserved for only whoever assumes the responsibility to feed fish.

Fish cage farming in the individual household has increased steadily since many farmers in the first generation were successful and earned a fine income from the production in the early stage. Notwithstanding, physical terrain and community settlement are vital factors controlling the expansion of intensive fish farming in the village. According to the situations, there are around 20 fish cage farmers with different sizes of production classified by cage numbers. Most farmers in the village tend to exchange workforce, machines, and feeding techniques to improve the production system. Following the collective experiences from doing fish cage farming in the group from a previous duration, most farmers have a similar fundamental information and knowledge base to operate the farm. Contractual relations in fish cage farming, to identify, play an absolute role to control production factors, demand-supply relationship in the market sphere, and knowledge exchange between the farmers and fish companies.

Nonetheless, state authorities have less participation but have attempted to establish a new relationship in fish cage farming in this village.

2.5.3 Downstream Section

The lower part of the Ping river basin covers an area of approximately 2,949.12 square kilometers or 1,843,199 rai (8.54 percent of Ping river basin area) in some parts of Kamphaeng Phet and Nakorn Sawan provinces including Muang Kamphaeng Phet district (HAII, 2012). It consists of at least two fish-cage-farming villages alongside the Ping River in Kampheang Phet province. However, Ban Mai village in Thammarong district has been selected. Thammarong sub-district covers an area of approximately 47 square kilometers (Thaitambon, 2000). This village is around 22 kilometers from Kamphaeng Phet taking approximately 30 minutes travelling to the city. The absolute location of Ban Mai village is at 16 degrees 21 minutes 26.3628 seconds latitude and 99 degrees 36 minutes 50.1222 seconds longitude. It is bordered by Trai Treung sub-district to the north, Ban Thammarong, Thammarong sub-district to the south, the Ping River and Thep Nakorn sub-district to the east, and Pak Dong sub-district to the west. The important irrigation systems are the Bhumibol Dam, Tho Thong Dang weir, and Wang Bua weir to the north.

Ban Mai village is located in Thammarong sub-district, Muang Kamphaeng Phet district, Kamphaeng Phet province. The meaning of village name (Mai) is new because this sub-district and its villages were separated from another sub-district and established in December 1993 (Thaitambon, 2000). Moreover, there are no native people here since the original duration of the village because it was covered by the forest. Since the exploration of the grandparent generation who moved from Uthai Thani, Nakhon Sawan, and other surrounding provinces to settle down in the village decades ago, the forest areas were gradually changed and prepared for cultivation at least 50 years ago. The topography of this village is quite flat with plentiful water resources, and each household has owned a quite large land plot which is farmed all year round with various kinds of plants. Rice production took the highest share in farming activities in the early 26th Buddhist century and has become more intensive now having two to three crops per year. Afterwards, sugar cane plantations were developed for 40 years after the

establishment of a sugar factory in the village and eventually turned into the main cultivation of the village expanding throughout nearby communities. Cassava production is another crop plantation done by some villagers in later periods. By the way, agricultural production is still the main occupation from the past until now and is composed of both rice and crop production. Several villagers, however, were attracted to move to metropolitan areas in the previous decades for work as wage laborers in industrial sectors following the influence of industrial and urban development after launching the national economic and social development plan in Thailand.

Fish cage farming had been introduced to Ban Mai village in 2003 as individual intensive production by a fish company as well as the collaboration with the provincial fishery office. One farmer at that time had begun the operation and dispersed it to other farmers who saw the great opportunity to obtain alternative income above of crop and rice production or construction working. Afterwards, around 30 new fish cage farmers started to feed fish in the Ping River for five to six years ago by operating on the riverbank in front of their houses or public riverbank areas. The most populous feeding area in the village is located at the great river bend in the lower part of the village which has suitable physical characteristics for fish farming. At that time, all of the farmers endeavored to establish a local fish farming group to be associated with the fishery office and other state authorities in normal and crisis situations by setting one farmer as a volunteer in fish farming. Positively, the interaction among fish cage farmers to engage with state authorities was quite effective and made it convenient for all farmers when they encountered physical losses.

Unfortunately, there were several negative turning points instigated by some incidences in fish cage farming. Firstly, internal conflicts were implicitly declared for a period of time by a competitive state leading to individual conflicts since the 2011 major flood which was related to the assistance among farmers themselves. The position of headman of the fish cage farming group changed hands to a new person with less of a relationship with state authorities and among the fish farmers in other sub-groups. Secondly, riverbank erosion had a major impact because of the damages of the local infrastructure especially road and land losses from the strong water stream. Thus, local authorities

attempted to improve that riverbank by covering areas with sand to expand the land from the previous line of the riverside. This improvement caused the great river bend to disappear which had once been utilized for fish farming. Most of the fish farmers were affected by profit losses and production failure. The temporary and permanent discontinuation of at least 20 fish cage farmers in the village is now evident. Nowadays, only four fish cage farmers are left for the production. It, noticeably, can be supposed that fish cage farming in this village fell into a torpid state.

2.6 Climate Characteristics in Sub-Basin Areas

Thailand, as a part of the Southeast Asia region, has been impacted by regional climate change following long-term projection of future climate. By using the CCAM model to predict climate change in our region, the results indicated that temperatures tend to change in degrees and period of time. Days which the temperature goes over 33 degree Celsius will increase around two to three weeks per year. Cold days lower than 15 degrees Celsius, in the meantime, may be reduced vice versa. Rainfall amount, besides, may be enlarged to around 10-20 percent a year (Southeast Asia START Regional Center, 2011). Droughts, heat, and flooding, in other words, will extremely threaten people in Asia in the next decades (IPCC, 2014). It is very useful to provide basic understanding about our climate in a macro scale now. This study, anyway, is needed to gauge climate information in sub-basin areas to discern the relevance of fish cage farming in each site with micro-climate and water situations.

2.6.1 Natural Climate Patterns

Basic climatic factors for the analysis in fish cage farming are temperature and rainfall amount. In research sites, fish cage farmers in each village are confronted with different natural climate and disaster patterns in each season according to the village location. The Ping river basin is located in tropical savanna climate (Aw) and demonstrates different climate features in the three seasons. Summer usually starts from mid-February to mid-May, while winter begins around November to mid-February and is influenced by the northeast monsoon. These two seasons, generally, have lower amounts of rainfall with extraordinary (hot and cold) air temperature below the average. Those climate characteristics tend to affect to water temperature a little bit to be hotter

or colder than the normal. Water supply for fish farming, besides, may decrease especially in summer thanks to less water capital from a small amount of rainfall.

In the meantime, rainy season is the longest season in Thailand and impacted by the southwest monsoon. However, rainy season in northern Thailand has two significant peaks. The first peak, early rainy season, comes after the end of summer around mid-May to June which introduces the rainy season. Afterwards, there are approximately two months (mid-June to July) that the rainfall amount steadily drops. Water amount tends to increase during the summer and may be sufficient for fish cage farming.

The second peak/second rainy or monsoon season with the highest rainfall peak in a year starts around August to September in the Upper Northern region including the upstream areas of the watershed and from September to October in the Lower Northern region including midstream and downstream areas of the watershed. The occurrences of two rainy peaks are affected by the movement of a low-pressure monsoon trough (Intertropical Convergence Zone – ITZC) and tropical monsoon storms in the Pacific Ocean. Naturally, the highest water level usually stays at the second peak (figure 2.4 – 2.6).

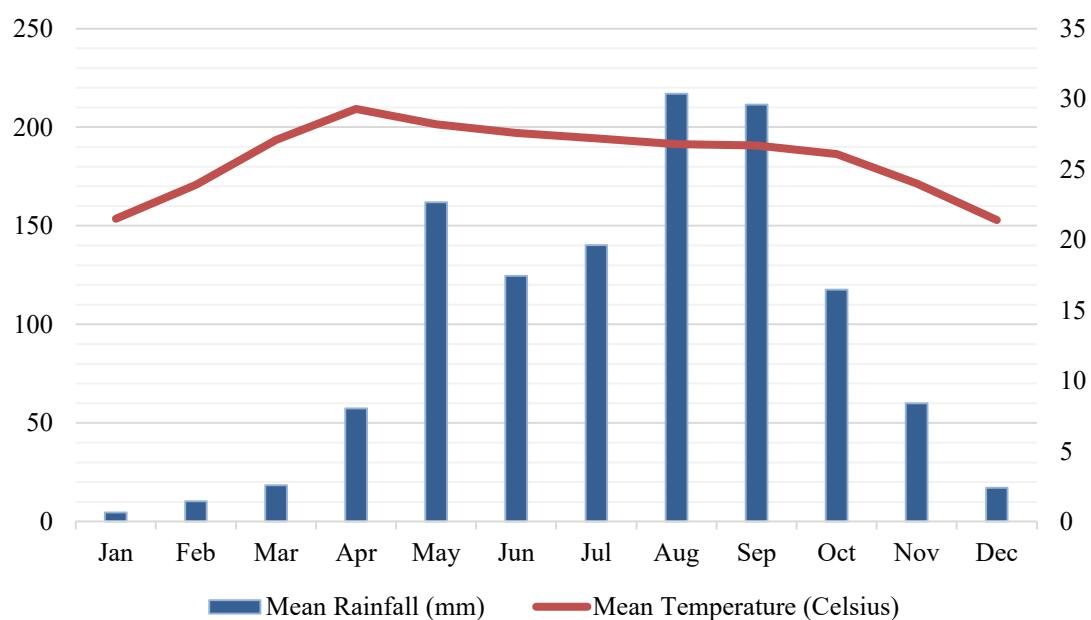


Figure 2.4 30-year period (1981-2010) climatic graph of Chiang Mai province
 (Source: modified from Thai Meteorological Department, 2010 by Santita, 2014a)

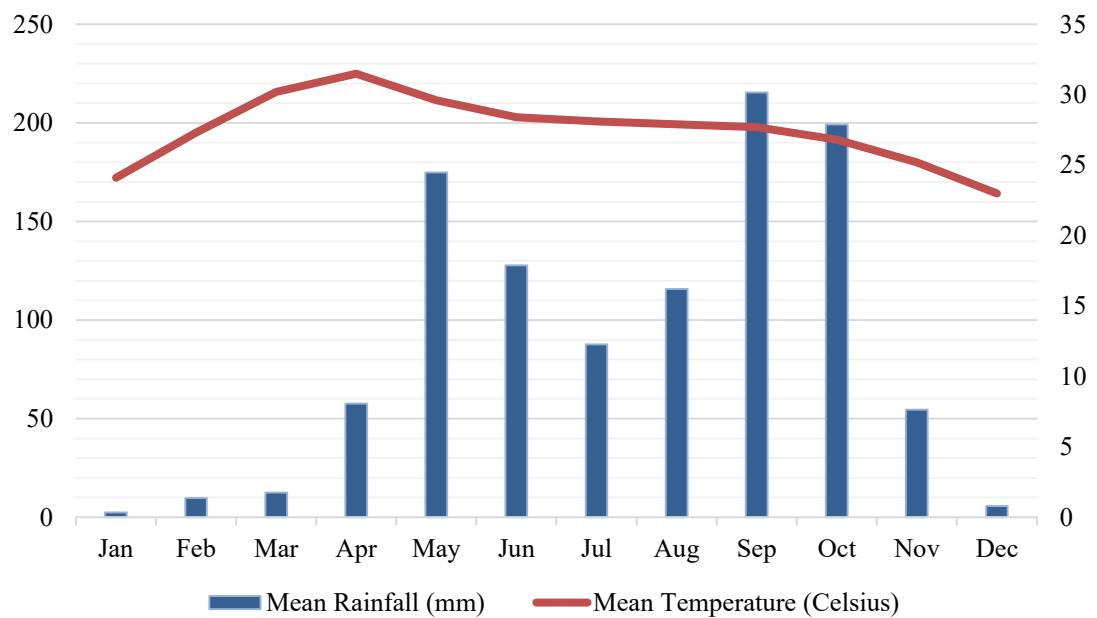


Figure 2.5 30-year period (1981-2010) climatic graph of Tak province
 (Source: modified from Thai Meteorological Department, 2010 by Santita, 2014a)

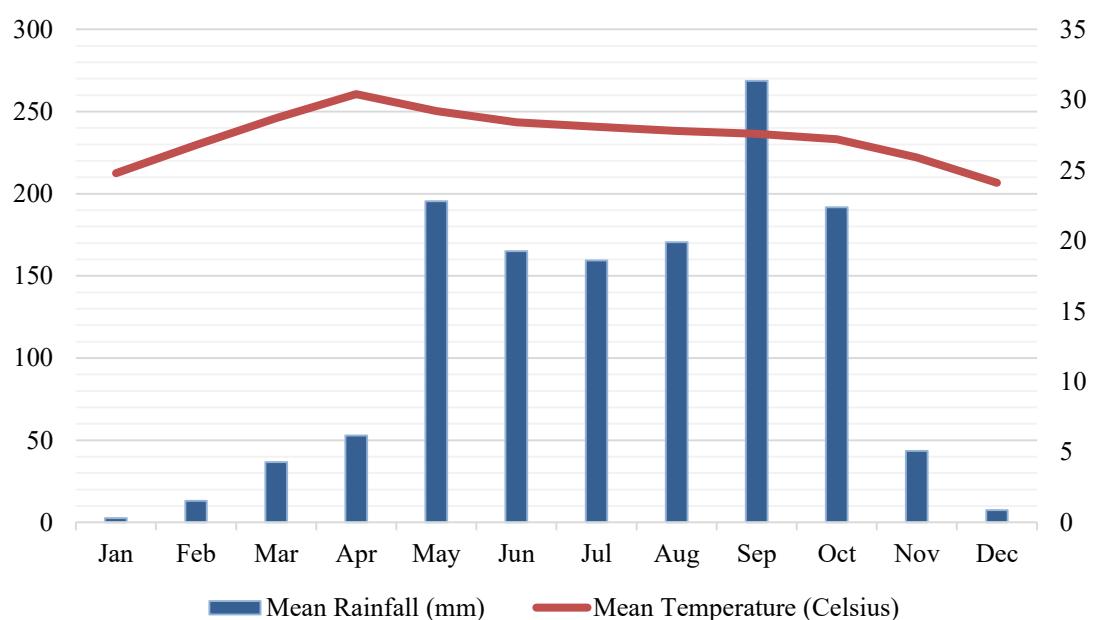


Figure 2.6 30-year period (1981-2010) climatic graph of Kamphaeng Phet province
 (Source: modified from Thai Meteorological Department, 2010 by Santita, 2014a)

Linking with disaster occurrences, droughts and floods are two major important disasters that occur in different time durations. A drought accompanied by shallowness and stagnant river water tends to emerge chiefly near the end of winter to the beginning of early rainy season (November – mid-May) and the duration between the two rainy peaks is varied by a dry spell period in each area (around late-June – July). Interestingly, drought is sometimes multiplied by extreme temperature in heat and the winter. Floods, meanwhile, together with overflow and strong current stream in the river are likely to take place in the second rainy season. Extraordinary incidences of drought and floods each year is also regionally affected by the influence of El Niño/La niña-Southern Oscillation (ENSO) in the Pacific Ocean.

The cumulative rainfall trend in the three provinces is very useful in understanding the characteristics and changes over inflow in water storage sources and atmospheric conditions. The rainfall amount has largely fluctuated through the 13-year duration following the statistics. The highest peak of rainfall amount in the research sites appeared in 2011 when one of the most massive floods with marked impacts occurred throughout Thailand. Rainfall amount in Tak and Chiang Mai was quite high in 2006 and in Kamphaeng Phet in 2008 compared to other years. The lowest peaks in the research sites, in contrast, were noticed in 2003, 2009, and 2012 (figure 2.7).

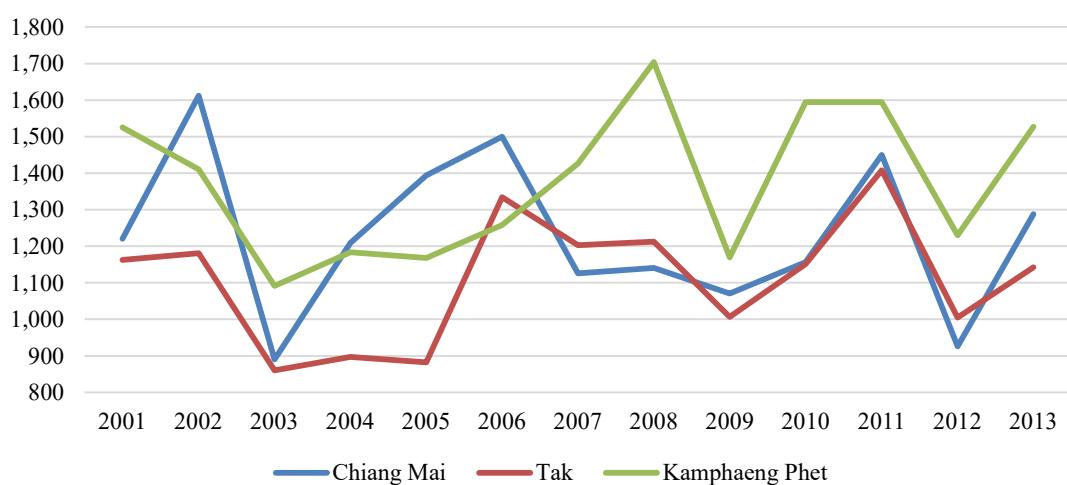


Figure 2.7 Annual rainfall in Chiang Mai, Tak, and Kamphaeng Phet province from 2001-2013 (Source: modified from Statistical Forecasting Bureau, National Statistical Office, 2014 by Santita, 2014a)

Categorizing by research sites in monthly rainfall from 2011 to early 2014, rainfall in later years has significantly been reduced and changed especially in 2012. In Chiang Mai province, early rainfall (May) was continuously lower. The first rainy peak in 2013, besides, was postponed from May to June-July. This phenomenon also led to a seasonal shift in the second rainy peak from August-September to September-October. The second peak of rainfall in Kamphaeng Phet province, however, has not changed for these years although rainfall in 2011 was quite heavier than other years (figure 2.8-2.10). Rainfall variation in those above and below-average years, to date, particularly after the 2011 massive flood has had a significant impact on water fluctuation which is linked with water storage in the major irrigation system.

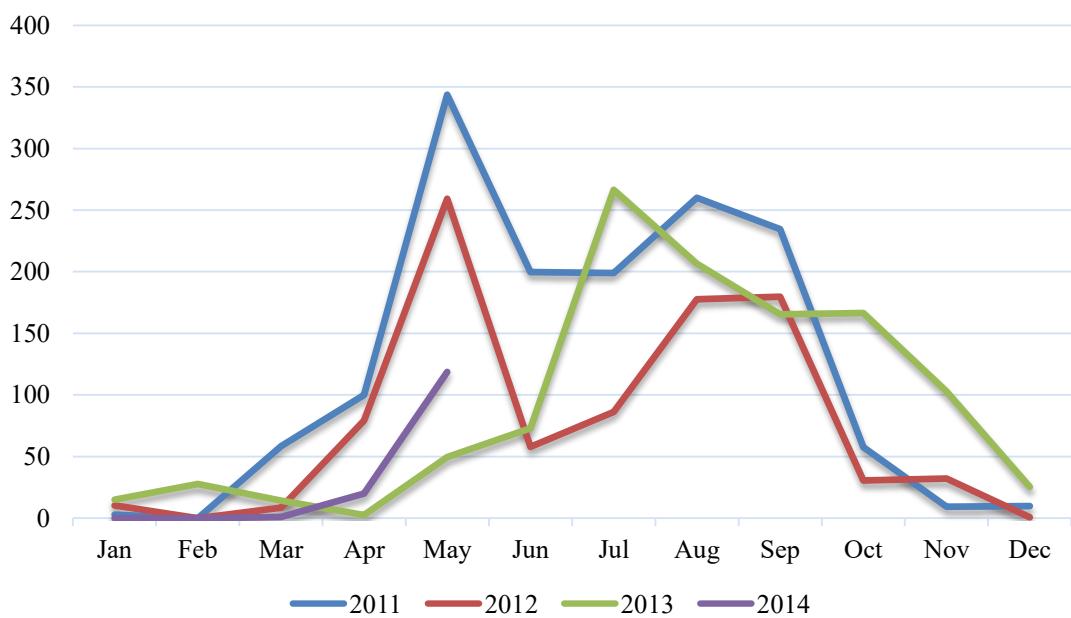


Figure 2.8 Monthly Rainfall at Irrigation Office I, Chiang Mai province from 2011-2014 (Source: modified from Hydrology and Water Management Center for Upper Northern Region, 2014 by Santita, 2014a)

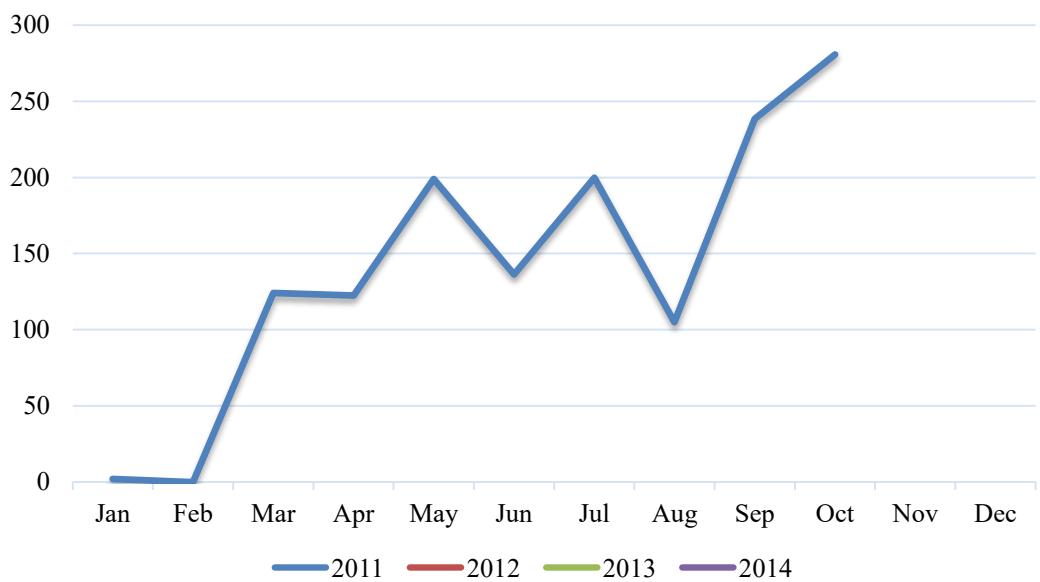


Figure 2.9 Monthly Rainfall at Tak Meteorological Station, Tak province in 2011
 (Source: modified from Office of Water Management and Hydrology, 2013
 by Santita, 2014a)

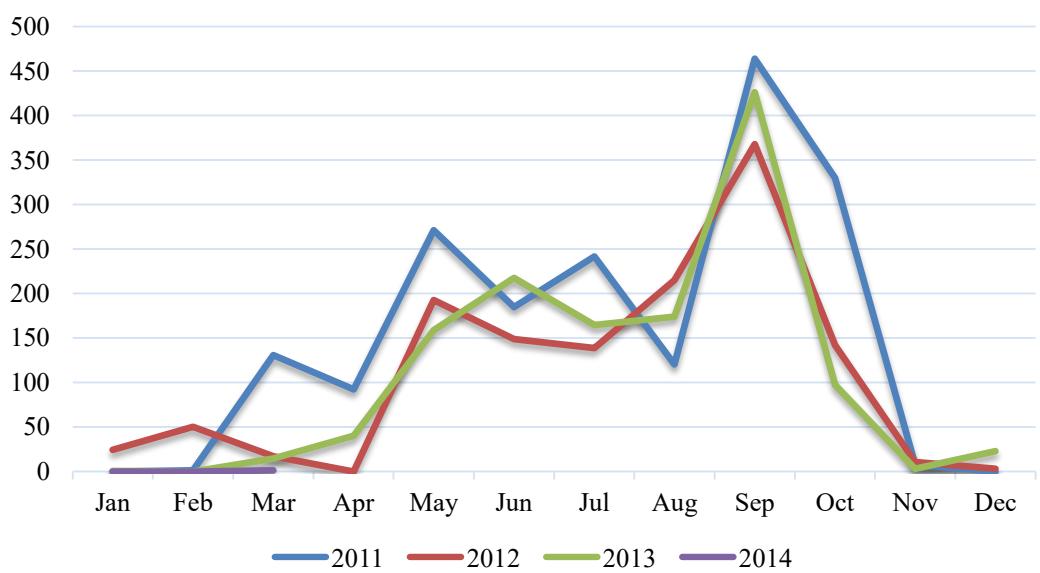


Figure 2.10 Monthly Rainfall at Wang Bua Irrigation Project, Kamphaeng Phet province from 2011-2014 (Source: modified from Hydrology and Water Management Center for Lower Northern Region, 2014 by Santita, 2014a)

Another factor is annual mean temperature at the country level. The graph below (figure 2.11) represents temperature trends since the 1950s until 2012. Annual mean temperature is likely to oscillate along years as a normal phenomenon. According to the trend line, annual mean temperature decreased respectively from 1950s to mid-1970s. Temperature, however, has increased since then until now at approximately 0.5 degrees Celsius to reach nearly 27.5 degrees Celsius. Annually, there were three major higher peaks in 1998, 2010, and 2012 which stayed above 27.5 degrees Celsius. The lower extreme peaks, in other words, tended to appear in the 1970s which remained below 26.5 degrees Celsius. To clarify in current situations, extreme heat temperatures in 2012 were closely linked with less rainfall amount in research sites as figure 2.7 informed earlier. This situation tends to create a crisis in fish cage farming both in water deficit and extreme heat temperatures for fish survival.

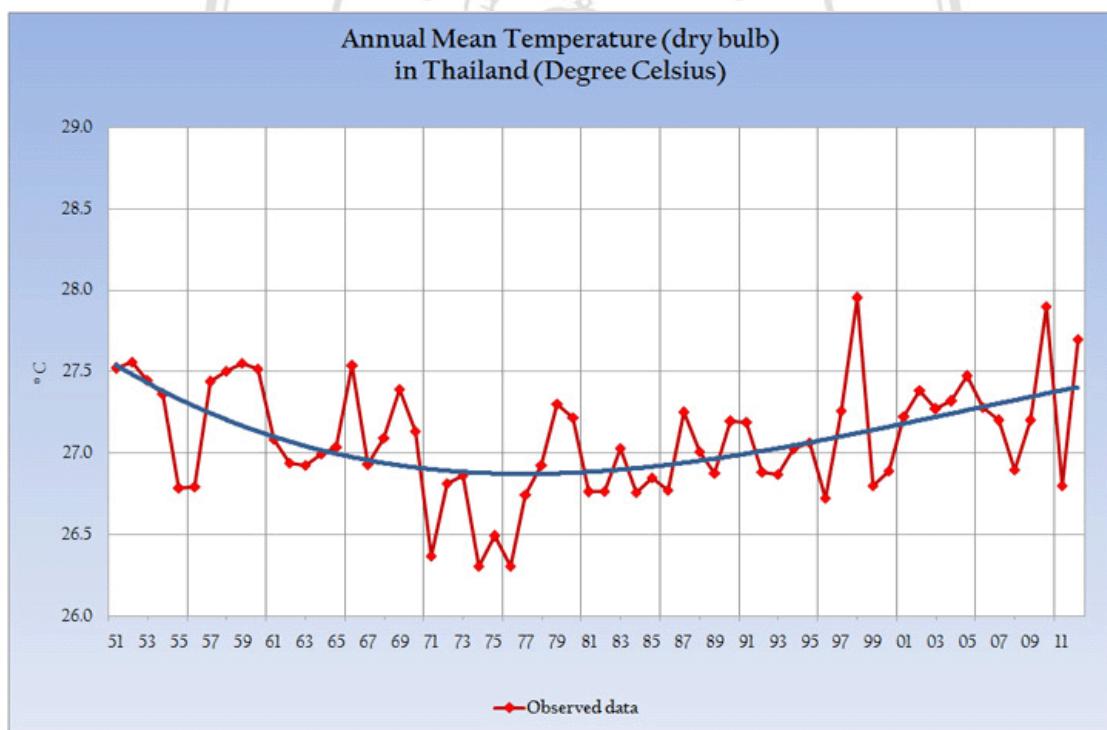


Figure 2.11 Annual mean temperature (dry bulb) in Thailand (Degree Celsius) from 1951 to 2012 (Source: Thai Meteorological Department, 2014 by Santita, 2014a)

2.6.2 Water Storage in Major Irrigation Systems

The amount of rainfall in the research sites has an obvious impact on water storage in the major irrigation systems. There are two major irrigation systems in the upstream (Mae Ngad Somboon Chol Dam) and midstream (Bhumibol Dam) areas to control water supply for multi-purpose uses in the basin scale. Inflow and water volume in Mae Ngad Somboon Chol Dam, firstly, are illustrated in annual and monthly periods. Major massive inflow rates over the average of much rainfall year (green line) were observed in 1994, 1995, 2004, 2005, and 2011. Less annual inflow years, on the contrary, appeared in 1990, 1992, 1993, 1997, 1998, 2000, 2009 and 2012 compared to less rainfall levels (red line) (figure 2.12).

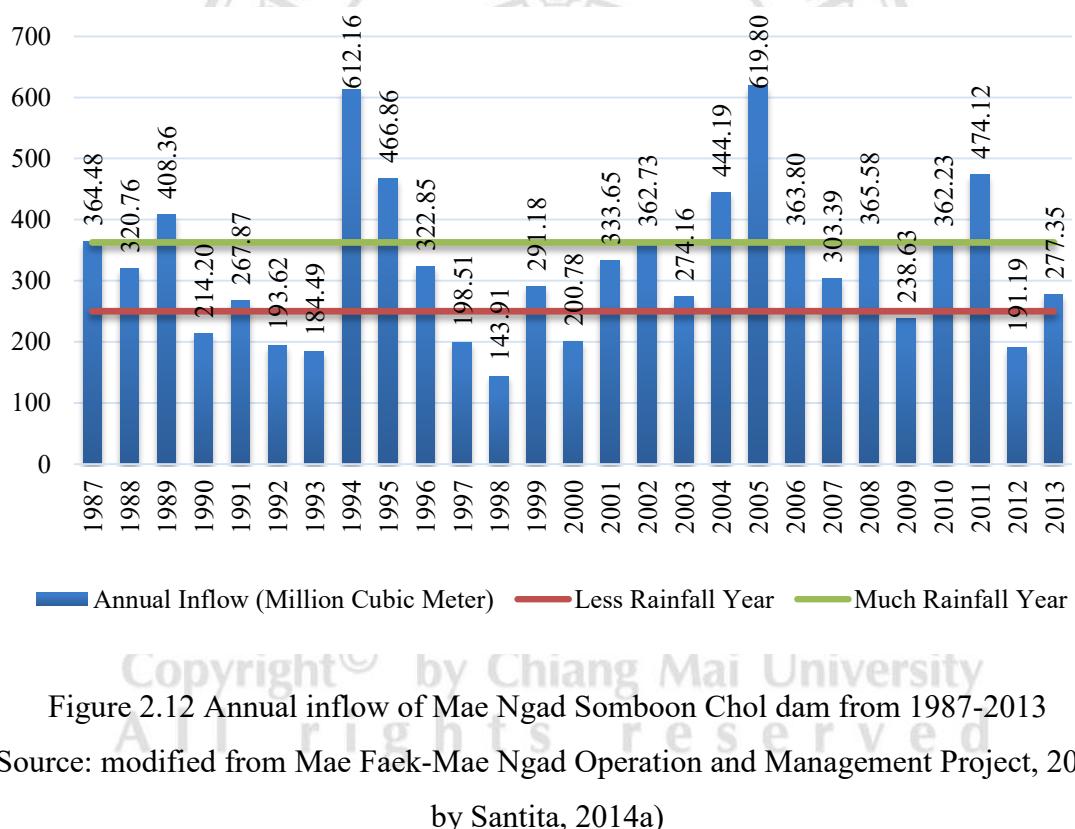


Figure 2.12 Annual inflow of Mae Ngad Somboon Chol dam from 1987-2013
 (Source: modified from Mae Faek-Mae Ngad Operation and Management Project, 2014
 by Santita, 2014a)

Although annual inflow during 2011-2013 was not the highest and lowest point in the 24-year period, water volume extremely fluctuated. Water volume in the reservoirs climbed up obviously and rapidly after the second rainy peak of 2011 from the influence of numerous monsoon storms hitting in a short duration. This excessive water level stayed over storage capacity for four months (October 2011 – January 2012).

Water supply, yet, was massively drained in mid-2012 along with less inflow thanks to a very low rainfall amount. Even though water volume slightly increased after the rainy season in 2012, it could not reach storage capacity (265 million cubic meters). This impact was also intensified particularly in the rainy season of 2013 by a decrease in the amount of rainfall compared to several years. Water storage, thus, dramatically decreased since the first month until the lowest point in August 2013 (figure 2.13). This context leads to a water crisis for agricultural uses and the production in other sectors.

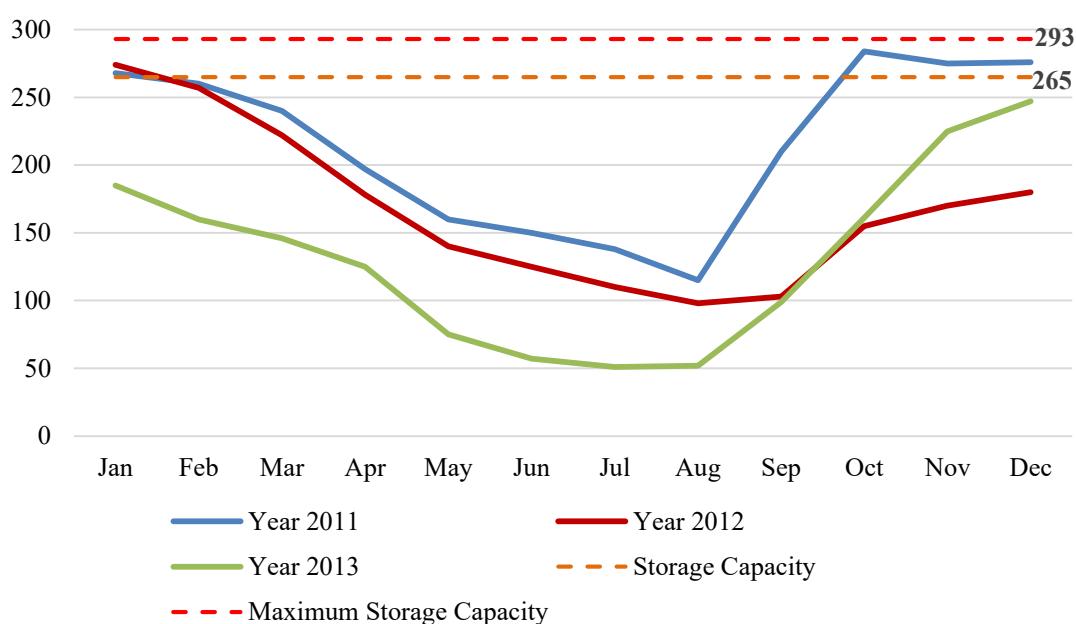


Figure 2.13 Monthly water volume in the reservoir of Mae Ngad Somboon Chol dam in 2011-2013 (million cubic meter) (Source: modified from Mae Faek-Mae Ngad Operation and Management Project, 2014 by Santita, 2014a)

Water storage in Bhumibol Dam, secondly, has been reported by the average percentage of monthly water supply for use from 2004 to early 2014. The percentage of water storage, likewise, was extremely high and nearly approached the maximum point in 2006 and 2011 particularly in the last quarter. Water, however, was drained explicitly in only five months from January to May 2012 (from 84.68 to 26.83 percent) to prevent a similar occurrence as the flooding in 2011. Water drainage in 2012 can be noticed as the highest rate in the 10-year period. Water supply in 2010 and 2013, thereby, is illustrated

as lowest water storage years compared to other years particularly in early rainy season (May to August) (figure 2.14).

Drainage and allocation plans for major irrigation systems, actually, have attempted to store water in the second rainy season and early winter by mainly relying on rainfall in order to serve all water users especially farmers in the rice production sector in summer (January and April) and the early rainy season (June-July) as this is the season having the highest need of water for plants and has the less amount of rainfall. Droughts, accordingly, can occur in a year that has a low rainfall amount in rainy season or drain too much water in low-water-use season. This incidence has been observed outstandingly since 2012 until now and has caused a lot of damage to fish cage farmers.

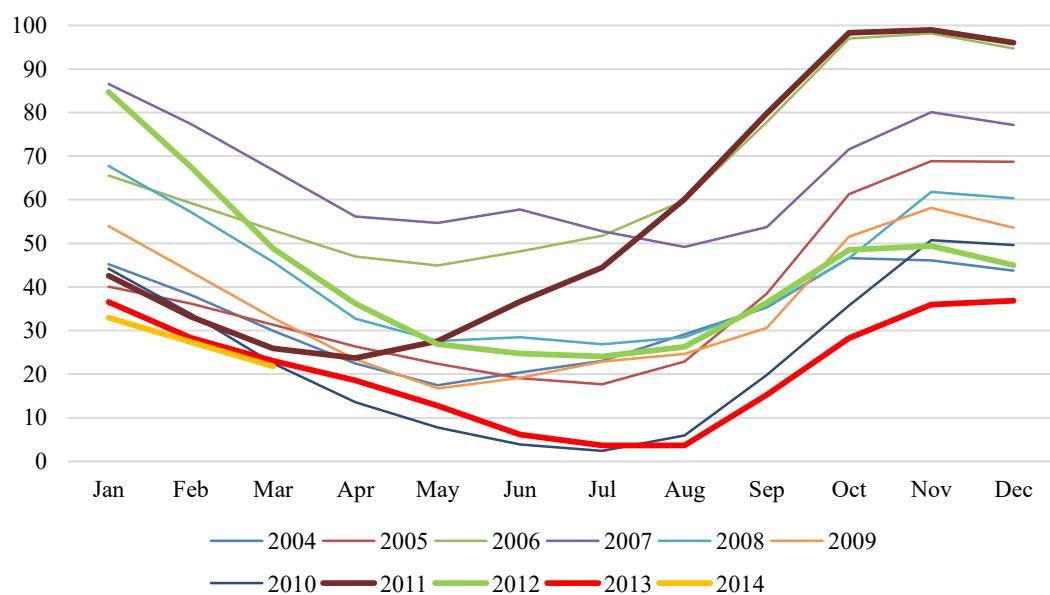


Figure 2.14 Average monthly water supply for use (percent) of Bhumibol dam from 2004 to 2014 (Source: modified from Kamphaeng Phet Irrigation Office, 2014 by Santita, 2014a)

2.6.3 Hydrological Profiles and Major Disasters

According to the information of RID (2012), physically, the floodplain areas are widespread in the basin from Chiang Mai to Nakorn Sawan provinces with the mountainous areas in the headwater. The Ping river basin has five major tributaries from various mountain ranges – Mae Ngad and Mae Tang River from the Dan Lao

range, Mae Kuang, Li, and Mae Chaem River from Thanon Thong Chai range – which meet the main stream in Chiang Mai and Lamphun provinces. The elevation in the basin is 25 – 1,300 meter above mean sea level with the difference of rive base flow slope ratio from 1:40 – 1:2,300 varying by the location. The elevation and river base flow slope ratio in the upstream, anyway, is much more than midstream and downstream.

To inform several hydrological statistics, the runoff in river water is very important to know the water volume in the river system. Runoff volume in the upstream section, generally, is likely to be high from August to October, and low from March to April. In Chiang Mai province, annual runoff for nearly a century has quite fluctuated and tended to drop below the average since the 1980s with a particularly very-low runoff in 1998–1999 being affected by the El-Nino oscillation. During the period of fish cage farming, annual runoff stayed below the average for almost 10 years particularly in 2003, 2009, 2012, and 2013 when it dropped twice. There, by contrast, were only three years – 2011, 2005, and 2006 – that annual runoff reached above the average respectively (figure 2.15). These statistics were quite relative to annual rainfall in Chiang Mai province in defined period of time which will be represented in another section.

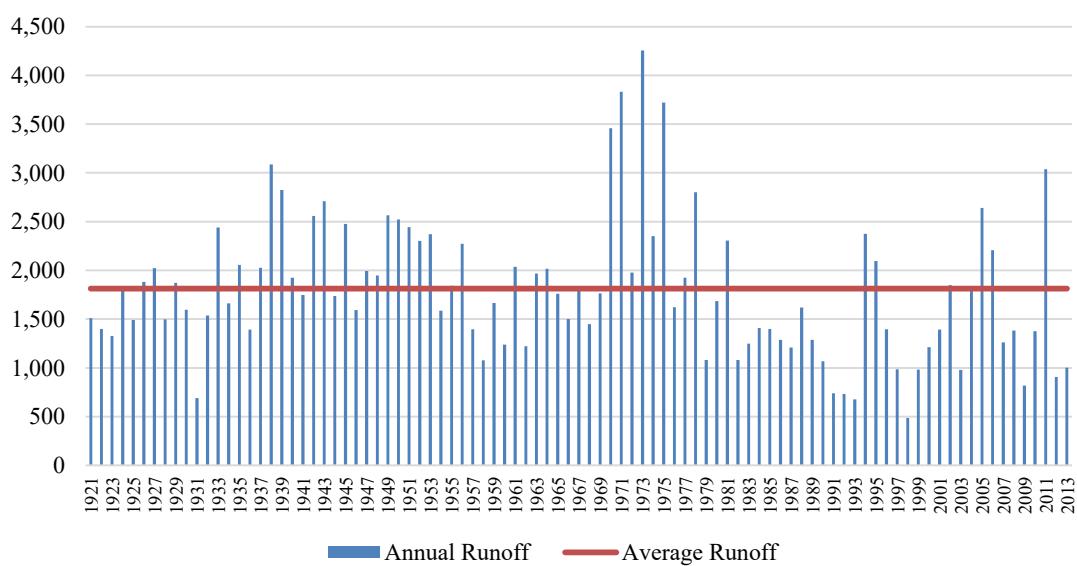


Figure 2.15 Annual and average runoff (million cubic meter) in the Ping river from 1921 to 2013 of P.1 (Nawarat Bridge) station, Chiang Mai Province
 (Source: modified from Hydrological Office I, 2014 by Santita, 2014a)

The statistics of P.2A (Tak) and P.7A (Kamphaeng Phet) station (figure 2.16-2.17) from Office of Water Management and Hydrology (2013), however, declared that there were two essential differences about runoff characteristics in midstream and downstream sections due to the irrigation plan of Bhumibol Dam as a major dam of this basin. According to cumulative runoff statistics from 2001 to 2012, runoff volume in the second rainy peak of P.7A, firstly, was higher in September and October twice than other months. Runoff volume in P.2A station, secondly, however, did not much oscillate for a year, and there were five months that the runoff volume was slightly higher than other months – September to October, and January to March. Annually, it is clear that runoff volume was significantly higher in 2006 and 2011, while it was lower in 2004 to 2005 compared to average annual runoff. These statistics also related to annual rainfall in Tak and Kampheng Phet province at that moment.

In the dimension of major disasters in the river basin, floods and droughts are the main disasters threatening many populations in facing life, asset, and non-evaluable losses related to physical and mental injuries. In regard to hydrological terrains, to start with, a flood in the basin can occur in the form of two characteristics. Firstly, a flood in the upstream manifested by tributaries is caused by heavy rainfall and flash flows from the mountainous areas as well as the lack of drainage buildings and various hedges and debris which affect the capacity of the main river to drain. The second type of flood emerges due to flat terrain and the shallowness of the main river when it decreases in the ability of drainage. Some districts in Chiang Mai, Lamphun, and Kamphaeng Phet provinces are usually impacted by floods. Around 25.89 percent of all villages are damaged by water deficit for agriculture and daily consumption. Interestingly, 1,056 villages in Chiang Mai province have experienced impacts of drought.

In conclusion, natural climate, water storage, and hydrological profile can obviously point out crisis's encountering fish cage farming in recent years. It is very noticeable that there were two years that extreme climate-related situations may have impacted fish cage farming. Extreme rainfall amount, water storage, and runoff in 2011, firstly, were connected with the 2011 major flood that occurred in Thailand. The severe shortage of water storage and rainfall, below-average runoff in the river system, and extreme heat

temperatures in 2012, on the contrary, precipitated an extreme drought at that time. Many consequences after these two years are very important to investigate.

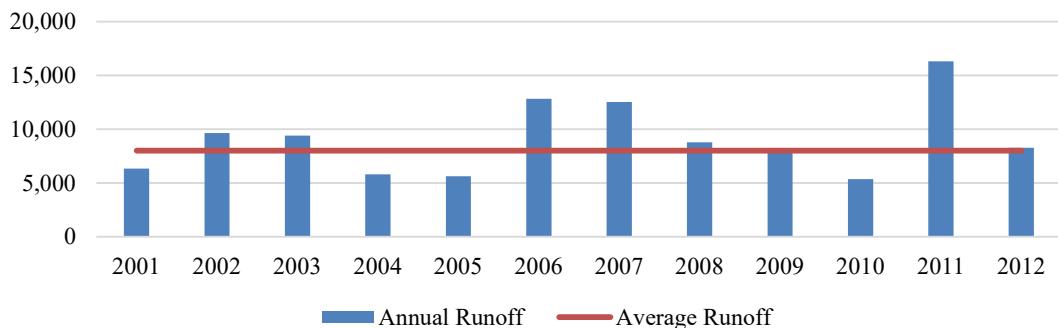


Figure 2.16 Annual and average runoff (million cubic meters) in the Ping river from 2001 to 2012 of P.2A (Ban Chiang Ngeon) station, Tak Province
 (Source: modified from Office of Water Management and Hydrology, 2013
 by Santita, 2014a)

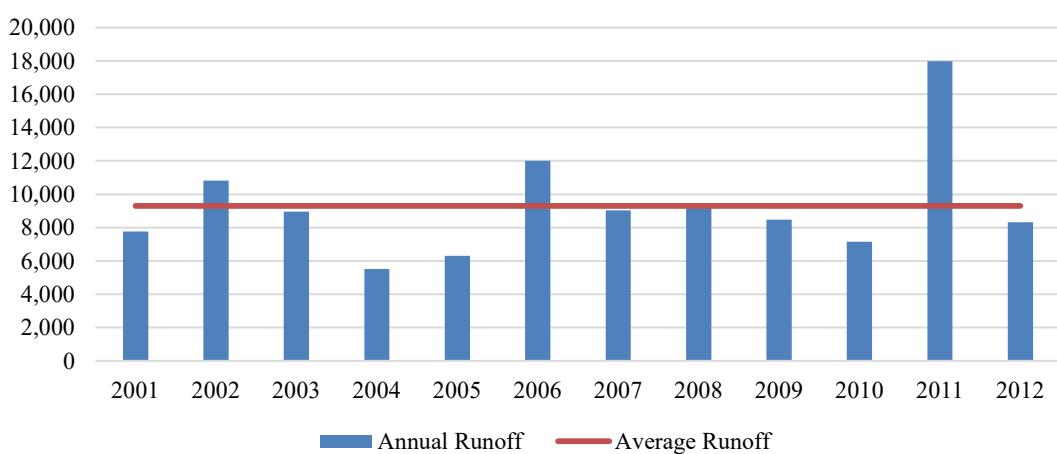


Figure 2.17 Annual and average runoff (million cubic meters) in the Ping river from 2001 to 2012 of P.2A (Ban Huai Yang) station, Kamphaeng Phet Province
 (Source: modified from Office of Water Management and Hydrology, 2013
 by Santita, 2014a)

2.7 Demographic Structure

According to the statistics in 2013, each research site has a male, female, and total population as represented in table 2.1. One can notice that all research sites have more females than males respectively. Classified by age group in population pyramids, the

middle-aged population from 35-54 years old is the major group in all research sites especially females. In the meantime, there is less of a population of elderly considered 65-69 years or older. Upstream villages, however, significantly have a lot of late-middle aged (45-59 years old) with less younger population (0-14 years old), while middle-aged population (30-44 years old) can be found in midstream and downstream villages rather than upstream villages.

Table 2.1 Population in research sites by sex

Population Site	Male	Female	Total
Ban Koh	271	293	564
Hua Kuang	367	401	768
Pradang	510	565	1,075
Ban Mai	353	382	735

The demographic structures in the village level portray a workforce that tends to be more elderly than the past along with the fact that fewer numbers of the offspring generation will grow up finding income in the future particularly in Northern Thai villages. The number of early elderly population (60-64 years old), besides, is likely to be enlarged as it forces them to participate more in production systems. Although the burdens of offspring and elderly are not much observed if they are calculated by the number of those people, aging workforces are not necessarily eligible to work in various production especially industrial and service sectors to gain additional income as these required a younger generation to perform these tasks. Thanks to the present process of development affecting rural perspectives, consequently, each household wants to enhance the life quality of their offspring by using more money and assets to improve their foundation in education as to access better social and economic status in the future. It, however, is still skeptical whether or not in situ intensive production like fish cage farming and other self-employed production are significantly begun by the combination of demographic and socio-economic reasons (figure 2.18-2.21).

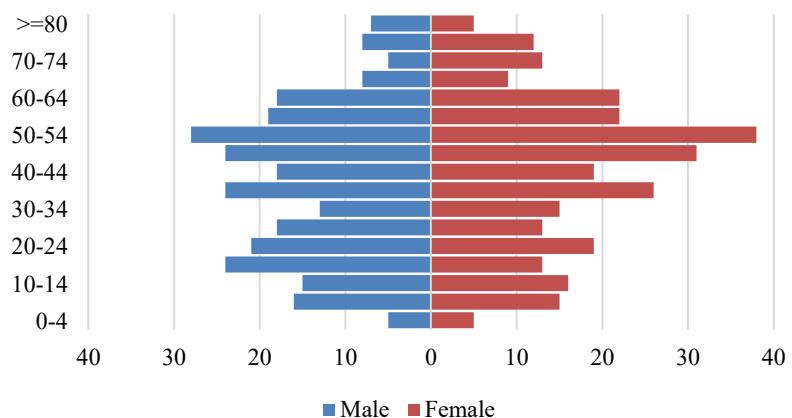


Figure 2.18 Population pyramid of Ban Koh village in 2013 (Source: modified from Nong Tong Pattana Municipality, 2013 by Santita, 2014a)

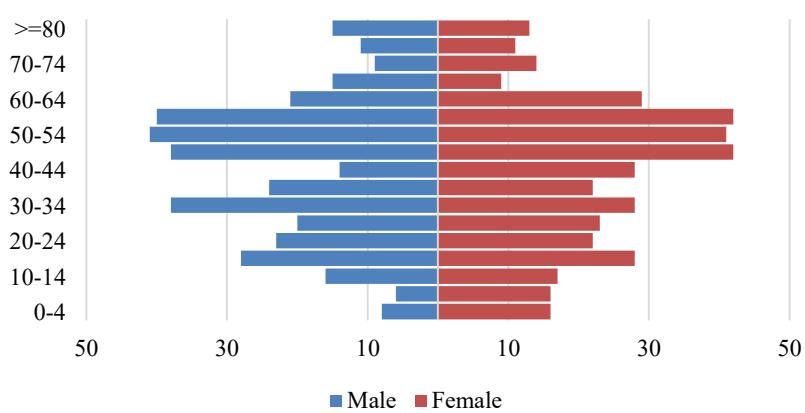


Figure 2.19 Population pyramid of Hua Kuang village in 2013
(Source: modified from Doi Lor District Office, 2013 by Santita, 2014a)

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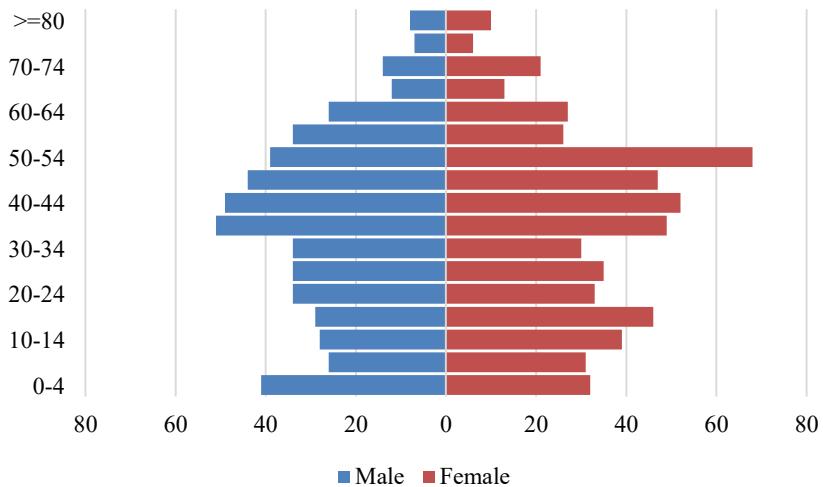


Figure 2.20 Population pyramid of Pradang village in 2013 (Source: modified from Wang Chao District Office, 2013 by Santita, 2014a)

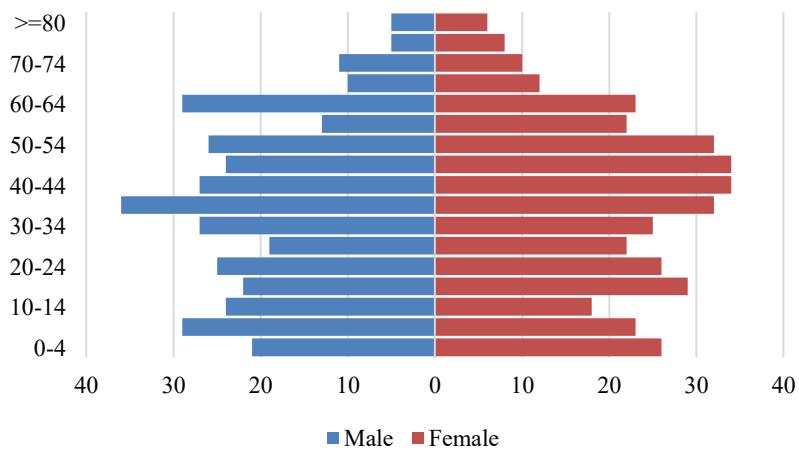


Figure 2.21 Population pyramid of Ban Mai village in 2013 (Source: applied Muang Kampheng Phet District Office, 2013 by Santita, 2014a)

2.8 Conclusion

In fish cage farming, there are many suitable requirements in climate-related and socio-economic functions that fish cage farming households have to be concerned about when operating an intensive production system which requires massive money and production capitals. Stabilities in artificial ecosystems related to climate and non-climate effects are

important to control fish produce and demand-supply equilibrium of the market. Fish cage farmers, however, do not stand alone, but as they also have to participate in both active and passive features related to private and public stakeholders, as well as cope with natural-physical actions which foster or obstruct fish cage farming according to different time and space variables.

Following general contexts in research sites in the most recent decade, tilapia cage aquaculture tends to be more popular among aquaculturalists although the proportion of cage farming is very little compared to other aquaculture systems especially the pond rearing system. The outstanding point of cage aquaculture is that it can reproduce a massive amount of production per area. There, however, are several remarks that may have caused risks in fish cage farming and their livelihood in recent years. Production amount of tilapia cage production, firstly, was likely to drop slightly. Extreme climate variability from natural and anthropogenic actions in last five years, secondly, has begun and been observed as damaging the fish cage farming opportunities. Changes in internal relationships in economic production structures from rural changes and economic development for decades, thirdly, tended to demonstrate some challenges to rural villagers in adjusting to a financial-based society. Demographic restructuring particularly with labor deficit and the aging society, lastly, tend to be occurring steadily parallel with rural changes in the past and is represented already at the current time.

Those factors, ultimately, may be induce risks and vulnerability to fish cage farming households, as well as the way they have adapted to those influences by mobility that is related to socio-economic changes mentioned earlier. Forthcoming chapters about risks, vulnerability, and mobility as an adaptation will be analyzed and answered and also whether or not those issues are associated with the general contexts of the research sites.

CHAPTER 3

Multiple Risks in Fish Cage Farming

Fish cage farming is an intensive agri-business/aquaculture which has been popular in many regions of Thailand since the last two decades and has created the highest productivity per area compared to other freshwater aquaculture types. Definitely, demand-supply relationship in market spheres from various stakeholders including individual consumers, food enterprises, and department stores, as well as state advocacy in the production system influences the red tilapia cage aquaculture sector to provide sufficient amounts of production in different time durations. In Northern Thailand, fish cage farming is significantly involved in the red tilapia market both within and outside the region. As fish cage farming is operated in river water, climate-related factors also play a great role in the stability of the production. Household as a production unit, however, is unable to control all of the variability affected by physical climate and socio-economic externalities although some factors from internal causes can be partly managed. This chapter, thus, tries to exemplify the interactions of climate-related and socio-economic issues as multiple risks negatively affecting fish cage farming as illustrated in production damages and failures.

The above two multiple risks are classified by categories and risks are also divided into two patterns recognized by scales of occurrence. The main focus of climate-related risks, firstly, is on the river and surrounding environments which can impact directly the fish and its production survival. External climate-related risks refer to climate-related negative disturbances occurred by the engagement of physical management from natural and anthropogenic actions from national policies, sub-basin actions, and local micro-climate system. External climate-related risks are considered by the effects in a village level related to natural climate and disaster patterns, irrigation systems, and flood prevention policy. In the meantime, each household also has internal risks from the exposure of cage location thanks to distinctive physical terrains of river and adjacent

areas which can intensify or reduce climate-related external risks from the outside compared to other fish cage farmers in the village. Those climate-related risks are represented and evaluated at each household from field observation and climate-related history from respondents by including water depth/shallowness, current flow/velocity, air-water temperature, turbidity, sediments contamination, debris, and other contaminations from toxic substances.

The socio-economic risks issue is another topic to understand as fish cage farming is involved with the market economy. Socio-economic external risks, to identify, also come from the collaboration of national, regional, and local actions from either private or public sectors including demand-supply and price fluctuation in market spheres, state authority's participation, and internal relations and management. The contractual relations system, besides, is a very critical issue in modern intensive aquaculture system provided by fish companies. Because fish cage farmers have full rights to decide to subordinate to various fish companies, contractual relations become a great exposure to manipulate or decline socio-economic external risks of fish cage farmers and deviate risks in different levels.

Table 3.1 Factors of the analysis in climate-related and socio-economic risks

Category Scale	Climate-Related Risks	Socio-Economic Risks
External hazards	1) Natural climate and disaster patterns 2) Irrigation systems 3) Flood prevention policy	1) Demand-supply and price fluctuation in market spheres 2) Participation of state authorities 3) Internal relations and management
Household internal exposures	Cage location	Contractual relations system

3.1 External Hazards of Climate Related-Risks

3.1.1 Natural Climate and Disaster Patterns

Following the information from 2013-2014, there are three natural hazards and disaster patterns affecting losses in fish cage farming. The most significant consequence in all research sites is drought and hot temperatures. Other hazards impacting on fish cage farming are cool/cold temperatures and overflow with heavy rainfall in the monsoon/second rainy season.

The first and the most severe external climate-related risk occurred in all research sites is drought and hot temperature. Less and late rainfall, with higher temperatures above average have an impact on fish cage farming. According to the statistics from Thai Meteorological Department (2014), the rainfall amount in summer and first peak of rainy season (March – May 2013) was below the average especially in March and May (-41 and -23 mm), while eight months of the year were above the average (figure 3.1). Mean temperature in most of the year including summer illustrated an above average of approximately of 0.2-0.9 degrees Celsius (figure 3.2).

It can be primarily assumed that drought and hot weather from natural weather in 2013 may be somewhat intensified. These statistics, likewise, also accord to fish cage farmers' perception and real situations about a lesser rainfall amount when it is late in early rainy season in all research sites compared to previous years. Dry spells can be also observed by farmers in hot and early rainy season. Those consequences affect hotter water temperature in the summer and early rainy season. Especially, fish cage farmers in Hua Kuang village and Ban Mai village who faced extreme hot temperatures particularly in 2013 accompanied by a severe drought and less rainfall amount compared to all previous years since they had started fish farming.

“Climate is unusual. Rain tended to disappear in this early rainy season and it is very dry. If there had been any rain in early rainy season, it would have come continually since last month (May)” (a medium-scale farmer in Hua Kuang village, 6 June 2013).

“Water was very hot when I dipped my hand into it. Last period (around some months ago) there was more drought than the present because water just came in recent 2-3 days” (a medium-scale farmer in Hua Kuang village, 8 June 2013).

“Rain came quite late and it was a drought this year. Actually, rain has come before April. Unlike this year, heat, drought, death, and so on... did you believe it? River water level is only up to my elbow when I dipped my arm into the river. When I saw it, I would like to be dizzy” (a large-scale farmer in Ban Mai village, 12 July 2013).

“It is the hottest year compared to all previous years. In last April, it was less hot than now (May). Rain did not come also, just only one time after Songkran (mid-April) but not heavy. It had just wind, not rain” (a small-scale farmer in Ban Mai village, 2 May 2013).

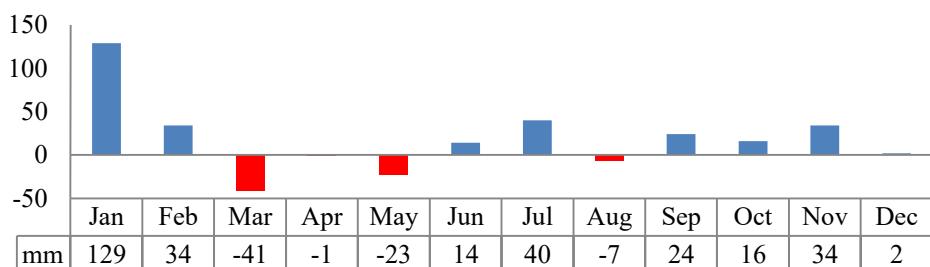


Figure 3.1 Monthly differences of rainfall amount in 2013 compared to 30-year period
 (Source: Thai Meteorological Department, 2014 by Santita, 2014a)

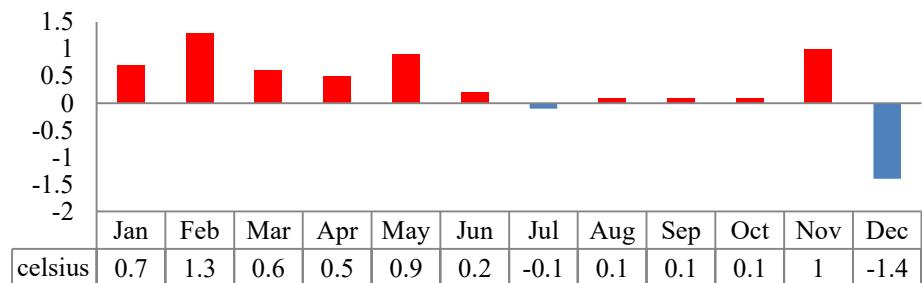


Figure 3.2 Monthly differences of mean temperature in 2013 compared to 30-year period (Source: Thai Meteorological Department, 2014 by Santita, 2014a)



Figure 3.3 Water level in dry season in Hua Kuang village

Besides the problem of drought, the mean temperature in December 2013 had importantly dropped approximately 1.4 degrees Celsius (figure 3.2). Cooler temperature below mean temperature in December 2013 and January 2014 (table 3.2) is an obvious index of extreme cool/cold temperatures in winter 2013-2014. In winter, all farmers were affected by the above-mean cool temperatures. Fish cage farmers considered that river water was cooler than a normal threshold that fish could intake feed. Thus, fish in that crop could not grow up rather well. Farmers in upstream areas, anyway, were impacted by extreme cold temperatures compared to previous years which caused many striking drawbacks to fish farming. Infection, parasites, disease, and fish death from cooler water temperature, besides, were widely found in many farms.

“Hundreds of fish died before New Year. Around 20-30 dead fish were found per day. It’s quite cold. Fish body was fluffy as a sponge covering its body” (a large-scale farmer in Ban Koh village, 8 January 2014).

“Fish in the winter tended to die continually. It would be puffy and some had red fleas and monogenea might attach to its body. Fish will die massively if those parasites adhere. Diseases and slow growth, besides, were seen in this season because fish eat less feed than other seasons” (a medium-scale farmer in Hua Kuang village, 9 January 2014).

“Cool temperature is partly engaged to fish disease. Fish cannot eat well sometimes” (a large-scale farmer in Ban Mai village, 17 January 2014).

“I observed my fish in the winter. They seemed to be ill when its fin was cleaved and its body was red. This winter is cold and longer than before. I thought, however, I can ordinarily pass this winter” (a medium-scale farmer in Pradang village, 4 February 2014).

Table 3.2 Differences of mean temperature (degree Celsius) in December 2013 and January 2014 compared to 30-year period mean temperature

Province \ Temperature	Mean Temperature in December	December 2013	Mean Temperature in January	January 2014
Chiang Mai	21.4	21.0	21.5	21.3
Tak	23.0	21.2	24.1	21.9
Kamphaeng Phet	24.1	22.0	24.8	22.5

Source: Thai Meteorological Department (2014)

Extreme temperature of both hot and cool/cold tended to have an impact on unstable water temperatures for fish survival leading to massive fish disease and deaths. However, temperature consequences do not occur by the interaction of air and water temperature as such. Water amount in the river is another essential factor to control water temperature. This problem was likely to have decreased in the winter of 2013-2014 compared to the summers because of more water depth and flow from sufficient water supply which will be explained in anthropogenic climate-related actions later.

Overflow and heavy rainfall, thirdly, are regular natural phenomena in the second rainy peak (monsoon). This occurs around August to September in upstream villages and

around September to October in midstream and downstream areas. Strong water current, massive water, debris, turbidity, and toxic/chemical contamination were usually discovered in overflow rather than other seasons. How strong of an overflow in each area is also accompanied by river channel characteristics and irrigation control in manipulating water current velocity. When stronger water current is observed, the more debris and turbidity appear. Heavy rainfall, in addition, leads to soil erosion and chemical contamination from agricultural and urban toxics into the river water.

All research sites were also damaged by normal overflow in the second rainy season causing fish disease, death, and killing by various reasons. A stronger current compared to other seasons could be distinguished especially in Ban Koh village (figure 3.4) which has a narrow river channel leading to massive fish deaths in mid-August and also flooded some cages in Hua Kuang village away from the location. Debris and rubbish from overflow also crashed into fish cages in Ban Mai village and thousands of fish died twice, in mid-September and early November. Changes of water color, turbidity, and water toxic were found in Pradang village. Fish cage farmers, generally, in all areas usually are aware of strong water current and chemical contamination from crop plantations and urban areas in the headwater of the canal and the northward areas of the basin. They declared that fish would not grow well because fish cannot intake feed well and this will lead to illness or death from toxins. Massive turbidity (soil sediments) dissolved in river water, moreover, also affected sudden fish death from gill clogging. This effect could be observed easily by the water color. Effects from overflow had been significantly multiplied by the drought in a previous duration which was related to irrigation management as well.

“Overflow and red water did not come last year because it lacked water after Nok Ten in 2011. I confronted fish death in this monsoon season and it has begun since yesterday. Oh! Around 1,000-2,000 fish died today” (a medium-scale farmer in Ban Koh village, 13 August 2013).

“Overflow came two times – September and November. In the last round there was not as much damaged as the first time because most fish died and I could not catch them in time. I lost hundreds of thousands of baht. Some

fish were rotten but some fish were fresh enough for sale" (a medium-scale farmer in Ban Mai village, 18 January 2014).



Figure 3.4 Turbidity and fish death in overflow season in Ban Koh village

“Water was now opaque in overflow season which started around early September and intensified in October... A lot of the crop field appears in the headwater and Pak Wang (the convergent point of Wang and Ping River). This turbid water with red or black and mud came from the canal to the river. Likewise, fish cannot eat well. Some wounds were found on its body as well” (a medium-scale farmer in Pradang village, 7 October 2013).

According to the three major negative consequences found in all seasons, each village had been affected by those disasters differently (table 3.3). Drought and hot temperature was examined in Hua Kuang village and Ban Mai village. Upstream villages encountered colder air and water temperatures than midstream and downstream areas. Massive effects from overflow illustrated by the number of fish deaths occurred in Ban Koh village and Ban Mai village. However, those natural climate risks did not singularly damage fish cage farmers. Anthropogenic climate actions, to date, were important issues to encourage more severity of climate-related risks in recent years.

3.1.2 Flood Prevention Policies

In 2011, the massive flood has had a great impact throughout Thailand in a 70-year period from five major tropical monsoon storms especially Nok Ten including the Northern Region which received 142 percent of extraordinary rainfall amount above mean annual rainfall during a 30-year period. This massive flood has influenced the collapse of Thai macro-economy and industrial sectors since October 2011 until now (Bank of Thailand, 2011). Yingluck Shinawatra’s government, following the situation, endeavored to resolve all flood-related consequences by transforming the administration and management system of significant irrigation systems particularly dams throughout Thailand to abide under the authority of Office of the National Water and Flood Management Policy.

After this organization was established in February 2012, water drainage decisions during flood-risks period (around the second peak of rainy season) of major dams in the Ping river basin including Mae Ngad Somboon Chol and Bhumibol dam have been entirely controlled. Also, there are significant changes in excessive water drainage after mid-2012 leading to a crucial state of water storage since the fourth quarter of 2012 to

2013 compared to previous years. This problem had also been fostered by less rainfall in first half of 2013.

Table 3.3 Natural-induced actions and climate-related characteristics by seasons following the perception of farmers

Sites/Season	Summer 2013 and 2014	Early Rainy 2013	Second Rainy 2013	Winter 2013-2014
Ban Koh	Slight drought, hot temperatures, less rainfall	Less rainfall with late rainy season	Immediate and strong overflow, turbidity	Colder than previous years
Hua Kuang	Less rainfall, drought, very hot temperatures	Less rainfall with late rainy season	Some overflows with debris	Colder than previous years
Pradang	Less rainfall, hot temperatures	Less rainfall	Some overflows, turbidity and debris	Cooler than previous years
Ban Mai	Drought, very hot temperatures, less rainfall	Less rainfall	Two strong overflows, turbidity, and debris	Cooler than previous years

In the local level, two villages – Hua Kuang and Ban Mai villages – were impacted by riverbank improvement as a consequence from the massive flood in 2011. Local organizations in each area tried to stop the erosion of riverbanks by constructing new embankments. However, riverbank improvements in the two villages were quite different. In Hua Kuang village, the riverbank had been reconstructed in the northward area of the village. Afterwards, water in this area was deeper and flowed faster than the past compared to other areas in the village, particularly in dry season. However, overflow and strong water current are likely to occur in the second rainy peak instead. While this project conducted in Hua Kuang village had both positive and negative

effects on several fish farmers, it led to explicit arduousness of most fish cage farmers in Ban Mai village.

After the riverbank was explicitly eroded by the 2011 massive flood, it was improved the next year by a local politician. The new embankment constructed to mitigate river erosion, unfortunately, was eroded instead by regular current flows because it had not been covered by a concrete structure to prevent the sedimentation of sand particles in the embankment. Fish cage farmers who had to relocate from the river bend which had enough water all year round to other worse areas have had to encounter much sand accumulation and river shallowness in all seasons except the second rainy season.

“I cannot continue fish cage farming thanks to riverbank improvement. All farmers had to move outside, but that area has no oxygen because water is quite stagnant in dry season. Besides, a lot of debris, garbage, trees, and so on crashed on the cages with strong current stream in overflow season. Fish death was occurred massively. Many farmers discontinued, but only two to three farmers still desperately operate. Formerly, water came to erode this area and we had some channels to feed” (a medium-scale farmer in Ban Mai village, 13 July 2013).

3.1.3 Irrigation Systems

The irrigation system issue is one of anthropogenic actions in the climate-related scheme particular in water resources. Multi-scale policy, management, and control by state authorities from national to sub-basin and local levels are interwoven. Irrigation infrastructures are dams, weirs, water gates, and irrigation projects which have different capacities to allocate water for water users including fish cage farmers. As the irrigation system in Thailand attempts to provide water resources for agricultural production, industry, and urban sectors, fish cage farming is therefore not a vital target of irrigation because of the production amount, popularity and expansion of activities, and economic cost compared to other economic activities. To identify, each village is controlled and managed under different irrigation systems and its scales leading to distinctive risks.

In upstream areas (figure 3.5), irrigation systems consist of dams, public local weirs (green square), regular weirs without a water gate (purple square), and weirs with water gate/regulators (red square). Each irrigation system has to supply water for agricultural and other uses in different coverage areas. Mae Ngad Somboon Chol Dam is an important storage source to manage water flow and runoff along the Ping River. According to the water deficit in Mae Ngad Somboon Chol Dam's reservoir from flood prevention policy and less rainfall supply, a lot of effects played out negative consequences and they varied by the local irrigation system in each village.

In Ban Koh village, firstly, Mae Ngad Somboon Chol Dam directly controls the water supply of the Old Mae Ping (Chollakhan Phinit) weir, which is located in the northward part of the village as well. As this weir chiefly irrigates for agricultural areas in Lamphun province, fish farmers in Ban Koh village must receive water mainly from the river under the schedule of the weir. Water is allocated for the Lamphun side into irrigated canals around seven days and drained for Chiang Mai side into the Ping River around five days all year round (table 3.4). If water is lower than the storage level especially in summer (March – May) and the water gate in Chiang Mai side is closed following the schedule, no water can flow across the embankment.

Fish farmers, in addition, must wait for water to flow over the Tha Makho weir again. In the southward part of Ban Koh village, the Sob Rong weir has the capacity to store and block water to be utilized in the village. It is better for fish cage farmers in the case of sufficient water flow. If water depth is lower than the height of the Sob Rong weir, river water may be stagnant and water hyacinth will pervade and spoil into the river water. It could also decrease the dissolved oxygen in the water. In hot and early rainy season when farmers are confronted with drought and lack of rainfall, water is stagnant and does not flow regularly leading to fish disease and death.

“Definitely, water hyacinth decreases dissolved oxygen level in our areas. It stayed at the Sob Rong weir when water was not enough to flow over this embankment and could be expanded by itself. I had just separated them yesterday” (a large-scale farmer in Ban Koh village, 4 June 2013).

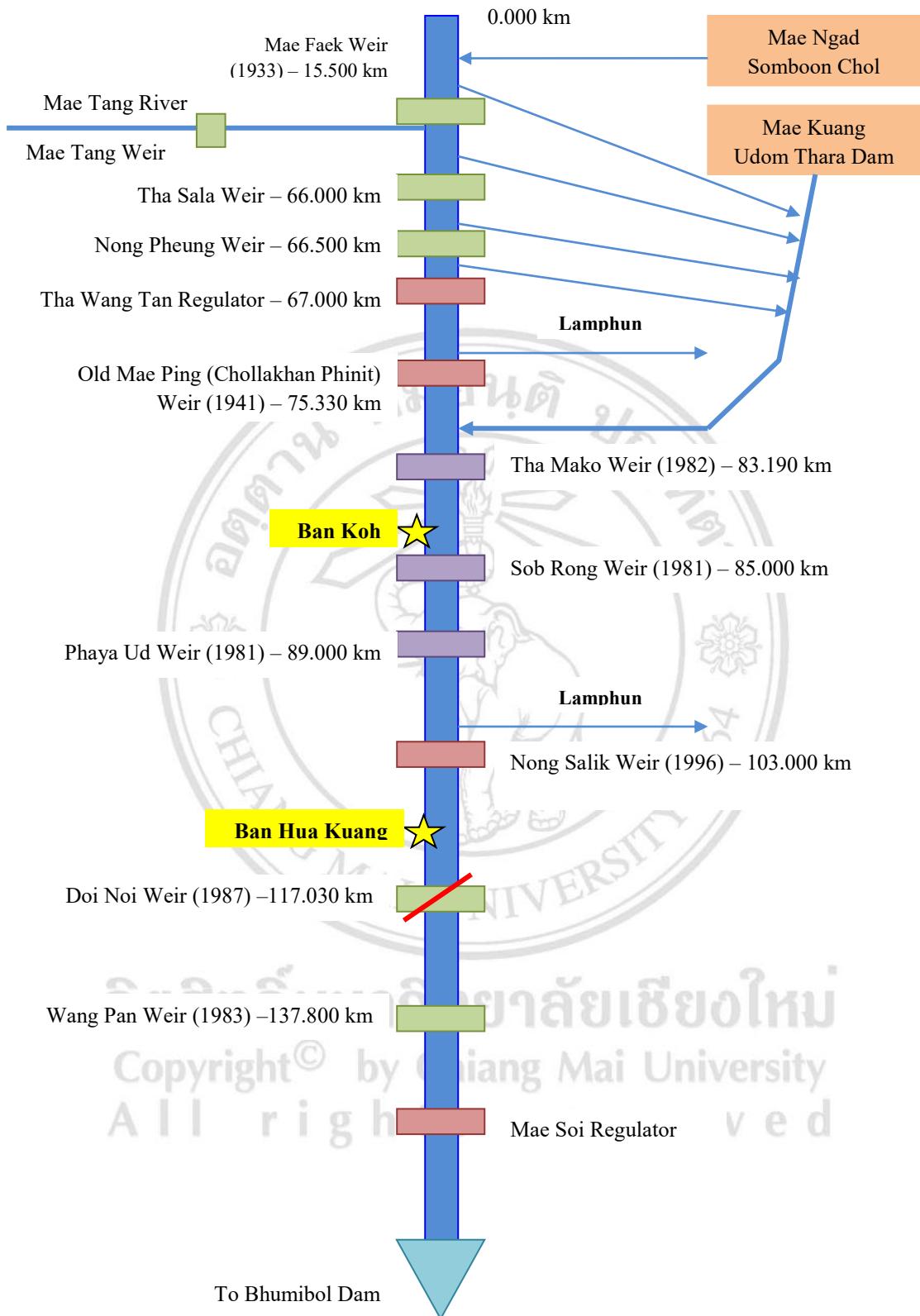


Figure 3.5 Irrigation systems in upstream areas of the Ping river basin
 (Source: modified from Irrigation Office I, 2014)

Table 3.4 Water drainage schedule of Chollakhan Phinit Weir in 2013

Water Allocation Timetable for Agriculture from Chollakhan Phinit (Old Mae Ping) Weir Year 2013						
Round	Date/Month/Year					
	Open (to Mae Ping canal)			Close (open to Ping River)		
1	1-7	January	2013	8-12	January	2013
2	13-19	January	2013	20-24	January	2013
3	25-31	January	2013	1-5	February	2013
4	6-12	February	2013	13-17	February	2013
5	18-24	February	2013	25-29	February	2013
6	1-7	March	2013	8-12	March	2013
7	13-19	March	2013	20-24	March	2013
8	25-31	March	2013	1-5	April	2013
9	6-12	April	2013	13-17	April	2013
10	18-24	April	2013	25-29	April	2013
11	30 Apr-6 May	May	2013	7-11	May	2013
12	12-18	May	2013	19-23	May	2013
13	24-30	May	2013	31 May-4 June	June	2013
14	5-11	June	2013	12-16	June	2013
15	17-23	June	2013	24-28	June	2013
16	29 June-5 July	July	2013	6-10	July	2013
17	11-17	July	2013	18-22	July	2013
18	23-29	July	2013	30 July-3 Aug	August	2013
19	4-10	August	2013	11-15	August	2013
20	16-22	August	2013	23-27	August	2013
21	28 Aug-3 Sep	September	2013	4-8	September	2013
22	9-15	September	2013	16-20	September	2013
23	21-27	September	2013	28 Sep-2 Oct	October	2013
24	3-9	October	2013	10-14	October	2013
25	15-21	October	2013	22-26	October	2013
26	27 Oct-2 Nov	November	2013	3-7	November	2013
27	8-14	November	2013	15-19	November	2013
28	20-26	November	2013	27 Nov-1 Dec	December	2013
29	2-8	December	2013	9-13	December	2013
30	14-20	December	2013	21-25	December	2013

Note: Attach this timetable at each irrigation canal sign which can be seen clearly

Source: Irrigation and Maintenance Office I, 2013

“Two main problems were low water and fish disease. Low water is a major cause of fish illness which occurred profoundly in the last year” (a medium-scale farmer in Ban Koh village, 9 August 2013).

“We have to ask for water from the weir as they would open once in seven days. When water reached our village, this weir might close their gates to the river. Sometimes, water hyacinth also came with that released water” (a medium-scale farmer in Ban Koh village, 8 August, 2013).

“Water did not flow now because of the schedule of Chollakhan Phinit weir. It might be drained this evening according to the timetable, but it would run to our village tomorrow evening” (a small-scale farmer in Ban Koh village, 8 August, 2013).

Another pattern of fish cage farming in Ban Koh village is located in the local irrigation called *muang*. It is also affected by water allocation from the Old Mae Ping weir because the inlet of *muang* is connected at the northward part of the Tha Mako weir. Likewise, stagnant water is a great problem for fish cages in *muang* system particularly in dry season thanks to insufficient water in the river channel. Dissolved oxygen in *muang* is also quite low accompanied by water hyacinth and weed spoilage. Water variability in *muang*, however, is quite a lot lower than in the Ping River particularly in second rainy season. Effects from overflow and strong currents tend to be mild in *muang*. Nevertheless, water use conflict between fish cage farmers and longan farmers alongside *muang* appeared especially in the monsoon season. Fish farmers were accused of accelerating flooding impacts to longan orchards because hundreds of cages in *muang* obstructed waterways and overflow. In the meantime, fish farmers said that they tried to clear debris and clean *muang* for fish farming to improve water quality instead, but longan farmers did nothing with the *muang* and toxins from the orchards were poured into the *muang* by heavy rainfall in the second rainy season. Although cage farming in *muang* was likely to be faced with various problems, most farmers in Ban Koh village who have operated in *muang* thought that feeding fish in this canal is safer than the Ping River, but the growth rate is quite slower.

“*Muang* in summer is quite dangerous for fish farming, but it is not risky in flood season” (a large-scale farmer in Ban Koh village, 19 August 2013).

“*Muang* water is stagnant and water hyacinth appeared a lot. Moreover, toxic chemical substances and herbicide from longan orchards came into *muang*. It is as a wastewater line for them” (a large-scale farmer in Ban Koh village, 13 August 2013).

“The water in *muang* is not dry. It usually stays two meters all year round. However, water is quite stagnant particularly in the nighttime. Feeding fish in the Ping River is more risky than the *muang*, but fish can grow faster” (a large-scale farmer in Ban Koh village, 18 August 2013).

“Fish in *muang* are less grown-up than in the Ping River” (a large-scale farmer in Ban Koh village, 19 August 2013).

In conclusion, the Chollakhan Phinit weir in the north which received lower water quantity and water supply had to be shared with irrigated areas in Lamphun province. Thus, the shallow river water became stagnant in the summer and early rainy season with the storage of local weir in the south, and the winter-summer crop of fish was prolonged (from 4.5-5 months to 6-8 months) to early rainy season (May-June) instead of catching in the late summer (April). When the second crop was started late in the early rainy season, instead of at the beginning time, the farm were again damaged by the overflow creating massive fish deaths. The fish farming period for each crop in *muang* took a longer time than farming in the Ping River. However, the water temperature in summer and winter was not a great problem for fish cage farmers in Ban Koh village because it did not much vary as water quantity was still adequate to absorb changes in extreme air and water temperatures.

Secondly, the village which has high climate-related risks as evaluated by fish death and disease incidences is Hua Kuang village. Severe drought in Hua Kuang village became a major problem for fish cage farming after the Doi Noi weir, the most important irrigation system southward of the village, had been destroyed by the 2011 flood. Accompanied by storage deficit, water supply from the headwater declined significantly

and the capacity to store water disappeared. In the summer and early rainy season, this village did not have enough water to feed the fish while some areas had no water in the river. A lot of fish died and waste and debris were silted through the river base flow and toxins and disease accumulated in the river.

To clarify what impacts from climate-related external hazards are, it is very important to understand that climate-related disturbances nowadays come from the coalition of physical-environmental and anthropogenic actions. However, water is a core focus in climate-related factors because fish cage farming cannot be absolutely operated without water resources. In this article, other physical-environmental or natural climatic stimuli are closely linked to water resources by observations to rainfall and temperature characteristics in each season both in spatial and temporal proximity. Anthropogenic actions, besides, are likely to be connected with irrigation management and disaster prevention policies. However, anthropogenic actions particularly in weir failure are going to negatively affect fish cage farming and alter natural climate stimuli to be more uncontrollable.

The major consequence to fish cage farming in Hua Kuang village came from the largest failure of the Doi Noi weir from the big flood in 2011. Six years before this event had occurred, however, there was another minor failure of this weir from the Chiang Mai flood in 2005. This minor failure, however, did not create as much damage as the recent failure.

“Around seven to eight years ago, the weir was eroded on both two sides and water in the river was running through those channels. This year I have not started fish cage farming yet, just quit from the factory” (a medium-scale farmer in Hua Kuang village, 23 September 2013).

Nine out of eleven of the fish cage farmers who had begun their operation before the weir failure in 2011 had been directly and extremely affected during that period. After this failure, the irrigation office had actualized and launched two projects in only two years with large massive funding to maintain the Doi Noi weir. However, those two projects were only temporary and urgent assistance to the farmers in all sectors including fish cage farming. The first project was done in 2012 and entailed installing a

sheet pile in the water storage unit to replace the weir. After using around eight million baht to maintain this repair in the first round, it collapsed again due to the seasonal overflow in mid-2012 returning to the previous situation in 2011. The second attempt was finished in the summer of 2013 by cutting half of the budget compared with the previous maintenance. Thousands of sand bags were used instead of a sheet pile to recline the river water level particularly in summer. In the second round of weir repair, the authority had corresponded with Hua Kuang villagers and other nearby communities by giving a 200 baht daily wage to 20 laborers who came from the area.

“Authorities told us that new weir construction will be launched in mid-2013, but I do not know whether they have enough budget or not. Last year, eight million baht for repair could not change anything except only a few sheet piles that cannot resist the overflow, so it has already crashed. Also, this one, four million baht, comes to repair again by putting sand bags. Wait! It might be the same. They are not sincere, just thinking” (a medium-scale farmer in Hua Kuang village, 13 February 2013).

This second effort was worked on for months until the budget was not enough for maintenance. Unfortunately, both weir repairs were totally unsuccessful and had no capacity to control water quantity in every season. An important physical characteristic of weir failure appeared to be from lower river water levels and drought in recent years and these tended to be more serious than before.

“Low water or drought occurred very much, but no flood at all. Before 2013, we had never seen drought, water was still okay in 2012. But in 2013, it was a drought” (a large-scale farmer in Hua Kuang village, 25 June 2013).

“Whew!...This is the longest drought this year. It has died continuously for 2-3 years. I lose every time. If water was enough...and the weir was maintained, it would probably be fair for us” (a medium-scale farmer in Hua Kuang village, 24 June 2013).

“The first year I started the production, I was faced with water...low water (laugh). Fish cannot grow up perfectly” (a small-scale farmer in Hua Kuang village, 24 June 2013).

Irrigation allocation from the upper areas is another control factor to water availability in each season. The Nong Saleek weir exerts a chief role in water resources allocation in the Ping River for agricultural production in Lamphun province. San Pa Tong and Doi Lor districts including Hua Kuang village are other areas which also receive water resources. However, those areas in Chiang Mai province are not prioritized to obtain water resources because there are not target points. When river water is lower in the summer and first rainy season, the irrigation office at Nong Saleek weir has to control water by opening the water gate at the optimum rate to save water for Lamphun irrigated areas.

“Water came a lot some days ago that we talked together, but it is dry today. Nong saleek weir releases water because water hyacinths are much more. However, they usually open the water gate five centimeters every day, or up to the demand. Maybe that day they opened 20 centimeters. Water from Mae Ngad dam goes down to the Ping River, but I am not quite sure that they released any today or not. However, no water was released from Nong Saleek today at all” (a medium-scale farmer in Hua Kuang village, 7 April 2013).

Natural climate stimuli also impact on fish cage farming after weir failure. Air temperature greatly affects water temperature when the water depth decreases to the crisis point especially in the summer. When river water drops below 50 centimeters together with a weak flow from the northward stream, water temperature rises and water backflow is more severe than usual. Those problems can obviously cause massive fish death because fish cannot eat well and resist very hot temperature especially two-month fish or older. Although some fish can survive in the summer, their growth rate is very low and the duration of fish feeding in each round is totally prolonged from 3.5 – 4.5 months to 5.5 – 8 months.

“I have got a problem in summer. Water is hot while it should be cooler than the present. Fish cannot adjust themselves immediately” (a medium-scale farmer in Hua Kuang village, 25 June 2013).

“Fish died massively...whew!...at least hundreds a day and it has been like this for months. All farmers face the same situation. The water is hot. It is not relevant to cloud. Toxic water may come when the overflow appears, but likely to be nothing from this now” (a medium-scale farmer in Hua Kuang village, 22 September 2013).

Fish cage farmers are also impacted from cold temperatures. Although cold temperatures are a normal characteristic of climate in Northern Thailand, in late December 2013 – January 2014, the temperature in the recent winter dramatically dropped compared with previous years. This has a great effect on fish much like summer. However, small fingerlings will be affected instead of mature fish. The growth rate of fingerlings is significantly obstructed because fish cannot eat anything due to inappropriate temperature leading to a prolonged feeding duration. It also partly causes massive fish death if the water depth and flow are not sufficient. Anyway, the water depth and flow when it is close to winter are likely to be higher than summer. Thus, the influence of temperature seems to be lower than summer.

“It is cold. Fish rarely eat in the morning....This New Year is extremely cold and has stayed this way for a long time. Usually it is not cold like this, just 2-3 days” (a medium-scale farmer in Hua Kuang village, 8 January 2014).

“Lots of fingerlings die in this season because it is cold, but mature fish do not die almost. In this winter, 100-200 of 10-to-20-day fingerlings die per cage” (a large-scale farmer in Hua Kuang village, 7 January 2014).

Fish cage farmers in Pradang village, thirdly, seemed to have the lowest climate-related risks compared to other villages because this village is located near the Bhumibol dam which provides sufficient water supply for farmers. Two major external climate-related risks from lower water storage of in the Bhumibol dam are daily water fluctuation and sand accumulation. To start with, water fluctuation in the Ping River is influenced daily

by electricity generation of the Bhumibol dam and has only become an essential problem to fish cage farming. Following this observation, water level tended to be increased to around 30-50 centimeters in the morning (10.00 – 14.00 hours) and decreased a little bit from late evening and reduced to the lowest rate at midnight. Nowadays, fish farmers have to face extreme daily fluctuation of river water more than the past. Although this fluctuation always occurs daily and during the intense in summer and first rainy season every year, production losses illustrated by fish death and disease occurrence have been the highest since they had begun the operation. At least 50 centimeters of daily fluctuation has a severe impact on farmers. The extreme daily fluctuation is varied by the average depth of water. Daily fluctuation was explicitly intensified when water is quite shallow. Sand accumulation, secondly, was another cause of water shallowness of regular depth which was affected by less water runoff in the river.

“Water is not deep now. It is just lower than my knee. I have to rely on water from [Bhumibol] dam. Water has increased at 10 am around less than 50 centimeters, not one meter. It also decreased from 2 pm till the morning. Water is quite dry in the morning because the dam closed the water gates. I am not sure when the dam does open” (a large-scale farmer in Pradang village, 14 July 2013).

Another minor anthropogenic climate related-risk that occurred in the second rainy season was a toxic/chemical contamination from herbicides and pesticides at the headwater and in the northward areas of the basin flow into the natural canal and the Ping River at the convergent point within a village. As mentioned earlier, this negative anthropogenic factor importantly interacts with natural climate risks.

“Water from *Pak Wang* (convergence point of Ping and Wang River) comes a lot in overflow peak with herbicides and pesticides. I thought that those chemical substances must be contaminated in water” (a medium-scale farmer in Pradang village, 26 August 2013).

Ban Mai village, lastly, also has high climate-related risks particularly by anthropogenic actions. Drought tended to cause massive damages to fish cage farmers in this village.

According to the riverbank improvement to prevent floods and erosion, fish death and disease became normal incidences in summer and early rainy season. Further, farmers obviously received overflow risks in the second rainy season as they had no area to avoid the strong flows. Those problems may have also interacted with the irrigation systems in the northward areas in particular.

Before the fish farmers' relocation after riverbank improvement in 2012, the reduction of river water depth and the occurrence of sand islands and their accumulation had been appearing significantly for nearly a decade in the Ping River in Ban Mai village. Besides the Bhumibol dam, there are two irrigation projects in Kamphaeng Phet which store water resources for agricultural production within and in nearby provinces. Initially, the Tho Thong Dang irrigation project was established three decades ago and increased the height of embankment in the last year. Besides this, the Wang Bua irrigation project, established in 2006, supplies water mainly for rice production in Kamphaeng Phet and Phichit province. Afterwards, river water significantly dropped and waterways had been changed from the occurrence of sand islands. Generally, water depth and flow in most areas of the Ping River in the village is quite shallow and stagnant except at the great river bend which most fish farmers have utilized for fish farming. Nonetheless, climate-related variability especially heat and drought started after riverbank improvement.

"Water in Ban Nong Pling and Wang Bua is better than my village because they have a weir to store water. Wang Bua weir is located before water reaches my village. Thus, my village receives less water amount" (a small-scale farmer in Ban Mai village, 12 July 2013).

Sand accumulation leading to water shallowness in the new location of farming affected by severe drought with hot water temperatures in all seasons except winter had intensively emerged. Fish could not eat feed well in hot environments and found it difficult to survive in shallow water. Each crop had been extended from four to five months to at least six to seven months. Moreover, fish disease and death obviously occurred to most fish cage farmers from drought and extreme temperatures illustrated by low and stagnant water particularly in the summer and winter. In contrast, fish cage

farmers were also faced with fish death from overflow in the second rainy peak because the new location was totally exposed to strong currents as there were fewer areas to pull cages back to avoid water currents. Toxins from farm production and sand sediments were also suspended in the water current.

“Water condition has changed after the authority improved the riverbank.

Sand was moved by the water stream to accumulate in the fish farming area just only after a week” (a medium-scale farmer in Ban Mai village, 28 August 2013).

Another minor problem that occurred in the village areas was the contamination of water by a molasses eruption from the sugar factory. Although several farmers indicated that contaminated water did not cause a lot of problems to fish cage farming, some farmers were directly affected from embankment construction to block the contaminated water. They had to change feeding area or discontinue fish farming because there was less water depth and flow.

“The factory must treat the water with molasses contamination to be good enough before releasing in the river. Yet, the factory worried that they cannot stop this problem. Thus, they talked to me and urged me to stop fish cage farming. I agreed and did not complain about them” (a large-scale farmer in Ban Mai village, 12 July 2013).

The evaluation of climate-related external risks (hazards) in this research was conducted by intensity, frequency, time duration, areal extent, speed of onset, persistence and reversibility of impact, and spatial dispersion in order to describe the hazardous consequences to fish cage farming in each village before examining in the level of household (table 3.5). To date, fish cage farming in Hua Kuang village and Ban Koh village has been significantly impacted by physical landscape deterioration and transformation leading to a lack of suitable environment for farming. Fish cage farming in Hua Kuang village, firstly, tended to have a very high risk after weir failure because of persistence and reversibility of impact, time duration, intensity, frequency, and areal extent. All farmers were totally affected by drought for at least 2-3 years after weir failure illustrated by massive fish deaths and disease many times and continually

compared to other villages. Likewise, fish cage farming in Ban Mai village, secondly, is likely to face high risk with the same risk factors as the Hua Kuang village. Fish farmers were challenged by relocating to worse environments and perceived much frequency, longer time duration, and persistence and reversibility of drought.

Table 3.5 Anthropogenic actions and level of climate-related risks in each village

Problem Site	Level of Risks	Main anthropogenic actions	Important Consequences as External Risks
Ban Koh	Moderate-High	Irrigation and weir control	Seasonal fluctuation related to stagnant water and overflow, lower DO rate
Hua Kuang	Very High	Weir failure and weir control	Less river water and no water in hot and early rainy season, waste accumulation
Pradang	Moderate-Low	Dam control, chemical contamination	More extreme daily fluctuation, fish disease
Ban Mai	High	Riverbank improvement, contaminated water	Loss of a better-quality riverbank, less river water depth, sand accumulation causing shallowness

Source: modified from Santita (2014a)

In the meantime, fish cage farming in Ban Koh village, thirdly, received a little bit lower risks than the earlier two villages, but this village still had moderate-high level of risk because of the range of risky situations was a lot shorter than Hua Kuang and Ban Mai villages particularly during drought. They were not forced to change to worse farming environments which required a lot of capacity to adapt. However, speed of onset and intensity of overflow and strong currents during the monsoon season were very obvious and caused immediate damages to fish farmers from massive fish death. Fish cage farming in Pradang village, finally, was least damaged by external climate-

related risks as time duration of intense disasters were very short and did not occur annually. Although water fluctuation in the river appeared daily, the impact of this action was not very severe compared to other villages, except in the summer and early rainy season. Fish death, which is one of the most significant indicators of fish survival, sometimes emerged and was not too violent. Moreover, irrigation control from Bhumibol dam is quite stable in the dimension of water supply which could control water-related variability potentially. Thus, fish cage farming in this village was just confronted with moderate-low risk.

3.2 Internal Exposures to Climate-Related Risks

Risks come from the interaction of external hazards which occur outside the household level, while internal exposures are manipulated by the household itself. In terms of fish cage farming based on a unit of household, cage location is the most important climate-related exposure which each household has selected (table 3.6). Various feeding zones in each village have several impacts on water depth availability in deficit seasons, water temperature in summer and winter, water flow, current action, and its circulation related to stagnant water and overflow. In drought situations which occurred mostly in recent years in all research sites, farmers in most villages tended to be exposed to shallowness, stagnant water, sand accumulation, and lower dissolved oxygen rate. In rainy season especially the second peak, farmers were also faced with overflow and strong current.

3.2.1 Ban Koh village

Following the information, fish cage farmers in Ban Koh village had two major different opinions as to cage location. The first group believed that each location had distinctive characteristics related to water amount, flow and velocity, dissolved oxygen rate, and depth. Another group trusted that each location was not significantly distinct because it was located in the same river channel so it is not likely to experience a variance in the level of damage. Each cage location is quite different according to the intensity, difference in time duration, and frequency of disaster to fish cage farmers in each area. Thus, cage location in Ban Koh village may be divided into three areas.

The northern zone, first, is located in the river bend area which is exposed to flooding, overflow, and strong current impacts in rainy season. It also has a higher level of dissolved oxygen rate compared to other areas especially when water depth drops in dry season because this area is quite far from the Sob Rong weir leading to much water flow and greater velocity. Although this area seems to be better in drought which occurs throughout the basin, fish cage farmers received great impacts in the second rainy peak because it is the narrowest part of the river channel of all of the research sites and it also lacks river terrace areas to avoid strong water streams. Thus, this area is one of the most exposed zones in the village.

Table 3.6 Internal exposures to climate-related risks by exposed areas of each village

Sites/Exposed Areas	Northward	Central	Southward
Ban Koh	Overflow, strong current, high DO	Normal current, low DO	Stagnant water, slow current, depth, low DO
Hua Kuang	Overflow, strong current, depth	Water shallowness, more riverbank areas for avoiding overflow	Water shallowness, sediment accumulation, more riverbank areas for avoiding overflow
Pradang	Moderate depth and flow, some sand accumulation	Sand accumulation, shallowness, moderate flow	Exposure to overflow, strong flow (all year round), no sediment
Ban Mai	Extreme shallowness and flow, but not exposed to overflow	Moderate-Low depth and flow, sand accumulation (north central area)/ More depth, exposed to overflow (central area)	Water shallowness, sand accumulation, safe in overflow season

Source: modified from Santita (2014a)

The central zone, secondly, is very long in distance, but cage farmers do not cluster in definite areas. The central zone is a combination zone between the northern and the southern zone. The strength of water current is normal, but dissolved oxygen rate is also lower than the northern zone. This area, therefore, is as a neutral zone of exposure.

The southern zone, third, in the Sob Rong village is located and attached to the Sob Rong weir. This area is quite effective in protecting overflow and strong currents in rainy season. However, there were several farmers locating cages at the river bend which may encounter a high velocity of water stream. Although water levels in this zone are deep, this zone has become one of the most exposed areas in the village in drought situations thanks to stagnant water, slow current, and lower dissolved oxygen rate. Besides, the dispersion of water hyacinth nearby the weir particularly when water level is not higher than the weir embankment tends to decrease the dissolved oxygen rate and cause toxic substances in the river water.

Fish cage farmers in Ban Koh village, furthermore, also feed in *muang* canals. In the opinion of fish farmers, fish farming in *muang* can be safe from overflow and strong currents in rainy season, but fish cannot grow as fast as in the Ping River. In dry season, it is impinged by excessive stagnant water although water depth is quite sufficient and stable for feeding all year round. If a *muang* is divided by zones, physical characteristics of each area will be similar to the Ping River zones – the northern zone tends to be greater than the central and southern zone in dry season. However, the *muang* system is not influenced much by overflow. The northern zone of *muang*, thereby, is likely to be superior in contrast to other zones.

3.2.2 Hua Kuang village

Internal exposures of each zone, however, are quite lower than before when the Doi Noi weir was destroyed by massive flooding in 2011 because all farmers in all zones had been extremely and immediately influenced by the extreme drought. To describe the characteristics of physical exposure in the river in Hua Kuang village; there are three main zones in the villager reflecting the differences in water depth, flow, quality, riverbank characteristics along with its exposure to each season.

The northern zone, first, is the largest zone covering a long distance in the village. This zone is exposed to overflow in monsoon season rather than drought because of the deep and narrow channel. Fish cage farmers in this area have encountered fish death from overflow many times. It was a consequence that developed after the riverbank in Hua Kuang village had been improved last year by local authorities to save the riverbank from erosion. Fortunately, this area usually has at least one meter of water depth all year round. Following that, this zone will not be exposed to drought. However, the north zone has been divided into two minor zones. Northern 1 zone is very exposed to overflow because of the deep and narrow channel as well as no riverbank area to move cages in. Anyway, it is scarcely affected by drought. Following the current situation, this zone has a lot of advantage compared to the other areas. Northern 2 zone has a mix of characteristics between north and central zone. Although it is not much exposed to overflow compared with Northern 1 zone, this zone can survive in monsoon season by moving cages in the river bend for months. However, fish cage farmers had to partly suffer from drought in dry season.

The central zone, second, is located in the center of the community. This zone has sheer exposure to drought in dry season especially after the weir failure because water is quite shallow (0.5 – 1.5 meters) almost year round. Anyway, the river channel in this area is quite wide, so the exposure in overflow season is lower than the north zone. According to this incidence, some fish cage farmers have had to invest in riverbank improvement to gain more water in dry season and use the riverbank as a shelter in overflow season.

The southern zone, third, is located in the southward part of Hua Kuang village including Pa Lan village as well. It is very exposed to backflow in the dry season because water cannot flow directly to the channel and this channel is not very wide. The exposure to drought in this zone, besides, seems to be the highest of all zones. The farmers, however, can gain a few benefits from the riverbank in overflow season similar to the central zone and mitigate problems by using the methods that farmers in the central zone had done. Compared with other zones in the village, following the severe drought after the weir failure, the southern zone is the worst in water availability during every season.

3.2.3 Pradang village

Physical internal exposures of each area in Pradang village are quite outstandingly observed by the river base floor, water depth, flow and velocity, accumulation of sediments, and river terrace. Fish cage farming zones are categorized into three zones.

The northern zone, first, is a neutral zone related to sand accumulation and flow/velocity of water streams. Water depth is at the optimum rate except in dry season which may be exposed to a little sand accumulation causing shallowness at some times.

The central zone, second, is the most exposed areas in the village especially during drought impacts although it might be safe from flooding, overflow, and strong current consequences. In dry season, sand is widely accumulated under the fish cages impacting the shallowness of the river channel and toxic/chemical accumulation in sand and sediments.

The southern zone, third, is located outside of the community. In drought periods, fish cage farmers in this zone have few drought effects because of the two-meter water depth with continual flow and velocity all year round. The river channel in this zone is deep, very steep, and has no sand accumulation. It may be the best zone in case the water current is not very harsh. However, water current in the second rainy peak is quite strong and may have impact an on fish bruising and survival.

3.2.4 Ban Mai village

The level of internal exposure played an extensive role in the relocation of cages to new areas after the riverbank improvement because fish cage farmers had small differences when they laid fish cages in the same great river bend. Currently, exposed areas in Ban Mai village are demonstrated to three areas.

The northern zone, firstly, is separately located in the northern part of the river bend. Nowadays, fish cage farming in this zone is very exposed illustrated by the very slow current and exceeding sand and sediment accumulation. It is very difficult to feed fish almost all year round.

The front zone of the river bend, second, receives a strong current and fast flow in rainy season and tends to be massively damaged by overflow. In dry season, this zone may

have some advantages in water depth to reduce water temperature. However, it is quite hard to define this zone as the best farming area of the village.

The back side of the river bend, third, faced a lot of problems in drought situations. Water depth, flow, and velocity were very low leading to stagnant water. At the head of this area, a farmer located cages in this area to obtain a better environment for fish farming. In contrast, most farmers in this zone suffered a lot similar to the northern zone.

3.2.5 The Interaction of External and Internal Climate-Related Risks

Internal exposure is a significant element in intensifying or reducing external risks. The number of fish cage farmers' households located in different cage locations is represented in table 3.7. The grey-grid areas are the most exposed areas following the description of internal exposures. It can be defined that the most exposed areas in each village are chiefly affected by drought illustrated as stagnant water, shallowness, and sand/sediment accumulation except the northward area in Ban Koh village which was also influenced by overflow. Seventeen of the forty-two farmers (40.48 %) in all research sites, statistically, had located their cages in those areas. They tended to encounter more climate-related risks than the others. Accompanied by external risks (hazards) of each village, three farmers in Hua Kuang village (7.14 %) were the most risky group from climate-related risks. On the contrary, eight farmers in Pradang village (19.05 %) were the least risky group. Risks from climate-related consequences, anyway, are not the only risks in the consideration of the research. Intensive fish cage farming, currently, also perceives socio-economic risks both from the external and internal forces on fish cage farmers as they require massive needs of high productivity, enough assistance, and efficient collaboration within the village and with other related stakeholders.

3.3 External Hazards of Socio-Economic Risks

Socio-economic risks also have external and internal risks faced by each household. This issue are demonstrated as financial profit/loss and compensation, legal and rights approval, and cultural-technical assistances. Risks are represented in three dimensions.

Table 3.7 Numbers of farmers by cage location as internal exposure

Exposed Areas Sites	Northward	Central	Southward	Farmers in the Most Exposed Areas	Level of Risks
Ban Koh village	3 (without 1 farmer feeding only in muang)	4	3	6	Moderate-High
Hua Kuang village	6 (3 farmers in zone 1 and others in zone 2)	2	3	3	Very High
Pradang village	3	3	5	3	Moderate-Low
Ban Mai village	2	4	3	5	High
Total				17 (40.48%)	

Source: modified from Santita (2014a)

3.3.1 Demand-Supply and Price Fluctuation in Market Spheres

The red tilapia price, generally, is directly and obviously varied by demand-supply interaction since intensive red tilapia aquaculture started. Nowadays, there are many fish companies involved in intensive fish cage farming and each company has a different proportion of productivity to share in the market spheres. However, the red tilapia price offered to fish cage farmers is quite similar and changed by demand-supply relations. Moreover, the red tilapia price throughout the country is defined as a standard price for each company. Thus, fish cage farmers in all of the research sites must be engaged with this relationship for various reasons.

The first minor issue is the increase of variable production factors' prices which have been changed and fluctuated over time. As fish cage farming is under contractual relations, variable production factors, price, and distribution systems are managed and

controlled by the fish companies. Above the demand-supply relationship, firstly, price is interacted with variable cost in the production especially fingering and feed prices. Three quarters of the basic variable costs, minimally, is feed price (figure 3.6). Feed use amount and price, moreover, can go up if fish in that crop do not grow leading to a prolonged duration from the four-month target set by a company. The most significant reason encouraging the extension of feeding duration is influenced by and interacted with drought. If feed prices in for each crop increases to more than the fish price at that time, fish cage farmers tend to lose their profit.

Since intensive fish farming began, fingering and feed prices have risen continually particularly in the last two or three years when they had increased nearly three times compared to the beginning of that time. In addition, there is no evidence that fingering and feed prices have been reduced until now. This problematic issue has occurred in all research sites equally as the general and most obvious consequence to intensive farming.

“Feed is more expensive than previous times...from 350 to 400, 450, and more than 600 baht a bag now. I use at least three bags per day to feed fish. Also, fish do not die when it is small, but die when eating much feed” (a medium-scale farmer in Hua Kuang village, 8 March 2013).

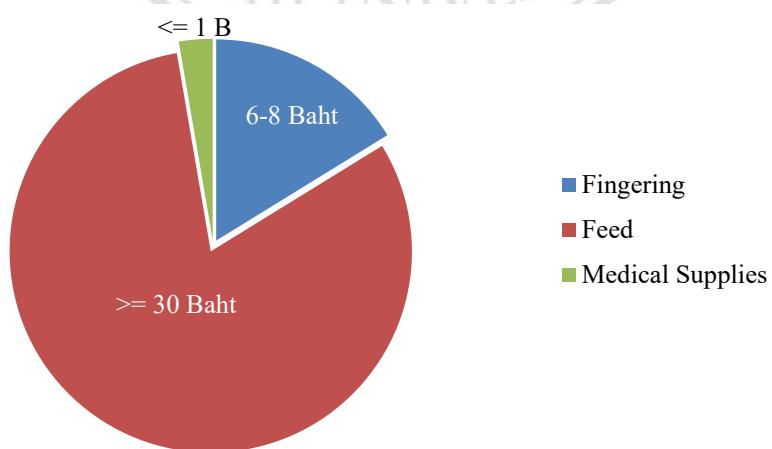


Figure 3.6 Minimum estimation of basic variable costs in 4-month cropping of fish cage farming per fingering

Excess demand and supply is the second issue in terms of market relations. Price offered by the fish companies fluctuates over time. At the beginning, the fish price was just only 40-50 baht per kilogram. Later, the fish price had been adjusted due to higher variable production costs. The graph below represents the average red tilapia price trends during different durations (figure 3.7). The great turning point from the massive flood in 2011 is used to analyze the development of fish prices because this period had a massive enlargement of fingering and feed prices. Fish prices, statistically, have fluctuated and steadily dropped from basic linear analysis. Interestingly, it reached prices higher than 80 baht per kilogram in 2012. Unfortunately, the prices since the second quarter of 2013 until the first quarter of 2014 dramatically fell to around 15 baht in only three quarters. Linking negative fluctuating feed prices, a marked increase in fingering and feed costs, and massive damage with fish deaths in 2013, fish cage farming in 2013 tended to be the most risky year due to multiple risks.

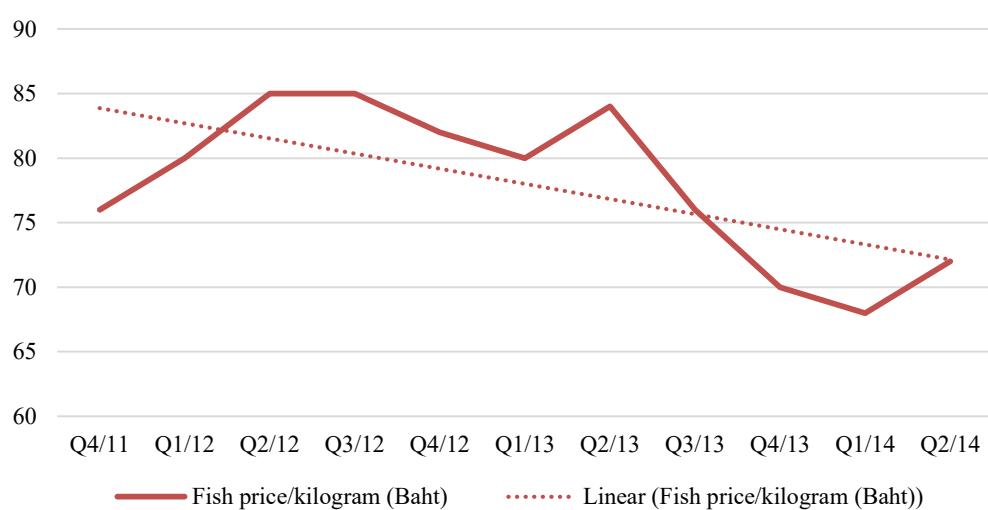


Figure 3.7 Average red tilapia prices (Baht) after the massive flood in 2011
 (Source: Santita, 2014a)

This characteristic of price fluctuation is closely relevant to production periods of fish cage farmers throughout the country. In the Ping river basin, a large amount of production tends to be released to the market in the second rainy season because this season has suitable climate-related features for fish cage farming. In the meantime, excess supply is likely to occur in this season as well leading to a great drop in fish

prices. Thus, most of the farmers earn limited profit from this season. On the contrary, fish prices in the summer are usually higher than other seasons because of excess demand. Most fish farmers cannot produce fish in the regular size, control the crop and use feed in a four-month period of time, and obtain enough quantity of fish to earn excess profit. Some farmers, besides, still lost their profit in spite of higher prices offered. This phenomenon was also intensified by climate-related risks which essentially forced fish cage farmers to operate seasonally because of the lack of good environments for fish growing.

The second reason that controls production cost and fish prices is the division of fish size which is defined by each fish company. It, actually, is determined by three sizes – small (below 500 gram/fish), regular (500-1,000 gram/fish), and large/jumbo (more than 1,000 gram/fish) – which has an impact on different prices. Definition of fish size, however, is a little bit different by each company. Typically, a small size is substandard fish which always has the lowest price compared to other sizes, while regular and large size may obtain regular prices offered by a company. Regular size, to identify, is the most populous item for general consumers, yet it also varies by areas and regions. Large/jumbo size fish, however, are sometimes classified as substandard size because it is not relevant to the dynamics of consumers' behaviors. The more farmers maximize the production of regular fish size, the more profit they will earn. Consumers now tend to prefer larger fish than in the past (around 700-900 grams) and this demand restricts the size of productivity from each farmer.

Unfortunately, most farmers can scarcely control all of the fish to harvest regular size in worse than normal climate-related environments, thus, leading to too small of a fish. Fish that are not categorized in any size (less than 400 gram/fish) and dead or ill fish affected by physical causes (such as flood, drought, lack of dissolved oxygen, disease, and so on) are usually not the responsibility of a fish company. Fish farmers, thereby, have to sell this tiny fish by themselves or specifically agree with the company to receive that product for a very low price. Besides, external factors from the selling process of a fish company are also discerned.

Along with that situation, fish cage farmers, actually, have no rights to sell fish by themselves according to the contractual agreement. Fish sales must always be done from the catching process to market distribution elsewhere while fish cage farmers have no involvement to sales actions in the a fish company. They have to call a fish company when they desire to sell their crop. Afterwards, a fish company may inspect fish sizes and make an appointment to harvest the fish for sale within a week in the state that demand-supply relationship is close to an equilibrium point.

In excess-supply duration, nevertheless, overdue harvest occurs from the problem of productivity distribution. In 2013, excessive amounts of fish from various sources together prompted less of a capacity for market spheres to carry the sales. In addition, political instability also partly obstructed the distribution of fish from the countryside to metropolitan areas. A fish company has to grab fewer amounts of fish per time and must come many times to clear that crop. The harvest duration, thus, is likely to be stretched from three to four days to at least two weeks per crop. Following this situation, there are several drawbacks to fish cage farmers. First, although some companies give a regular/full price for jumbo fish, most farmers have to give more feed in the extended range. Thus, fish farmers must endure more feed costs and earn lower profits or lose assets because the increase of fish weight does not offset the feed cost loss. Moreover, farmers may have a great disadvantage when a fish company determines a lower price for the large (jumbo) fish. Second, the next crop may be explicitly postponed to a less suitable period for fish farming when fish cage farmers have already planned to feed seasonally. It will lead to production failure in the next crop thanks to climate-related risks in unsuitable seasons.

“I told the officer of a fish company that if you give me fingerings and feed and catch my fish to sell on time, that is enough. I am satisfied... But now, the company caught my fish for a long time and it was not finished. A lot of jumbo fish are still here. That is a problem” (a small-scale farmer in Pradang village, 4 February 2014).

Even though this issue caused economic damages to lots of farmers in all research sites and several farmers had to lose some crops, fish cage farmers in Pradang

village tended to receive the most severe effects despite the fact that climate-related characteristics in this village were quite convenient for fish production.

“I did not know much but I have already known that my fish company sold fish very late. Oh! They caught fish more than a month per farmer by selecting only regular sizes and leaving jumbo-size fish in my cages” (a small-scale farmer in Pradang village, 4 February 2014).

The fingerings issue is also a problem for many farmers. In quality terms, it leads to the limitation of growth, fish death in early months, and fish diseases. In quantity terms, the major problem is the absence of fingerings from reliable sources. To point out, fish farmers can access fingerings in three patterns – obtain fingerings via contractual companies, get directly from fingerings farms, or attain fingerings directly from the Department of Fisheries – following the terms of agreement with a fish company and individual production system. Most farmers, except those in Ban Mai village, had acquired fingerings through the first and second pattern while farmers in Ban Mai village could also access fingerings by the third pattern. Each pattern of fingering access is different in quality and quantity.

The first pattern is the most popular type for fish cage farmers. Farmers who access fingerings through contractual companies can require a fingering amount for their production but they have no rights to select sources and sizes of fingerings. Currently, several fingering farms are also quantitatively and qualitatively damaged by climate-related risks and fish diseases. Thus, farmers have to order fingerings via a fish company at least one month in advance for feeding in the next round. Unfortunately, fish quality from various sources is not equal, and its quality tends to drop and fingering sizes are not equal in each round. Several farmers have encountered immediate and early-month deaths of the fingerings. In case of immediate death, most farmers have agreed with a fish company for compensation in fingering or financial claims in limited amount of days (around seven days to one month depending upon the agreement). However, they have to lose some fish to earn revenue in that crop and use the reclaimed fish in the next round of production. More importantly, fish dying after the claim period are not the responsibility of a fish company. Natural disaster is not much related to

fingering quality, and early-month death is a major problem for farmers. The massive deaths of the fingerings, in the farmers' opinion, were due to unidentified causes. Another problem of fingering quality is related to technical problems from breeding transformation. All red tilapia in intensive production must be male in order to prevent fish reproduction that imparts stunted growth in the fish. Unsuccessful sexual transformation of fingerings, unfortunately, leads to total weight loss of productivity.

The second pattern of fingering access is acquiring them directly from the fingerings farms. This pattern is only allowed for fish farmers who subscribe to contractual relations in case the company is unable to provide a suitable amount of fingerings. However, some companies permit this rights to farmers particularly to whoever handles a large operation. Those farmers, therefore, have more alternatives in selecting fingerings from a farm which they have trusted although fingering quality is sometimes not good enough because of climate-related risks. Claiming rights in fingerings, nonetheless, have to be committed directly to the fingering farms. This access is quite safer than the previous one, yet it cannot evidently investigate that the fingerings from an individual selection are always good enough. Experience and trust in farm selection are very essential in this consideration.

The last pattern of fingering access is directly linked with the Department of Fisheries. Many farmers in Ban Mai village were involved in this access and received cheap fry (*bai ma kham* fish) from the department. However, the fry used in the production are very tiny, so fish farmers spent a longer duration in feeding compared to other types of access. Fry also die normally at the beginning time; hence, farmers need order in higher amounts than larger fingerings. Besides, there is no commitment from the department to assuage a death claim. Fortunately, sex ratio from the breeding transformation process and reproductive problem did not occur. Farmers who decided to choose this kind of access had to accept full risks when the fry/fish died. In case they needed to feed the same amount, they must choose the second pattern of access. By the way, fingerings from some farms do not approach the standards leading to uncontrollable problems from fingerings. Nowadays, the last pattern of access is temporarily not observed because the department ran out of fry production provide to fish farmers in Kamphaeng

Phet province. Thus, those farmers faced a problem of lacking fingerling quantity from a regular source and sought other alternative sources.

In sum, fish cage farmers obtained risks in fingerings' quality and quantity in various aspects. In such, production time may be extended, profit earned is likely to decline, and a suitable time for farming will go away when those fingerling-related problems greatly influence the farmers. Following these results, most farmers identified that fingerling problems emerged much more in 2013-2014 because of neglected fingerling selection as an exploitation tool of the fish companies and low fingerling quality and quantity produced by fingerling farms which were mostly affected by climate-related risks as well. The fingerling quality problems particularly in the first pattern of access were often observed by the fish farmers in Pradang and Ban Koh village.

“I will not obtain fingerlings from this company anymore. I ripped inside a fish and found a lot of old eggs in every small fish. You can see many black dots that will be changed to fingerlings soon” (a small-scale farmer in Ban Koh village, 13 August 2013).

“I released 5,200 fingerlings in my cages but only 2,000-3,000 may survive. Fingerlings died in the first two or three days” (a small-scale farmer in Pradang village, 25 August 2013).

3.3.2 Participation of State Authorities

Fish cage farmers have interacted with various state departments in socio-economic terms including the Department of Fisheries, Marine Department, and local administrative organizations. Each authority has different responsibilities and participation in fish cage farming, but they also engage with each other as mentioned in Chapter II. Fish cage farmers in each village, however, perceived various kinds of participation both positive and negative. In socio-economic risks from state authorities' participation, there are two core topics relating to farmer registration and the association with local organizations, as well as zoning and tax policy.

Farmer registration and the association with local organizations is one of the major concerns in this participation. Most farmers in all research sites have enrolled for farmer

registration except farmers in Pradang village because they have just begun operating fish farming in recent years and are now in the process of preliminary registration with the department. Therefore, farmers in Pradang village have very little involvement with the department.

A Fisheries' announcement promoting aquatic farmers in all aquaculture sectors to enroll for farmer registration, necessitates that most farmers be evaluated for further standardization including safety level, food safety, and GAP. Those certifications, however, are quite useful in order to become involved in the food and aquaculture industry. Most farmers, as of yet, just produce red tilapia for intra-region and domestic market which do not require much standards because it is rarely convenient for sales. A fish company has an explicit responsibility to manage products and distribute them to the market. Thus, standardization in fish cage farming is not very significant in the farmers' opinion in current situations.

Farmer registration may be helpful in legal coverage, knowledge and technical encouragement, fingering obtainment in various species for aquaculture, and financial compensation in various disaster events. Farmers must renew their registration every three years to attain those rights. In recent years, the Department of Fisheries has followed state policy in local administration by transferring all burdens to municipal offices particularly in Ban Koh village. Dysfunctional association amongst those bureaus, unfortunately, has obstructed farmers in Ban Koh village in renewing their registrations. Afterwards, farmers' registrations in two upstream villages were expired leading to unattainable rights from the department. Farmers in two villages declared that they had never received any financial compensation in disaster events despite the fact they enrolled in this program. Yet, district fishery officers responded that fish farmers who feed during prohibited seasons declared by the Department of Fisheries could not receive any compensation. All aquatic standards, besides, could not be extended as well.

“It is not relevant that farmers who enroll in food safety or other standards will sell better fish than the others. It just depends upon the fish companies (laugh). Besides, I cannot continue my fish registration” (a large-scale farmer in Ban Koh, 23 June 2013).

Fish farmers in Hua Kuang village, however, who have still connected with district fisheries officials to gain other species fingerings received the announcement from the department, and asked for water-related coordination from irrigation authorities for fish cage farming although all farmers could not reenroll in the registrar. In contrast, fish farmers in Ban Mai village have still collaborated with the fisheries provincial office and other related administrative organizations to earn financial compensation in disaster events, gain knowledge and technical assistances, and fingering access because they could continue register with the department. Yet, the relationship between fish farmers in Ban Mai village and the fisheries provincial office had significantly disappeared after the new officer came.

Tax policy and aquaculture criteria are other consequences from farmer registration and the dysfunctional management of the local authorities. The marine Department is also a vital authority involved in this problem as it is the legal tenant in all river channels and adjacent areas (riverbank, island) in Thailand. The interaction between the Department of Fisheries and Marine Department has exerted a mandate through municipal authorities to manage riverbanks used for fish cage farming in zoning and tax policy. Likewise, this policy was tentatively introduced to Ban Koh and Hua Kuang villages.

Tax policy and legal regulation are managed by the Marine Department. To identify, fish cage farming in the river can deter the water channel, so farmers must be charged by local organizations following the 63rd and 64th navigation acts in Thai water ministerial regulations established in 1993. According to the information, fish cage farmers in upstream villages would be charged around 50 baht per square meter by municipal offices. This policy accompanies the 2011 Public Aquaculture Criteria released by the Department of Fisheries. This regulation has various practical ways for fish cage farmers. They, however, could not follow all of the criteria because of climate-related risks affecting their production. Several farmers had to move their cages to a water-sufficient area at the center of river channel or opposite the riverbank. This announcement, besides, had attempted to limit the amount of cages in area while farmers have to expand their enterprise. Under those pressures, fish farmers in Ban Koh and Hua Kuang villages had disagreed with the tax and zoning policy of the aquaculture

criteria. They stated that fish farmers would subscribe to those actions of the departments if they received financial compensation in disaster events and obtained enough assistance from the fishery office. These reasons brought about the discontinuation of farmer registration in Hua Kuang village in order to prevent illegal action against them. This continuation was actually advised by the fishery office. Ultimately, tax policy and aquaculture criteria were not approved by fish farmers and were cancelled (table 3.8).

3.3.3 Internal Relations and Management

Above and beyond external relations of farmers to related stakeholders, internal relations and management in the level of village is also important. According to the results, internal relations tend to be partially useful for fish cage farmers and impact as socio-economic risks to a few farmers. They could exchange knowledge, learning methods, and workforce among each other, but financial exchange and assistance among them have been rarely investigated. Nevertheless, each village has a different structure of internal relations and management.

Following the background of fish cage farming in Ban Koh village, the competitive state among farmers was found to lead to the collapse of the fish farming group. However, they still joined together as sub-groups to access loans for starting individual production. Besides this, they also helped each other by sharing the workforce, exchanging knowledge in their sub-group, and obtaining the information from fishery volunteers of the village. To identify, the relationship among fish farmers is an informal collaboration. They tend to assist farmers within their sub-group before helping other people. Farmers who intimate with fishery volunteers may attain faster news and information on the one hand. Most farmers in this village said that they could not live alone without colleagues because it would affect the labor workforce in the heavier work in fish cage farming such as moving and fixing cages, harvesting fish, and so on. Farmers all sub-groups, further, have sometimes grouped for negotiating with irrigation departments to drain more water into the river channel. Each farmer, anyway, had full rights to select fish companies in contractual relations, define the feeding period, and manage their in own farm. In sum, internal relations in Ban Koh village were not

obstructed by socio-economic risks to fish cage farmers. However, the relationship between farmers and local fishery office was not much observed.

Table 3.8 Public Aquaculture Criteria 2011

Topic	Issues
Infrastructure and Basic Factors for the Production	Has enough infrastructure, live near breeding sources, has aeration system in normal and emergency events
Environmental Problems	Should be far from community, industrial estate, chemical contamination area, water sources of waterworks system at least 200 meters, use environmental-friendly materials
Social Problems	Do not make nuisance to other water users Do not live in prohibited areas,
Water-Related Problems	Has good water quality for aquaculture, not obstruct water transportation, not retard irrigation drainage system
Fish Farming Factors	<ul style="list-style-type: none"> - Cage areas can cover only 2 per cent of flowing water areas, and 0.25 per cent of closed water bodies - Length of fish cages must be below 60 meters and not cover more than one-third of river channel. - Farmers can lay cages only in 2 rows, and must leave at least 3 meters between the next cage - Each pillar must be far away at least 3 meters - Do not build permanent house/shelter on cages - Install lamps to lighten for boat transportation - Control medical and chemical uses in optimum rate - Feed in optimum density - Dispose rubbish properly - Do not carry alien species to feed - Clean all cages every 30 days - Inform statistics information to fishery officer

Source: Department of Fisheries, 2011

Fish cage farmers in Hua Kuang village and nearby villages had informal collaboration as Hua Kuang village fish farmer association. This group consisted of the headman and the secretary who took charge as the acting headman to work with all farmers and local fishery officers. Any assistance from the local fishery officer had passed through the secretary. Like Ban Koh village, various assistances and information coming to the village were transferred firstly to Northern 2 zone as the secretary lived here before spreading to the other villagers. Internal relations in exchanging knowledge, techniques, and workforce were based on the relatives and friends network. However, all farmers in the village had explicit trust in his responsibility. To conclude, the relationship among farmers tended to encourage fish cage farming in a positive direction rather than being socio-economic risks for them.

In Pradang village, although some conflicts from fish farming group production at an earlier time dictating that fish cage farmers operate individual farms and individual conflicts appeared, internal relations in this village were likely to be helpful and advantageous for fish cage farmers and might have been the best internal relationship compared to all villages. All farmers in the first generation of the village had collected experiences, techniques, and learning methodologies from the group before beginning individual operations. This informal collection of farmers in Pradang village had to be secure enough because the connection between farmers and the Department of Fisheries was only at the beginning stage. Moreover, when they had encountered some exploitative issues, they could participate as a farming group and deal collectively with fish companies because most farmers had subscribed to the same company and some similar problems may have occurred.

In Ban Mai village, most fish cage farmers had operated their production at the great river bend before it was improved by local politicians to prevent riverbank erosion. In the past, those farmers helped each other in technical assistance and workforce. However, the good internal relationship tended to decline when several farmers stopped their production because of severe climate-related risks after the riverbank improvement. In other words, individual problems which were related to the assistance between the old fishery volunteer and other members occurred in the river bend area

after the 2011 massive flood due to the urgent shocks. Those farmers, thus, had to separate in different ways; one of them relocated cages outside of the river bend area and stopped the operation at a later time, and the fishery volunteer had been changed to a new person in the river bend area. That partisanship had led to unequal distribution of news, information, and benefits among them. Some farmers thought that this situation occurred because they were jealous of each other in a strong competitive state of intensive production. Some of them needed more profit than the other farmers and wanted to be the head of the village. It had also become risks for one of the farmers, but turned to another farmer as the new head, who could reduce risks by suitable access to information and techniques. Later, the natural disaster community which was established after the massive flood, became the first formal collaboration of farmers who were still operating fish farming. This community had been set up by the command of the village headman and provincial fisheries and other related offices to officially and reliably obtain financial compensation in disaster events. All farmers in the community had to inform the amount and date/time to the secretary after they had released the fingerings. In further examination, risks from internal relations may have decreased after this association. Internal conflicts in the village, yet, tended to make massive socio-economic risks to one farmer to stop the production.

When exploring the villages, each had different socio-economic risks due to the relevant stakeholders and their actions to obstruct fish cage farming benefits. In terms of company exploitation, most farmers in Ban Koh village and Pradang village dealt with less quality of fingerings, change of contractual agreements, insufficient after-sale care, and overdue catching. Following those issues, the profit in fish farming declined because each crop was prolonged, so they had to spend more on feed despite the fact that some farmers gained a satisfied productivity. Besides, upstream villages attained less financial aid in disaster events, struggled with registration continuation problems, and were pressured by tax payment requirement from local authorities. Internal conflict, to date, was discovered in Ban Mai village which entailed unequal distribution of state benefits to farmers, less internal assistances, and a competitive state among fish farmers, but this conflict has not been as severe in recent years and not affected all farmers. In Hua Kuang village, socio-economic risks were slight compared to other villages

because the fishery officer and farmers had still assisted each other in related information and coordination with the irrigation office although they discontinued the registration and had never received financial compensation from the department.

To evaluate the regular benefit loss in fish cage farming by socio-economic risks, farmers in Ban Koh village and Pradang village had moderate to high socio-economic risks as fish cage farming now is under contractual relations and most of them had previously been highly exploited by the fish companies. The extension of the official unit, besides, had scarcely appeared. But the great collaboration in Pradang village partly reduced some risks by dealing directly with the fish company (table 3.9).

Table 3.9 External socio-economic risks in the village

Problems Sites	Level of Risks	Main actions and stakeholders	Important Consequences as External Risks
Ban Koh	High	Company exploitation, Dysfunctional cooperation among official units	Less quality of fingerings, change of contracts, registration discontinuation, no compensation for any disaster events
Hua Kuang	Moderate -Low	Official aids in financial benefits	No compensation for any disaster events, tax requirement for fish cages
Pradang	Moderate -High	Company exploitation, overdue catching, less cooperation with fishery unit	Less quality of fingerings and after-sales services, overdue catching, no registration
Ban Mai	Moderate	Internal conflict	Unequal distribution of state benefits and internal assistance, competition state among fish farmers

3.4 Internal Exposures of Socio-Economic Risks

Socio-economic risks received by each household were not equal due to the selection of contractual relations subscribed to as internal exposures to fish cage farmers' household. Each company offered different conditions related to variable costs, financial payment system, fish prices, size standardization and selection, catching date and amount, market availability, after-sale services, and quality of technical suggestions. Each farmer joined contractual relations with a distinctive number of companies, financial purchase systems, and self-relationships because they needed to distribute risks in the market aspect, production factor availability and cost, and services. Selecting what and how many companies were involved in the production was up to individual trust and social relations (table 3.10-3.11).

Table 3.10 The amount of contractual company selected by fish cage farmers in each village

Category Site	Independent Farmer	Contractual Relations (companies)		
		One	Two	More Than Two
Ban Koh	0	6	2	3
Hua Kuang	0	8	3	0
Pradang	0	9	2	0
Ban Mai	1	5	3	0

Table 3.11 Financial system in contractual relations by types

Type Site	Full Cash	Partial Credit	Full Credit
Ban Koh	0	11	0
Hua Kuang	3	7	1
Pradang	0	11	0
Ban Mai	3	6	0

According to the results, most of them (41 of 42 farmers) had subscribed to contractual relations. Approximately 67 percent of all farmers (28 of 42 farmers) had chosen to contract with one company. The rest of them had subscribed to two companies or more. The reason why some farmers had decided to engage with many companies was to distribute the risks in quality of fingerings, feed price, fish price, and distribution system to the market among fish companies. The difference in company numbers, however, was not as important as financial credit systems. Interestingly, more than four-fifths of the farmers (35 of 42 farmers, 83.33%) had operated fish farming by purchasing on partial credit or an insurance system which farmers had to deposit some money around one-fifth of the total feed cost before starting each crop and receive the excess profit after selling the fish in each crop. Nearly one-fifth of the farmers used full cash to access all production factors. In that case, farmers could reduce additional feed costs which were added to the partial credit system. As most of the fish farmers who selected the full credit system were from medium and large-scale farming households, they tended to have more power to access various sources of fingerings and medical supplies to avoid quality problems. Following the analysis, more than half of all the farmers were likely to join in the partial credit system with one company, and this group tended to gain the most risks in socio-economic issues especially farmers in Ban Koh and Pradang villages. In contrast, farmers selecting more than one company with the full cash system partly had better opportunities to avoid socio-economic risks in contractual relations. The amount of farmers in this group, nevertheless, was very small compared to the major group.

Contractual relations had exerted the most important consequence to fish cage farming in socio-economic terms of both internal exposure and external hazards because production factors gain, market system, and income which were significant elements of intensive production mostly came from the fish companies. In this research, thus, socio-economic risks tended to be mostly influenced by the economic-financial system aspect of the production which is related to demand-supply and price fluctuation in market sphere and the business agreement between farmers and fish companies. Although state participation and internal management were partly supported in the negotiation for some financial and social disadvantages of production and basic benefits that the farmers

should obtain, those two factors had less of an effect in earning massive income and played a minor role in fostering the sales process that could provide financial revenue. And this was an essential tool to sustain the fish farmers' life and expand the operation in a capitalist society.

3.5 Multiple Risks

Multiple risks from climate-related variability and socio-economic stresses had been displayed as production failure caused by massive or chronic fish death and disease, as well as low production amounts compared to the time and production factors spent in each round. This effect led to low profits, high losses, and also debt accumulation among fish farmers to the fish companies. Financial loss from production failure was also affected by cage location and the effects of contractual relations in each household (figure 3.8). Multiple risks, thus, must be assessed at either the village or household level.

Firstly, multiple risks were evaluated by massive fish death, financial losses, and socio-economic exploitation in the village level (table 3.12). Climate-related risks, as a result, were likely to influence most villages rather than socio-economic risks except in Pradang village. Following the results, fish farmers in Ban Koh village received high multiple risks affected highly by both climate-related and socio-economic risks. Many problems from both these aspects – very low fingering quality, massive fish death in monsoon season, chronic death in the first rainy peak and winter, loss of power in negotiating with fish companies, and discontinuation of registration – became more risky to most farmers. In the meantime, fish cage farmers in Hua Kuang village and Ban Mai village experienced moderate-high multiple risks particularly in climate-related risks – weir failure, loss of suitable area for feeding, and chronic and immediate fish death from extreme drought and hot temperature. Pradang's farmers, however, perceived moderate multiple risks and which tended to be derived from socio-economic risks – exploitation of fish companies in overdue harvest, fingering quality, and after-sale service – rather than climate-related risks. This result is also fundamental to the household risks analysis which is the main unit of analysis.

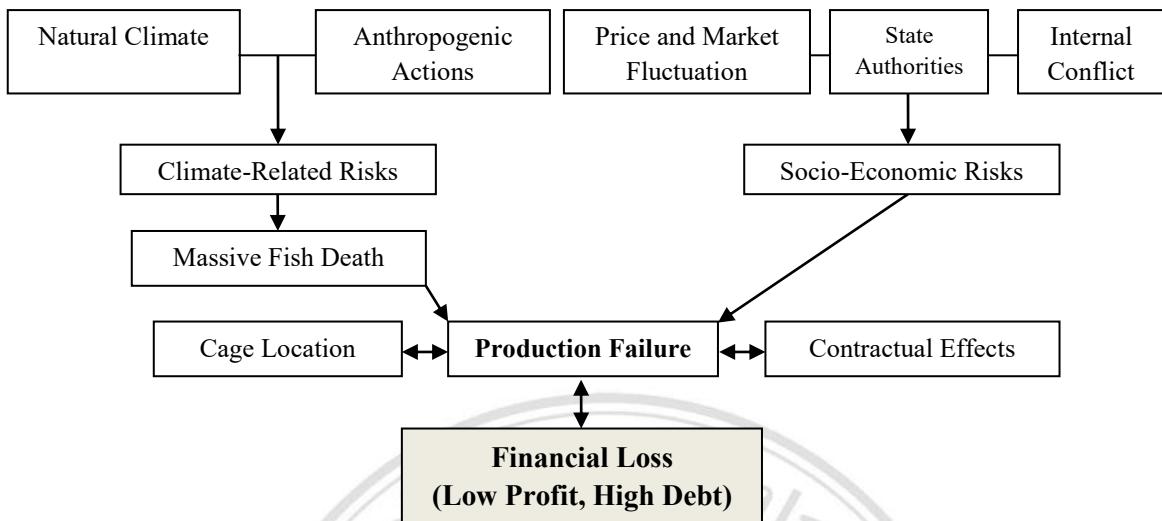


Figure 3.8 Multiple risks in fish cage farming

Table 3.12 Level of multiple risks in fish cage farming by village

Type Site	Climate-Related Risks	Socio-Economic Risks	Multiple Risks
Ban Koh	Moderate-High	High	High
Hua Kuang	Very High	Moderate-Low	Moderate-High
Pradang	Moderate-Low	Moderate-High	Moderate
Ban Mai	High	Moderate	Moderate-High

Secondly, internal climate-related and socio-economic exposures are very useful to classify multiple risks of households. According to risk analysis together with internal exposures, nearly four-fifths of the fish cage farmers' households particularly in Ban Koh, Ban Mai and Hua Kuang villages were faced with high (38.10%) and moderate (40.47%) multiple risks. And this was intensified by exposed conditions particularly cage locations which were quite different among farmers rather than payment systems. Nine of the eleven Ban Koh farmers' households had acquired high risk. An equal numbers of farmer in Ban Mai village had attained high and moderate risks on the one hand. Most households in Hua Kuang village, on the other hand, had evidenced moderate risks. In contrast, eight of the eleven farmers in Pradang village had not been much impacted by multiple risks, and they were the major group of low-risk fish farmers in the Ping river basin (table 3.13).

Table 3.13 Numbers of fish cage farming households by level of multiple risks

Type Site	High Risk	Moderate Risk	Low Risk
Ban Koh	9	2	0
Hua Kuang	3	8	0
Pradang	0	3	8
Ban Mai	4	4	1
Total	16 (38.10 %)	17 (40.47 %)	9 (21.43 %)

3.6 Conclusion

The fish cage farmers had struggled with multiple risks since the beginning of the production. Those risks especially climate-related disturbances had intensified after the massive flood in 2011. Irrigation systems in each sub-basin are the most important anthropogenic factor in controlling and changing natural-induced external risks as the results have been illustrated. Besides, internal exposures from cage location is another essential determinant in differentiating climate-related risks in each household. Socio-economic risks had been mostly influenced by the interaction of contractual relations, demand-supply and price fluctuation in the market sphere as fish cage farming nowadays is an intensive production. Participation of state authorities and internal conflicts had chiefly exerted socio-benefit losses rather than income deficit. Financial losses are the major element to consider in measuring production failure from multiple risks. Most fish-farming areas had moderate to high multiple risks induced by climate-related risks rather than socio-economic risks. Farmers having high multiple risks were explicitly caused by locating cages in the most exposed areas of high climate-related risk villages, subordinating to only one company by partial credit system which provide low-quality fingerlings, and having overdue harvest and strict size selection. Each household, however, may had a different level of vulnerability from mitigation of the climate-related risks and the fundamental livelihood characteristics related to household burdens, occupational diversification, and access to capitals in reducing or increasing these multiple risks affecting fish cage farming and household livelihood existence.

CHAPTER 4

Multiple Household Vulnerability

In the previous chapter, multiple risks were described and classified in village and household levels related to fish cage farming. External hazards as risks at a community level such as climate-related (natural climate and disaster patterns, flood prevention policy, and irrigation systems) and socio-economic risks (demand-supply and price fluctuation in market spheres, participation of state authorities, and internal relations and management) were analyzed qualitatively on the one hand. Internal exposures in a household, on the other hand, only focused on cage location and contractual relations which are fundamental factors in fish cage farming. According to risks in fish cage farming, they had to find some pathways to physically mitigate the risks. As a household does not rely on fish cage farming as such, moreover, other factors in the household provide livelihood. The previous chapter, however, did not provide a clear enough picture of the means of different capacities in household existence.

This chapter on multiple household vulnerability, attempts to provide deeper and wider perspectives in both fish cage farming and livelihood of fish cage farming households. It is observed by households' sensitivities by means of current household demographic structure, occupational diversification in rural changes, risk perception, as well as access to capitals in other related economic activities and techniques in fish cage farming. To clarify different multiple household vulnerability, the interaction between production sizes particularly in fish cage farming and levels of mobility are very essential to investigate. This section adopts qualitative analysis with basic quantitative data to demonstrate vulnerability in a more concrete sense.

4.1 Production Sizes and Multiple Risks in Fish Cage Farming

Fish cage farmers are fundamentally divided into three groups according to production sizes – large, medium, and small-scale households. The major criterion to classify

production sizes depends mainly on the amount of cages, their areas, and other assets in fish cage farming. As is illustrated in the table 4.1, cage areas per household tend to overlap in regard to production sizes because some farmers had increased or reduced their cages afterwards. This research, anyway, tends to classify production size of fish cage farming at the beginning to understand the dynamics of vulnerability in all of the perspectives.

Land size in farm production and other assets owned by a household, besides, are considered because fish cage farming is just a part of the economic activities in most households. Following the classification, there are 13 large-scale, 17 medium-scale, and 12 small-scale farming households which owned different sizes of cage areas – 345.85, 205.06, and 89.92 m² per household or 19.21, 11.39, and 5.00 cages in average calculated by an 18-square-meter cage. This classification is different due to production sizes of the population in each village. Cage areas of large and medium-scale households in Hua Kuang, Pradang, and Ban Mai villages are not much different compared to small-scale households, and also overlapped. Fish cage farmers in Ban Koh and Hua Kuang villages, in other words, were likely to have had larger cage sizes than midstream and downstream villages.

Table 4.1 Farmers by production sizes and average cage areas per household
at the beginning time of studying

Site Size	Farmers in Each Size			Range of Cage Areas per Household (m ²) and		
	Large	Medium	Small	Large	Medium	Small
Ban Koh	3	4	4	336-724	200-270	36-138*
Hua Kuang	4	4	3	360-640	224-448	128-288
Pradang*	3	5	3	180-216	108-216	72-288
Ban Mai	3	4	2	90-468	108-180	36-63

Note: Some of them also join as a member of SML fish farming group.

According to the result of multiple risks of fish cage farming in each household, a major amount of farming households in all production sizes tended to have moderate to high multiple risks. Medium-scale farming households had a bit lower multiple risks for

some farmers, but received high multiple risks in greater proportion than other groups. All small-scale farming households in Ban Koh village had high multiple risks. These groups in Hua Kuang and Ban Mai villages received moderate multiple risks compared to large and medium-scale farming households which were affected slightly higher (table 4.2). This relationship, anyway, cannot reflect much difference among production sizes because various mitigation strategies of farmers were not deployed enough to differentiate vulnerability. Their mitigation pathways in climate-related arenas and household-related factors in socio-economic terms, to identify, have to be added for deeper analysis.

Table 4.2 Multiple risks of fish cage farmers by production sizes

Site Size, Risk	Large-scale households			Medium-scale households			Small-scale households		
	High	Mode -rate	Low	High	Mode -rate	Low	High	Mode -rate	Low
Ban Koh	2	1	0	3	1	0	4	0	0
Hua Kuang	1	3	0	2	2	0	0	3	0
Pradang	0	1	2	0	1	4	0	1	2
Ban Mai	2	1	0	2	1	1	0	2	0
Total	5	6	2	7	5	5	4	6	2

4.2 Current Household Demographic Structure

To begin with, household demographic structure is the important element in rural changes that explains the composition of household members related to generation, age and dependency status, amount of household members, gender, and educational status. General demographic and generation structures can fundamentally be classified by household characteristics (figure 4.1). Over half of the fish farming households (54.76 %) were two-generation households which were composed of parents and offspring. Other household characteristics were three-generation (21.43 %), one-generation (11.90 %), skip-generation (9.52 %), and single member household (2.38 %) (table 4.3). Many

large-scale farming households (9 of 13 households) and half of medium-scale farming households (9 of 17 households) were two-generation households. Small-scale farming households, however, had various patterns of households except single member household. Interestingly, three of the four skip-generation households in this study were small-scale farming households. Some relationships in basic structure of household with production size were revealed. Age, dependency status, gender, and educational status have to be proved further.

In a household, age and dependency status are very important in division of household labors. In Thailand, labor between at the ages of 15-59 years old is the main workforce in all production sectors. Children or offspring in the educational system at any age, however, are also counted as a dependency age because they cannot create any income, and they are still funded by their parents or grandparents. Elderly people are sometimes as dependency status when they have no occupation. Deformed people and crisis patients who are not be able to work are also in the dependency status.

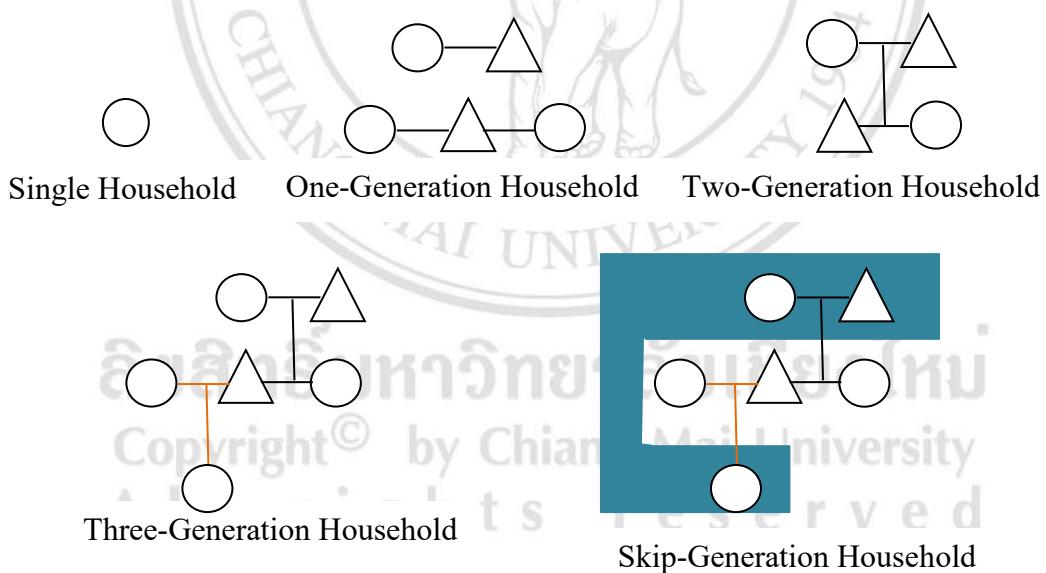


Figure 4.1 Different types of household characteristics (adapted from Nipon, 2011)

Table 4.3 General demographic structures by household characteristics

Demographic Structure Site, Size	Single	1-Gen.	2-Gen.	3-Gen.	Skip-Gen.
Ban Koh		1	3		
			2	2	
			2		1
Hua Kuang			2	2	
			4	1	
			1		1
Pradang		1	3		
			1	2	
			1	1	1
Ban Mai		3	1	1	
			1	1	
			1		1

In general, most of the farmers in all research sites tended to be middle-aged people. The range of fish cage farmers' age was from 33 to 67 years old. Three quarters of the household members who were responsible as fish cage farmers were seniors or late-middle aged people with the average age of approximately 52.63 years old. The rest of the farmers were elderly and middle-aged people (table 4.4). Most fish cage farmers in upstream areas, besides, had started fish cage farming earlier than in downstream and midstream areas. In the upstream villages, farmers had begun their production at around the average age of 41-42 years old, while farmers in downstream and midstream were elder than upstream farmers at the beginning (47 and 51 years old).

Table 4.4 Age of a household member who is responsible as fish cage farmer

Age Site	Average Age (years)	Middle-aged (<45)	Senior (45-59)	Elderly (>=60)
Ban Koh	51.67	0	11	0
Hua Kuang	51.55	2	7	2
Pradang	54.73	1	7	3
Ban Mai	52.67	1	6	2
Total	52.63	4	31	7

The number of household members and their age are important in visualizing how many people can be engaged as labors in a household and the labor market. The assessment of workforce in a household, indeed, is investigated by age, dependency status, and gender. Household characteristics are also related to age, gender, and dependency structures, and basically, can define significant relationship to household burdens in different sizes of production. Following the analysis, there are several important factors to classify the sensitivity in household characteristics ordered by burdens – workforce ratio, children burdens, and the elderly. Three-generation and skip-generation households tended to have more of a dependency ratio from children (2 and 1.5 dependent persons per household). Skip-generation households, however, had the least number of workforces (2.25 persons) compared to three-generation households (3.44 persons) and other types of household characteristics. Meanwhile, one-generation households and single member households had no dependency burdens, but they had totally to find income sources by themselves without any offspring to help. In sum, skip-generation households became the most sensitive unit because they had to carry the burden of more dependent persons with a smaller workforce in a household, while other household characteristics had more of a workforce to subsidize dependency age in a household or had less dependency age although they had less workforce (table 4.5).

Table 4.5 Average numbers of household members, dependency, and workforces per household by production size

Household Characteristics	Number Household	Member (person per household)	Dependency (person per household)	Workforce (person per household)
Single	1	1.00	0.00	1.00
One-generation	5	2.40	0.00	2.40
Two-generation	22	3.47	1.04	2.43
Three-generation	9	5.44	2.00	3.44
Skip-generation	4	3.75	1.50	2.25
Total/Average	42	3.74	1.14	2.60

Following the analysis of production size, there are several relationships that appeared in the household structure. Following the results in table 4.6, the average number of household members was around 3.74 person per household with more women than men (2.07 and 1.67 person per household). Workforce ratio from a gender perspective at average was nearly equal between men and women (1.31 and 1.29 person per household) in all production sizes. Medium-scale households had fewer members than other production sizes. Large and medium-scale households, meanwhile, had more of a workforce ratio (workforces: total household members) compared to small-scale households (1:1.32, 1:1.42, and 1:1.63).

Table 4.6 Average household members and workforces by production size

Size	Members			Workforce (person)		
	Total	Male	Female	Total	Male	Female
Large	3.85	1.54	2.31	2.92	1.46	1.46
Medium	3.42	1.71	1.71	2.41	1.24	1.17
Small	4.08	1.75	2.33	2.50	1.25	1.25
Average	3.74	1.67	2.07	2.60	1.31	1.29

To deal with age and dependency burdens in children, elderly, deformed, and the incapacitated person, total dependency age in small-scale farmers was the highest number (1.58 person per households) compared to medium and large-scale households (1.00 and 0.92 person per household). Medium and small-scale households still had children burdens more than the large-scale households (70.59, 69.23. and 46.15 per cent of all households in each production size). More interestingly, small-scale households had more children burdens when assessed by the number of children (1.78 persons per household) compared to medium and large-scale households (1.25 and 1.16 persons per household). Elderly people, to identify, are not very problematic in households nowadays. Large and small-scale households had the highest proportion having at least one elderly (6 of 13, and 4 of 12 households). Most elderly in those households (11 of 13 households which have at least one elderly) still had an important role in the workforce. Their responsibilities in households, nevertheless, were totally embedded at home and they did not move elsewhere. Deformed people and patients in four households, to date, were not essential when comparing differences in production size.

Classified by production sizes, it is obvious that small-scale farming households were the most sensitive group in the low workforce ratio, and had more dependency burdens including children' burdens in education and elderly limitations in working. The analysis of household characteristics, anyway, is just an overview to illustrate household sensitivity in each production size. Each household, to define, still had different details in issues mentioned earlier. And in addition, household characteristics analysis must join with occupational diversification in current situations to entirely understand the pathways used to access financial, social, and cultural capitals of each household.

4.3 Occupational Diversification

Diversifying occupation, nowadays, is a very normal phenomenon in rural changes as a way of finding additional sources of income, external social networks, and cultural capitals including working skills and experiences. Each household, to highlight, usually revealed as labor division by age, gender, and specialty of each person from different occupational backgrounds. Most of the fish cage farmers in the research sites (39 of 42 farmers or 92.86 %) had more than one occupation in the household. According to the

time spent in economic activities and revenue earned among household members, fish cage farming households were based on both farm and non-farm production in nearly the same amount (18 and 16 from 42 households). Some households (8 of 42 farmers) could not identify as being farm or non-farm households. Sixteen of the forty-two farmers (38.10 %) stated that the income from fish cage farming was the main source, while the rest thought that it was an additional work to share household income sources. These proportions, significantly, were nearly scattered in all production sizes.

According to various occupations among the fish cage farmers, this research estimates roughly the share of profit in agricultural production and fish cage farming in the two previous crops including the recent crop. Non-farming activities could be assessed by an approximate total income per year. In the case of large-scale farmers, they could diversify the income by owning larger land size (13.54 rai per household) and earning more savings. Most large-scale farmers (11 of 13 farmers) had engaged in fish-farming, farm and non-farm production as contractors in the construction sector and as monthly employees, while some medium and small-scale farmers tended to have another occupation in non-farm activities rather than farm production because those farmers had less land size (5.53 and 5.02 rai per household). The workforce amount in the large-scale household and effective household characteristics (two-generation household) which were found to be the most in this group, to identify, may have had greater variations to foster in occupational diversification.

Farm-based households particularly rice and longan production, however, have tended to receive fluctuated and lower income in recent years from the failure of the rice mortgage policy (high prices in summer 2013 but lower twice in winter 2013 – summer 2014) and a lower amount and price of longan in the northern part of Thailand. In contrast, daily wage labors were likely to have higher wages (at least 200 baht per day) from the government policy increasing the minimum daily wage. Contractors in the construction sector had more burdens in their production from the daily wage increase. Occupational diversification, however, could not be used to investigate and assess the level of sensitivity because each occupation made a distinctive level of capital in different capacities, and risk perception also varied in fish cage farming.



Figure 4.2 Flying lantern business as an alternative occupation in Ban Koh village



Figure 4.3 Sugar cane plantation in Ban Mai village

4.4 Risk Perception in Fish Cage Farming

The following three major climate-related risks: the interaction of natural and anthropogenic changes in flood prevention policies and irrigation systems, drought and hot temperature, cool/cold temperature, overflow and heavy rainfall in monsoon season, and various actions bounced by climate-related risks, fundamentally, were directly correlated with the perception of most farmers in Ban Koh, Hua Kuang, and Ban Mai villages. Most of the farmers in these three villages had explicit concerns about the climate-related consequences. Several farmers in Pradang village, in the meantime, also recognized climate-related risks as instigating important damages in the production despite the fact that this village was affected in a moderate-low level. Socio-economic risks, in another word, had sometimes worried the farmers particularly in regard to price fluctuation and market demand. They, by the way, expressed that market-related factors in fish cage farming had already been controlled and managed by the fish companies. Realizing that socio-economic risks had become a main threat to fish cage farmers' perception, following the analysis, and take place frequently often causing massive fluctuation and production failure damages to their business. This perceptual function, thus, probably leans more toward instability of climate-related factors from natural and anthropogenic actions instead.

Each household had perceived and recognized a different climate-related awareness thanks to distinctive external hazards that occurred in the village, internal exposures in the household level, as well as different experiences encountered by each farmer by the effect of distinctive levels of damages and failures. Following their attitudes, major perception of risks, nowadays, are affected by drought with extreme (hot) temperatures, and overflow/flood in monsoon season. Farmers' perception may have shifted a little bit according to disaster situations in each season. Those concerns about drought, nevertheless, had been emerged significantly after the failure of irrigation-related authorities to monitor and prevent flooding impacts. A major proportion of the farmers in all research sites tended to be aware of climate-related risks after experiencing external hazards and internal exposures at first. Internal exposures were likely to collaborate with external hazards to reflect risk perception in Ban Koh and Pradang

villages as they have also received multiple effects from both overflows which were the main disasters in this village and drought which had just occurred in the last two years.

“Water was not much this year. This year was the worst drought year. It is dry now. ... Anyway, if overflow is too extreme, I have to reconsider what I should do because fish cage farming has become the [main] occupation of my household. If I stop to feed, I will not stop for a long time; maybe only two months (August to September)” (a large-scale farmer in Ban Koh village, 6 June 2013).

“The most dangerous period is overflow. Rain comes in September to October. There were big floods in the last two years...Drought, however, can be found every year, but it is quite severe this year” (a large-scale farmer in Pradang village, 14 July 2013).

External hazards, in contrast, caused a similar awareness among farmers in Hua Kuang and Ban Mai villages rather than internal exposures from changing fish farming environmental infrastructures. After the weir failure in Hua Kuang village and riverbank improvement in Ban Mai village, most farmers suffered by drought and extreme temperatures. Before those infrastructures had exerted some influences on fish cage farming, overflow was a concern of the farmers as they were never faced with severe drought in the past.

“Water is very low, and it is a drought now. So, I feed haphazardly (laugh). What can I do? I have already released fingerlings before water dropped. In the past, water was much more than now. Our weir has been collapsed for years. If the weir was good, the situation would not be like this because water might be saved by the weir” (a medium-scale farmer in Hua Kuang village, 13 February 2013).

“Once I had farmed here. Now the water is quite dry, so I moved my farm to operate over there. After the authority improved the riverbank, I had to relocate again. It was very inconvenient to feed” (a large-scale farmer in Ban Mai village, 12 July 2013).

Risk perception among households in all research sites, nevertheless, was not strongly linked with production sizes, but it was likely to be influenced by cumulative self-assessment and effects in general contexts of villages at that moment. Fish cage farmers, in addition, had observed the situation of others and exchanged risk perception among themselves in the village. The most risky disaster to fish cage farming is directly supported by a lack of physical capacity and knowledge to resolve climate-related problems, as well as the effects of production failure in the past concern of the individual. It is very important, hence, to reconsider different adaptive capacities in terms of fish cage farming by knowledge and techniques from individual and collective actions to understand further the relationship between risk perception and the participation of farmers in their society.

Fish cage farming techniques in mitigating climate-related risks has been constructed in different time durations and types of disasters. It has noticeably impacted risk reduction in the production. A cumulative learning system from iterative actions in climate-related and geographic features is an important tool to adjust to risks. Each individual has to perceive their environments through the knowledge from related stakeholders in order to correct the manifold problems and thus improve the chances of securing a major reduction of elimination of risks. Qualified knowledge can reduce production failure in either fish killing or profit losses. Techniques in fish cage farming can be divided into five types: urgent solutions, physical innovations, landscape changes, feeding patterns, and feeding durations. Those issues, to date, are accompanied by individual and collective actions. Techniques in reducing risks in fish cage farming can be accessed through financial, social, and cultural capitals of different production sizes.

4.5 Access to Capitals in Occupational Diversification and Techniques in Fish Cage Farming

This is a major part of this chapter showing the ways farmers accessed financial, social, and cultural capitals from various occupations of household. This issue is very important to connect the understanding of risk perception to the access of fish cage farming techniques by these three capitals as well.

4.5.1 Financial Capital

Financial capital can be evaluated by profit and revenue share from all three sectors, as well as savings, debt, and land size in each household. This issue is the most important element in recognizing the accumulation of capital for investment in occupations and other assets. To assess income by the fundamental estimation from productivity, cost, and income in farm and non-farm production (table 4.7), large-scale farmers had the highest income both from farm and non-farm occupation. Most large-scale farmers earned the mass of their main income from non-farm occupational sources (five households, at least 300,000 baht per year) particularly as contractors in construction sectors and from monthly income, farm production (three households, at least 200,000 baht per year), and fish cage farming (three households, from 100,000-500,000 baht per year).

Table 4.7 Average household income in farm and non-farm production
from basic estimation (baht per year)

Occupation Size	Farm	Non-Farm	Total*
Large	125,833	202,500	303,077
Medium	84,500	164,286	185,000
Small	95,714	158,333	174,583

Note: Total household income is the total average, while farm and non-farm income are calculated in only some households which have done the occupation.

In fish cage farming, the estimation of revenue could not be calculated exactly because fish cage farmers sometimes could not remember the actual profit or loss in all crops. The number of crops of each farmer was also not equal. Besides, each crop had different amounts of fingering release and death. Thus, this research tries to provide cumulative profit trends of fish cage farming households in each group of production sizes based on some parts of the information obtained. In the village view, most farmers in Pradang village (8 of 11 farmers) still had some profit from fish cage farming. In contrast, farmers in Ban Mai village tend to financially lose in recent years (6 of 9 farmers).

Farmers in Ban Koh village and Hua Kuang village, meanwhile, tended to procure varied amounts in low profit, no profit, and low financial loss.

In the perspective of production sizes in intensive fish cage farming (table 4.8), this product is mostly based on financial capital rather than assets, particularly land. Thus, capital had a lot of influence on changing the total income of households varied by production sizes. Many large-scale farmers (8 of 13 farmers) and some small-scale farmers (5 of 12 farmers) tended to have low biannual cumulative profit. However, large and small-scale farmers were quite different in the number of fish cage farmers who lost their income in fish cage farming. Medium-scale farmers, unfortunately, were the most sensitive group in fish cage farming income as most farmers (13 of 17 farmers) had had no profit or low to high financial losses in recent years. The phenomenon among medium-scale farmers can be described as such; that many farmers in this scale had been affected by severe internal exposures: a lack of individual checking in their farms and with contractual fish companies, a lack of experience as they had just begun the operation, and less engagement and participation in collective actions among other fish cage farmers in reducing climate-related risks.

Table 4.8 Cumulative profit trends compared to total variable costs by production sizes

Trend Size \ Trend Size	High Profit	Low Profit	No Profit	Low Loss	High Loss
Large	1	8	1	1	2
Medium	0	4	3	5	5
Small	1	5	1	4	1

After combining an estimate of all the above factors, financial wealth accumulation of a household can be explained that the large-scale households tended to have higher a security of financial capital than the medium and small-scale farmers which had similar financial behaviors. Large-scale farmers had low financial sensitivity because they had higher profits and income than other groups although they had some debt. In the meantime, medium-scale farmers did not earn much high financial capital because they

had more financial losses from fish cage farming. In the case of small-scale farmers, they received less money from fish cage farming because of their small production size although they still had some profit (table 4.9). It is interesting that social and cultural capital is also involved with sensitivity analysis in access to capital.

Table 4.9 Financial capital security among fish cage farming households
by production sizes

Security Size \	High	Moderate- High	Moderate	Moderate- Low	Low
Large	6	6	0	1	0
Medium	0	2	8	5	2
Small	0	1	5	5	1

Financial wealth accumulation from various and intensive sources of income became a useful function to physically mitigate the problems in fish cage farming by various short-and-long-term techniques. According to financial capital illustrated above, large-scale households who had massive income and savings could financially access qualified techniques in risk reduction. Expensive physical innovations to reduce climate-related risks such as the water turbine, box cage, strong cage, and triangle head preventing strong overflow and debris were accessed first by large-scale farmers (figure 4.4 – 4.5). Use of expensive remedies in urgent solutions could be quickly applied by large-scale households as well. They were also capable to invest in improving landscape for fish cage farming by cage relocation, river dredging and terrace improvement. Medium and large-scale households could also feed more crops and sell many times in a season to diversify climate-related risks by ordering more than one generation of fingerlings as they needed a more massive amount of fish than small-scale households. Although larger production sizes mostly illustrated in financial dimensions could foster the survival of large-scale households in upstream villages (Ban Koh and Hua Kuang villages) to ameliorate climate-related risks, it cannot entirely assist in case of large-scale households in the midstream and downstream sections as social and cultural capitals also played great roles in decreasing climate-related risks.



Figure 4.4 Water turbine system in Ban Koh village



Figure 4.5 Fish cage farming in *muang* canal in Ban Koh village

4.6.2 Social Capital

In each occupation, social capital can be replaced by social networks which guarantee the interaction of people in different areas, status, and occupations. Social networks can be a good social capital when it advocates several societal advantages to household economic activities to earn other capitals. To begin with, village-based social capital is quite important for farmers as they had been settled in the village for a long time and developed cousin-based, neighborhood-based, and acquaintance-based relationships. Farmers can benefit from those groups in cultural and labor perspectives. They, basically, can share their knowledge, methodology, and information, exchange their household labors helping in various kinds of work, deal with other related stakeholders outside the village, and be involved with money exchange some time. This relationship is the most important element for farm and fish cage farming production as those operations are mostly located within the village. It is also attached with social status among themselves in negotiations with the outside, particularly in fish cage farming.

The second social networks comes from occupational-based relationships which are typically found in the workplace. This relationship can be established both inside and outside the village depending on occupations of the household member. The workforce in the household must engage with the workplace to expand their social networks. Occupational-based relationships can depend on both linkages to the office or company which is often sought by an employee in any institution and from cousin-based, and acquaintance-based relationships especially when being a contractor or self-employed. Another kind of social network is demonstrated by formal linkages to either private or public agencies. All farmers, basically, are always governed by local administrative organizations and village headmen as direct and contiguous public units to provide general infrastructures and supervisions for improving life quality and basic welfare and assistance. Other formal linkages are varied by their occupations, but farm and aquaculture production tended to rely directly on those units as they were self-employed farm work rather than other self-employed non-farm work which may engage in the market and economic system. Fish cage farming collaborates with several governmental

institutions and fish companies as mentioned already. Independent farm production has to be involved with the agricultural district and provincial office and the market sphere.

Social networks in each production size were quite similar, but there were some distinctive patterns in social status. Occupational diversification played a great role in encouraging diverse and strong social networks in various sectors particularly in the areas outside of the village. Social networks in one occupation sector could sometimes assist and link to other productions. Most households tended to have strong social networks in at least one production system and had enough social capital to foster their livelihood. Households with high social capital, however, should have a strong connection in all production systems which each household had done. Many large-scale farmers tended to have a high social status as a leader of group or quota within the village in fish cage farming and farm production, and knew senior sales representatives in fish cage farming from the outside because of their economic wealth. They, besides, rely very much on cousin-based relationship in farm and non-farm production. In the case of medium-scale farmers, half of them also had a high status in fish cage farming in either private or public institutions as leaders, major participants or part of a committee, and also knew local politicians to access several opportunities to gain new knowledge and jobs in all types of production. Cousin and acquaintance-based relationships also appeared among some of them. Several medium-scale farmers, however, had low social status in fish cage farming and non-farm production, and depended less on exchange labor from their cousins in farm production. These characteristics were also illustrated in small-scale households but they slightly had stronger social capital in general. They, however, were more determined to collaborate with more social networks than medium-scale farmers particularly in fish cage farming as they had a smaller production size.

In the viewpoint of access to fish cage farming techniques, social capital exerted several important collective actions to relieve climate-related risks. Urgent solutions from extreme overflow and drought, firstly, needed social networks especially within the community in exchanging knowledge and labor with other households particularly in immediate damages including moving the cage to an area with sufficient water, herbal

and chemical use, and extraordinary sales. Social capital based on kin and close-acquaintance relations could foster small and medium-scale household's involvement in all types of landscape changes which cost a lot of money to do so. In terms of physical innovations, social networks sometimes eased the access to order, occupy, and exchange climate-related risk reduction equipment across production sizes (figure 4.6). Strong social networks, in the case of Pradang village, could also provide good opportunities to receive new feeding patterns to negotiate with fish companies. In this sense, social capital was already tied with households who occupied large-scale production size. In Ban Mai village, however, participating in collective actions was the most important way to join in collective action and help farmers in all scale to slightly decrease the risks rather than having large-production size. In this case, two large-scale farmers who had high vulnerability were massively affected by unchangeable environments from riverbank improvement and the lack of social relations with the major fish farmers' group, while medium-scale farmers who also had high vulnerability were influenced only by internal exposures.

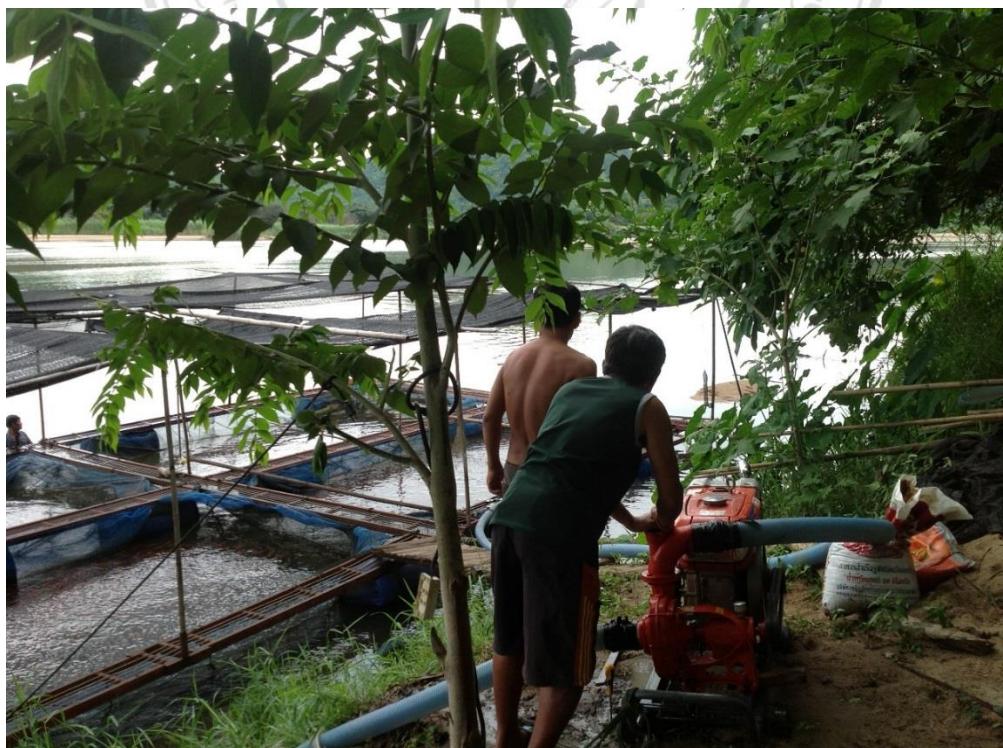


Figure 4.6 Sand sucking by machines in Pradang village

4.5.3 Cultural Capital

Cultural capital, in other words, is one of the important entities to promote specialty in production systems. Following the analysis, cultural capital is closely linked with and influenced by occupational diversification and social and financial capitals which provide more opportunities to receive working skills and experiences from different jobs especially non-farm production. Social capital, further, can ease the access to cultural capital through training and knowledge extension from related private and public companies especially farm and fish farming production. The measurement of cultural capital can be done by observing the level of specialty and different financial capital earned from all production systems.

Farming households which had more production activities and were in a higher status in their work among more members, tended to have more cultural capital. Households which had a larger workforce and less dependency burdens also carried a higher level of cultural capital. Thus, the working skills and experience of the elder generation and education level of offspring were very essential to assess cultural capital. Applying cultural capital to each member to foster household production in the whole affair, besides, was also counted. It is very obvious that all large-scale farmers had moderate to high cultural capital from various jobs among household members who earned a have high salary and which required excess working skills and a higher education level. Several large-scale households which had only moderate cultural capital were affected by dependency burdens. Most medium and small-scale farmers, nonetheless, could not receive high cultural capital because of a smaller workforce, more child and education burdens, and less working skills and experience for other production systems especially households which chiefly depended on daily wage labor and small and medium size of production farms.

In the case of different production sizes among fish cage farming households, cultural capital – experience and efficient knowledge and skills in fish cage farming – was one of the great devices to fill this unequal gap led by financial wealth in dealing with climate-related risks. Applying cultural capital in fish cage farming was widespread in the application of all risk reduction techniques. To start with, various methods of urgent

solutions were closely linked with adopting and producing new feeding patterns and also useful for defining in-season feeding durations. Farmers who had more experience in disasters could adjust feeding duration and patterns to the new environments effectively. For example, they had tried to reduce feed pellets at the beginning according to small fish structure, stop giving feed to fish in extremely shallow water and overflow, or diversify many fish crops during risky seasons. Use of physical innovations, in addition, was applied by collective actions and sometime exchanged knowledge besides financial wealth (figure 4.7). These processes had been encouraged and adopted by lifelong learning methodologies from both individual and collective actions within and across villages. Although cultural capital with other capitals could support the decision of cage relocation, it was not very essential for landscape changes as they tended to rely more on social networks and large amounts of money.

To describe capital in the production size context, cultural capital in fish cage farming was often embedded in large-scale households because of effective individual learning applied from wider social networks and secure financial capitals. This characteristic, however, did not always occur in all research sites in cultural perspectives. In Pradang village, participation from social learning and experiences in feeding patterns from the older fish farmers' generation was very important in mitigating to climate-related risks. Three medium-scale farmers, who were quite new in the production circle, had the highest sensitivity among farmers in the village because they separated themselves from the collective actions at times which created a lack of knowledge in development.

All means of access to capitals in regard to occupational diversification tended to be similar. Social capital, however, partially decreased the sensitivity of financial and cultural capital in several farmers as it could be intrinsically increased in each household. Results indicate that most farmers in all production sizes had moderate (16 of 42 households) to moderate-low (12 of 42 households) sensitivity of access to capitals. Most large-scale farmers (11 of 13 households) were less sensitive to access all capitals, while medium and small-scale farmers tended to be more sensitive and there was no household receiving low sensitivity. In the case of moderate-sensitivity medium-scale households, they were quite sensitive in financial capital. Explicit differences in

social and cultural capitals influenced the medium-scale households who had moderate-low and moderate-high sensitivity. In the small-scale households who had moderate sensitivity, finally, social capital was a useful element to facilitate them (table 4.10).

Table 4.10 Sensitivity of access to capitals in occupational diversification
by production sizes

Sensitivity Size \n \diagdown	High	Moderate-High	Moderate	Moderate-Low	Low
Large	0	1	1	5	6
Medium	2	4	7	4	0
Small	0	2	8	2	0



Figure 4.7 Triangle head and blocking pillar (*Lak Ro*) in Pradang village

4.6 Multiple Household Vulnerability and Levels of Mobility

Fish cage farming households had received multiple vulnerability levels from multiple risks in fish cage farming and various sensitivities in terms of current household demographic structure, occupational diversification, risk perception, and access to capitals and techniques in fish cage farming. Assessing multiple household vulnerability can be achieved by connecting and comparing each sensitivity to define the threshold of unsafe status for household survival at risk as mentioned earlier in each part. Different research sites and production sizes also excessively influenced this point.

Households were mostly vulnerable in moderate to moderate-high levels (17 of 42 households in each level). There were only 11 households categorized as moderate-low to low vulnerability. The main reasons in becoming vulnerable were lower capacity to access fish cage farming techniques, insecure livelihood from low-wage jobs and having less land which limited abilities to diversify occupations, and more household dependency burdens. Three quarters of the medium-scale households (13 of 17 households) perceived moderate to moderate-high levels of vulnerability. Small-scale fish farming households were the group that was most vulnerable in moderate to moderate-high level (11 of 12 farmers). On the contrary, half of the large-scale households (7 of 13 households) had low to moderate-low level of multiple vulnerability related to their livelihood because they had a larger workforce to reach working opportunities and gather massive capitals from their diversification, and could also connect or develop techniques in fish cage farming by themselves from rich abilities in financial, social, and cultural perspectives (table 4.11).

Table 4.11 Multiple household vulnerability by production sizes

Vulnerability Size \	High	Moderate-High	Moderate	Moderate-Low	Low
Size					
Large	0	1	5	6	1
Medium	1	6	7	1	2
Small	0	6	5	1	0

The multiple household vulnerability in each research site, anyway, was quite different. Fish cage farmers in Pradang village, to start with, were the least vulnerable group compared to all villages because the effects from climate risks were quite low. Production sizes did not have much impact on the distinction of multiple household vulnerability. In Hua Kuang village, most farmers in all production sizes were moderately vulnerable in spite of very high climate-related risks because they received lower socio-economic risks in contractual relations and tried to change production patterns at some time to reduce financial losses. Large-scale households, by the way, tended to have slightly more power in financial capital, social status and networks, and experiences in both fish cage farming and other related economic activities to reduce their multiple risks. The vulnerability trend in Ban Mai village, also, was quite similar to Hua Kuang village. Lesser vulnerability in terms of household demographics and access to capital in occupational diversification among large-scale farmers rather than other groups, notwithstanding, was a great component to reduce total vulnerability despite the fact that most of them were affected by the lack of access to techniques in fish cage farming. In Ban Koh village, several disadvantages incurred from fish companies and the different sizes of fish cage farming production enforced a lot of farmers to access various fish cage farming techniques. It was very obvious that large-scale farmers in Ban Koh village had lower vulnerability from climate-related risks than other groups. All vulnerability in socio-economic terms also emphasized the divergence among production sizes (table 4.12).

Approximately one-fifth of the fish cage farmers, unfortunately, had stopped their operation at least six months for a variety of reasons. Nine of the forty-two households in all research sites: five households in Ban Mai village (two large-scale and three medium-scale households), one large-scale household in Pradang village, one large-scale household in Hua Kuang village, and two medium-scale households in Ban Koh village had discontinued fish cage farming. Most farmers in Ban Mai village (4 of 5 households) paused because of high sensitivity in accessing fish cage farming techniques although they had moderate to moderate-low sensitivity in socio-economic factors. The rest of the farmers in Ban Mai village, Ban Koh village, and Pradang villages obtained high financial losses only one time which did not totally compensate

them although some of them still had some money. They really recognized, particularly in large-scale households, that they would earn nothing from less productivity and be damaged by more severe environments causing debt accumulation.

Table 4.12 Multiple household vulnerability by research sites

Vulnerability Size, Site	High	Moderate-High	Moderate	Moderate-Low	Low
Large					
Ban Koh				3	
Hua Kuang			2	2	
Pradang			1	1	1
Ban Mai	1		2		
Medium					
Ban Koh		3	1		
Hua Kuang		1	2	1	
Pradang			3		2
Ban Mai	1	2	1		
Small					
Ban Koh		3	1		
Hua Kuang		1	2		
Pradang			2	1	
Ban Mai		2			
Total	1	13	17	8	3

In the meantime, four households in Hua Kuang village (one large-scale, two medium-scale, and one small-scale household) temporarily stopped fish cage farming in the summer of 2014 as water levels were very low and risky for fish death, despite the fact that they had never discontinued the operation before. Those people said that they would not necessarily receive high losses in the production. Farmers in this group tended to turn back to the main occupation that each household had done for years before operating fish cage farming. Only two households in Ban Mai village (one large-scale and one medium scale household) changed to a new occupation by using their residual financial capital and selling some of their fish cage farming assets to start self-employed work in village areas. Two small-scale households in Hua Kuang village and

Ban Mai village, anyway, had recently increased their investment in production size by adding more cages due to heavy elderly and children' burdens that limited their capacity to move elsewhere, as well as a lower climate-related sensitivity than other households in the village.

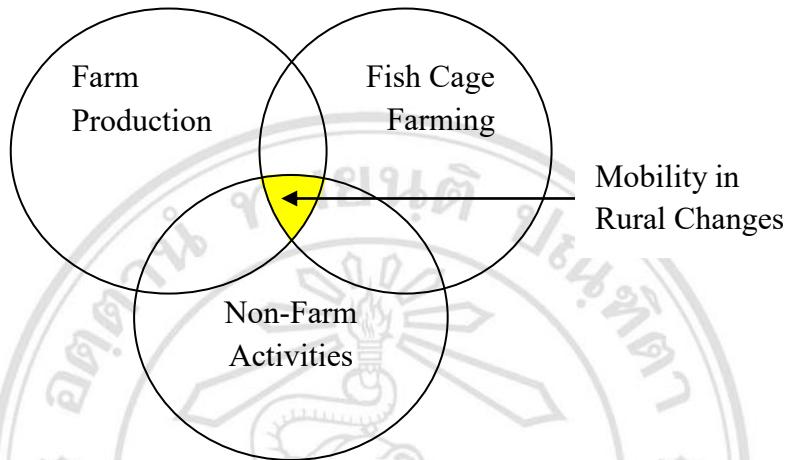


Figure 4.8 Household occupational diversification and mobility in rural changes

The interaction of multiple household vulnerability also significantly emerges with different levels of mobility. Besides occupational diversification that can foster access to capitals, mobility is an important movement by household members associated with those diversified activities. To assess average vulnerability score among the farmers' groups, the score of each level of vulnerability was measured from high (5) to low (1), multiplied by numbers of vulnerable households in each class, and divided by the total numbers in large, medium, and small-scale farming households. The higher the average vulnerability score, the more vulnerable that group became among the farming households. The result was also basically correlated with the levels of mobility in each household. It is very obvious from the average vulnerability score, following table 4.15, that mobility may share in reducing multiple risks in fish cage farming and strengthen the capacity of the household to survive in socio-economic terms particularly in highly and moderately-mobile households to obtain moderate multiple household vulnerability. This research, however, had to analyze in deeper detail in the next chapter how financial, social, and cultural remittances from mobility in pre and post-farming periods

contributed to household adaptation to climate-related and socio-economic risks, particularly in fish farming related activities.

Table 4.13 The relationship between multiple household vulnerability and levels of mobility of fish cage farming households

Vulnerability Levels of Mobility	High (5)	Moderate-High (4)	Moderate (3)	Moderate-Low (2)	Low (1)	Average Vulnerability Score
High	0	2	9	5	1	2.71
Moderate	0	7	4	2	2	3.07
Low	1	4	4	1	0	3.50

4.7 Conclusion

Following multiple risks in fish cage farming, it must be recognized that each household has different vulnerability from different production sizes and levels of mobility. Current household demographic structures, firstly, have major impacts on the sensitivity of small-scale households which have a low workforce ratio, and more dependency burdens including children' burdens in education and elderly limitations in working. Occupational diversification, secondly, is important for most of the households to financially and culturally challenge livelihood risk in rural changes. Large-scale households occupy larger land sizes that are useful for farming perspectives and higher working status that can generate massive income and valuable working skills in terms of non-farm occupations. Access to financial, social, and cultural capitals from occupational diversification, therefore, is convenient for the large-scale households who diversify more occupations by household members and encounter fewer problems in household demographic structure. In terms of access to fish cage farming techniques, production size obviously affects vulnerability, particularly in upstream villages. Small and medium-scale households tend to have higher sensitivities than large-scale households. In contrast, social networks in Ban Mai village, and experience as well as social learning in Pradang village in reducing climate-related risks in fish farming

greatly affected to different levels of sensitivity in this perspective among fish farmers instead of production size.

Multiple household vulnerability, thus, is typically found in medium and small-scale farming households. Households which have a lot of vulnerability, besides, tend to be minimally-mobile households. Although large-scale households who have less multiple vulnerability tend to migrate in high and medium levels, and there are no minimally-mobile households in this group, it is quite obscure to assume that medium and small-scale households who are minimally-mobile households are the most vulnerable group. Even though the interactions of production size and vulnerability, as well as levels of mobility and vulnerability, are directly varied, multilateral relationships among production size, levels of mobility and multiple household vulnerability are still vague. In the next chapter, mobility as a response to multiple risks and vulnerability, will analyze the contribution of remittances from different mobility behaviors as they are classified at levels of mobility in each production size and risks and vulnerability of households.

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CHAPTER 5

Mobility as an Adaptation to Multiple Risks

Fish cage farming households are affected by multiple climate-related and socio-economic risks and vulnerability in fish cage farming and other related patterns of occupation, household structure, and access to capital. They have to find some pathways to respond, mitigate, and adapt to risks and vulnerability in their life. Mobility is considered as one of the livelihood strategies to deal with short and long-term effects from both environmental and non-environmental drivers, different household members in any distance (intra-village, provincial, inter-region, or overseas areas), time durations (seasonal, temporary, or permanent), types of jobs, and purposes (building up a life foundation, existing in daily life, doing other occupations, or investing in fish cage farming and other occupations) of mobility. Remittances in financial, social, and cultural capitals may be strategic for fish cage farmers in the adaptation to normal and irregular situations. In this research, fundamentally, the division of temporal contexts at the beginning time of fish cage farming in each household is an indicator to classify mobility behaviors in pre and post-farming period in three groups of household mobility levels – highly-mobile, moderately-mobile, and minimally-mobile households. Mobility behaviors can be defined in two major categories by frequency – periodic and episodic mobility – with different components. Production size in fish cage farming is a preliminary factor to understand each mobility behaviors. As a result, those bits of information will be synthesized to observe remittances earned by those households in response to multiple risks and vulnerability.

5.1 Mobility in Pre and Post-Fish Farming Period

Like farm and aquaculture production, fish cage farming is an area-based occupation that must be settled at a specific location and one that is difficult to move. Household members who are responsible as laborers for fish cage farming often spend some time taking care

of fish and other activities in the production system. Those people normally have some qualified experience in operating with fish and usually reside daily in their hometown. A household, therefore, must define each role to their members by gender, age and dependency, and capacity to work in each production system. After starting fish cage farming, mobility patterns tended to gradually change according to the commitment of some members to feed and operate the farm, while the household labor system may have been rearranged to share various occupational burdens and household work. Anyway, 40 of 42 households (95.24 percent) experienced moving at least one time for work. Mobility, consequently, may be divided into two categories by temporal contexts defined by the nature of fish cage farming.

Mobility in the pre-farming period is seen by different behaviors and other components and it can be categorized into four patterns – pre-farming mobility which had been started and discontinued before fish cage farming (1), started before fish cage farming but discontinued when beginning fish cage farming (2), started before fish cage farming but discontinued after taking up fish cage farming (3), and started before fish cage farming and continuing until now (4). In the meantime, mobility in the post-farming period means that mobile activity which occurred after starting or stopping fish cage farming. There are three types classified by time of discontinuation – post-farming mobility which had been started and has discontinued already (5), had been started and still operating until now (6), and being started after households had discontinued fish cage farming (7).

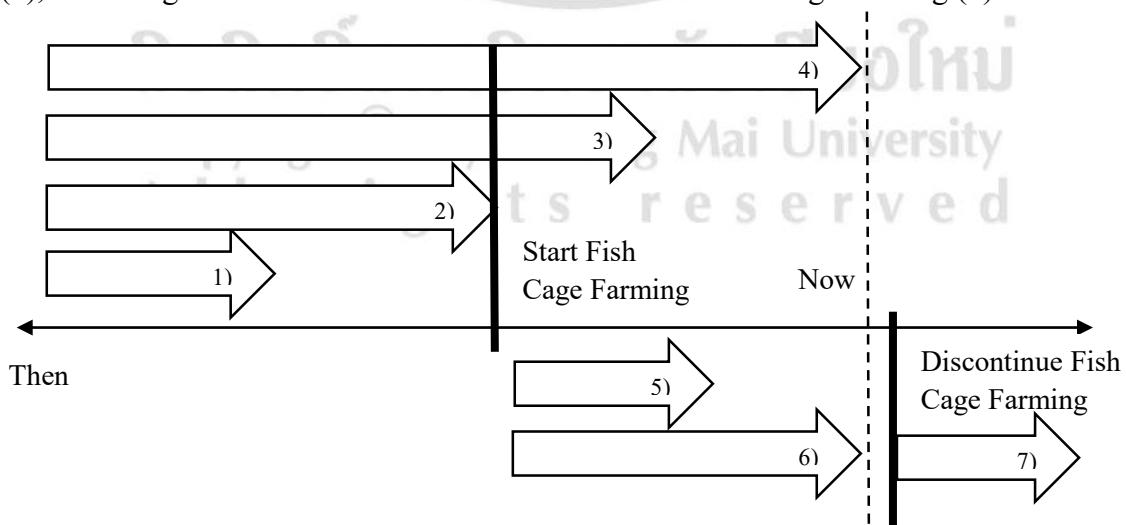


Figure 5.1 Mobility in pre and post-farming period by point of discontinuation

5.2 Periodic Mobility

Periodic mobility is the continuous action of movement made by any household members for procuring work as a common practice in everyday life. It can be done for a short or long period of time in all levels of spaces. In this research periodic mobility is subdivided into three categories by different time and space relationship – daily routine mobility, internal mobility, and the overseas sojourner – to perceive the different drivers, household members who move, the distances, and types of jobs.

Table 5.1 Types of period mobility by time duration, frequency, and distance

Dimensions Types	Time Duration and Frequency	Distance/Destination
Daily Routine Mobility	Work as a commuter who travels to the workplace and comes back to the hometown every day	Any distance that mobile person/migrant can come back home every day
Internal Mobility	Reside nearby the workplace as a normal routine and do not come back daily to the hometown	Inside the country
Overseas Sojourner	Reside following the agreement of work and commit to return to the hometown in later years	International countries

5.2.1 Daily Routine Mobility

Most rural villagers in Thailand, formerly, had settled down and performed village-based work; either farm or non-farm production depending upon the available natural resources in such areas. Daily routine mobility, nowadays, is a general action of villagers in many communities in Thailand. This occurred after the rural changes transform occupational structures and consumption behaviors between rural and urban areas and had influenced and were aggregated by the expansion of prosperity distribution from the capital city, particularly due to industrial development and regional development policies in the

primary city from the 4th National Economic and Social Development Plan in 1977-1981. Various transportation systems including bus, individual car, motorcycle, and other mass transit systems, besides, were very significant in promoting mobility in each household. As a daily commuter travelling farther distances than the previous time, they could come back and stay at their hometown. The capacity of daily routine mobility in each household and village, to identify, was determined by the distance from the hometown, travelling time, and availability of jobs.

Daily routine mobility was often the main occupation of several household members in earning a regular daily wage or monthly income from private or public sectors, or contractors. Household members who decided to perform this role had to spend more time at work and travelling to the workplace. Workplaces in daily routine mobility were in the intra-village/residential and provincial levels. Those occupations from this mobility pattern tend to be permanent works. The requirements of working skills, experiences, and education were also distinctive following the types of jobs. Different salaries from each occupation had a major impact on the purposes of mobility.

Thirty of the forty-two households (71.43 percent), generally, had at least one experience in daily routine commuting. Both male and female members also had responsibilities to move. Upstream households, interestingly, were likely to engage in daily routine mobility more than midstream and downstream households. In upstream areas, in both Ban Koh and Hua Kuang villages, which were located in Chiang Mai province, the principal city of regional development where industrial and service sectors had been expanding for the last 30 years, job became quite attractive in both villages. Several villagers had also responded to that expansion by commuting to work. Most households in those areas (20 of 22 households) had at least one experience in movement as a daily routine within or nearby villages or provincial areas. Half of the households in Pradang and Ban Mai villages (10 of 20 households), however, had worked as commuters. They had been employed as daily wage laborers in farms, factories, or technical work, contractors in construction work, self-employed work, monthly employees, and civil servants. There, significantly, were several other concerns about this mobility in regard to temporal contexts, drivers, and purposes of mobility.

The majority group (24 of 42 households, 57.14 percent) began to move before fish cage farming. Pre-farming daily routine mobility was chiefly found in two patterns – mobility which has still processed until now (4), and mobility which had already been stopped before fish cage farming (1). The offspring generation in three households (two large-scale households and one small-scale household) also engaged in current mobility. In other words, post-farming mobility started and still operating now (6) was also discovered in five medium-scale, four small-scale, and two large-scale households. Those mobility types are also found in the parents' generation rather than their offspring.

Most households had started daily routine mobility before fish cage farming. Non-environmental factors including working skills supported by previous mobility actions or education, social networks, and children' burdens were the major drivers among households (27 of 29 households, 93.10 percent) to find additional income. In case of the first type of mobility (1), those mobile people needed to stop commuting in order to be employed in certain work especially farm production and self-employed jobs at home before starting fish cage farming. They, also, sometimes had that kind of work before moving. Mobility practices in the fourth type of pre-farming period, meanwhile, were related to the division of household labor. Half of the households (7 of 14 households) had to divide roles between male and female members in fish cage farming by time, while four women and three men were responsible for fish cage farming alone. Availability of working skills and experiences for the job, nevertheless, often localized spatially the female members, especially the mother, to move to adjacent areas of the hometown. Immobile or intra-village mobile persons, thus, often fed fish in the afternoon while mobile persons working farther away, may have operated in the morning and evening.

Each production size had a similar number household members that had experience in daily routine mobility. Types of jobs among production sizes, notwithstanding, were quite different. Many of the large-scale households (5 of 8 households who had daily routine mobility) tend to do self-employed work having an intensive financial outcome or as employees who received a higher monthly salary as namely technicians and civil servants. This proportion significantly decreases in medium and small-scale households (4 of 14, and 2 of 6 households who had daily routine mobility).

5.2.2 Internal Mobility

Internal mobility means mobility activities within Thailand in which a mobile person, as a normal routine, resides nearby the workplace area and does not return home daily. This kind of mobility was permanent and that mobile person could either commit to returning to the hometown or staying permanently at the destination. It is quite different from daily routine mobility in time duration and place of migrant's residence. Occupational and economic activities evidenced by internal mobility can be both employee and self-employed in the non-farm production sector. Internal mobility, besides, is performed by an individual or various members as collective mobility in the level of household. This kind of mobility had been practiced for a long time due to national and regional development and before the prosperity of economic and industrial development became widespread in the rural areas. Internal mobility, anyway, among fish cage farming households tended to appear in farther distances, particularly in different provinces and inter-region scale. Labor deficit in industrial and metropolitan areas was the major reason to attract a workforce from the hinterland to core areas. Working skills, education, and social networks were importantly related to the types of works, specialty obtained, and revenue. Basic needs for offspring and livelihood-related affairs were the great impetus for them to move. Each area has different patterns of internal mobility in the past decades.

Following the results, twenty-three of the forty-two households in research sites had at least one time of internal mobility, and most of them moved across the region (21 of 23 households). Major cities that they migrated to for industrial and construction were Bangkok and metropolitan areas. In case of contractors in the construction sector, they migrated to many provinces and regions of Thailand due to the customers. It, statistically, appeared that households in midstream and downstream villages (14 of 20 households, 70.00 percent) internally moved rather than upstream villages (9 of 22 households, 40.91 percent). The mobile persons in Ban Mai village were sometimes motivated by low revenue from agricultural production in the village. Suitable reasons why the lower-Ping river basin villagers had more internal movement than upper areas, was this area had less opportunities to access secondary and tertiary jobs as it had lacked city and industrial development in their provinces during the past era. In the parental generation, men have

more burdens to move for working than women. Several women also migrated to help their husband in self-employed work. The offspring in nine households particularly in large-scale households (5 of 9 households which offspring has participated in internal mobility) had involved in moving in intra-province, inter-provinces, and inter-region scales without the restriction of gender. Education, to identify, was the most important factor to foster different types of jobs of internal mobility.

Approximately half of the households in each production size had experienced internal mobility activities seeking different kinds of jobs. Most mobile persons in the large-scale households, anyway, were of a slightly higher working status which required higher working skills and education than medium and small-scale households particularly in the parental generation. Several mobile persons (3 of 7 internal mobile households) in large-scale households were dependent contractors in construction work which was invested in by massive financial capital and working skills for work done in different provinces and regions. In temporal contexts, internal mobility operated by parental generation in most households was stopped before (1) or when beginning fish cage farming in their hometown (2). In the case of the first type of pre-farming internal mobility, the motives for mobility can be classified into three major reasons. First, they moved in order to find better opportunities for early adulthood members and returned home to operate some type of work before starting fish cage farming. Second, they tried to spend a short range around of 1-5 years so as to receive more income in accordance with the low income from agricultural production and jobs inside the village, and higher household burdens. Third, they migrated for a short time around of 1-5 years to prepare themselves for further mobility actions. In the meantime, the second type of internal mobility was the last type of mobile activity in farther distances and they choose fish cage farming as the next occupation from that mobility. Anyway, internal mobility in the offspring generation was likely to occur after fish cage farming and many of them were still employed at that point in time (6).

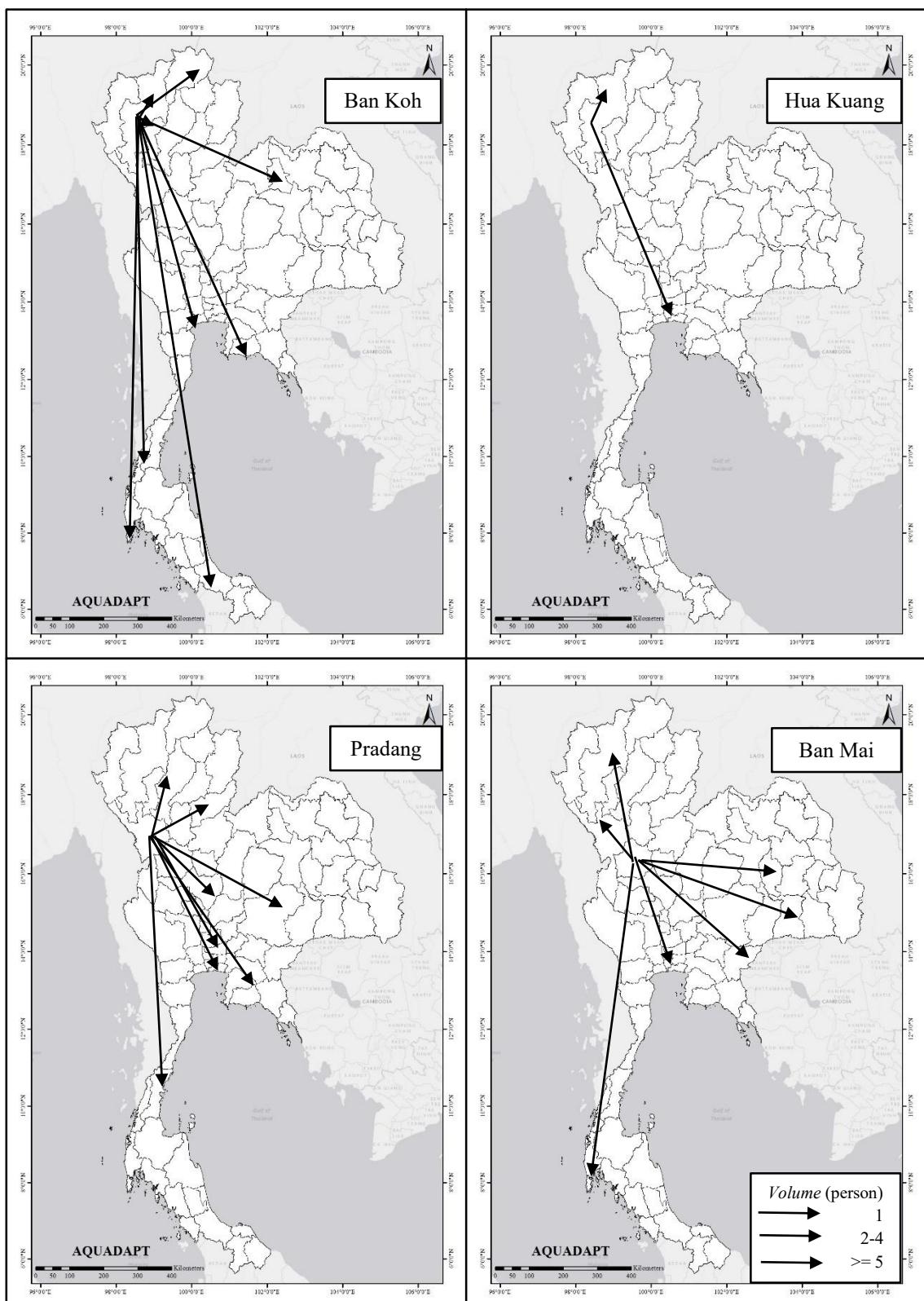


Figure 5.2 Map of internal mobility of fish cage farming households

5.2.3 Overseas Sojourner

The overseas sojourner participated in one of the international mobile activities in which immobile household members in the homeland committed a mobile person who would eventually come back and in the meantime, send remittances to improve the life quality at home either at that time or in the future. In Thailand, working in overseas countries as a laborer or technician was first promoted in 1975 according to excessive economic growth in the Middle East region (Saudi Arabia, Iraq, Qatar, and Bahrain). International migrants from Thailand, afterwards, had expanded to the East Asian region (Taiwan) and Singapore around 25-30 years ago due to the great industrial development in that area. Those periods of economic and industrial development had instigated massive stream of Thai laborers who moved outside the country for work.

In research sites, ten households had been mobile as overseas sojourners; and significantly, six of ten sojourners came from large-scale households. To migrate for overseas work, mobile persons had to collect a large amount of financial capital from various activities. Mobility as a daily routine and internal mobility was one of the pathways to find enough money to encourage this mobility action. Several households accumulated savings from village-based occupations in both farm and non-farm jobs. In other words, some migrants had accumulated enough working experience to escalate from permanent work in internal mobility action to become a laborer in an overseas region for a future duration at that moment. The major drivers of the overseas sojourner in research sites were a higher than usual income at that moment, household (child and asset) burdens, agricultural failure, and floods. Working overseas was seen as a permanent movement because migrants had to spend at least 1-2 years living there.

Mobility to overseas was quite popular among households in Hua Kuang village (four households) and Pradang village (four households) around 25-30 years ago, while it was less evident in Ban Koh village (two households) and not evident in Ban Mai village. Most overseas sojourners from Hua Kuang and Pradang villages (7 of 8 households) migrated according to the national policy of international working extension in the Middle East, while all overseas sojourners from Ban Koh village moved because of individual

working skills to Australia and Indonesia. Large and medium-scale households tended to financially benefit from this mobility rather than small-scale households because of faults in agency collaboration and illegal actions of the company in overseas affairs. Some sojourners (3 of 10 people) migrated more than one time to numerous countries. These people (except small-scale households) have enough social networks, working skills, and experience to extend the next mobility activities to both inside and outside the country. They could also accumulate more money from international mobility. Most of them (9 of 10 households), nowadays, had stopped this mobility before fish cage farming (1). One medium-scale farmer in Hua Kuang village, anyway, had still moved to Singapore after starting fish cage farming and he had already stopped his overseas mobility (5). One farmer in Pradang village migrated again after discontinuing fish cage farming (7) as he had received massive losses. In the household level, it was totally explicit that the male member (father) in the parental generation was the only mobile person who migrated as an overseas sojourner. Besides, there were no offspring members migrating for international work.

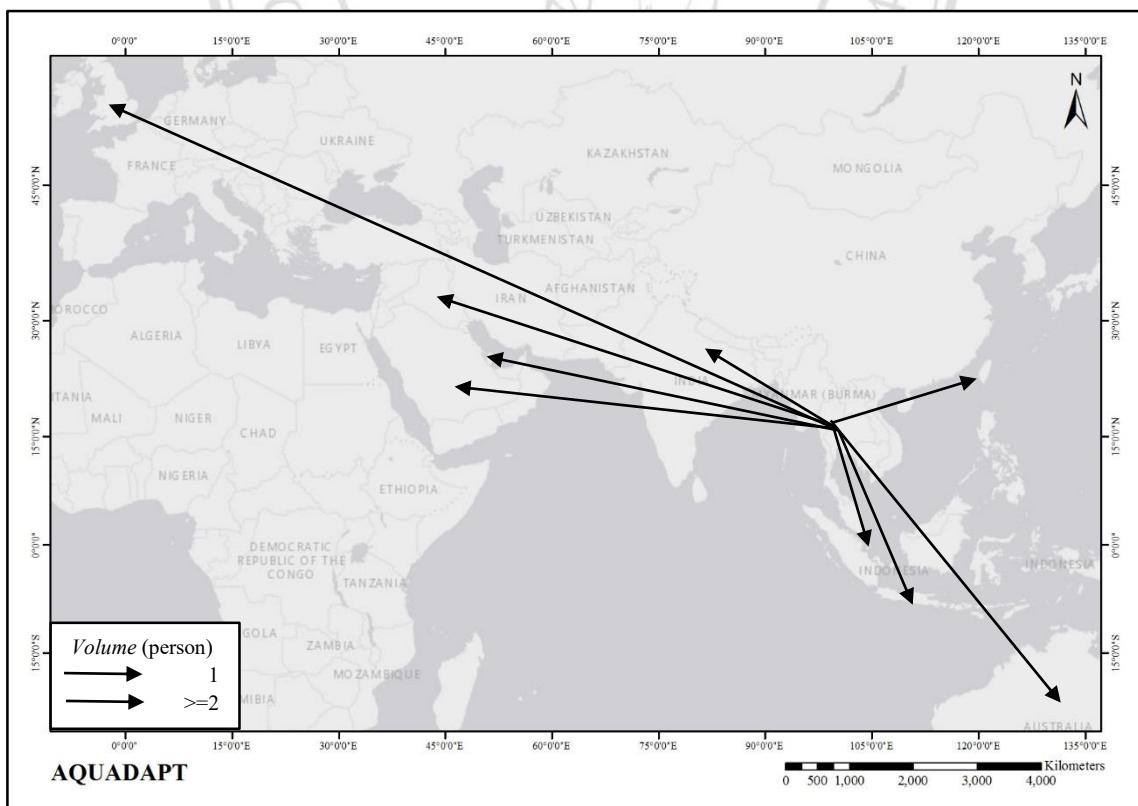


Figure 5.3 Destinations of overseas sojourners in research sites

All types of periodic mobility, in conclusion, were motivated by different drivers, operated at different times and frequencies, appeared in different spatial scales, and were acted upon by different people in gender, age, and generational categories. Non-environmental factors including income, less job opportunities, household and children' burdens, education, working experience, and social networks had been factors in determining the manifold mobility behaviors for a long time. Internal mobility and overseas sojourners were earlier patterns that eventually reduced to relocating to shorter distances. Those two types of mobility tended to be finished already before starting fish cage farming, while daily routine mobility was the most popular mobility patterns among households that still have operated currently for some time by male and female members. It, nonetheless, is very clear that periodic mobility among most households had declined in distance, length of time, and frequency because of age, change of household structure, increase of job opportunities inside the country in recent decades, and the willingness to operate self-employed activities both farm and non-farm work close to their hometown. Household members who were mainly responsible for fish cage farming in 26 of 39 households which had participated in periodic mobility (66.67 %) had to stop all periodic mobility activities before (30.77 %), when starting (25.64 %), and after starting fish cage farming for a while (10.26 %). Daily routine mobility was the only activity that still continued since starting fish cage farming until now. Previous mobility activities which required longer distances and permanence of time duration in working, to declare, were often the responsibility of the men in the parental generation.

Migrating as skilled labor, with longer distances, further frequency, and different labor statuses (as self-entrepreneur rather than daily-wage laborer) before starting fish cage farming was likely to be found in the large-scale farming households (12 of 14 households) rather than the others in every type of periodic mobility. Those may have been supported by household demographic availability, consequent mobility achievement, and readiness of mobile persons to work outside the village. The purposes and results of mobility illustrated as remittances, by the way, will be introduced in the next sections. There, however, is another mobility which occurs during specific needs in spare time or unexpected situations especially hazardous events.

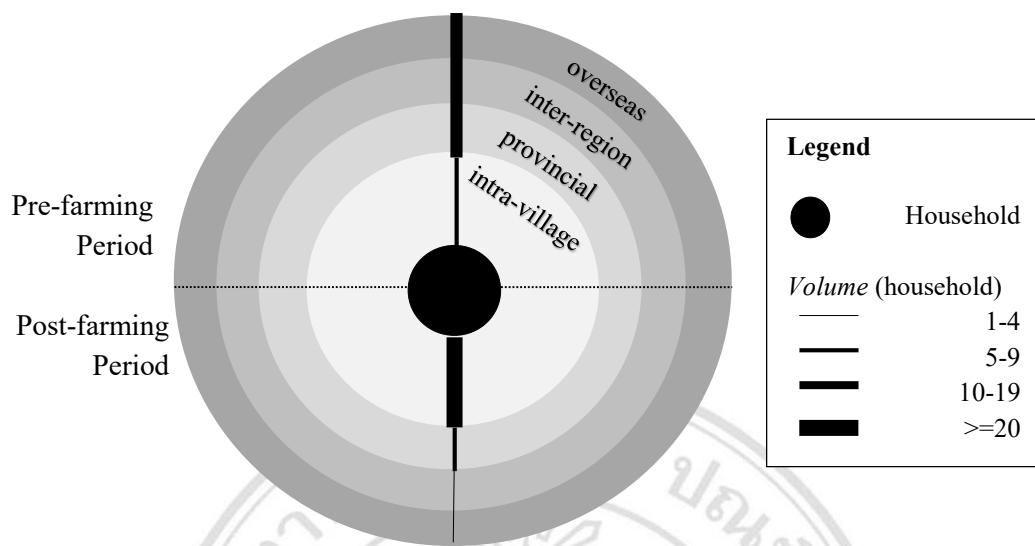


Figure 5.4 Estimated volumes of farthest distance of mobile households
in pre and post-farming period

5.3 Episodic Mobility

Episodic mobility is quite different from periodic mobility in frequency and time duration. While periodic mobility is a routine activity of human mobility in spatial and temporal interactions, episodic mobility is an intermittent action of movement that is pushed voluntarily or involuntarily due to unsafe conditions in social, economic, political, and environmental reasons. Episodic mobility, besides, is not a major occupation and activity of households to earn income for subsidizing in the long run, but is an immediate or supplementary movement in regular or irregular incidences. This can be described in two patterns – spare-time mobility and mobility related to hazardous events – which are quite different in the drivers of mobility.

5.3.1 Spare-Time Mobility

Spare-time mobility means to perform mobility during any spare time outside of the main occupation. This mobility includes during the day, week, or seasonal period but is not the permanent work of that mobile person. It, thus, can be divided into daily spare-time mobility in which a mobile person has to come back home every day, and seasonal mobility which explains temporary movement of people for working for approximately several weeks or months. Migrants in spare-time mobility can also be moving inside the

village or province, intra-region, and inter-region scales. The length of distance in the two minor categories of mobility, however, is quite different. Daily spare-time mobility usually appears in shorter distance, while seasonal mobility will occur in all spatial scales especially moving across regions. Spare-time mobility tended to be found mostly in farm-based households because they may have had free time in the off-farm season after cultivation. Spare-time mobility, besides, might appear in non-farm self-employed households who had enough spare time in the production system. Types of jobs in spare-time mobility are usually based on working skills and experiences from previous periodic mobility or the work entailed low-skill jobs where the employee earned a minimum wage. Mobile persons engaging in spare-time mobility can be hired by an employer or receive income from the exchange hiring system that occurred within a village especially with farm workers.

The characteristics of spare-time mobility were closely related to production structures and spatial contexts of in the household and village. In the research sites, eleven of forty-two households had spare-time mobility in daily and seasonal time. Both male and female members in the parental generation carried out spare-time mobility. Most of them (10 of 11 households) were medium-scale and small-scale households in Ban Koh and Hua Kuang villages (9 of 11 households). The popularity of spare-time mobility activities was demonstrated in the longan cultivation and construction sectors. Longan cultivation, to start with, was the most famous farm production in the village among the fish cage farming households. Most households in Ban Koh village who planted longan had to hire laborers from different villages, particularly during cultivation time because there were few farm laborers in the village as non-farm production was the major occupation among the villagers. Labor exchange in farm production, thus, had disappeared a long time ago. Two medium-scale fish cage farmers, yet, had operated labor exchange and one farmer had done seasonal spare-time mobility by buying and transporting longan from the orchards to the factories in Chiang Mai and Lamphun province in longan season (around August to September). In contrast, farmers in Hua Kuang village tended to use exchange hired laborers among the farm-based households as there were still a large number of farmers in the village. One medium-scale household often worked as daily wage laborers

as well as moving outside the village to transport rice production to the factory in cultivation time.

In the meantime, construction work was also a popular non-farm job in the village for mobile persons who had several skills. Four farmers in Ban Koh village sometimes moved as small-scale contractors or daily wage laborers both within the village and to nearby districts in Chiang Mai and Lamphun province around five days per month on average. This job was a kind of daily spare-time mobility. Both spare-time mobility activities had still operated before fish cage farming until now in five of ten households (four medium-scale and one small-scale households). Large-scale households had no spare-time mobility or stopped before fish cage farming. Only one small-scale farmer in Ban Mai village had moved seasonally inside the province and to the northeastern region for two to three months per year during rice cultivation time.

5.3.2 Mobility Related to Hazardous Events

Mobility related to hazardous events is an episodic mobility in accordance with physical, social, economic, and environmental losses affected by disasters. This mobility is an immediate or short-term action to mitigate those losses by earning money. It will develop into further mobility activities both periodic and episodic mobility in any scales of places – village to international scale. Mobility related to hazardous events; by the way, needs various factors in the household level at that time to move conveniently. Social networks and cultural capitals for this mobility are essentially required to suddenly respond to the disasters. Fish cage farming and household occupational structure played a significant role in the decision to migrate. Availability of household members in the amount of members, age, dependency, and household burdens was also important to define whether or not a household could move. In other words, the development and job opportunities outside the village should be realized as well.

In this research, fish cage farming was compared as a major driver of this mobility according to multiple risks and vulnerability in each research site including production failure, losses of income, and debt accumulation. Although most villages, except Pradang village faced several incidents of damage in fish cage farming, only seven of forty-two

households (two large-scale, three medium-scale, and two small-scale households) exhibited mobility activities during hazardous events and become employed in non-farm occupations. Interestingly, five of the seven households were in Hua Kuang village because fish cage farming households in this village had received massive climate-related risks for at least two years. Mobility related to hazardous events among those people, however, consisted of increasing the time of routine mobility, particularly in self-employed work and daily wage labor in the construction sector (3 of 7 households). In addition they procured a new job or revived previous jobs and skills to open new opportunities in working (4 of 7 households). Men were totally responsible for this mobility in all households. Two of them from Ban Mai and Pradang villages had changed their occupation after discontinuing fish cage farming. Most of these mobility activities (6 of 7 households) had been done within a village or provincial level and mobile persons had committed to returning home every day, similar to daily spare-time mobility. Only one-large scale household member in Pradang village went back to his company for overseas work before he started fish cage farming. There, however, had been no evidence of mobility related to hazardous events in Ban Koh village.

To compare, fish cage farming households did not move much episodically in either spare-time mobility or mobility related to hazardous events. It might be supposed that episodic mobility requires more spare time with enough social networks and working skills as well as household availability in demographic and burden structures. This phenomenon, to date, is also relevant to the rest of the number of periodic mobility actions among them in which three quarters of the households had attempted to stop mobility activities of both periodic and episodic actions. Major reasons for various fish cage farming households to stay in their hometown and not migrate were: there was no pathway to move elsewhere as they did not know anyone else outside the village, their households had enough working burdens to do and they had no time to spend for extraordinary works, and finally, they (members in parental generation) were too old to work having some limitations in health, thus, employers did not need to hire them. Why many households in the research sites do nothing in mobility activities as short-term

adaptation to multiple risks, may be relevant to immobile actions among them particularly after starting fish cage farming.

5.4 Immobile Actions

Immobile actions had been practiced a lot as alternatives among households to earn several incomes after farmers began to operate fish cage farming in their hometown. Several occupations which were settled in any place had often been done by immobile persons, especially women and children at the same time with mobility actions. Almost all of the households in the research sites (37 of 42 households) had immobile actions in different time durations as a part of occupational diversification. Four-fifth of them (31 of 37 households) had immobile occupations before starting fish cage farming, particularly in farm-based production (longan, rice, sugar cane, and cassava), as well as husbandry as the main occupation along with other minor jobs in periodic mobility interfering with those immobile actions for a while. Several households, however, which farm-based production was not a major occupation in the past tended to start those activities after reducing periodic mobility from a long distance in previous years.

After starting fish cage farming, thirty-three of the thirty-seven households (89.19 %) which had immobile actions before fish cage farming had still operated those occupations especially farm productions. Half of the households (18 of 37 households) admitted that immobile occupations had the greatest share in income earned among the household members above fish cage farming and other occupations which were accompanied by mobility actions after they began fish cage farming for years. Immobile works, currently, might be effective due to the division of household labors. Men and women participated in immobile activities together including the parental and grandparental generations. The plowing and cultivation duration in farm production was the most influential immobile activity to stop periodic and episodic mobility for a while particularly for self-employed mobile workers because those periods required a lot of household labor to conduct and give a hand in succeeding at this stage. Both periodic and episodic mobility, however, had also been essential for them to expand and increase the size of immobile occupations especially, fish cage farming, land size in agricultural production, and other occupations

requiring massive financial capital to start. The sizes of the immobile actions closely interconnected with access to capitals in occupational diversification. Large-scale farming households occupied more intensive operation on farm and non-farm production. The interactions among mobile and immobile actions which have different drivers, people, distance, and time duration to actualize will be described more in the purposes of mobility in pre and post-farming periods to construct adaptive capacity to multiple risks and vulnerability among fish cage farming households by access to financial, social, and cultural capitals as remittances.

5.5 Purposes of Mobility and Remittances

According to mobility with various drivers, people, distance, time duration, and frequency, the outcome is illustrated as financial, social, and cultural remittances in the pre and post-farming period and used as tools for understanding the purposes of mobility and the adaptive capacity in the process of adapting to multiple risks and household vulnerability. Purposes of mobility consisted of four dimensions.

Building up a life foundation was the basic need of households in the early stages to survive in manifold ways including purchasing physical things for daily use such as land plots, houses, and vehicles, as well as financial savings and children's education to uplift the quality of life. This stage was very essential in providing wealth accumulation in financial, social, and cultural ways for the future and it required massive funds to construct and accumulate.

Daily existence for all households was to basically sustain their daily life for buying food and other basic consumptive elements. Financial remittances for this mobility was not required much compared to other purposes of mobility. Other remittances, however, were significant for mobile persons when preparing to move elsewhere to find income, particularly in episodic situations.

Doing other occupations required many social networks, working skills, and experiences from mobility activities to start a new occupation by both mobile and immobile actions; for example, construction employment and farm production. It was a type of continuous

activity from one previous action to another which was significant in gaining enough remittances in the next duration.

Investment in fish cage farming and other occupations directly relates to financial capital as the most vital tool to begin intensive fish cage farming production which necessitated the preparation of massive fund. Other occupations, besides, at a later time also needed financial capital to start as well.

To achieve those purposes of mobility, remittances in financial, social, and cultural capitals were preferred by all households as results of mobility in any temporal and spatial scale from mobile members to their households. Financial remittances, firstly, refer directly to money earned from all mobility actions and its use for investment in fish cage farming and also, other physical assets such as land plots, vehicles, and so on. Social remittances, secondly, describe the social networks received from all mobility activities in order to access financial and cultural capitals in any period of time. Cultural remittances, thirdly, can be interpreted as working skills and experiences from working in mobility actions, as well as training and education to do other jobs and apply for fish cage farming. The explanation of purposes of mobility and remittances for adaptation can be demonstrated in two periods of time – pre-farming and post-farming periods.

5.5.1 Pre-Farming Period

Mobility in the pre-farming period exerts a great significance to the adaptation in pre-farming itself and post-farming situations. Although most of the farmers had migrated for work to earn additional revenue, different types of mobility and household-related factors reflect a great distinction in remittances. Household-related factors were demonstrated earlier as occupational structure, gender, life foundation, and child's burden. Mobility-related factors, meanwhile, were the consequences of household burdens which were represented by the types of jobs, distance, time, and frequency leading to different income, working skills, experiences, and social networks of the mobile person to the outside in later periods.

1) Financial Remittances

Periodic mobility was a great source of financial remittances at the beginning rather than episodic mobility which was collected money for existing in daily life as such. Types of jobs and distance in mobility directly varied according to financial remittances. Financial remittances were often received from the first mobility activity in the early life of mobile people especially the parental generation. Until now, mobility of parental generation took a massive proportion of financial remittances, while mobility of the offspring generation could not assist much no matter how far they moved.

Internal mobility in the inter-region scale and international migration tended to be first movements to send financial remittances back to the hometown and accumulated for further mobility activities either in longer or shorter distances. Initially, most of the laborers hoped and believed that moving long distances would earn massive income to build up a secure life foundation and expand into further economic activities of him/herself or other members in the household. Long-distance mobility in each village, however, was obviously divergent in career types. Interestingly, four-fifths of the fish farming households in three villages (Hua Kuang, Pradang, and Ban Koh villages) have moved to inter-region and international areas as self-employed domestic or technician, as well as technicians and laborers in overseas regions especially the Middle East and East Asia. Most farmers (4 of 6 farmers) in Ban Mai village who migrated for domestic work as an employee and wage laborer, yet, earned low financial remittances.

In the case of overseas sojourners, it has been illustrated that those people in medium and large-scale households tended to be more financially successful than small-scale households in a short period of around one to five years. They could utilize financial remittances in

three major arenas – purchases for assets and education (build a new house, buy farm land plots, and collect money for the child's education), investment into other non-farm occupations such as construction work and self-employed works, and continuous accumulation in fish cage farming through previous occupations in the past. Overseas sojourners and self-employed domestic contractors in large and medium-scale households, to date, tended to collect money for those actions faster than domestic workers who were employees in the factory and wage laborers in the construction sector. Medium and small-scale long-distance mobile persons in Ban Mai village and the small-scale overseas sojourners who were unsuccessful, unfortunately, had less or no money, and it was necessary for them to come back to do self-employed works again or a wage labor in local areas instead.

Some households also continued their mobility from the long distance scale to daily routine mobility in short distances. Although many households had never moved in inter-region and international scales, they had migrated by daily routine mobility in provincial and intra-village scales. The daily wage from daily routine mobility, typically, was significantly varied by the types of occupations. Households who had worked as a technician, teacher, and construction contractor could receive massive funds compared to the daily wage laborer. Money from daily routine mobility, anyway, tended to be not as much as from internal and overseas mobility. Financial remittances from daily routine mobility, thus, tended to be used for existing daily much more than building up a life foundation which took a longer time to collect, except for mobile persons who were skilled workers and could accumulate money to build up a strong life foundation, and in addition, access loans in order to invest in fish cage farming. In case of intra-village mobility people, financial remittances (daily/monthly income) earned from very-short-distance mobility were chiefly used for daily living. It was quite

difficult to accumulate massive financial capital to invest in other economic activities in the pre-farming period and build up a life foundation rapidly as long-distance mobile persons.

Financial remittances (money) could be partially utilized to begin fish cage farming. They often took out a financial loan to foster the production at the beginning. Only financial remittances in terms of land from the pre-farming period had some part in the adaptation in the post-farming period by the dependence on farm income. The larger size fish operation fostered massive financial remittances that were co-invested with some financial loans, particularly farmers using the full credit system, a greater power in negotiation when contracting with fish companies. Most farmers who had larger size operations at least had a chance to migrate for long-distance working. Farmers who had a monthly income as employees in provincial areas were able to sustain their life as well in pre and post-farming period and divide up some money to help fish cage farming.

2) Social Remittances

Social remittances become a significant item to encourage mobility decisions in different time durations. The first mobility activity, particularly in inter-region and international level, was likely to be supported by cousins, friends, surrounding people in the villages, or the direct advertisement of overseas working companies in hiring labors. After the first mobility ended, mobile persons may have established social contacts in job areas outside the village. Sometimes, social and cultural capitals had been tied together to foster later mobility actions. Some people changed their careers so they had to start all new social networks applying their working skills to find a job. This pattern of changing household occupations were usually occurred in the self-employed and wage laborer in construction.

Social networks from long-distance mobility, notwithstanding, tended to be meaningless especially in the post-farming period if they stopped mobility actions. Many fish farmers had already realized that social networks either from mobility or relatives were not very significant in fish cage farming because contractual relations held with the fish companies had controlled most production systems. Although social remittances could not be used directly to assist the fish cage farming operation, social networks from previous mobility actions were very useful for the household diversifying and keeping social relations with their acquaintances and colleagues before operating fish farming.

3) Cultural Remittances

Cultural remittances received from mobility in the pre-farming period were the only obvious items to foster fish cage farming and do other household occupations during both pre and post-farming periods. Working skills and experience, formerly, rather than education level were quite important in the parental generation as most farmers had a low education. Nearly all of the farmers in all production scales who moved via internal mobility in inter-regional areas and overseas countries obtained construction, technical, and other skills as they had never learned before. They endeavored to collect those skills to search for a new job and continue to move elsewhere for work either part of a workforce in the factory or beginning immobile self-employment in the farm and construction sectors.

Those working skills and experience also be applied at doing some work in fish cage farming including building and fixing cages, managing their own methodology, and constructing new knowledge from their learning systems to deal with contractual exploitation. Those outcomes could reduce fixed and variable cost in production related to cage building expenses, fingering quality, amount of feeding, as well as

power negotiation with the company in physical fishing and its market system. However, it had to be accompanied by the financial capital that each fish cage farmers have collected and financial system subordinated to by different farmers. Large-scale farmers, to identify, could use both massive financial and cultural capitals from the pre-farming period more effectively than other farmers.

In the meantime, only a few short-distance mobile persons attained high cultural capitals unless they had wider social networks based on their previous occupation or the foundation from their relatives for patronage. Cultural remittances, besides, could be reinforced by both self-potentiality from working and self-behavior in learning. In post-farming period, working skills and experiences were very gainful in beginning or continuing other occupations immediately which were usually based on previous occupational structures of the household. Construction workers tended to have more advantages than farm-based households because it was easy to seek a job in different areas in crisis situations and thus, earn a year round income.

5.5.2 Post-Farming Period

Mobility in the post-farming period was a consequential action from the pre-farming period as mobility activities in post-farming period were found less. Although, as we have already recognized, fish cage farming was an important factor in restraining mobility activities, fish cage farmers in the parental generation needed to stay at the hometown and diversify life. This was done by pursuing mobility in shorter distances and time durations or immobile actions to deal with risks in the production system both climate-related and socio-economic factors that have become more intense in recent years. The target of remittances earned, thus, dramatically changed and different from the pre-farming period.

1) Financial Remittances

Financial remittances particularly daily or monthly income was the greatest tool to mitigate financial losses of production failure in the

post-farming period. All research sites had a massive failure that had never occurred before in the history of fish cage farming throughout the years. The enthusiasm of mobility for financial needs in the post-farming period, however, was diverged from the threshold of production failure and cultural remittances of pre-farming mobility. Fish cage farmers in Pradang village have illustrated a clear picture of less mobility because of being the least risky village compared to all the other research sites although some of the farmers had lots of working skills and experience in previous inter-regional and overseas mobility. They, further, had less action in occupational diversification by either mobile or immobile actions in the post-farming period particularly large and medium-scale households which had more financial capital from internal and international mobility and households which had more reproductive burdens in the grandchildren generation.

The highest volume of mobility in the post-farming period as well as immobile actions, in the meantime, appeared in Hua Kuang village as all fish cage farming households were affected by very high climate-related risks which were represented through massive and frequent financial losses from production failure. At first, they earned money daily, though a small amount, from mobility activities to support daily living. In Ban Koh village, fish farmers had two pathways to earn money – doing non-farm immobile occupations, particularly in flying lantern business or moving to nearby villages to earn huge funds (construction, merchant, and self-employer). Episodic mobility in the post-farming period to compensate for losses in fish cage farming did not appear much among fish cage farmers. Yet, fish farmers in Ban Mai village were not able to move conveniently because of less working skills and experiences as well as less job opportunities even though they had been damaged a lot by climate-related risks and sensitivity. Most

households in Ban Mai village in all production sizes, thus, have to rely on immobile actions rather than financial remittances from mobility.

2) Social and Cultural Remittances

Social remittances received from post-farming mobility were slight from episodic mobility as this was a temporary mobility which needs only a small amount of money to sustain daily living. Using social remittances for this immediate mitigation was related to other occupations in the household instead. In intensive fish cage farming, social networks were limited and directed by contractual relations. Likewise, cultural remittances in post-farming mobility were quite scant because all farmers who migrated tended to use working skills and experiences from pre-farming mobility. To identify, social and cultural remittances were not the main outcome of the fish cage farmers in adapting to multiple risks because they were not concrete entities that immediately helped the fish farmers' livelihood to survive in disaster situations. However, those two remittances from the post-farming period would be applicable for the next mobility decisions as they emerged from pre-farming mobility.

5.6 Effects of Mobility in Reducing Multiple Risks and Vulnerability

Various benefits from financial, social, and cultural remittances from mobility in pre and post-farming periods had their own characteristics for adaptation both in the short and long term. To evaluate, firstly, cultural remittances seemed to be an important key in all time periods and household occupations. Pre-farming cultural remittances from non-fish farming activities played a greater role in supporting and developing the establishment of fish farming and non-aquaculture activities in later periods. It, moreover, could essentially facilitate earning some money for life survival in hazardous events of fish farming at first and provided basic pathways to develop social and cultural remittances of the post-farming period for the next mobility which would occur again in the future if multiple risks were intensified. Secondly, financial remittances especially money were quite

significant for adapting in different patterns. In the long run, money and other assets earned from remittances can construct secure life foundation before investing to fish farming and other activities which required massive fund used from their own savings together with access to loans. In contrast, money was the most important element of all remittances in the post-farming period needed to urgently support production failure and financial losses from multiple risks in fish cage farming until fish farmers could strongly survive after the failure. Then, the investments created by mobility in the post-farming period would emerge. Currently, financial remittances received from both hazardous and routine mobility as short-term mitigation tend to be more helpful than long-run remittances in adaptation to fish cage farming. Thirdly, social remittances from mobility both in the pre and post-farming period could not assist fish cage farming directly and had the least influence in adapting to multiple risks. Although social networks could aid mobile people to obtain cultural remittances, using social networks in fish cage farming under the contractual system were likely to be unaccomplished. Social remittances were applicable for other occupations including farm and non-farm production as they needed to hire many of laborers to do the work at one time. It, however, could be good for the next mobility like cultural remittances received in post-farming mobility. To describe, the linkages of social remittances especially social networks from mobility between pre and post-farming was quite vague because it was difficult to adopt social networks from one occupation to other types of work as they needed different skills and experiences.

To measure the adaptive capacity of the household, the amount of remittances received and their uses in adapting to multiple risks in fish cage farming and household vulnerability was an important indicator. Levels of mobility and remittances were respectively related, but some households obtained higher or lower remittances from mobility levels. Large-scale households where most of them had a medium to high level of mobility tended to have higher financial and cultural remittances from mobility in longer distance with great working skills, and profitable immobile actions supported by financial remittances of mobility and fostered by experiences which have been started since the pre-farming period. Those remittances were used to share in the investment in expanding fish cage farming. Moreover, the farmer's effective financial strategies,

knowledge in addition to the techniques of the fish company, as well as the high social status among fish cage farmers in the village led to excessive access to capitals as planned adaptation. Most medium and small-scale households, however, were likely to receive lower remittances varying by lower levels of mobility in types of jobs, distance, and time duration. As daily routine mobility and episodic mobility were the most famous mobility behaviors of those households, they could not earn massive income and cultural capitals as the large-scale households had. When they faced severe disaster in fish cage farming, they also had fewer pathways to migrate because they have less investment to expand mobile and immobile activities as well as fish cage farming to accumulate higher income, social networks, and experiences as anticipatory adaptation before disasters occurred (table 5.2).

Table 5.2 Level of remittances earned by production size

Remittances	High	Moderate	Low
Production Size			
Large	9	4	0
Medium	3	6	8
Small	2	5	5

Remittances from mobility were very essential in constructing planned/anticipatory adaptive capacity from the past until now. Highly-mobile households decided to move internally and internationally for longer and more frequent time durations to firstly earn massive money and obtain working skills in order to begin other occupations including fish cage farming if they received high remittances from the mobility. Also, they could reduce mobility in the post-farming period as they had built enough of a life foundation or secure investment by doing other occupations in large scale production as well. If fish cage farming was profitable for them, they could expand their operation or change several techniques to reduce losses and increase more revenue. In the case of having only fish cage farming as a main occupation and it failed, they could quit fish cage farming for a

time and turn to other employment or operate in other sectors rather than forcing themselves to lose more in fish cage farming. This situation might be contrasted to minimally-mobile households as they had less experience from working outside. When they encountered severe problems in fish cage farming, it was very difficult to recall remittances from mobility to assist in time. Multiple risks from fish cage farming could be more severe if immobile production could not have enough capacity to help the households, especially from farm production which was very exposed to climate-related and socio-economic risks (such as state policy in price) similar to fish cage farming.

The adaptive capacity of fish cage farming households was analyzed by remittances from mobility and household vulnerability as a combination of multiple risks in fish cage farming, climate-related vulnerability in fish cage farming, and socio-economic vulnerability from sensitivities of households in demographic, occupational, and capital structures. The result pointed out that remittances and household vulnerability were closely related to each other. Large-scale households had higher adaptive capacity to multiple risks rather than medium and small-scale households. All of the large-scale households had a moderate level of capacity to reduce fish cage farming, while most medium and small-scale households (13 of 17, and 10 of 12 households) have moderate to low capacity to adapt to multiple risks as they earned lower remittances from mobility (table 5.3). In the level of village, households in Ban Mai village had a slightly less adaptive capacity in fish cage farming compared to other villages.

Table 5.3 Adaptive capacity of fish cage farming households to multiple risks
and household vulnerability by production sizes

Adaptation Size	High	Moderate- High	Moderate	Moderate- Low	Low
Large	6	4	3	0	0
Medium	2	2	5	7	1
Small	0	2	6	4	0

5.7 Conclusion

Mobility as adaptation to multiple risks and vulnerability is classified as periodic and episodic mobility in pre and post-farming periods. Each type of mobility had different drivers, frequencies, time durations, types of jobs, and purposes. Periodic mobility covered intra-village to international scales as permanent mobility in the pre-farming period. It is also preliminarily fostered by non-environmental factors especially household burdens to build up a life foundation, and expand to other occupations and investment in fish cage farming in the future. It tends to be a great pathway for earning massive remittances for adaptation in fish cage farming and other household burdens. Being overseas sojourners and using internal mobility in the inter-region scale were influential for the adaptation rather than daily routine mobility because mobility in long distances tends to require higher working skills in employment and it can provide more income to mobile persons. Daily routine mobility in which mobile persons have high working skills/status, anyway, can also receive high remittances. Large-scale households are the major group to engage with those periodic mobility activities rather than medium and small-scale households. Episodic mobility, in other words, is likely to be an urgent solution in disaster events and an alternative to subsidize daily living by earning additional income as spare-time mobility. This mobility, yet, cannot generate much social and cultural remittance to fish cage farmers compared to periodic mobility. However, episodic mobility was not very popular among fish cage farming households either in pre or post-farming periods in all production sizes.

Remittances are effective tools in an adaptation to multiple risks in fish farming. Those remittances are obviously connected to levels of mobility in almost all of the households. Pre-farming period mobility is very important in the accumulation of remittances. Cultural remittances received in pre-farming period are related to working skills and experience of mobile farmers, and it is a sustainable way to adapt with multiple risks. In the meantime, financial remittances particularly money can also immediately aid in production failure in fish cage farming and have the best capacity in short-term mitigation. Social remittances illustrated as social networks, however, bring a vague picture of linkages from the pre to post-farming period to directly assist fish cage farming.

Social networks, anyway, can be useful for non-fish farming production in the pre-fishing period and sometimes be applicable to the post-farming period. Yet, obtaining social and cultural remittances in the post-farming period is quite difficult. To analyze with household vulnerability as a representative of multiple risks in their livelihood, large-scale farmers tend to have a higher adaptive capacity to rehabilitate production losses rather than medium and small-scale farmers. Thus, mobility has an important role in adaptation both in the short and long term for the households in fish cage farming and other related activities.



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CHAPTER 6

Conclusion

Fish cage farming is an alternative intensive aquaculture which originated around two decades ago in the Ping river basin as an immobile occupation. As this production had to rely on nature, climate-related risks were major obstacles since natural and anthropogenic actions of climate seemed to have threatened fish cage farmers in recent years. Socio-economic risks, besides, from market relations and social connections between fish cage farmers, related stakeholders, and authorities also had the potential to impact as risks in commercial production. More importantly, the household was the most important unit that totally shouldered the burdens by themselves. Fish cage farming, however, was only a part of the household occupations. Mobility was also one of socio-economic activities joining with the dynamics of household livelihood. This research, thus, analyzed the situations with a holistic point of view which related to mobility as an adaptation to household subsistence, particularly in fish cage farming as a main focus.

This research attempts firstly to answer questions about the experiences of the fish cage farmers to climate-related variability and socio-economic stresses in fish cage farming both external and internal multiple risks in the level of households with related stakeholders in the village, sub-basin, and national authorities. The investigation of multiple household vulnerabilities, secondly, is also included with household characteristics in demographic perspective, occupational diversification, and risk perception, as well as access to capitals from diversified occupations and techniques received in fish cage farming. The last objective of the research is to understand the different remittances earned from periodic and episodic mobility in pre and post-farming periods by fish cage farming households as a contribution to adaptation to multiple risks and vulnerability. According to the results from these three questions, those outcomes have to be reconsidered to prove for the findings of the research and synthesized again

with theoretical discussion to see the concurrence and the differences between results and academic thought. This research, in addition, illustrates field obstacles and solutions, basic recommendations for further studies, and policy suggestions for related stakeholders in fish cage farming.

6.1 Major Findings

6.1.1 Multiple Risks in Fish Cage Farming

Climate-related and socio-economic risks were influenced as multiple risks on fish cage farming households since they had first begun operating until now. Climate-related risks are influenced by external hazards from natural climate and disaster patterns, irrigation systems, and flood prevention policy. In the meantime, internal exposures of the households by cage location also intensify or decrease external hazards. In socio-economic risks, external hazards come from demand-supply and price fluctuation in market spheres, participation of state authorities, and internal relations and management. Each household is exposed diversely to socio-economic risks by different contractual relations systems.

Major risks encouraged by natural climate and disaster patterns appear in three patterns – drought and hot temperature, cool/cold temperature, and overflow and heavy rainfall in monsoon season. The most problematic issue for all research sites and the farmers, anyway, was drought and hot temperature which were extremely severe since they had started to operate fish cage farming, and quite relevant to regional climate change. Other actual elements of drought and hot water temperature in recent years were flood prevention policy and irrigation systems by state authorities. After the 2011 major flood, the Thai government established ONWFMP to command irrigation and management plans in crisis incidences in 2011-2012. These actions led to a water supply deficit in dam reservoirs and minor irrigation systems alongside the river. Some research sites, unfortunately, also had several problems from local irrigation systems. Climate-related risks, thus, tended to be heightened by anthropogenic actions. Each zone of cage location within a village, by the way, had an explicit role to change external climate-related risks.

Fish cage farmers in Hua Kuang and Ban Mai villages which lost suitable environments for fish cage farming and lived in most exposed areas received high climate-related risks.

In socio-economic stresses, price and demand fluctuation was very problematic from trouble climate-related conditions because the amount of productivity had fluctuated in different seasons which did not occur much in the previous years. In late 2013, fish prices were at the lowest rate after the 2011 major flood while variable production factors' prices had been higher and never been reduced. Profit losses were observed in all areas at the end of year. The participation of state authorities, moreover, was not much financially beneficial due to less compensation in disaster events, registration problems, and inflexible restrictions. Internal relations, however, in all research sites except Ban Mai village partially assisted in risk reduction. Economic relations in market sphere, thus, were most significant for intensive fish farming. In terms of exposure, each farmer was differentiated by a number of fish companies and financial systems. Farmers who joined only one company in the partial credit system found it difficult to diversify the quality of fingerings and cultivation time, thus, they became the most risky farmers in socio-economic terms.

In multiple risks, production failure from massive fish killing, profit loss, and debt accumulation were the major threats to intensive fish cage farming. Most farmers in all research sites except Pradang village had moderate to high multiple risks by receiving more climate-related effects than socio-economic impacts. Individually, some farmers had high multiple risks that were explicitly caused by exposed cage location in high climate-related risks villages, subordinating to only one company by the partial credit system which provided low-quality fingerings, and had overdue harvest and strict size selection problems.

6.1.2 Multiple Household Vulnerability

Fish cage farming households were classified in three production sizes – large, medium, and small-scale farming households – in which cage areas and other assets were not equal among the research sites. Multiple household vulnerability was analyzed by four

perspectives of sensitivity – current household demographic structure, occupational diversification, risk perception, and access to capitals and techniques in fish cage farming.

The current household demographic structure can define workforce and dependency burdens explicitly. Skip-generation households had become the most vulnerable unit because these households carried the burden of more dependent persons and fewer workforces. Following different production sizes, small-scale households also had a low workforce ratio, and more dependency burdens including children' burdens in education and elderly limitations in working compared to other scales. Occupational diversification, secondly, was also reconsidered to seek various pathways of access to capitals. Each occupation, by the way, made distinctive income, assets, and developed particular social networks, working skills, and experiences. Large-scale households occupied larger land sizes that were useful for farming perspectives and higher working status that could generate massive income and valuable working skills in terms of non-farm occupations.

According to occupational diversification, large-scale households, thus, had much security in accessing financial capital from massive income in various occupations. Next, social capital in the form of social networks, were quite similar in each production size. Large-scale households, yet, tended to have stronger networks in fish cage farming and other activities. Social capital, further, could ease the access to cultural capitals through training and knowledge extension from related private officials and public companies. Farming households which had more production activities in a higher job status, besides, attained more cultural capitals. It was very obvious that all large-scale farmers had moderate to high cultural capitals from various jobs among the household members. Some households, however, were obstructed access to this capital as they were affected by dependency burdens. In conclusion, most of the large-scale households (11 of 13 households) were less sensitive to access capitals, while medium and small-scale farmers tended to be more sensitive.

According to climate-related risks in fish cage farming, farmers had to reduce those risks by accessing fish cage farming techniques based on risk perception. In terms of risk perception, the climate-related perceptive illustrated through drought with extreme hot

temperature and overflow/floods were major risks that they perceived. Following this issue, fish cage farming techniques from individual and collective actions can be described as five groups – urgent solutions, physical innovations, landscape changes, feeding patterns, and changes of feeding duration. As a result, large-scale households in the upstream villages could access various techniques through financial, social, and cultural capitals more efficiently than medium and small-scale households. Unlike Pradang and Ban Mai village, this situation did not occur because experiences and social relations in collective actions were important in mitigating climate-related risks as production sizes were not much different.

In regards to multiple household vulnerability, fish cage farming households were mostly vulnerable in moderate to moderate-high levels. Large-scale households had moderate to low vulnerability, while most medium and small-scale households perceive moderate to moderate-high vulnerability. In the level of the village, production sizes massively affected the disadvantages among the small-scale households in Ban Koh village especially climate-related vulnerability. Large-scale households in Hua Kuang and Ban Mai villages had a slight amount of amassed financial capital, social status and networks, and experiences in both fish cage farming and other related economic activities to reduce multiple risks. In contrast, production sizes did not greatly impact the distinction of vulnerability in Pradang village.

6.1.3 Mobility as an Adaptation to Multiple Risks

This chapter was a core part of the research in clarifying household adaptation to multiple risks based on multiple vulnerabilities. In terms of occupational diversification, mobility is considered as one of livelihood strategies to deal with short and long-term damages. Mobility is motivated by various drivers, mobile persons, distances, time durations, types of jobs, and purposes of mobility. Time scopes for this analysis were divided into pre and post-farming periods by using starting time of fish cage farming as a break. In each time duration, mobility behaviors were defined in two directions – periodic and episodic mobility. Remittances, which are important to construct adaptive capacity to access financial, social, and cultural capitals, were the main target of adaptation in the research.

Periodic mobility is differentiated into three categories by different time and space relationship – daily routine mobility, internal mobility, and overseas sojourner. Non-environmental factors including income, less job opportunity, household and child's burdens, education, working experiences, and social networks all were part of those mobility behaviors. Men were more responsible in this action than women, particularly in long-distance permanent mobility. Working skills, education, and social networks were importantly related to types of works, specialty obtained, and revenue which are attained more from long-distance mobility. More than half of the household members who were mainly responsible for fish cage farming now had stopped all periodic mobility activities before and when starting fish cage farming.

Episodic mobility is an intermittent short-term action encouraged by unsafe conditions because of social, economic, political, and environmental reasons. It, however, was not very popular among households compared to periodic mobility. Episodic mobility can be described as spare-time mobility and mobility related to hazardous events. Spare-time mobility covered in a day, week, or seasonal period, but it was not the permanent work of that mobile person. Migrants in this mobility could also move inside the village or province, intra-region, and inter-region scales. It was closely related to production structures and the spatial contexts of the household and village. Secondly, mobility related to hazardous events was motivated by physical, social, economic, and environmental losses affected by disasters to mitigate those losses by earning money. It would be developed into further mobility activities both periodic and episodic mobility in any scales of place. It might be supposed that episodic mobility required more spare time, enough social networks, working skills, and household demographic availability. Immobile actions, so, were quite convenient for households, particularly in the post-farming period. Four-fifths of them had immobile occupations before starting fish cage farming, particularly in farm-based production as the main occupation along with other minor jobs in periodic mobility interfering with those immobile actions for a while. After starting fish cage farming, thirty-three of the thirty-seven households which had immobile actions before fish cage farming have still operated those jobs especially farm productions until now.

Remittances from mobility are divided into financial, social, and cultural remittances. Those were very useful in approaching the four purposes of mobility – building up a life foundation, existing daily life, doing other occupations, and investing in fish cage farming and other occupations. Pre-farming mobility was very important to accumulate those remittances. Cultural remittances received in that period were related to working skills and experience of mobile farmers in sustainably adapting with multiple risks. Pre-farming cultural remittances from non-fish farming activities had a greater role in developing fish farming techniques and supporting non-aquaculture activities in later periods. In the meantime, financial remittances (money) could also aid immediately in production failure in fish cage farming with the best capacity for short-term mitigation. In the long run, money and other assets earned from remittances could construct a secure life foundation before deciding to invest in fish farming and other activities which required massive funds of their own savings together with access to loans. Social remittances illustrated as social networks, however, brought a vague picture of linkages from the pre to post-farming period to directly assist in fish cage farming. Social networks, anyway, could be useful for non-fish farming production in the pre-fishing period and sometimes were applicable to the post-farming period.

Household adaptive capacity is analyzed by remittances from mobility and household vulnerability as a combination of multiple risks in fish cage farming, climate-related vulnerability in fish cage farming, and socio-economic vulnerability of households in demographic, occupational, and capital structures. The result pointed out that remittances and household vulnerability were closely related to each other. Large-scale households had a higher adaptive capacity to multiple risks rather than medium and small-scale households. In the level of village, households in Ban Mai village have the least adaptive capacity in fish cage farming compared to the other villages.

6.1.4 Unexpected Findings

Following the major findings in each of the research objectives, several surprising outcomes from the analysis could be explored covering risk, vulnerability, and mobility as an adaptation. First of all, in terms of multiple risks, this research found that the current

natural climate is just a minor part of climate-related risks as disaster prevention policy has intensified drought in recent years instead. In another way, a bilateral relationship between farmers and contractual fish companies was rather prominent in conducting risk in socio-economic terms compared to various stakeholders in this sector. Secondly, I was really surprised in this study of multiple household vulnerability that sensitivity in access to fish cage farming techniques obviously varied by the range of differences in production sizes among the households. Minimally-differentiated production sizes among fish cage farmers in a village could limit the capacity of large-scale households to receive good techniques, but they should have some necessary capitals that were popular among farmers instead. Following ground information, moreover, most of the farmers who were of the parental generation had felt more pressure to depend on the income earned by themselves rather than being looked after by the offspring generation as those people had been affected by social and economic pressures from the consumerist society, and many of the children were still studying. Finally, the utilization of remittances in the pre-farming period illuminates the outstanding role of adaptation instead of practicing real physical mobility as an adaptation when problems arose for the to farmers.

6.2 Theoretical Discussion

The main argument of the research can be divided into three major points related to risks, vulnerability, and mobility as an adaptation to multiple risks. Firstly, though household risk is also physically, socially, and economically differentiated by the level of exposure of various areas particularly changes in regional systems (Cardona *et.al.*, 2012; Schneider *et.al.*, 2005; Daze *et.al.*, 2009), this research shed light on a little bit different point of view; that each perspective of risk – climate-related and socio-economic risks – has unequal impetus to deteriorate fish cage farming in each research site and in different seasons. Climate-related risks, totally, were the main consideration of many farmers in the research sites. Anthropogenic manipulation through authorities was entirely concerted and expedited with drastic natural climate, as well as having intensified severe influences on fish cage farming in recent years. This understanding is quite relative to the clarification of many scholars attempting to point out various physical systems and anthropogenic management pathways as prominent accelerators in climate-related terms

by time, duration, frequency, and areal extent, etc. (Burton *et.al.*, 1978; Daze *et.al.* 2009; Handmer, 2003; Schneider *et.al.*, 2005; UNDP, 2002). This research, in addition, allows in producing a minor challenge that demand-supply fluctuation in red tilapia fish market under contractual relations with fish companies, as the most significant issue of socio-economic risks, is intensively impacted by climate-related risks. The outcome of risk analysis in this research, thus, can newly specify the influential socio-economic factor as risk to intensive fish cage farming as a bilateral relationship.

Socially and physically-induced sensitivities, secondly, have an excessive impact on multiple household vulnerability. It, however, is very difficult to define which topic of vulnerability is the most influential. To point out, there are two major engagements from both dimensions. The capacity to diversify occupations, one of the brand-new points, is differentiated by the influence of the stream of modern development causing rural changes affecting each region and community, as well as distinguished by dependency burdens in the household level. Children' burdens were the most problematic issue for other workforces to access capitals which are coherent with the study of Nipon (2011) who explained about the burdens of the skip-generation household in taking care of children, and results from Sittitrai *et.al.* (1991) who emphasized that the control of family size diminishing increased household well-being in the future. Elderly people in the household, however, were not highly oppressed in finding income sources. Households which occupied large-scale production had less an encounter with this problem than other production sizes. Another beneficial result of the research is a declaration about the sensitivity of risk reduction by fish cage farming techniques. Even though farmers who were able to operate large-scale production size farms, this could not be a single absolute criterion in decreasing risks from climate-related impacts in the case where production sizes among the farmers were not much different. This kind of relationship; therefore, redefined adaptive capacity in terms of fish cage farming and production sizes that farmers in those villages should rely on that outstanding significant capital at some time rather than balancing capitals for adaptation.

According to the comprehension of mobility in dynamic contexts, thirdly, it is very noticeable that fish cage farming and immobile operations were economic activities

replacing substantial agriculture and a great amount of mobility in the previous era. By using mobility as an adaptation to multiple risks, the utilization of remittances from pre-farming period driven by socio-economic needs to obtain better life chances from limited resources in local area, and find better alternatives for children became more important than relying on post-farming mobility. This situation can be comparative to the fruitful findings of Head *et.al.* (2011), Rigg (2001), and Rigg (2005) that immobile actions or in-situ adaptation were founded due to the development of modern rural society by the intensification of individual agri-business, cottage industry, and piece work beneath the power of commercialization and counter-urbanization. Remittances used for adaptation consist not only financial remittances, but also include social and cultural remittances as various studies have proven (de Hass; 2010; Findlay, 2011; Rigg *et.al.*, 2012; Scheffran *et.al.*, 2012). There, however, is no judgment from all of the studies as to which type of remittances is the most effective strategy in adapting to multiple risks and vulnerability.

Cultural remittances, illustrated as working skills and experiences obtained from pre-farming mobility, turned into the most important and sustainable adaptive capacity in all perspectives of livelihood existence including fish cage farming. The outcome of mobility in cultural terms is directly varied by longer distances of mobility (particularly in the international level), and high working status from periodic internal and daily routine mobility. It is also consistent with the comprehension of Rigg *et.al.*, (2012) that the values of socio-cultural and practical skills have been attached to migrant workers, thus, enabling them to engage with market motivation effectively with their new aspirations. Large-scale households, outstandingly, have attained more cultural remittances than the others, so they could access more cultural capitals to avoid damages. They, moreover, received lower vulnerability than other groups because they could utilize the remaining remittances to start a new enterprise immediately or intensify other occupations in order to sustain, despite the fact that some of them did not have suitable access to fish cage farming techniques for reducing climate-related risks which led to the discontinuation of fish production.

In accordance with the viewpoint of Adida and Girod (2011), financial remittances became minor adaptive factors which were utilized for the improvement of basic

infrastructures and the life quality of households. This research, in addition, added more understanding of the idea that obtaining financial remittances to build up a life foundation was an important process in preparing the financial readiness of a household before engaging in intensive fish cage farming. Mobility in the post-farming period, anyway, was still essential to some people who had less opportunities to financially diversify in situ, and relevant to various opinions about short-distance mobility during hazardous events caused by environmental change (Tacoli, 2009; Findlay, 2011) or environmentally-induced economic migration (Afifi, 2009). Social remittances, finally, provided an obscure image to directly assist fish cage farming as mentioned in several literatures, despite the fact that it is quite expedient for other economic activities and episodic mobility. It might be incurred by strong commercial bilateral relations rather than using self-networks to facilitate fish cage farming.

6.3 Obstacles and Solutions in Field Research

6.3.1 Collecting the information in all of the research sites in the same season was quite challenging. Spending many weeks at one time in each site to attain insight data was totally impossible. Important issues taking place empirically at that moment, most importantly, should be emphasized by asking respondents at first. Another problem related to the operational quality of key concepts in the field sites was quite complicated. I had to survey many times before in-depth interviewing with guideline questions in order to prove that I really understood the contexts of each village.

6.3.2 The information had to be collected many times in all seasons. Collecting in-season data is quite important because real situations, feelings, attitudes, and effects are immediately illustrated. There, however, were many case studies in the research sites. I, therefore, had to shorten my interviews and at the same time grasp all of the information. Taking notes from the preliminary analysis after finishing every field work was very important to catch up on several outstanding issues related to the thesis statement.

6.3.3 Many farmers could not remember statistical information about profit and loss of various production types in previous crops especially in farming and fish cage farming production as only a few of them had kept records. I, as a researcher, accordingly, had to

estimate by calculating from size of production, amount of productivity, and production cost to fulfill this part of the data.

6.3.4 Several farmers felt reluctant to answer in deeper details repeatedly especially in regard to personal profiles. Developing trust among the respondents, therefore, was very essential in order to attain enough information for the analysis. Helping with their work sometimes, talking about out-of-research issues, and being sincere to respondents could ease the data collection. It, however, was important to recognize that the self-character in each research site (e.g. talkative, friendly, introverted, angry, aggressive, etc.) was quite different.

6.3.5 Some farmers were not available at the site when our team went there site leading to missing information. Many of them had a lot of work burdens, so it was quite difficult to gain completed information. The interview conducted later referring to that period may be plausible by asking him/herself, cousins, or neighbors. Most sample groups in the research sites, by the way, participated with a satisfied response.

6.4 Recommendations

6.4.1 Spatial mobility is a main focus in the adaptation of fish cage farming households. Although the study of remittances can provide wider point of view about socio-economic dimensions to reduce household risks, social mobility among fish cage farmers was not much analyzed as the abstract idea of mobility. In my opinion, it was very useful to see the relationship between spatial and social mobility in defining the dynamics of fish cage farmers' status in adaptation to multiple risks.

6.4.2 This research emphasizes on socio-economic risks in various issues. Although I highlighted on market and demand-supply fluctuation from a bilateral relationship between farmers and fish companies, contractual relations issue was just described from the villagers' point of view. To understand the full interaction, power relations between those two entities should be scrutinized in-depth as fish cage farming is an intensive production in which most farmers have subscribed to a contractual system nowadays.

6.5 Policy Suggestions

6.5.1 Many fish cage farmers could scarcely access climate-related information from any authorities except by watching the television. Climate risk communication networks among fish cage farmers and related authorities are were strong enough. Nowadays, fish cage farmers have to mainly observe weather and climate situations by themselves. State authorities and academic sectors should associate together in monitoring micro-climate situations for fish cage farming and farm production as a precautionary mitigation system to reduce repeated major production failures.

6.5.2 Fingering quality is a problematic issue among farmers now because of severe climate-related risks and the carelessness of companies inspecting the quality as fingerings cannot supply all of the farmers throughout the country. This problem is another major cause of fish killing and disease above those of climate-related risks. State authorities should have some agreements with the fingering producer and fish companies to control the quality from the production place, transportation process, and selection of fingerings to farmers, as well as promote new technical methodologies to increase the capacity of the fingering producers. In the meantime, fish cage farmers should have enough knowledge to observe and negotiate through collective action amongst the farmers in the village with fish companies in case of receiving low-quality fingerings.

6.5.3 Besides the climate-related risks which obviously contributed to the people's damages, contractual relations was one of an important ways to trap and fix the relationship between the two major actors – farmers and fish companies. Being a type of intensive production, a lot of money was mobilized from either their own savings or from a loan investment by the farmers themselves. Besides, contractual relations seemed to obscure other social networks from participating in the production system as the process from providing production factors to sell were private mechanisms. Risks in production, thus, were shared and responded to by only the fish companies and farmers. Yet, farmers had the full responsibility in compensation in the case of loss and irregular events. Unfortunately, farmers had lower capacity to absorb the failure as they had only some financial assets which were not much compared to the fish companies. Thus, state

authorities especially the fisheries department should assume more responsibility in intervening and controlling this relationship.

6.5.4 Mobility demonstrated a clear picture of engagement in adaptation to multiple risks of fish cage farming. In risky situations, at first, all farmers had to mitigate life security for the household members to survive before improving fish farming production to be more stable. Remittances from mobility in each household, however, were not equal. Household structure and burdens, besides, had massive impacts halt all mobility activities. To resolve this problem, it was impossible to reorganize and change household burdens and structures because household demographic patterns could not be transformed by any action and also, externalities in the occupational circle were very intensive. As many fish cage farmers were faced those problems, this led to less ability to migrate outside and could not rely on offspring remittances. The collaboration of in-situ social networks among fish cage farmers within a village as a forum to exchange learning methodologies, knowledge, and techniques in fish cage farming could be applied as long-term adaptation. Different abilities and thresholds of experience in fish cage farming which were partially reflected by different levels of remittances attainment could compromise and connect several gaps of an adaptation in fish farming among themselves. Financial affairs may not have been necessary in this collaboration in order to avoid the financial conflicts that had occurred in some villages already.

6.5.5 The expansion of translocal social collaboration in fish cage farming, by the way, should be prepared when each village is ready and strong enough to set some local policies to negotiate with the related private sectors and public authorities as a bottom-up approach. Notwithstanding, the most important gap limiting the encouragement of a fish cage farming adaptation policy is that there is not much interest on the part of the related state water-related and economic authorities to advocate this operation as massive aquaculture production in the country. This is a significant issue that all participants in the fish cage farming circle have to heavily recognize in order to increase the negotiation capacity of the fish cage farmer in adapting to multiple risks.

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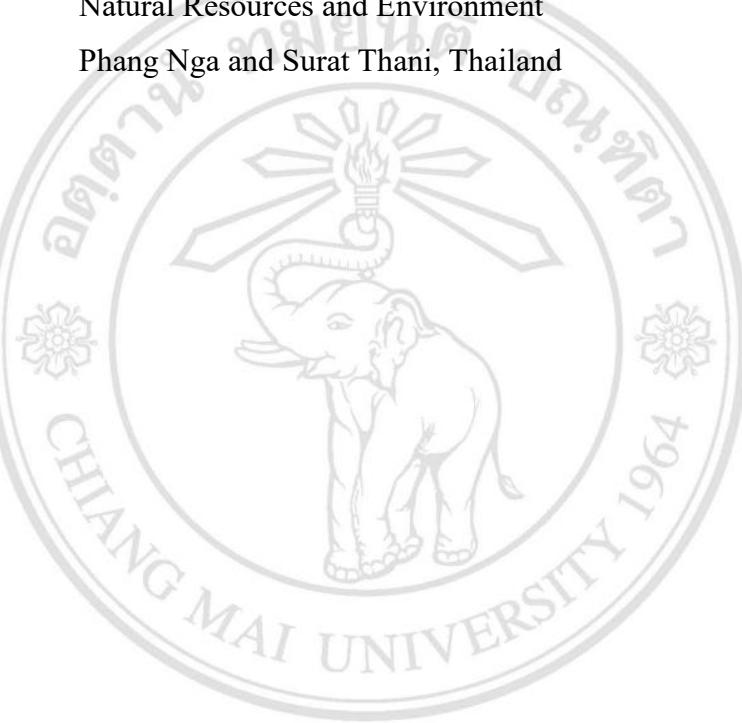
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