CHAPTER I
INTRODUCTION

Lord Curzon in 1890 stated "It is a gamble on the monsoon", a famous statement referring to the rainfed agricultural situation in India. That statement could very well be applied to farming conditions in Northeast Thailand. Moreover, such a gamble becomes more complex because it interplays with more socio-economic dynamics. This chapter introduces brief characteristics of the study site at regional and community levels. The justification for conducting this research is provided followed by the research problem and objectives. The methodology used is also briefly presented followed by the expected outcomes.

1.1. Background Information and Resource Management Problem

Northeast Thailand is mainly a large plateau on sandstone, called "Isaan", which is usually characterized by poor soils and under the influence of the erratic monsoon rainfall. It covers one third of the Kingdom's area and contains a third of its total population. Northeast Thailand's 20 million inhabitants mainly belong to the Lao and Khmer (in the southern part) ethnic groups. The Isaan region is also, by far, the poorest of the country and is still a major rainfed lowland rice (RLR) growing area on millions of hectares (Jongdee, Pantuwan et al., 2006; National Economic and Social Development Board, 2003; Office of Agricultural Economics, 2007). The severe agro-ecological constraints cause low paddy yields with an average of some 1.8 t ha^{-1} (Somrith, 1997). Two sub-regions can be distinguished: the Chi and Kong Basins in the upper part and the Mun Basin in the lower northeast. The upper northeast is characterized by an undulating topography favouring the adoption of important industrial cash crops such as kenaf, cassava and sugarcane. In the more monotonous lower northeast, the agricultural diversification out of rice is still far more limited. Although the famous aromatic jasmine rice (KDML105) is largely grown, its higher commercial value cannot compensate the low farm productivity (Office of Agricultural Economics, 2007).

Past agricultural research and development efforts emphasized agricultural intensification by alleviating the risk of drought and improving soil fertility but their

impact has been limited. Particularly, when water availability has been improved by governmental agencies, farmers have not taken this opportunity to intensify their production practices as expected (The World Commission on Dams, 2000). In this context and in most cases, agricultural production is not sufficient enough to satisfy local households' economic needs in this relatively poor part of the Kingdom (average monthly household income is about 8,800 baht (190 euro) as reported by the National Statistical Office of Thailand, 2007). Many people in the 20 to 35 year old age bracket consistently migrate to search for more profitable off-farm employment in industrial and urban areas; the Northeast provides the largest proportion of out-migrants nationwide as more than a third of all interregional migration originates from this region (Santiphop, 2000).

Labour migration, particularly working abroad, is regarded by migrants as a strategy of life support and is sometimes life-enhancing (Jones and Pardthaisong, 1999). Remittances from migrant workers are also a key factor in reducing income disparity among regions. However, labour migration from farm to non-farm sectors is an increasingly important issue in Thailand as farm labour scarcity affects many social and technical changes in the agricultural sector (Shinawatra and Pitackwong, 1996). At the same time, the King of Thailand's concept of sufficiency economy, and its application in agriculture through the "New Theory" advocating the adoption of integrated agricultural production systems, is being promoted among local farmers to improve food security and secure a decent quality of life at the farming household level (Jitsanguan, 2000). In particular, these development efforts have led to the digging of thousands of small farm ponds in the paddies of Issan during the last 15 years (Jitsanguan, 2001). This theory was first introduced to Ubon Ratchathani's farmers in 1984. However, its adoption is still limited by inadequate water availability.

The Lam Dome Yai watershed where the study site is located, is the largest watershed in southern Ubon Ratchathani province, lower northeast Thailand. The Lam Dome Yai River merges into the Mun River flowing eastwards to join the Mekong River at the Thai-Lao PDR border. The social-agroecological system (SAES) of this watershed is characterized as an RLR ecosystem in a drought-prone (and in some parts flood-prone) area allowing only one low yielding rice crop cycle per year.

The majority of RLR growers are small and resource-poor farmers with very limited access to irrigation water, and their farm management still relies heavily on human labour. Various strategies – such as diversification into annual, or more recently perennial, cash crops – have been used by community members to increase their agricultural output and secure adequate household incomes. However, for many of these small holders, labour migration has been perceived to be the most successful choice for attaining their economic goals, even if they have to leave their land and water underused and put their children in the care of elderly people at home in the dry season. Once some family workers move out, the household needs to adapt its farming strategy and practices to deal with family labour scarcity. For instance, more labour-intensive farm activities are either abandoned or downsized.

The influential Royal Irrigation Department (RID) has attempted to implement a controversial project to build a new dam on the Lam Dome Yai River to increase irrigated areas in this watershed. Like in other areas of the Northeast region of Thailand, it was observed that similar costly investment and centrally controlled water storage and distribution infrastructures were inadequate in meeting local farmers' needs, and faced maintenance problems leading to even lower efficiency (Chantawong, Boonkrob et al., 2003). The suitability of such top-down water improvement schemes is also questionable as they usually do not work well with small farmers' socio-economic strategies, especially regarding labour mobility. Therefore, an important assumption of my research team was that a similar costly failure could occur in the Lam Dome Yai watershed if a better understanding of the interaction between land / water use and labour mobility/migrations was not achieved and taken into account by policy makers at this stage. Moreover, it was deemed necessary to create understanding among the most concerned stakeholders, in particular the main group of end users: the local farmers. Through this bottom-up approach, more practical and acceptable alternative water development scenarios could emerge prior to their implementation.

Stakeholder involvement is also promoted at the national level under the decentralization of the management of local resources policy (Charoensutipun, 2001). Several local administrative bodies (like the now powerful and well-funded Tambon

Administrative Organization-TAO[1]), and government agencies (like the Community Development Department-CDD, under the Ministry of Interior which is responsible for the promotion and development of community organization, leadership and networks for poverty eradication and local development) are active. Consequently, it was decided that a collaborative modelling process based on the Companion Modelling (ComMod) approach would be launched to investigate this key interaction in the central part of the watershed.

The key renewable resource management problems in this study area are:

1. Water availability and labour issues are widely recognised as important impediments to agricultural development at the study site and in this region. But a poor understanding of the interaction between land/water use and labour migration could lead to the failure of costly state-funded development of new water infrastructures.
2. Local farmers have limited knowledge regarding the current situation and consequences of these interactions between land/water use and labour migration.

The related research questions are:

1. Can a collaborative modelling approach improve the understanding of the interactions between land/water use and labour migration for the different kinds of concerned stakeholders?
2. Can a collaborative modelling approach create a common understanding and representation of the problem among stakeholders?
3. Is it possible to use the collaborative modelling approach to integrate scientific and indigenous knowledge between scientists and the local farmers with primary education level?
4. Can local farmers use tools produced through the collaborative modelling process to discover new knowledge particularly regarding farm management and labour migration practices?

[1] One 'tambon' or sub-district is made of 10-12 villages.

5. What are the effects of the collaborative modelling process on farmers' farm management and labour migration practices?

1.2. Research Objectives

The main research objectives were as follows:

1. To improve the understanding of the interactions between land/water use and labour migration and use the results to improve the design of more adaptive future water management policies.
2. To offer tools and a methodology that enhances the capacity of expression of the different stakeholders, to facilitate their collective assessment of the problem at stake, and to improve their coordination through the collective identification, simulation and assessment of scenarios of change.

To accomplish these main objectives, specific objectives were defined as follows:

1. To understand the recent land use and cover change in the study area and the driving factors of such changes.
2. To categorize the local household-based agricultural production systems (APS) to elucidate their respective strategic decision-making processes regarding farm management and labour migration practices across types.
3. To design a conceptual model representing the structure and interactions of the components of the system under study to be taken into account.
4. To implement Role-Playing Games (RPG) and an Agent-Based Model (ABM) based on this gradually improved conceptual model.
5. To organize participatory simulation workshops using associated RPG and ABM tools to share knowledge and establish a common understanding of the problem among stakeholders, and to enrich and validate the conceptual model.
6. To identify and explore future scenarios with the concerned stakeholders and assess their simulated results by focusing on the co-adaptation and co-viability of stakeholders' land/water use, and labour migration.

1.3. Materials and Methods

1.3.1. Study site and participants

The Ban Mak Mai village is located in a sub-watershed of the central part of the Lam Dome Yai watershed and represents a typical RLR-producing area found across the lower northeast Thailand. 21 local rice farmers belonging to 11 diverse farming households of this village were recruited to join this research to cover all main farm types based on a typology of the local farming households built during the initial diagnostic phase.

1.3.2. Methodology

Collaborative modelling refers to group model building with active involvement of model users in the modelling process. It is a promising approach that enables a better understanding of complex issues through the exchange and integration of knowledge derived from different disciplines and experiences (Eden and Ackermann, 1996). A shared understanding and representation of the problem at stake built among participating stakeholders during the process can result in improved collective resource management, and adaptive management capacity (Ashby, 2003; Narayan, 1996; Selener, 1997). Companion Modelling (ComMod) is a very interactive modelling approach involving the collaboration of stakeholders throughout model design and its use. This approach refers to a dynamic perception of the decision-making process in which the scientific and technical perception is only one point of view among others, and not the pre-supposed right perception toward which the decision should be attracted (Barreteau, 2003a). ComMod aims to develop a series of models that integrate stakeholders' representations and knowledge by encouraging stakeholders' participation throughout the process so that their adaptive capacity increases. It emphasizes better understanding of interactions between ecological and socioeconomic dynamics.

ComMod is based on continuous and iterative back and forth phases between the laboratory (model implementation), and field activities (interviews, specific field surveys, and/or participatory modelling and simulation workshops) generating a succession of evolving loops. The decision-making process of stakeholders is considered as essential to understand interactions among stakeholders whose

objectives, perceptions, kind of information and representations are different (Bousquet and Trébuil, 2005). An important concept of the ComMod approach is Multi-Agent Systems (MAS), which originated in the field of computer science (Distributed Artificial Intelligence: DAI) and social science (Artificial Life). It is a promising concept that allows researchers to represent complex systems. MAS is based on the idea that it is possible to represent the behaviour of entities active in a common world in computerized form, and that it is possible to represent a collective phenomenon as the outcome of the interactions among an assembly of individual agents with their own operational autonomy (Ferber, 1999). Models produced through ComMod processes, therefore, reflect the MAS concept. ComMod models support co-learning in areas where the researcher is a stakeholder among other stakeholders in the system. An original characteristic of the ComMod methodology is the flexible association of key tools such as RPG and ABM, and also geographic information system (GIS), surveys and interviews (Bousquet et al., 2005).

In this case study, ComMod is used to develop a comprehensive model with stakeholders regarding interactions between rice farm management and labour migration practices in lower northeast Thailand through a collective learning platform and a series of participatory workshops. This ComMod process focuses on knowledge exchange among stakeholders, including the research team, to create a shared representation of the system through the development of a co-designed ABM. The ABM is, then, used by stakeholders to explore possible future scenarios of change. Moreover, with this platform, stakeholders' adaptive capacity could also improve.

1.3.2.1. Initial Diagnosis Activities

This research phase identifies the system under study (e.g. literature review, GIS operations, field surveys, and agricultural system analysis) in order to produce the necessary field-based knowledge. For the climatic analysis, rainwater volume and its distribution still play a crucial role in determining the level of agricultural yields, especially in the RLR ecosystem. But rainfall distribution in this area is very erratic and farmers have to adapt their cropping calendar to current field conditions such as soil moisture and water resource accessibility. The local climate is analyzed by using 50-year meteorological data (1953-2003) from the northeast meteorological centre.

The frequential analysis of rainfall distribution is used to illustrate the highly variable and unpredictable characteristics of the local climate (See chapter II for more details). To analyze land use and cover change (LUCC) and to understand the causes of such changes, spatial and temporal analysis of remote-sensed (RS) data and Geographic Information System (GIS) operations are carried out. Satellite imagery, aerial photographs, and topographic maps are acquired from various sources. RS and GIS operations are processed to explicitly display the spatial changes of three successive periods (see details in chapter III).

The current landscape and land use is an historical product of the past relationship between farmers and their environment. This must be understood to assess the initial situation at the beginning of the research. The household-based APS refers to the whole structured set of plants, animals and other activities selected by a farmer for his production unit to achieve his objectives. The APS is finalized by a farmer's socioeconomic objectives and related management strategy. APS typology identifies the different types of farmers by looking at their respective interests, means of production, social relations, and behaviour towards technological evolution. It is assumed that different types of farmers pursuing different socio-economic objectives by implementing different strategies exist and that they have access to different amounts of land, labour and capital resources. The purpose of using APS analysis is to examine the diversity of decision-making processes among these heterogeneous groups of farmers regarding the problem under study. Field surveys with semi-structured interviews are carried out to acquire complementary information about the relationship between production combinations (farm and non-farm activities) and labour migration (see chapter V for more details). The elicited farmers' decision-making processes are later used to conceptualize the behaviour of rule-based agents in the ABM.

1.3.2.2. ComMod Process

The outputs of the preliminary system analysis are used for the model formalization. The conceptual model is formalized in the Unified Modelling Language (UML) to represent decision-making processes of stakeholders as well as the structure and the relationship of components existing in the system under study. The conceptual model

is also used as a mediation tool for knowledge sharing among different experts. Another use of the conceptual model is to design RPGs and an ABM. From this point, the continuous and iterative ComMod cycles begin to develop a shared representation between stakeholders through the collaborative modelling process (see chapter VIII for more details).

First, the initial conceptual model is transformed into RPGs (see chapter IX for more details). The RPGs facilitated by the researcher are played by stakeholders through series of participatory modelling workshops. The results derived from RPG sessions are used to enrich the initial conceptual model, which is transformed into an ABM prototype. The ABM is built under the CORMAS[2] (COmmon-pool Resources Multi-Agent Systems) platform, which is a programming environment dedicated to the creation of a MAS with a focus on natural resource management. Subsequently, the family of ABMs is co-constructed through a series of short participatory simulation workshops, and the final version of the ABM is used by local rice farmers to explore possible future scenarios (see chapter X for more details). The simulated results are used for further analysis to better understand the system under study or formalize new questions and hypotheses (see chapter XI for more details).

1.4. Expected Outcomes

The outcomes expected from this research are as follows:

1. The research team and other concerned stakeholders would have better understanding of the current situation regarding the interactions between land & water and labour migration through the knowledge sharing activities during the collaborative modelling process.
2. Games are certainly simpler than the real world system but it simulates some of its complexity . RPGs are relatively simple and represent the system where participating farmers live and work. Therefore, the participating farmers should be at ease when playing it. Their decision-making processes could be revealed during the gaming sessions.

[2] CORMAS is being developed at CIRAD (http://cormas.cirad.fr/indexeng.htm) in Montpellier, France, and is based on the Smalltalk object-oriented language.

3. The ABM could be a powerful tool to integrate knowledge from diverse sources and engage participating farmers in the virtual environment to build a shared representation and explore scenarios of interest.
4. The stakeholders' knowledge of the defined problem can be improved through the co-learning process occurring throughout the participatory modelling activities.
5. The stakeholders' adaptive capacity could be increased, helping them become more resilient and better prepared to face external shocks.
6. More appropriate opportunities for investment to alleviate climatic risk and improve economic conditions would emerge as result of the collaborative modelling and collective learning process.

The dissertation comprises three parts and: (i) Agrarian characteristics of lower northeast Thailand (four chapters), (ii) Companion Modelling (ComMod) to understand the interaction between land & water use, and labour migration (three chapters), and (iii) Results (four chapters). The introduction, and conclusion, discussion and recommendations are presented separately in chapters I and XIII respectively.

Chapter II presents the dynamics of the agrarian system in the lower northeast region. The biophysical and socioeconomic characteristics of the northeast region influencing the current regional context are compared to other regions. The characteristics of the study area include: the evolution of transportation networks; APS and land use change based on interpreted findings from farm surveys, and the analysis of secondary data using GIS and RS presented in chapter III. A review of the literature regarding labour migration in Thailand is provided in chapter IV with an emphasis on migration decision-making processes. Chapter V presents a synthesis on the diversity of APS based on the integration of three successive farm surveys carried out in the study area. Based on the comparison and identification of similarities and differences between various APS, several main types of farmers are defined in a typology.

Chapter VI presents the collaborative modelling approach illustrated by the analysis of six collaborative models. The highly interactive collaborative Companion

modelling (ComMod) approach and methodology and its underlying theories are presented in chapter VII. Chapter VIII deals with the ComMod process implemented in Lam Dome Yai watershed, including details on the participants. Detailed information on the process design and its implementation, as well as the recapitulation of the evolving modelling tools over the whole process is also provided in this chapter. Three RPGs and the Ban Mak Mai (BMM) Agent-Based Model implemented in this experiment are described in chapter IX and X respectively. Chapter XI presents the explorations of scenarios carried out by running the BMM simulations during participatory simulations with RLR farmers and in the laboratory. The assessment of ComMod's effects on participating farmers is presented in chapter XII, followed by the conclusion, discussion and recommendations in chapter XIII.