

# Developing a Cooperative and Sustainable Land-Use Model for the Hill Tribes of Northern Thailand

An Interactive Qualifying Project

Submitted to the faculty

Of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

---

**Obiora Ofokansi**

---

**Brigitte Perera**

---

**Caitlin Swalec**

---

**Alexander Zitoli**

Sponsored by the Raks Thai Foundation

Date: March 2015



---

**Professor Bob Kinicki Co-Advisor**

---

**Professor Fabienne Miller Co-Advisor**



## Abstract

In an effort to protect the forests of Northern Thailand, the Thai Government created laws which limit hill tribes' ability to use the land. This limited access impacts the livelihoods of hill tribes, which are rural forestry communities. This project will develop a cooperative land-use model between the government of Chiang Mai Province and the hill tribes using Geographic Information System (GIS) technology. In collaboration with Raks Thai Foundation (RTF), the team will identify how current forest management policies affect the hill tribes and what the hill tribes need in order to sustain their livelihoods. After analyzing GIS data collected from RTF and interviewing stakeholders the team will identify options for cooperative land-use between the government and hill tribes.

## Table of Contents

Abstract.....	1
Table of Contents.....	2
List of Figures.....	4
1 Introduction.....	5
2 Background.....	7
2.1 Land-Use Modelling Process and Components.....	7
2.1.1 Feedback Loops in Land Modelling.....	10
2.1.2 Environmental Entitlement Mapping.....	11
2.2 Geography of Chiang Mai Province.....	13
2.3 Hill Tribes in Chiang Mai Province.....	16
2.3.1 Hill Tribe Uses of the Forest.....	17
2.3.2 Legal Status of Hill Tribes and their Lands.....	18
2.3.3 Thailand Land Titling Project.....	18
2.4 Community Forestry.....	19
2.4.1 Community Forest Requirements in Thailand.....	20
2.4.2 The Rise of Community Forestry in Thailand.....	20
2.4.3 Community Forest Bill.....	21
2.5 Raks Thai Foundation.....	22
2.6 Geographical Information Systems.....	22
2.6.1 Geographic Data Types: Geodatabase and Documentation.....	23
2.6.2 ArcMap10: Data Analysis.....	24
2.6.3 GIS in Community Forestry.....	24
2.7 Summary.....	25
3 Methods.....	26
3.1 Interview with Raks Thai Foundation.....	26
3.2 Compilation and Initial Analysis of GIS Data.....	27
3.3 Interviews with Hill Tribe Leaders.....	29
3.4 Interviews with Chiang Mai Province Policy Makers.....	30
3.5 Assessment of Raks Thai Foundation's GIS Abilities.....	31

3.6 Creation of Land-Use Model .....	32
Works Cited .....	33
Appendix A: Work Schedule for Team Thai Tree.....	37
Appendix B: RTF Land-Use Model Interview .....	38
Appendix C: Hill Tribe Interviews .....	39
Appendix D: Policy Maker Interviews .....	40
Appendix E: RTF GIS Interview .....	41

## List of Figures

Figure 1: Land-Use Modelling Process (Briassoulis, 2000) .....	8
Figure 2: Dam Location and Watershed Area of Sam Sob Village (Raks Thai, 2014) .....	9
Figure 3: Environmental Entitlement Map (Leach, 1999) .....	11
Figure 4: Marantaceae Leaf Collection in Southern Ghana (Leach, 1999) .....	12
Figure 5: Various Types of Land Cover in Northern Thailand (National Geographic, 2014) .....	14
Figure 6: Deforestation in Thailand (Bruneau, 1995) .....	15
Figure 7: Migration of Hill Tribes to Northern Thailand (Young, 1974) .....	16
Figure 8: Data Visualization Displaying Flood Risk in the Chao Phraya Watershed (Google, 2014) .....	23
Figure 9: Conceptual Model of Data Relevance .....	28

# 1 Introduction

Across the globe, approximately 1.6 billion people rely directly on nearly 160 million km<sup>2</sup> of forests for food, water, and shelter (World Wildlife Fund, 2014). They live, cultivate, and hunt on forest lands. Forests provide ecological functions such as watershed regulation and biodiversity preservation that enhance the quality of life of forestry communities (Barbier, 1993). At the same time, humans destroy about 120 thousand to 150 thousand km<sup>2</sup> of forest each year, primarily through timber production (World Wildlife Fund, 2014).

From 1913 to 1998, Thailand lost approximately 50% of its total forest cover (Grainger, 2004). In response to Thailand's deforestation problem, the Royal Thai Government created many laws, including the National Logging Ban of 1989, to prevent deforestation throughout Thailand. However, this top-down approach legally limits land-use for the hill tribes, rural agricultural and forestry communities located in the Chiang Mai Province, that depend on forests for their livelihoods (Thailand Collaborative Country Support Program, 2007).

Additionally, this top-down approach influenced farmers and the Royal Forest Department (RFD) to introduce community forest management as a policy which integrates local dependency on forestry in regions like Chiang Mai Province (Ongprasert, 2011). The current policy of community forest management does not adequately consider land-use rights of hill tribes nor the hill tribes' knowledge of forest management techniques (Huamaungkaew, 2013; McQuistan, 2004).

A popular tool used to facilitate community forest management is a Geographic Information System (GIS). It is an information technology that integrates hardware, software, and data in order to capture, manage, analyze and display all forms of geographically referenced

data (ESRI, 2008). Local communities can use GIS to collect geospatial data that helps them visualize their own land while providing the government with a more comprehensive understanding of local land and resources (Baral, 2004). Land-use models, created with GIS data, are effective methods for displaying current and potential future land-use. Land-use models encompass a range from maps indicating which people use an area of land and how they use it, to compilations of diagrams, tables, and maps displaying the costs and benefits of a proposed land-use (Pijanowski, 1997). A thorough land-use modelling process includes detailed reviews of the stakeholders' needs through analysis such as entitlement mapping. No one has proposed an approach to forest land management in Chiang Mai Province that integrates the needs of both the government and the hill tribes in a cooperative framework.

The goal of this project is to develop a cooperative land-use model between the government of the Chiang Mai Province and the hill tribe communities using GIS technology. In collaboration with Raks Thai Foundation (RTF), our team will identify how current policies impact the hill tribes of Chiang Mai Province and what they need in order to sustain their livelihoods. Our team will analyze GIS data collected from RTF. We will also interview hill tribe members, Chiang Mai Province policy makers, and RTF representatives to understand the stakeholders' needs. Once we analyze this data in the form of an entitlement map, and reassess the GIS data, our team will identify options for co-operative land-use between the government and hill tribes.

## 2 Background

The concept of a land-use model is the keystone of our background chapter. In theory, a land-use model functions as a tool to resolve land-use policy conflicts by showing how people currently use a geographic region and how they could use it in the future. However, in practice, land-use models incorporate a complex and dynamic set of relationships between people, policies, and the land. This background chapter presents the history of the hill tribe people of Chiang Mai Province, the policies developed by the Royal Thai Government, and the geography of Chiang Mai Province to develop the context for our land-use model for Chiang Mai Province. This land-use model will address the issue of land-rights and deforestation in the Chiang Mai Province of Thailand.

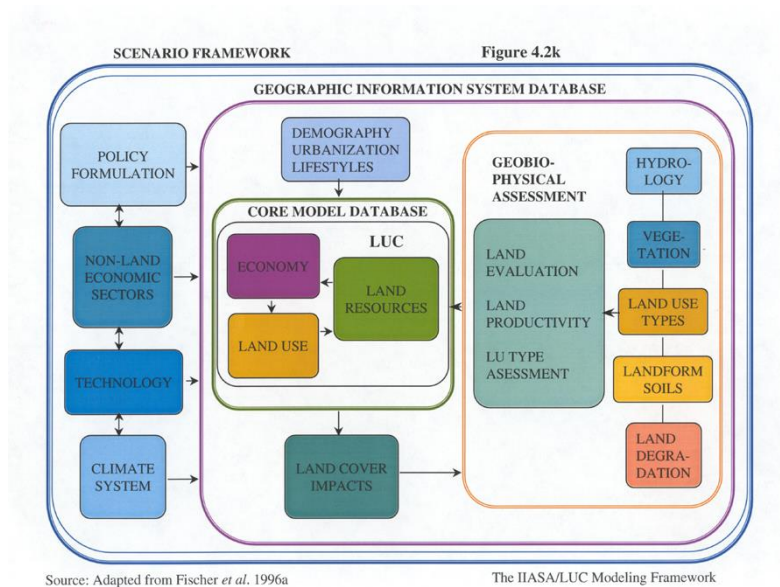
### 2.1 Land-Use Modelling Process and Components

A land-use model shows who uses land and how they use it at a past, present, or future point in time. One form of a land-use model is a map that shows boundaries on areas of land and indicates who uses each area of land and how they use that area of land (for agriculture, residence, recreation, etc.) Another form is a written document which explains who uses the land, and how they use the land. Additionally, a land-use model can be a collection of documents such as maps, diagrams, and tables that represent not only the usage of the land, but the costs and benefits of a potential usage of the land. Selection of the most effective land-use model depends on the preferences of the creator(s) and the information available (Baral, 2004).

Figure 1 below shows a process diagram for creating a land-use model. Dr. Helen Briassoulis of the Department of Geography at the University of the Aegean developed this process diagram. The layer “Core Model Database,” is the physical product of the land-use

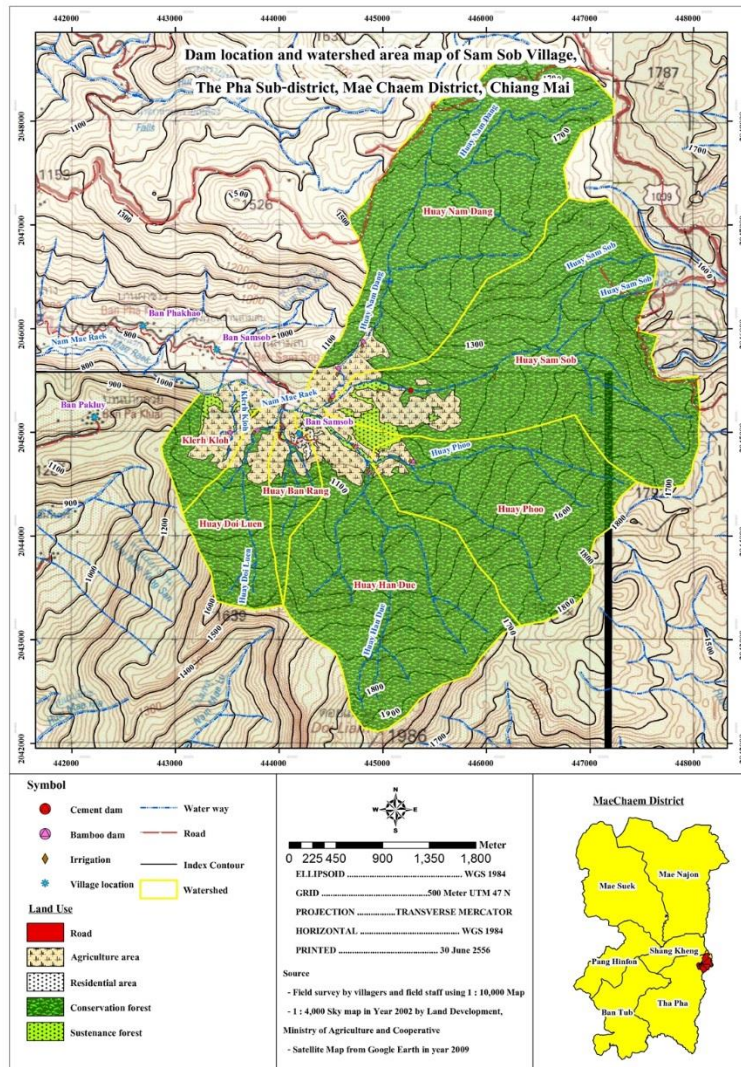


model, though it does not specify which form the land-use model should take. As shown in Figure 1, the “Core Model Database” must clearly demonstrate the relationship between the economy, land resources, and land-use. In this project the hill tribes’ livelihoods will function as our primary focus for “economy.”



**FIGURE 1: LAND-USE MODELLING PROCESS (BRIASSOULIS, 2000)**

Figure 1 also shows the role of Geographic Information System (GIS) data in the land-use model process. GIS is an information technology that stores data referenced by spatial coordinates (Maguire, 1992). It provides a systematic tool to display geobiophysical information, which includes data on land-use types (such as agriculture, residence, conservation, etc.) and land degradation (such as deforestation), overlaid with demographic and cultural data (Briassoulis, 2000). For example, Figure 2 below, shows land-uses including conservation forests, sustenance forests, residential, and agricultural areas. Field villagers and field staff collected the GIS data mapped in Figure 2 (Raks Thai Foundation, 2014).



**FIGURE 2: DAM LOCATION AND WATERSHED AREA OF SAM SOB VILLAGE (RAKS THAI, 2014)**

The purpose of using GIS in this project is to collect, analyze, and display spatial data on land-use in the Chiang Mai Province. With the information gained from this GIS analysis, we will be able to assess the impacts of current and proposed land-use policies in Chiang Mai Province on the stakeholders, which include hill tribes, policy makers, and Raks Thai Foundation.

As shown in Figure 1, prior to using GIS data, the land-use modelers must establish the “Scenario Framework.” The “Scenario Framework” sets the context and scope of the land-use model by outlining the policies, geography, and stakeholders who use the region of land that the model features (Briassoulis, 2000). These contextual factors influence every other stage of the land-use modelling process. Hence, a change to one of these factors could result in an altered land-use model. Likewise, by a mechanism called feedback, a change in land-use could result in an altered component of “Scenario Framework,” such as a policy change.

### 2.1.1 Feedback Loops in Land Modelling

One of the major challenges to land-use modelling is dealing with feedback loops which complicate land-use matters by creating dynamic networks between the land and the land users. Feedback loops occur in a variety of forms, such as social, natural, and economic forms, and at multiple scales, including local, regional, etc.(Hersperger et al., 2011). Given the local scale of land-use models, it is difficult to represent feedback loops which are part of a larger scale. Dr. Meine van Noordwijk, Chief Science Advisor of the World Agroforestry Centre, suggests that land-use models should focus on identifying local-level feedback loops which provide the opportunity for improved land-use through education and adaptation (Purnomo, 2011). In Chiang Mai Province, feedback occurs throughout the network of the hill tribes, government, and land. Environmental entitlement mapping is one way to analyze the feedback which occurs in a complicated land-use system.

### 2.1.2 Environmental Entitlement Mapping

An environmental entitlement map, as shown in Figure 3 below, depicts the relationship between different social actors (aka stakeholders) and their environmental endowments and entitlements (Leach, 1999).

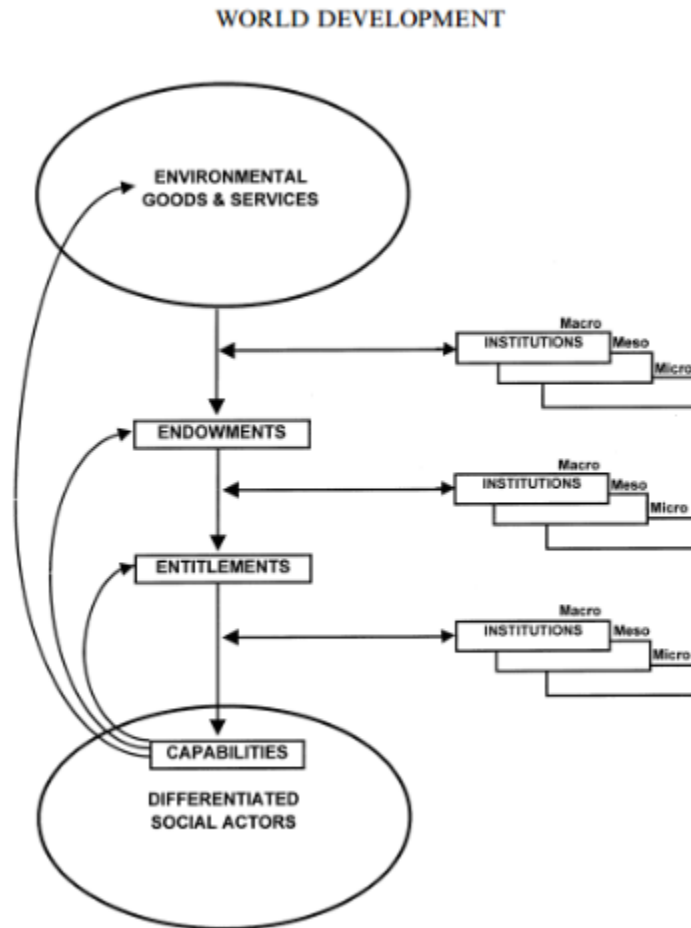
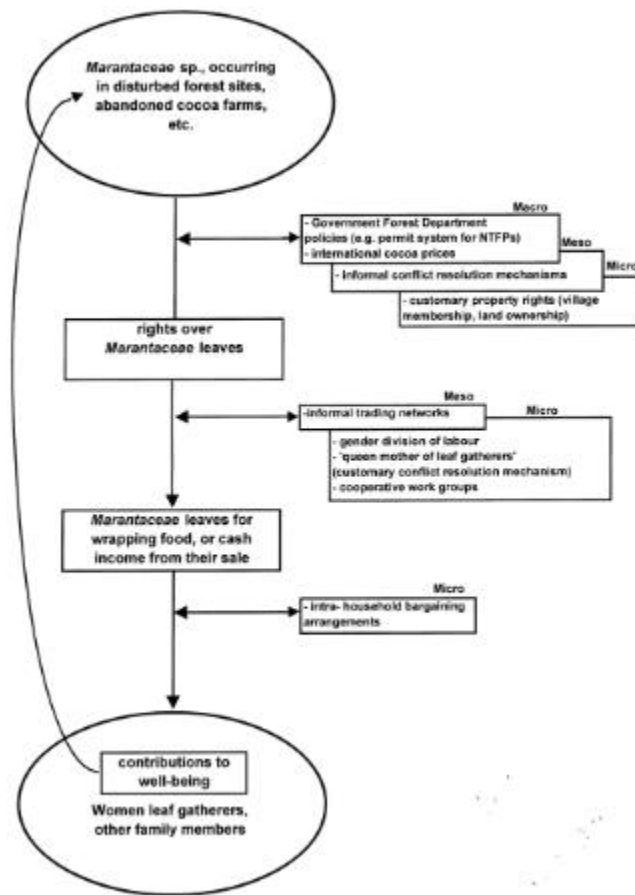


FIGURE 3: ENVIRONMENTAL ENTITLEMENT MAP (LEACH, 1999)

Endowments refer to stakeholders' rights and resources, while entitlements refer to stakeholders' command over resources (Devereux, 2001). As shown in Figure 4 below, an example of an endowment is the leaf gatherers' rights over *Marantaceae* leaves, while an

entitlement is the leaf gatherers' ability to use the leaves to wrap their food or to sell them for income. As the figure indicates, entitlements come from endowments.



**FIGURE 4: MARANTACEAE LEAF COLLECTION IN SOUTHERN GHANA (LEACH, 1999)**

Entitlement maps also show how feedback occurs as the stakeholders gain effective control over the environmental resource from which the endowments and entitlements stem (Leach, 1999). According to Dr. Melissa Leach, the Director of the Institute of Development Studies, analysis by environmental entitlement mapping is a necessary component for resource management which includes minority groups (Leach, 1997). Entitlement mapping not only helps to indicate the environmental needs of a minority group, but puts the role of the institutions, including policies, which affect the minority group, into perspective. In this way, an

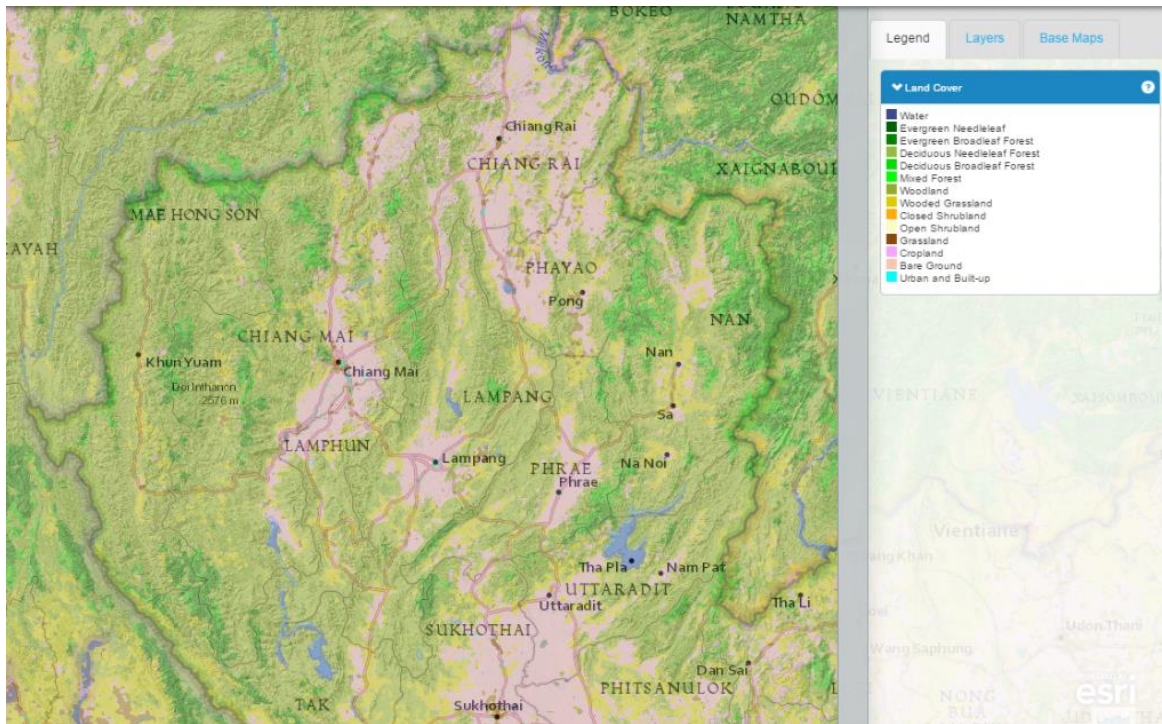
environmental entitlement map helps to outline the “Scenario Framework” for a land-use model. In the following sections we will review the components which make up the “Scenario Framework” of our project, including the geography of Chiang Mai Province, the hill tribes which live in this region, and the policies which have affected land-use in this region.

## 2.2 Geography of Chiang Mai Province

Thailand consists of four geographical regions, each one exhibiting its own unique terrain. The northern region, which includes Chiang Mai Province, is mostly mountainous, making the region the origin of streams and rivers in Thailand. Just within the Mae Gok watershed, which spans the Chiang Mai and Chiang Rai Provinces, the total forested area is 1,012,031 Rai, or approximately 1,600 km<sup>2</sup> (McQuistan, 2004).

Northern Thailand contains three principal forest types, which ecologists classify based on their elevations. In the valleys and lowlands, forests contain mixed deciduous trees with teak being the dominant species (McQuistan, 2004). As the elevation increases, the forest type evolves to evergreen with hill evergreen forest becoming the dominant type. This type of forest thrives at elevations where the climate is more humid, and trees in this area retain their leaves throughout the year. Above 800 meters, on the uppermost slopes of the forests, the dominating species are *Pinus merkusii* and *Pinus kesiya*, pine trees native to Thailand. Above 1800 meters this forest type begins to combine with the evergreen species (McQuistan, 2004).





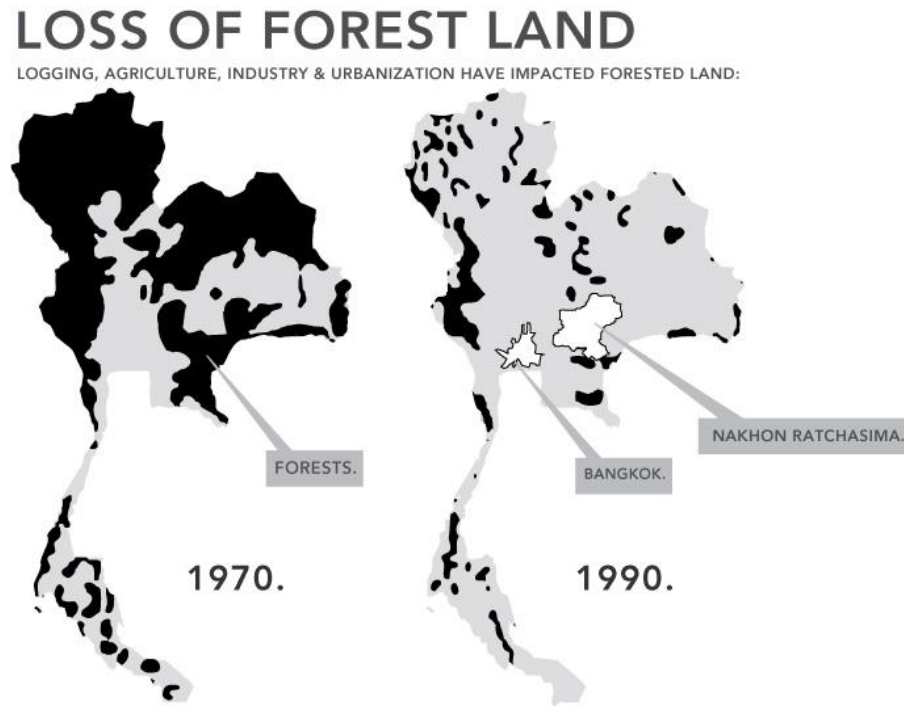
**FIGURE 5: VARIOUS TYPES OF LAND COVER IN NORTHERN THAILAND (NATIONAL GEOGRAPHIC, 2014)**

Figure 5 shows the varying terrain and forest type in Northern Thailand. As shown, Chiang Mai Province contains mainly cropland and forest land.

The forests in the Chiang Mai Province are rich in tree species and provide a refuge for a diverse array of animals. These forests also offer numerous products such as honey beeswax, herbs, charcoal, and orchids (McQuistan, 2004). Additionally, the forest ecosystem components interact with each other to purify air and water, control the climate, and recycle various nutrients and wastes (Krieger, 2001). These forests do even more, playing a role in watershed regulation, biodiversity conservation and primary production (McQuistan, 2004). However, a majority of the previous forest areas in Chiang Mai Province are now weed-like grasslands due to deforestation.

The area of forest land in Thailand has been declining for decades. Figure 6 shows the forest cover lost between 1970 and 1990. As shown in the figure below, deforestation has

occurred throughout most of Thailand, and the Northern region in particular shows signs of dramatic forest cover loss.



**FIGURE 6: DEFORESTATION IN THAILAND (BRUNEAU, 1995)**

During the 1990's, the nation's annual deforestation rate, which nets deforestation against reforestation, exceeded the worldwide annual deforestation rate. From 1990 to 2000, Thailand experienced an average annual deforestation rate of 0.28%, well above the global annual average deforestation rate of 0.18%. However, from 2000 to 2011, the average annual deforestation rate in Thailand dropped to 0.02%, below the global rate of 0.11% (World Bank, 2014). Thailand's forest loss significantly impacts rural farming and forestry communities, like the hill tribes of Chiang Mai Province, which rely upon forest ecosystems for food, fuel, and shelter (Krieger, 2001).



## 2.3 Hill Tribes in Chiang Mai Province

Hill tribe villages in Chiang Mai Province, which subsist on agricultural lifestyles, are among the most disadvantaged group in society due to limited Thai citizenship and delayed land settlement (Chaleo, 2004). The largest concentration of hill tribe members reside in Chiang Mai Province, totaling over 1,000 villages and over 200,000 members. The largest hill tribes in Chiang Mai Province are the Karen, Hmong, and Lahu, respectively. As shown in Figure 7 below, Thai hill tribes living in the forests of Northern Thailand are migrants from surrounding countries, mainly Burma, Laos, and China. As migrants, the hill tribes have limited legal status in Thailand. Additionally, their lifestyles, including their farming techniques, are unique. The following subsections explore the agricultural practices in the forest and the legal status of the hill tribe villagers in the Chiang Mai Province.

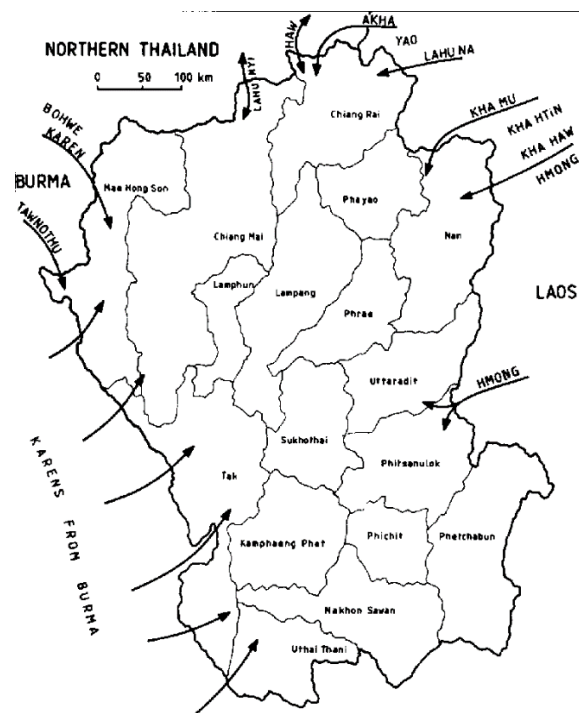


FIGURE 7: MIGRATION OF HILL TRIBES TO NORTHERN THAILAND (YOUNG, 1974)

### 2.3.1 Hill Tribe Uses of the Forest

Hill tribes practice two types of shifting cultivation agriculture on forest land: pioneer and rotational shifting. First, the Hmong, Akha, Lahu, Yao, Lisu, and Mein hill tribes favor pioneer shifting cultivation. Second, the Karen, Lua, and Khamu hill tribes favor rotational shifting cultivation. Shifting cultivation is a land utilization method where a farmer cultivates a piece of land for several years and then deliberately leaves the land for a period of time to restore its fertility by natural vegetative growth (FAO, 2014). The Food and Agriculture Organization, which functions under jurisdiction of the United Nations, does not classify shifting cultivation as an act of deforestation (FAO, 2014).

The hill tribes practicing pioneer shifting cultivation (the Hmong, Akha, Lahu, Yao, Lisu, and Mien) are considered to be highland tribes (Forsyth, 2008). In the Chiang Mai Province, they numbered approximately 261,000 people in 1987, and 362,000 in 1996 (Delang, 2002). Unlike other forms of shifting cultivation, pioneer shifting cultivation occurs in undisturbed forests (Erni, 2009). Farmers cultivate the undisturbed land for 10-20 years and then leave it fallow as they move to more undisturbed forest.

The hill tribes practicing rotational shifting cultivation (the Karen, Lua, and Khamu) are considered to be lowland tribes (Forsyth, 2008). In the Chiang Mai Province, rotational shifting cultivators numbered about 285,000 people in 1987 and 418,000 in 1996 (Delang, 2002). In rotational shifting, farmers cultivate the land then leave it fallow for a period of 6-10 years. The farmers reuse the land after the fallowing period (Delang, 2002). Tribes practicing rotational shifting cultivation live a sedentary lifestyle, cultivating on rotating plots of land while leaving other plots of land to fallow.

### 2.3.2 Legal Status of Hill Tribes and their Lands

Obstacles to acquiring citizenship cause difficulties for hill tribes regarding their own legal status and their ownership of the land that they cultivate. In recent decades, Thai legislation has indirectly targeted the hill tribes residing in Chiang Mai Province. The Thai Government has established laws concerning immigration and citizenship since the 1970's. These laws apply to the hill tribes, who migrated to Chiang Mai Province for centuries without attaining official documentation or without legal permission (Young, 1974). Thailand's Nationality Act B.E. 2508 Section 7.*bis*, amended in 1992, states that a person born in Thailand to alien parents does not acquire citizenship if their parents "entered and resided in the Thai kingdom without permission under the law on immigration" (National Legislative Assembly, 1992). Without official citizenship, government policies regarding land-use exclude hill tribes.

### 2.3.3 Thailand Land Titling Project

One of the land-use policies that excluded the hill tribes is the Thailand Land Titling Project. A large motivator of this project was that people lacking official title deeds inhabited 18% of total agricultural lands (Bowman, 2004). In cooperation with the World Bank and the Government of Australia, the Royal Thai Government issued title deeds to eligible landholders throughout Thailand in the early 1990's (Burns, 2004). At this time, the Thai government found that 46% of total land area in Thailand was agricultural even though the government designated 50% of total land area for conserved forest lands. Title deeds covered only 12% of the agricultural land area and 21% of the agricultural land lay within national forest reserves (Bowman, 2004). Although the project ended with the Thai Government handing out approximately 13 million title deeds to individual landowners, the government did not include

hill tribes into this distribution of land. However, it did reveal that many hill tribes and other cultivators had been illegally farming on conserved lands.

As a result of the altered legal status of forest-dwelling communities, farmers' organizations and forest dwellers concurrently built a foundation for community forestry in Thailand. Community forestry is a branch of forest management where local communities play a role in forest management and land-use. The following section delves into the advantages of community forestry in Thailand.

## 2.4 Community Forestry

As a strategy for resource and land management, community forestry is an efficient method for integrating the knowledge of local communities with national government agendas. In the case of forest management, the collaboration of indigenous communities and federal agencies generates effective solutions for management plans (Higgs, 2003). Local communities understand their lands with a greater familiarity and level of understanding than most centralized governments do. Inclusion of indigenous communities in land arrangements is invaluable to governments without the knowledge of how local ecosystems function (Baral, 2004). As previously discussed, the hill tribes in Northern Thailand have extensive knowledge of cultivation practices and how to maintain forest ecosystems. In cooperation with a sub-district of the Chiang Mai Province, hill tribes have potential for a community forest arrangement. For these hill tribes to establish a community forest, they must meet official Thai community forestry requirements.

### 2.4.1 Community Forest Requirements in Thailand

Community Forest organizations in Thailand must follow a series of steps to become legal community forests. The requirements to establish a legal Community Forest (CF) are listed below:

1. Develop a detailed CF management plan
2. Demarcate forestland into specific zones
3. Identify and signify the CF members and committee members
4. Zone the community forest land for conservation, marking the location of non-timber product and timber utilization (not located in the conservation zone)
5. Use the timber products planted and harvested within the community, but do not sell the timber products (Thailand Collaborative Country Support Program, 2007).

The Royal Forest Department (RFD), the key governing body for forest preservation and management, registers and establishes community forest organizations which meet these requirements (Ongprasert, 2011). Once established, community foresters manage zones for protecting forests, for sustaining life, and for economic use (Saenpakdee, 2012). This breakdown of land enables the fulfillment of government policies and the maintenance of agricultural livelihoods. To incorporate community forestry in national laws, the Thai government and related parties have drafted and passed legislation to legalize the existence of community forests.

### 2.4.2 The Rise of Community Forestry in Thailand

Prior to the emergence of community forestry, the RFD supported and drafted numerous laws that put forest management decisions in the control of national organizations (Ongprasert, 2011). However, the national logging ban of 1989 spurred responses from Thai farmers and

forest dwellers to demand redistributed control of forested lands to Thai citizens (Brenner, 1999). National farmers' organizations and forest dwellers created the "civic version" of the Community Forest Bill, allowing local communities to establish and manage community forests. (Brenner, 1999). In response to this bill, the RFD drafted their own community forest bill in 1990 to ensure that they could meet their standards of forest management while allowing local communities to maintain national forest land (Brenner, 1999).

Passed in 1994, the Tambon Council and Tambon Administrative Act redistributes administrative power to sub-district (tambon) governments (Adulyadej, 1994). Tambons' are sub-districts composed of 10-15 villages within districts of Thai provinces. The decentralization of the Thai government influenced the Tambon Administrative Act, which places the power to approve resource management and development plans within sub-districts in the hands of the sub-district government rather than the national government (Adulyadej, 1994).

### 2.4.3 Community Forest Bill

Following many years of debate, the National Legislative Assembly of Thailand (NLA) passed the Community Forest Bill in 2007 to allow communities to establish and manage community forest areas through the hierarchy of government levels (Ongprasert, 2011). Though the ratification of the bill was a progressive move for Thai forestry policy, the bill does not allow for conversion of forests to agricultural lands. This portion of the bill directly impedes many hill tribes ability to maintain agricultural livelihoods (Huamuangkaew, 2013). As a potential solution to the hill tribes' limited use of land, non-governmental organizations (NGO) are attempting to incorporate the use of GIS in community based forest management. Raks Thai Foundation, the sponsor of this project, is one of these NGOs.

## 2.5 Raks Thai Foundation

The NGO Raks Thai Foundation (RTF) is working with hill tribes in the Chiang Mai Province. RTF, a member of CARE International, promotes strong communities and assists the disadvantaged in Thailand. Their mission aims to determine suitable solutions for poor and disadvantaged communities and to participate in developmental activities throughout Thailand. RTF is collecting GIS data with hill tribe villagers to create a cooperative agreement between the hill tribes and the government. The following section describes GIS, software and tools used to create maps, and GIS in community forestry.

## 2.6 Geographical Information Systems

Mapping Geographic Information System (GIS) data for land-use purposes provides a visual model of how people use land. GIS is an information technology that integrates hardware, software, and data for capturing, managing, analyzing and displaying all forms of geographically referenced material (ESRI, 2008). This project will utilize GIS via the program ArcMap10. GIS can improve communication and understanding between different parties and provide a method for better record keeping of the status and change of geography. Additionally, GIS assists in the process of decision-making, using insights gained from spatial data as a basis (ESRI, 2008).

GIS allows users to visualize, question, analyze, and interpret data in order to understand relationships, patterns and trends in spatial data. It stores complex geographical data and presents it in the form of maps (Burdett, 2013). GIS users can plot relevant data by creating scaled maps that are centered by refinements set by the user. Data visualization helps users to recognize patterns or trends that the model displays (Pourabbas, 2014). For example, Figure 8 below, shows a data visualization of flood risk zones in Thailand's central basin. This map uses color to

categorize the severity of risk (Google, 2014). Rather than analyzing the tabular form of the data for risk categories, this GIS map shows the trends in risk categories in a clear, visual format.



**FIGURE 8: DATA VISUALIZATION DISPLAYING FLOOD RISK IN THE CHAO PHRAYA WATERSHED (GOOGLE, 2014)**

In addition to accessing spatial database management systems, users perform other functions such as selecting, sorting, extracting, classifying and displaying geographic data based on topological and statistical criteria (Pourabbas, 2014). These different functionalities are intended to provide the user with distinct viewpoints of data.

### 2.6.1 Geographic Data Types: Geodatabase and Documentation

Geographic data is categorized into two types, geodatabase and documentation, that are used to display spatial data. Geodatabase data serves as the visual representation of the map. It contains data that can be represented in two sub-types: raster data that uses a grid cell structure or vector data that is displayed more like a map (Davis, 2001). Documentation data, the second type of geographic data, are text files that contain content quality, creation, and spatial



information about a dataset. GIS depicts geographic and documentation data layers to provide visual and textual representation on maps (Maguire, 1992).

### 2.6.2 ArcMap10: Data Analysis

The software ArcMap10 compiles GIS data on a map template. Users combine layers of data to create a feature called an overlay. Overlaying data can involve combining two layers of data to yield a more comprehensive and sophisticated representation of geospatial data (Baral, 2004). When using GIS software, clipping and buffering datasets provides a more specific and accurate visual. Clip analysis in ArcMap10 involves selecting features of interest from a data layer, e.g. land with a slope gradient greater than 15% or cities with populations less than 50,000, etc. (ESRI, 2013). Users create clip files from unaltered layer files or from overlaid layers. Buffering a layer file is useful when the collected data inaccurately represents the physical size or space that an attribute represents in the physical world (ESRI, 2013). Overlaying, clipping and buffering are three tools used in GIS analyses that enable comprehensive data analysis.

GIS software provides tools to alter data allowing users to thoroughly analyze relevant data by comparing and manipulating data sets. GIS is a useful tool for analyzing topics such as land use, culture, and even politics as they pertain to geographic locations.

### 2.6.3 GIS in Community Forestry

One method of collecting and creating GIS data and maps is known as Participatory GIS (P-GIS), which allows for the implementation of a scheme with the input of community stakeholders. GIS is a useful tool in community forestry which integrates socio-cultural information with geobiophysical information to incorporate the needs and priorities of local communities (Baral, 2004). The P-GIS coordinators use traditional methods such as interviews,

surveys, and focus groups to gather community input. Using these methods illuminates areas of agreement and conflict between the stakeholder groups. Each method for gathering data also involves some form of paper maps that allow participating community members to record spatial details, in a process known as participatory mapping (Forrester, 2014).

Participatory mapping benefits communities by incorporating the local and in-depth knowledge of stakeholders into GIS maps (Forrester, 2014). P-GIS and community forestry encourages a two-way learning process. First, the P-GIS coordinators learn from the community. Second, the community learns about their land through the P-GIS results (McCall, 2004). This cooperative effort results in data analysis which is sophisticated enough for acceptance on governmental and international levels (Baral, 2004).

## 2.7 Summary

The hill tribes of the Chiang Mai Province rely on forest land for their agricultural livelihoods. Their living situation is complex because the forests are disappearing, but the Thai Government's attempts to curb deforestation have not provided the hill tribes with an opportunity to secure their livelihoods. Community Forestry is one method that could provide the hill tribes with this opportunity. In order for the Thai Government to recognize the hill tribes as community foresters, they must participate in the creation of a land-use model. For this purpose, Raks Thai Foundation has been collecting GIS data with local hill tribes. The following chapter describes the methods that we will use to develop this cooperative land-use model between the hill tribes and the local government.

### 3 Methods

To facilitate cooperative use of forest land in Northern Thailand, the Raks Thai Foundation (RTF) has been documenting land-use data in several hill tribe villages in Chiang Mai Province. The main goal of this project is to develop a framework for using GIS technology to create a land-use model which identifies four main areas of forest land, which are explained in section 3.2. An additional goal is to share our methodology for use in other provinces throughout Thailand. Our team plans to address this goal by completing five objectives:

1. To establish requirements of the land-use model
2. To compile GIS data to identify options for a land-use model
3. To assess the hill tribes forest management techniques and their impact on the land
4. To understand how forest management policies impact the hill tribes and what the hill tribes need to sustain their livelihoods
5. To identify the limitations of RTF's ability to analyze GIS data and create a land-use model for Chiang Mai Province or other provinces.

The timeline for completing our methodology is in Appendix A.

#### 3.1 Interview with Raks Thai Foundation

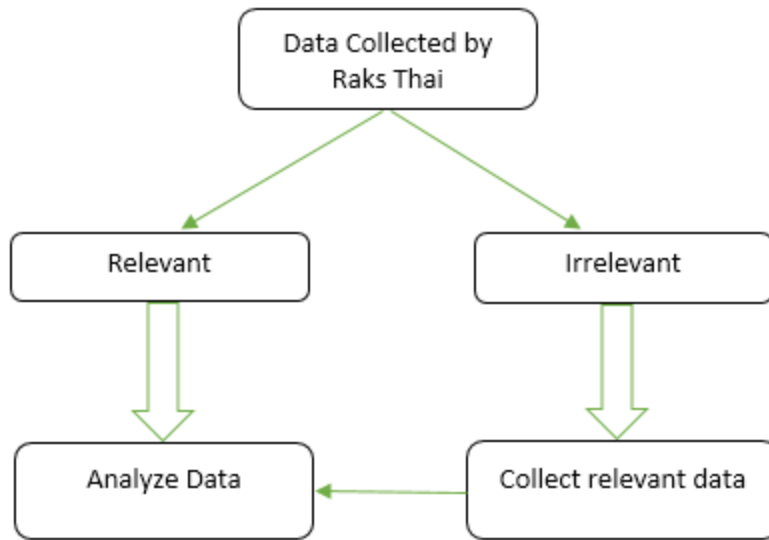
We will conduct an interview with RTF Chiang Mai Office in order to determine what their concept of a land-use model entails. In our research, we found that there are multiple formats for land-use models, including land-use proposals and collections of land-use maps. To address these inconsistencies, we want to clarify RTF's expectation for a land-use model. We would also like to understand RTF's reasoning behind the collection of the GIS data we will have access to.

The targeted population for our interview is staff members of the Chiang Mai branch of RTF. We expected this population to consist of approximately five people based on feedback from previous IQP groups working with RTF in Chiang Mai. Since this is a small population, we expect to be able to interview two workers to get the data we need. A sample of the interview questions is included in Appendix B.

### 3.2 Compilation and Initial Analysis of GIS Data

We will collect the land-use data which RTF has documented with hill tribes. RTF has been collecting GIS data with the villages about the location of their houses, agricultural lands, and common areas, which have existed for decades without any valid official records. In order to determine the relevance of this data, we need to review the data to determine if it gives enough detailed information on the state of the forest and the location of the hill tribes' houses. We also need to map the data and determine whether we have enough data which covers the full geographic region of the sub-district of interest in the Chiang Mai Province.

If we determine that the data is sufficient, we will begin analysis. If the data is not sufficient, we will use sources from RTF and Chulalongkorn University to collect relevant GIS data. This step of our process is shown below in Figure 9.



**FIGURE 9: CONCEPTUAL MODEL OF DATA RELEVANCE**

Once we have collected relevant and complete data we will analyze the data. We will create GIS maps by overlaying the shapefiles on a base map of Chiang Mai Province. GIS software will be available for our use at Chulalongkorn University in Bangkok.

We will study these maps in order to identify four main areas of forest land: (1) degraded forest land on which hill tribes reside, (2) healthy forest land on which hill tribes reside, (3) degraded forest land which is uninhabited, and (4) healthy forest land which is uninhabited. We will use these four categories to help us define boundaries in our land-use model so that we can match appropriate land-uses to the four categories of land. Examples of land-uses include conservation (limited access), inhabitation (land-rights granted), and limited inhabitation (conditional land-rights granted).

### 3.3 Interviews with Hill Tribe Leaders

We will interview hill tribe leaders and hill tribe farmers to discover what agricultural and/or forest conservation practices they use due to limited access to the forest land in which they have resided. From these interviews we will gain information on the hill tribes' impact on the forest land and on the policies which affect the hill tribes. Prior to interviewing hill tribe members, we will pre-test our interview questions (Appendix C) with our Thai partners to compare ideas and ensure that our questions are culturally appropriate. After reviewing our questions with our Thai partners, we will pre-test our questions with a RTF representative who can further ensure that our questions are appropriate.

These interviews will take place in hill tribe villages within the Chiang Mai Province. We plan to travel to Chiang Mai Province during Week 2 of our project to conduct initial interviews and during Week 4 to conduct follow up interviews. We will conduct these interviews with the help of a representative from RTF that speaks both Thai and the dialect of the hill tribes. Our Thai partners will also be present to translate the interview from Thai into English. We will ask for consent from the hill tribes in order to record the interview. If we receive permission, we will record these interviews using an audio recording device. We will ask our Thai partners to translate questions and responses into English when there is confusion or when the topics deviate from the pre-tested interview questions.

After the interviews we will create transcripts of each interview. We will compare the transcripts to look for commonly indicated issues regarding the Thai policies. We will also look for trends in agricultural and/or forest conservation methods. With this information we will create an environmental entitlement map, using the template map as shown in Figure 3, to show

the dynamic relationships between the hill tribes, the government, and the forests. In our entitlement map, the forest land will be the environmental good and the hill tribe members will be the social actor. We will analyze the data from our various interviews to create this map which will show the endowments and entitlements that the hill tribes gain from the forest land. In addition to showing the relationship between the hill tribes and the forest land, this map will show the role of the government. Our entitlement map will ensure that we consider and meet the needs of the hill tribes.

### 3.4 Interviews with Chiang Mai Province Policy Makers

We aim to determine what, if anything is wrong with the current arrangement and what aspects of a land-use agreement are desired from the sub-district government in Chiang Mai. We will request to interview representatives from the Chiang Mai Provincial Forest Office and the Chiang Mai Land Office. Prior to interviewing these policy makers, we will pre-test our interview questions (Appendix D) with our Thai partners to compare ideas and ensure that our questions are culturally appropriate and relevant to our project. After reviewing our questions with our Thai partners, we will pre-test our questions with a RTF representative who can further ensure that our questions are appropriate.

These interviews will take place at the previously mentioned government offices. We will conduct the interviews with two of our Thai partners and two of ourselves. Assuming that the government representatives only speak Thai, our Thai partners will ask questions and translate the government representative responses line by line to us in English. We will ask for consent from the policy makers in order to record the interview. If we receive permission, we will record these interviews using an audio recording device.

After the interviews occur, we will create transcripts of each interview. We will compare the transcripts and compile a check-list of the policy makers' needs. We will use this check-list from this analysis as we create our land-use model to ensure that we have addressed the policy makers' needs.

### 3.5 Assessment of Raks Thai Foundation's GIS Abilities

We will interview the RTF Chiang Mai Office in order to understand their limitations to using GIS software to create maps. The information obtained from these interviews will lend to the creation of a guide that RTF can replicate and use in other land-use contexts. Since RTF is our sponsor, we will be in contact with them through the duration of the trip. We will conduct initial interviews during Week 2. During Week 4, we will bring a draft of our GIS guide to RTF to ensure that we have adequately addressed their needs. During Week 7, we will present the final draft of our GIS guide book.

The targeted population for our interview is staff members of the Chiang Mai branch of RTF. We expected this population to consist of approximately five people based on feedback from previous IQP groups working with RTF in Chiang Mai. Since this is a small population, we expect to be able to interview two workers to get the data we need. A sample of the interview questions is included in Appendix E.

After the population is interviewed, we will compile the answers to understand what the RTF workers know about GIS and what technical GIS skills they lack. Using this information we will create a GIS guide based on the GIS tutorials we take, but tailored to the needs of RTF's workers.



### 3.6 Creation of Land-Use Model

Once we have interviewed our stakeholders, RTF, the hill tribes, and the government, we will reassess our preliminary GIS maps (from Method 3.1). During this reassessment we will determine if the maps which we created reflect the needs of the stakeholders interviewed. We will suggest changes to current land-uses to help meet the needs of these stakeholders. We will present our suggested land-use model in the form which we determine to be most appropriate (in Method 3.1).

## Works Cited

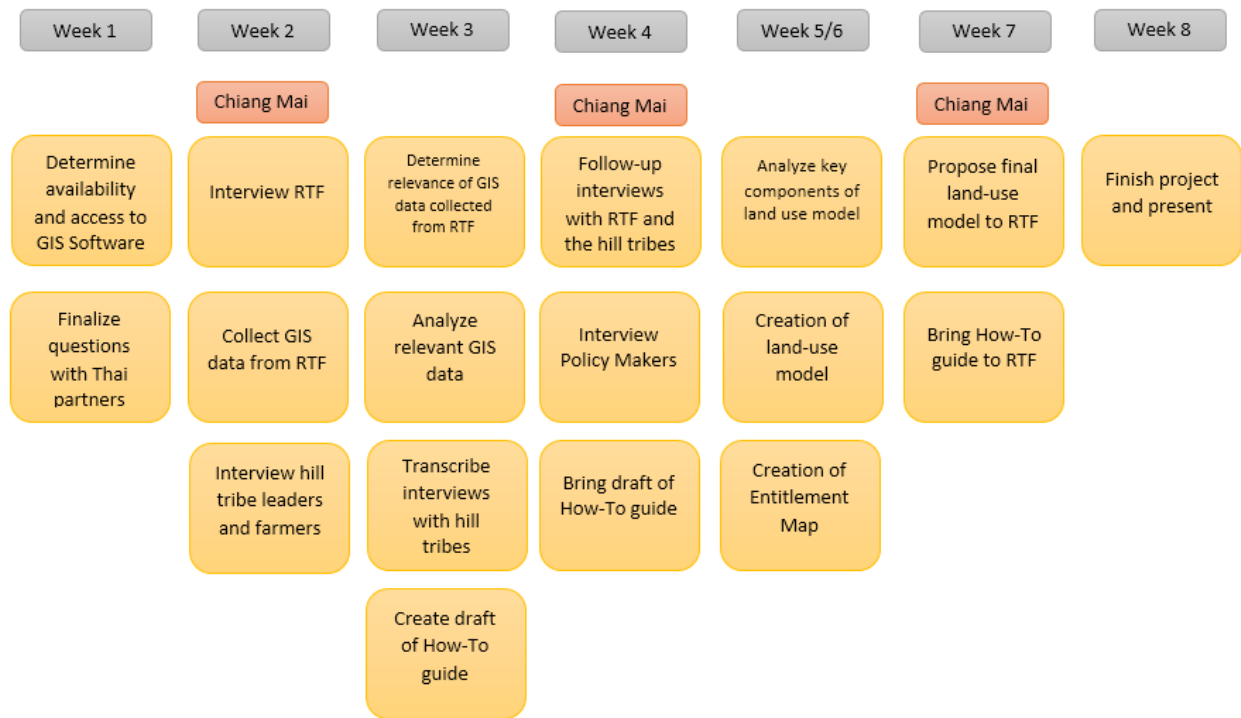
- Adulyadej, B. (1994). Tambon Council and Tambon Administrative Authority Act, B.E. 2537. Retrieved from [http://thailaws.com/law/t\\_laws/tlaw0462.pdf](http://thailaws.com/law/t_laws/tlaw0462.pdf)
- Baral, H. (2004). *Applications of GIS in Community-Based Forest Management in Australia (and Nepal)*. (Master of Forest Science), The University of Melbourne. Retrieved from [http://www.iapad.org/publications/ppgis/gis\\_applications\\_in\\_cbfm.pdf](http://www.iapad.org/publications/ppgis/gis_applications_in_cbfm.pdf)
- Barbier, E. B. (1993). Economic Aspects of Tropical Deforestation in Southeast Asia. *Global Ecology and Biogeography Letters*, 215-234.
- Bowman, C. (2004). *Thailand Land Titling Project*. Paper presented at the Scaling up Poverty Reduction: A Global Learning Process and Conference, Shanghai.
- Brenner, V., Buergin, R., Kessler, C., Pye, O., Schwarzmeier, R., & Sprung, R.-D. (1999). Thailand's Community Forest Bill: U-Turn or Roundabout in Forest Policy? In R. Buergin (Ed.), *Socio-Economics of Forest Use in the Tropics and Sub-Tropics* (3rd ed.). Freiburg, Germany: Albert-Ludwigs-Universität Freiburg.
- Briassoulis, H. (2000). *Analysis of Land Use Change: Theoretical and Modeling Approaches* Retrieved from [http://www.rri.wvu.edu/web\\_book](http://www.rri.wvu.edu/web_book)
- Bruneau, M., & Taillard, C. (1995). *Géographie universelle asoc*. Paris: Hachette.
- Burdett, A., & Bowen, D. (2013). *BCS Glossary of Computing and ICT*. Swindon, GBR: BCS Learning & Development Limited.
- Burns, A. (2004). Thailand's 20 year program to title rural land *World Development Report 2005*: World Bank.
- Chaleo, K. a. J., Kaewchote. (2004). Communities for Watershed Protection. Mae Khan, Thailand. *Bohol: Asia Forest Network*.
- Davis, B. E. (2001). *GIS: A Visual Approach*. Albany: Delmar Thomson Learning.
- Delang, C. O. (2002). Deforestation in Northern Thailand: The Result of Hmong Farming Practices or Thai Development Strategies? *Society & Natural Resources*, 483-501.
- Devereux, S. (2001). Sen's Entitlement Approach: Critiques and Counter-critiques. *Oxford Development Studies*, 245-263.

- Erni, C. (2009). Shifting the Blame? Southeast Asia's Indigenous Peoples and Shifting Cultivation in the Age of Climate Change: United Nations Framework Convention on Climate Change.
- ESRI. (2008). What is GIS: Guide to Geographic Information System. Retrieved December 4, 2014, from <http://www.gis.com/whatisgis/>
- ESRI. (2013). ArcGIS Resources. *Analysis Tools*. Retrieved from [http://resources.arcgis.com/en/help/main/10.1/index.html#/Welcome\\_to\\_the\\_ArcGIS\\_Help\\_Library/00qn0000001p000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/Welcome_to_the_ArcGIS_Help_Library/00qn0000001p000000/)
- FAO. (2014). FAOSTAT: Glossary from <http://faostat.fao.org/site/375/default.aspx>
- Forrester, J., & Cinderby, S. (2014). A Guide to Using Community Mapping and Participatory-GIS. <http://www.iapad.org/publications/ppgis/Borderlands-Community-Mapping-Guide.pdf>
- Forsyth, T. (2008). *Forest Guardians, Forest Destroyers : The Politics of Environmental Knowledge in Northern Thailand*. Seattle, WA, USA: University of Washington Press.
- Foundation, R. T. (Cartographer). (2014). Dam Location and Watershed Area Map of Sam Sob Village.
- Google (Cartographer). (2014). Thailand Flood Map: Forecasting Daily Flood Risk in the Chao Phraya Watershed. Retrieved from <http://grahamemde.com/thailandfloodmap.html>
- Grainger, A. (2004). Societal change and the control of deforestation in Thailand. *International Journal of Sustainable Development & World Ecology*, 364-379.
- Hersperger, A., Anna, M. H., Maria-Pia, G., Peter, H. V., & Matthias, B. (2011). Feedback Loops in Conceptual Models of Land Change: Lost in Complexity? *Ecology and society*.
- Higgs, G., White, S., & Kidner, D. B. (2003). Socio-economic applications of geographic information science. London: Taylor & Francis.
- Huamangkaew, M. (2013). Readiness Preparation Proposal (R-PP) for Country: Thailand. Bangkok, Thailand: The Department of National Parks, Wildlife, and Plant Conservation.
- Krieger, D. J. (2001). *The Economic Value of Forest Ecosystem Services: A Review*. Washington, D.C.: The Wilderness Society.

- Leach, M., & Mearns, R. (1997). Environmental entitlements. *Discussion paper (University of Sussex. Institute of Development Studies)*.
- Leach, M., Mearns, R., & Scoones, I. (1999). Environmental Entitlements: Dynamics and Institutions in Community-Based Natural Resource Management. *World Development*, 225-247.
- Maguire, D. (1992). *Geographic Information-Systems - An Introduction*. London: Edward Arnold Publishing LTD.
- McCall, M. K. (2004). Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Netherlands: Dept. of Urban & Regional Planning and GeoInformation Management.
- McQuistan, C. (2004). RRA Report on Mae Gok Watershed in Chiang Mai and Chiang Rai Provinces: Watershed Profile: Regional Environmental Technical Assistance 5771-Poverty Reduction & Environmental Management in Remote Greater Mekong Subregions Watersheds Project (Phase 1).
- National Geographic. (Cartographer). (2014). Map Maker Interactive. Retrieved from [http://mapmaker.education.nationalgeographic.com/?lg=1&b=1&f=123&bbox=147.51848%2C-64.01450%2C120.79973%2C64.01450&ar\\_a=1&t=0&ls=000000200000](http://mapmaker.education.nationalgeographic.com/?lg=1&b=1&f=123&bbox=147.51848%2C-64.01450%2C120.79973%2C64.01450&ar_a=1&t=0&ls=000000200000)
- National Legislative Assembly. (1992). Thailand's Nationality Act B.E. 2508 as amended by Acts B.E. 2535 No. 2 and 3.
- Ongprasert, P. (2011). Forest Management in Thailand. Bangkok, Thailand: Royal Forest Department.
- Pijanowski, B. C., Long, D. T., Gage, S. H., & Cooper, W. E. (1997). A Land Transformation Model: Conceptual Elements, Spatial Object Class Hierarchies, GIS Command Syntax, and an Application for Michigan's Saginaw Bay Watershed *Land Use Modeling Workshop*. East Lansing, Michigan: Michigan State University.
- Pourabbas, E. (2014). *Geographical Information Systems: Trends and Technologies*: CRC Press.
- Purnomo, H., Herry, P., Grace, V., Betha, L., & Meine van, N. (2011). Feedback Loops Added to Four Conceptual Models Linking Land Change with Driving Forces and Actors. *Ecology and society*.

- Saenpakdee, A., & Thiengkamol, N. (2012). Formulation of Community Forest Act in Thailand. *The Social Sciences*, 7. Retrieved from <http://docsdrive.com/pdfs/medwelljournals/sscience/2012/71-76.pdf>
- Thailand Collaborative Country Support Program. (2007). Community Forestry in Thailand. Retrieved from [http://www.helsinki.fi/vitri/research/Educational\\_Projects/forrsa/RE\\_2\\_Course%20and%20workshop%20proceedings/lecture/9jan/07community.pdf](http://www.helsinki.fi/vitri/research/Educational_Projects/forrsa/RE_2_Course%20and%20workshop%20proceedings/lecture/9jan/07community.pdf)
- World Bank. (2014). World Development Indicators: Deforestation and Biodiversity. Retrieved from <http://data.worldbank.org/sites/default/files/wdi-2014-book.pdf>
- Young, G. (1974). *The Hill Tribes of Northern Thailand* (5th ed.). Siam City, Bangkok.

## Appendix A: Work Schedule for Team Thai Tree



## Appendix B: RTF Land-Use Model Interview

Interview questions for RTF about our land-use model (To be translated to Thai)

1. What is the current state of the policy which we will be supporting with this land-use model?
2. What hill tribes will we be working with? Which hill tribes do you perceive to be needing this land-use model the most?
3. How do you define a land-use model? What specific components of the land-use model are you looking for?
4. How do you see GIS being a successful tool for this land-use model?
5. Tell us about the GIS data you've collected. What kind of data did you collect? Which hill tribes have you worked with to collect this data? What was your purpose for collecting this data?
6. What level of involvement would you like to see from the hill tribes in the development of the land-use model?

## Appendix C: Hill Tribe Interviews

Interview questions for hill tribe leaders (To be translated to native dialect)

1. What are your methods of cultivation? What do you cultivate/grow/produce? Who is it for? Do you use it or is it sold at local markets?
2. Have your methods of cultivation changed in recent years? How have they changed in recent years?
3. Have you noticed degradation in your land? In general or are there specific species impacted?
4. What are your methods for maintaining forest? Do you see the impacts of your activities on the forest?
5. How is your land designated? For example, do you have strict spaces for residence, cultivation, and spiritual lands, respectively?
6. What is your understanding of the Thai policies pertaining to your land? Do you see the effects of these policies on your land?



## Appendix D: Policy Maker Interviews

Interview questions for Thai Policy makers (To be translated to Thai)

1. Do you know if any community forests have been established by other hill tribes in the Chiang Mai province? In Thailand?
2. Once a community forest is established, what role does the government play within the forest?
3. What are your concerns regarding the inhabitation of hill tribes in forested regions of Chiang Mai?
4. How do you perceive the current situation in terms of forest management with the hill tribes?
5. Do you expect a community forest arrangement to be established with the hill tribes?
6. Are you familiar with GIS? Do you see GIS as being successful in developing a land-use model?
7. Has a GIS solution been presented to you before? Was it successful? What did you like about? What did you not?
8. What has previously prevented the government from approving a land-use model for the hill tribes in Chiang Mai Province?
9. What projects have you worked on with Raks Thai Foundation lately? Was it successful?

## Appendix E: RTF GIS Interview

Interview questions for RTF (To be translated to Thai)

1. How have you worked with GIS previously? Have you used it for land-use agreements specifically?
2. We're aware that you've been collecting GIS data - how have you used it?
3. Are you familiar with P-GIS? If so, how have you used it?
4. What projects have you worked on with the government lately? Was it successful?
5. What is your level of knowledge about GIS technology? Are there any specific areas you would like to know more about?