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Local Knowledge and the Ecology of Medicinal Plants in Northern Thailand

Group Bachelor Thesis

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Introduction

Since centuries medicinal plants have been collected, providing the base of human health care.

Till this day, especially in developing countries and rural areas, medicinal plants collected from the wild play an important role for people's livelihood (Iqbal, 1993; Walter, 2001). It is estimated that worldwide more than 50 000 medicinal plant species are used (Duke & Ayensu, 1985; Jain & De Fillipps, 1991; Moerman, 1996; Padua *et al.*, 1999) of which about 80 % are collected from the wild (IUCN, *et al.*, 2009) In most cases cultivation is expensive, difficult, and results in loss of genetic diversity and environmental degradation (Anon, 2002b). Scientific studies partly support the inferior quality of cultivated medicinal plants compared to specimens from the wild (Schippmann *et al.*, 2002). Wild medicinal plant resources are increasingly limited by deforestation from logging and converting forests to plantations and pasture (Ahmad, 1998; Cunningham, 1993). Around 8 % of all medicinal plant species are additionally threatened (Walter & Gillett, 1998) by a worldwide increasing demand (Kuipers, 1997; Cunningham, 1993).

In order to protect this important natural resource, strategies for a sustainable ecosystem management have to be generated.

The aim of this study was to record the local knowledge and observe the ecology of medicinal plants in a village in Northern Thailand, in order to provide data for a sustainable ecosystem management.

To address the unique socio-ecological circumstances and pressures for each species an interdisciplinary approach combining ethnology, botany and soil science was necessary.

The study was conducted in the Black Lahu village Huai Hia, located in Northwestern Thailand, Mae Hong Son Province, Pang Ma Pha District. The inhabitants of the village are part of the ethnic minority of Black Lahu Sheh Le, who originally came from southern Tibet and China and moved through Burma to Thailand. Huai Hia is located in the western mountain range at an elevation of 1200 m. According to Maxwell and Elliot (2001) the vegetation of Northern Thailand consists of different forest types being the most diverse and complex in

Thailand. The forest can be broadly divided into deciduous and evergreen. The climate in this area is influenced by the monsoon and three seasons, the rainy season, the hot and dry season, and the cold and dry season are distinguished.

11. Conclusion

11.1 Value of Local Knowledge

Folk medicine is readily accessible, trusted, inexpensive, and successful. As it has long been an important component of the cultures of the hill tribes, folk medicine is therefore well-known and more readily understood. (McKenzie, J.L and N.J. Chrisman, 1977).

Local knowledge among medicinal plants is since thousands of years ago a traditional element of culture, ritual and traditional life for rural communities as well as in Huai Hia. The use of traditional medicinal treatment makes the villager independent from external supply which is much more expensive than traditional treatments. Independency is important for every person because to be able to make independently decisions in any cases.

Every villager of Huai Hia and other rural communities in this area has access to traditional treatment independently even if they are not registered by the Thai government as legal citizens of Thailand and are not allowed to have formal access to western treatment in the hospital. Another reason for universal access is that the medicine man is living in the village and any time accessible for the villager of Huai Hia.

The use of traditional medicinal treatment and the knowledge about medicinal plants is an alternative to modern medicine. An alternative shows the flexibility as villager to combine the western medicine with the traditional treatments. This results into increasing the application of traditional treatments in case of Huai Hia. This increases also the opportunity for the younger generation to get more in contact to local knowledge among medicinal plants.

Knowledge among medicinal plants shows high importance for the women of Huai Hia because of their need after giving birth. The women in Huai Hia are responsible for many tasks which are necessary for their family and the whole village. In order to continue these tasks after giving birth they need the sauna treatment.

A diversity of medicinal plants is the base for practicing traditional treatments. An intact knowledge among medicinal plants in Huai Hia can be an indicator for a diversity of medicinal plants in their ecosystems.

11.2 Loss of Local Knowledge

Through many conversations with the key informants, both older and younger, it was possible to see that there is a lack of knowledge transfer concerning medicinal plants in the Huai Hia village. This means that there is an increasing loss of local knowledge. In this study project, there are many different causes for this due to it being a rural area, which is getting more and more access to technology and development, which has an impact on the traditional life style of the villagers of Huai Hia. The village is very close to the Burmese border and, therefore, this area has a more focused support from the Thai military. The military built up a better infrastructure, which means roads, water supply and electricity, which is also very necessary for their military points and to have a broader overview about this buffer area. This infrastructure, which is built up by the military, is the main entrance for people from rural areas to bigger towns. The people in this area are getting access to education systems, health care systems and other societies with modern lifestyles. Since then, the first eco-tourists came in contact with the communities in this area, which also influences the communities. Huai Hia had, for approximately 25 years, access from the outside world and access to the next bigger towns, like Pang Ma Pha, for 10 years.

11.2.1 Education and Infrastructure

Through high school education, the students get more information about health care systems in developed areas and the importance of a better life standard. Exchange and experience with modern medicine, decreases the importance of traditional medicine for educated villager and students. Most high school students are not in the village and not regularly involved in the traditional life of the older generation. Just once per week, on the weekend, will they visit their home and

spend some days with their families and help them in the household or other activities. In this case of knowledge transfer, the medicine man mentioned that the younger generation is not interested enough in preserving the traditional use of medicinal plants and do not want to put out the effort to gain knowledge about medicinal plants.

Some conversations and interviews with younger adults (age 19-29; 6 women and 1 man), however, illustrated that they are interested in medicinal plants and want to know more, but they cannot put in the effort or the time to become an expert in medicinal plants, like the medicine man. For example, with traditional activities like traditional treatment, they cannot earn enough money for a single person much less for a whole family. Nowadays, being a medicine man does not have financial appeal to investigate more time and effort to it. Through education and jobs in other areas, the students and villagers, cannot spend enough time with the medicine man to obtain his knowledge. Education, which helps in finding a high valued job in a town, has more importance and can support even their family's financial conditions.

Many of the students of Huai Hia never had traditional treatment from the medicine man because they have access to western medicine, which is more effective and fast, in their opinion, but they saw the older villagers using the medicinal treatments from the medicine man. They also mentioned that almost every person above 40 years old is receiving some traditional treatments, which means everybody under 40 years are almost always using western medicine.

11.2.2 Intergenerational Pressures

Intergenerational pressures between younger and older generation are caused by access to education and job opportunity outside of the village. The younger generation is not able to put out the effort and does not have enough time to be interested in preserving the local traditional knowledge, a resource of the older generation. In Thailand, like in most Asian countries, the eldest person is the most respected and receives the most responsibilities in caring about important issues in their life. They have an advisory role on knowledge and traditional skills

associated with farming and of traditional Thai behaviors, values and beliefs (Caffrey, 1992).

The medicine man is open to transfer his knowledge, but he mentioned it is, for the last centuries, tradition that the younger generation has to show more interest in the knowledge about medicinal plants and must make the first step to the medicine man. This is because he is the older person and it is beneath him to make the first step towards younger person. There we have an intergenerational conflict, which is a barrier for transferring

11.2.3 Population Growth

According to FAO and geography.com the population growth is defined as the average annual percent change in the population, resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country. The growth rate is a factor in determining how great a burden would be imposed on a country by the changing needs of its people for infrastructure (e.g., schools, hospitals, housing, roads), resources (e.g., food, water, electricity), and jobs (indexmundi, 2008). The population in Thailand is about 65,493,298 and the national average population growth rate is about 0.6 % (Geography, 2009). In the case of the ethnic minorities, who are living in the northeast and northwest hill part of Thailand, the annual population growth rate is 2.9 %, about 751,886 persons, which is the total number of the ethnic minorities in Thailand in 2000 (FAO, 2002). The increasing population growth has many impacts on environment and humans, for example, resource and environment degradation.

The village head mentioned access to education and settlements from other villages and from Burma as causes for population growth. Therefore, the villagers have to expand their agricultural fields, which are the base to cultivate food. Increasing food production causes deforestation. The forest is the base for the medicinal plants, which is endangered due to expanding agricultural fields. The village is located in upper part of mountains and they are shifting cultivation to the mountains in order to expand their agricultural fields, which decrease their forest area. All the forests that are surrounding the village are living spaces for wild

medicinal plants that are essential to practice their traditional knowledge about medicinal plants. In this study, increasing population growth rate has impact to the knowledge about medicinal plants.

The medicine man mentioned some collection behaviors that he observed in the last ten years, for example, that through bigger forest fires the abundance of a few medicinal plants are decreasing. He must now to switch to another collection area or choose to go deeper into the forest to find the special plants. This needs more effort and more specified knowledge about the area and the plants to get the right medicinal plants. On the other hand, he mentioned agricultural cultivation is very important for their family to survive Lack of natural resources causes a lack of medicinal plants. This leads to a decrease in the practice, which increases the loss of knowledge among medicinal plants. Interactions responsible for knowledge loss are illustrated in Figure 5.

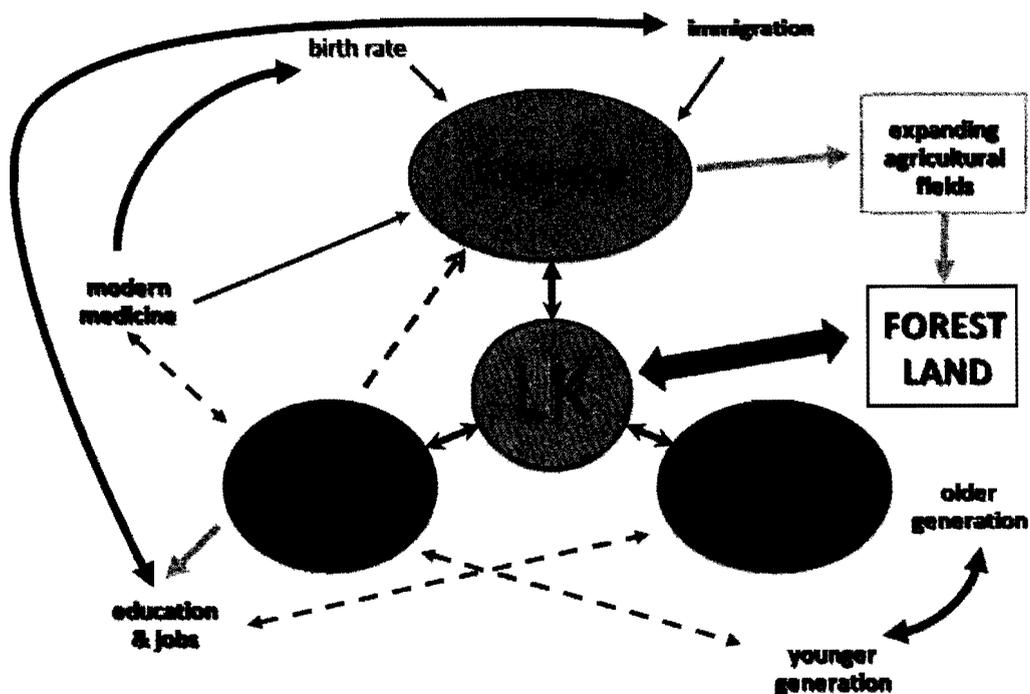


Figure 5: Influences on Local Knowledge about Medicinal Plants

11.3 Local Strategies to Preserve Local Knowledge

The Black Lahu villagers in Huai Hia live after the traditional Chinese lunar calendar which has twelve days (twelve animals) per week. The twelfth day is called "One singh" which means translated the "tiger's day", this day is the holiday of the whole week. On this day all the villagers have to stay in their village (Huai Hia) and come together to several events or activities. The first suggestion from the villagers was that all the villagers who are interested in medicinal plants and their treatments should come together with the local experts; the medicine man and the spirit doctor; and talk about several treatments and the plants. This should be continued for a long time till some villagers are getting more interest to this topic and are possible to get transferred the knowledge from the medicine man. The lesson should take place in the social gathering place with pictures of plants, plant examples and excursions to the forest, like collection areas.

Another suggestion for preserving knowledge comes from some younger villagers; one of them worked in an education program in Pang Ma Pha and had some experiences with the organizational structures in education programs. He suggested creating an "Institute of medicinal plants" in the village with the financial support from the government or non-governmental organizations. This institute should present the knowledge among medicinal plants in Huai Hia and the medicine man and should raise awareness about the value of medicinal plants and the knowledge. He should practice and transfer it to everybody who is interested in this traditional knowledge among medicinal plants. The medicine man should be paid as a worker who transfers his knowledge to the next coming medicine man or students as an occupation. There should be exchange and interaction between schools and the medicinal plants institute. The institute should also have students as future medicine men and women.

11.4 Additional Recommendation

One part of the study shows that women have to care about many important tasks in the village and also a important need of the medicinal plants in case of after giving birth. In light of this importance it is necessary to empower the women and include them as a important part in a natural resource management for example in the future “Institute of medicinal plants in Huai Hia” where the women are able to be experts in the special treatments and the resources of these treatments.

12. Research Approaches to Preserve Local Knowledge

An ethno-ecological studies of plants aims to stimulate a “re-installation” of lost knowledge and practices on the studied areas with respect to original cosmologies. (M. Heinrich and S. Gibbons, 2001).

In many conversations with younger generation and older generation I could observe that they started to think about the value of medicinal plants which is traditionally very important for their community and culture. They started to think about strategies how to preserve some how the knowledge, how to make the knowledge among medicinal plants attractive for the younger generation



Photograph 9: Overhanding of the booklet to the villagers of Huai Hia

or as an occupation. I could feel that there were some conversations between villagers going on about the importance of their medicinal plants. This study project tried to stimulate awareness about the knowledge of medicinal plants and the value of it. This should be continued by the villagers of Huai Hia and other research studies and the next step should be to realize the different strategies to

preserve the knowledge among medicinal plants which need a lot of time and effort.

During our research time we recorded via photographs, video and writings all the information about ecology, knowledge, standards among medicinal plants and we summarized all the information into a booklet, is called "*Medicinal plant knowledge among Black Lahu people in Huai Hia, Pang Ma Pha District, Mae Hongson Province, Northern Thailand*" (Photograph 10). This booklet includes all the ecological and medicinal information about the medicinal plants which the botanist and medicine man could identify in forest. This booklet was translated into Thai language and distributed in the village for the villagers. Another recording strategy was to visualize the knowledge among medicinal plants in Huai Hia. This was done by a Black Lahu video man who was invited from another village which is close to Chiang Rai. It was advantageous that he knew Huai Hia village before because villager exchange for the "New Year" festival. He spent some days with us in the village and did some transects with us and recorded many information. These records were presented in our last night in the village, in the house of the village head as video of 25 min. The video and the photographs of the two and half month's research time were over handed to the village head. All the villagers come together and watched the video and photographs and we discussed about the topic of medicinal plants and our time in Huai Hia. The presentation and handing over our information of the work to the villagers was very important for us because we wanted give some resources which generates or supports the transfer of the knowledge among medicinal plants another reason was to let them feel that they were a essential part for our study project which we are very thankful that we could do this. We recommended to use these recordings as helpful skills for discussing or even transferring the knowledge among medicinal plants in Ban Huai Hia.

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**Medicinal Plant Diversity in
Different Forest Types in
Northern Thailand**

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affect ecosystem resilience, rendering them more vulnerable to abiotic and biotic stresses while compromising their ability to supply resources. Effective use of biodiversity helps curing and preventing a plurality of diseases and illnesses, using plants containing effective agents and thus building the base for a considerable number of pharmaceutical drugs.

The importance and value of biodiversity for human health is underlined by the number of people depending on medicinal agents from the environment. It is estimated that three billion people rely on traditional, natural pharmaceuticals representing 80 % of the developing world (Farnsworth, 1988) and more than 50 % of commercially available drugs are based on extracts from non-human species (Grifo *et al.* 1997).

Most medicinal plants are collected from the wild (Lange & Schippmann, 1997; Srivastava *et al.*, 1996; Xiao Pen-Gen, 1991) demonstrating the strong linkage between collecting and the necessary local knowledge, mostly preserved by indigenous people. Over a long period of time a complex relationship between biodiversity and indigenous people has developed (Shiva, 2001). Indigenous people have been using the local biodiversity for centuries learning to sustain and respect the medicinal resources needed for their survival.

The influence of western lifestyles, access to new technology and modern medicines, as well as new laws or regulations for agricultural practices strongly influence the traditional life of indigenous people. For example, the ethnic minorities of northern Thailand lived for a long period of time in close relation with the surrounding nature and its resources. Changing political guidelines and a shift in their traditional culture causes many new conflicts for people and their environment.

6. Conclusions and Recommendations

In this study there were two contrasting examples of forest types. Egf, a former cultivated area, had by far the best habitat for medicinal plants with the least influence of human impact. However, if there are no severe human impacts over the time, it can regenerate to a habitat rich in medicinal plants. The fallow, actually representing a former forest which is now slowly regenerating vegetation, contained the most individuals of medicinal plants, but the lowest diversity of all. These two extreme examples clearly show that human impacts have an influence on the biodiversity of medicinal plants.

There are two possible ways how local people can behave towards their environment. According to their needs, forest areas are destroyed and turned into arable land in order to produce enough food for survival. In other respects it can be left uncultivated having a chance to regenerate and being a diverse forest, rich in plants, animals, and resources for humans.

Do ethnic minorities with their increasing population, their increasing need for food, which can only be produced on fertile land, still have the choice to live in a sustainable way with their environment?

Both the government and the Black Lahu people follow understandable aims. The protection of northern Thailand's environment and the need of food, are conflicting factors.

Education programs for villagers, supported by the Thai government, are needed in order to cultivate awareness about the effect of forest fires and forest destruction. The Introduction and learning of proper, sustainable agricultural practices could help to conserve the soil fertility of arable land.

In a participatory approach local stakeholders and the government have to find a solution between forest protection and subsistence farming. Already existing traditional cultivation methods, like the *rai mun wiang*, which is for example used by the Karen (Laungaramsri, 2002; Santasombat, 2004), are considered to be environmental friendly and approved since hundreds of years. In cooperation with Chiang Mai University, Karen farmers organized a scientific study of the impacts of *rai mun wiang* which was published to increase awareness of the authorities (Hares, 2009).

Local minorities like the Black Lahu should participate in the decision making progress about sustainable use of forest resources in respect to their cultural background and according to their needs for survival.

Finally, plans for a change in land use have to be accepted by the local people and political will to realize the plan, is necessary.

Such an agenda should take into account the social, cultural, and political dimensions and should address values (equity, ethics), sustainability (regulation, financing, knowledge generation, knowledge management, capacity building), and the research environment (Bodeker & Kronenberg, 2002).

Since this study was conducted at the end of the dry season/beginning of the raining season only a limited period of the year could be surveyed. The data gives just a hint and direction about the ecology and all its influencing factors on medicinal plants, but provides important information for a sustainable ecosystem management. More ecological data as well as different medicinal plants have to be collected in different seasons of the year. We highly recommend doing further analyses throughout the year to get a more detailed impression on this issue.

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Soil Variability of Medicinal Plant Habitats in Northern Thailand

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1. Introduction

Northwestern Thailand belongs to tropical mountainous areas that are influenced by a monsoonal climate. Historically, it was covered, by a number of very rich and diverse forest types (Pendleton, 1963). Because of this and other factors as slope steepness and its seclusion, these highlands have been classified in some systems as “hilly marginal lands” (Symons, 1967; Dent, 1973), being unsuitable for agricultural production. This is one of the reasons why there has been very little research on highland soils compared to the number of surveys in lowland areas in Northern Thailand (see 2.5 Soils). The highlands of Northern Thailand are settled by ethnic minorities practicing slash and burn cultivation cycles. This cycle used to be 20 to 50 years, but now, due to increasing population numbers, reduced to 7 to 15 years and less, which does not allow the forest to reestablish by itself (Thailand – UNEP, 1990). Beside slash and burn cultivation, these ethnic minorities depend on many natural products provided by the surrounding forests *e. g.* construction timber, fire wood, medicinal plants, and edible wild plants.

1.1 Problem statement

Due to population increase, ethnic minorities are confronted with land scarcity and land tenure conflicts, leading to an intensification of agricultural production and increased exploitation of natural forest products, as well as to a loss of biodiversity, an increase in erosion and the enhanced use of pesticides.

Soil and forest degradation induced by the extreme mountainous conditions such as slope steepness and high erosion risk as well as the use of natural resources by the ethnic minorities, threaten the existence of these important and diverse habitats. How is the habitat changing through human activity and is it worth to protect this natural environment? Approaching the problems with the attention on sustainable ecosystem management it is clear, that these habitats have to be protected in order to supply natural forest products for many more years, making human livelihood possible in this area. The question is more about the direct

benefit of the habitat conservation for the people who struggling for survival every day.

Surveying and evaluating soils provides an idea of the degraded conditions in the different habitats and can be used as basic information about the land use potential considering not only agriculture but also conservation of the forest habitats for increasing biodiversity. This is very important in times, where a conflict between agricultural production and environment can be observed. Further the evaluation of soils will also directly correlate with the condition of the vegetation.

Soil evaluation is a controversial and complex subject. The focus has always to be on the intentions the soil should be used for, on its capacity (Scheffer und Schachtschabel 2002). Soil evaluation systems are based on increasing productivity in agricultural land use. There is no existing system that evaluates soils for biodiversity potential of its vegetation. This study is an attempt towards soil condition evaluation in relation to different diversities of medicinal plant habitats. To achieve this aim, different objectives were followed:

- Identification of soil distribution in the study area by soil mapping along medicinal plant collection routes.
- Soil variability evaluation under different medicinal plant habitats in order to show the effects of human activity on mountainous forest soils in relation to its habitat.
- Correlation between soil properties and medicinal plant occurrence.

sustainable management.

6. Summary

Soil variability of medicinal plant habitat in Northern Thailand

The population in villages of ethnic minorities in Northern Thailand is increasing due to various reasons (immigration, birth rates, etc). In relation to this, land resources are declining. In order to produce more food, agricultural fields are expanding. Additionally, there is a higher pressure on the natural forest resources, such as timber, edible plants and mushrooms. These changes in space and time result in different effects according the peoples environment: loss of biodiversity, erosion, forest degradation. One attempt towards these problems can be soil evaluation. Soil evaluation can provide basic information about the potential of

soils, such as, use for agricultural production or to contribute to the conservation of natural habitats. This is especially important in times of worldwide conflict between agricultural production and environment, which the villagers themselves are facing on a smaller scale. In order to provide data for a sustainable ecosystem management, different objectives were followed:

- Identification of soil distribution in the study area by soil mapping along medicinal plant collection routes.
- Soil variability evaluation under different medicinal plant habitats in order to show the effects of human activity on mountainous forest soils in relation to its habitat.
- Correlation between soil properties and medicinal plant occurrence.

On the catenary transects, auger samples were taken, wherever a medicinal plant was collected. All important soil information was written down in a field form including the GPS coordinates for later mapping.

The results of these transects were 17 Alisols, occurring mainly on slopes with evergreen trees, and parent material, consisting of sandstone or slate. Furthermore, 6 Fluvisols were found along river streams showing human influence due to cultivation of paddy rice. Besides this, single occurrences of Gleysol, Stagnosol, Leptosol and Luvisol were recorded.

In order to evaluate the soil variability of different medicinal plant habitats, profiles were taken in each forest type. The following forest types were described:

primary evergreen, seasonal forest without pine (egf), deciduous dipterocarp-oak forest without pine (dof), deciduous dipterocarp-oak forest with pine (do/p), bamboo + deciduous seasonal forest (bb/df), tertiary growth (recent fallow with weeds).

The samples taken from these profiles were analyzed (pH, organic matter, bulk density, CEC, texture, exchangeable cations) in the laboratory of the Chiang Mai University. In addition to the profiles, 5 auger samples (bb/df only 3 due to steep slope) were taken within a distance of 100 m in order to ensure the representation of the different habitats by the profiles.

The evaluation of the investigated profiles can be summarized in the following.

Egf: Alisol, good topsoil, moderate organic matter content, acidic, moderate bulk density, SCL texture, very good rootability, good water holding capacity, charcoal.

Dof: Acrisol, less topsoil, low organic matter content, acidic, high bulk density, SCL texture, moderate rootability, dry, erosion activity, charcoal, termites

Do/pine: Acrisol, almost no topsoil, very low organic matter content, acidic, outstanding high bulk density, SL - SCL, moderate rootability, very dry, severe erosion, charcoal

Bb/df: Alisol, good topsoil, high organic matter content, acidic, low bulk density, SCL - SC, very good rootability, good water holding capacity, lots of charcoal.

Fallow: Alisol, good topsoil, high organic matter content, acidic, very low bulk density, C texture, moderate rootability, good water holding capacity, lots of charcoal.

Doing research on the growing requirements of plants and soil properties, it was found that most of the medicinal plants are tolerant to acid soils. Further, plants, especially those growing in dof or do/pine, showed a tolerance to dry conditions. On most of the sites, plants showing high adaption to the specific conditions were found. An example is *Curcuma zedoaria* (Christm.) Rosc., which due to Dhusentis interviews is used to cure flatulence and due to Manuels investigations was found only in the do/pine. *Curcuma zedoaria* (Christm.) Rosc. needs the exposure to sunlight, but also is growing on acid, dry and sandy soils. It has a tuber in which it can store water and nutrients and it is able to survive longer drought periods and fire events inside the soil. These characteristics refer to the properties of the do/pine habitat.

From all these findings we can say, that soils in the Huai Hia forest area show a potential for conservation of natural habitat rather than being used for agricultural production. An exception is the Alisol under the fallow, which can be sustainably cultivated after some liming and with the keeping of a moderate fallow period (about 7 years).

Zusammenfassung

Boden Variabilität von Habitaten medizinischer Heilpflanzen in Nordthailand.

Das Wachstum der Bevölkerung in Dörfern ethnischer Minderheiten in Nordthailand hat unterschiedliche Gründe (Einwanderung, Geburtenrate). Im Vergleich dazu nehmen die Landressourcen immer weiter ab. Um mehr Nahrungsmittel zu produzieren werden die Agrarflächen ausgeweitet. Hinzu kommt ein erhöhter Druck auf die natürlichen Waldressourcen wie Bauholz, essbare Pflanzen, Pilze. Diese Veränderungen in Raum und Zeit haben verschiedene Auswirkungen auf die Umwelt der Menschen: Verlust an Biodiversität, Erosion, Wald Degradation. Ein Ansatz um diese Probleme zu adressieren kann die Evaluierung von Böden sein. Evaluierung von Böden kann Grundinformation über das Potential der Böden geben wie zum Beispiel, ob ein Boden sich eher für eine agrarische Nutzung eignet oder mehr zum Erhalt von natürlichen Lebensräumen beitragen kann. Dies hat eine besondere Wichtigkeit in Zeiten eines weltweiten Konflikts zwischen Agrarwirtschaft und Umwelt, mit welchem die Dorfbewohner in kleinerem Maßstab konfrontiert werden. Um Daten für ein nachhaltiges Management von Ökosystemen zu erstellen folgende Zielsetzungen wurden verfolgt:

- Identifikation der Bodenverteilung im Untersuchungsgebiet durch Bodenkartierung entlang der Sammelrouten für Heilpflanzen.
- Evaluierung der Boden Variabilität in den verschiedenen Heilpflanzen Habitaten um die Auswirkungen menschlicher Aktivitäten auf Gebirgswaldböden im Verhältnis zu ihrem Habitat zu zeigen.
- Korrelation zwischen Bodeneigenschaften und dem Auftreten von Heilpflanzen.

Auf den Transekten wurden Bohrstockproben immer da genommen wo eine Heilpflanze gesammelt wurde. Alle wichtigen Informationen über den Boden sowie die GPS Koordinaten wurden in eine Feld Form geschrieben um die Transekte zu kartieren.

Die Ergebnisse dieser Transekte waren 17 Alisole, die hauptsächlich am Hang unter immergrünen Bäumen und auf Sandstein oder Schiefer vorkamen. Desweiteren wurden entlang Flüssen 6 Fluvisole gefunden, welche menschlichen Einfluss zeigten, da hier Nassreis angebaut worden war. Ausserdem sind ein Gleysol, ein Stagnosol, ein Leptosol und ein Luvisol erfasst worden.

Um die Bodenvariabilität der verschiedenen Lebensräume von Heilpflanzen zu evaluieren wurden Profile in jedem Waldtyp genommen. Folgenden Waldtypen wurden beschrieben:

Primärer immergrüner Saisonwald ohne Kiefer (egf), laubabwerfender dipterocarper Eichenwald ohne Kiefer (dof), laubabwerfender dipterocarper Eichenwald mit Kiefer (do/pine), Bambus und laubabwerfender Saisonwald (bb/df), tertiäres Wachstum (Brache mit Unkräutern).

Die Proben, welche von diesen Profilen genommen wurden, wurden im Labor der Chiang Mai Universität analysiert (pH, organische Substanz, Lagerungsdichte, KAK, Textur, austauschbare Kationen). Zusätzlich zu den Profilen wurden 5 Bohrstöcke (im bb/df wegen Steilheit nur 3) in einem Abstand von 100 m genommen um die Repräsentativität der unterschiedlichen Habitate durch die Profile sicherzustellen.

Die Evaluierung der untersuchten Profile kann folgendermaßen zusammengefasst werden.

Egf: Alisol, guter Oberboden, mittlerer Gehalt an organischer Substanz, sauer, mittlere Lagerungsdichte, sandig toniger Lehm, sehr gute Durchwurzelbarkeit, gute Wasserhaltekapazität, Kohle.

Dof: Acrisol, weniger Oberboden, niedriger Gehalt an organischer Substanz, sauer, hohe Lagerungsdichte, sandig toniger Lehm, mittlere Durchwurzelbarkeit, trocken, erosive Aktivitäten, Kohle, Termiten.

Do/pine: Acrisol, fast kein Oberboden, sehr niedriger Gehalt an organischer Substanz, sauer, auffallend hohe Lagerungsdichte, sandiger Lehm – sandig toniger Lehm, mittlere Durchwurzelbarkeit, sehr trocken, hohe Erosion, Kohle.

Bb/df: Alisol, guter Oberboden, hoher Gehalt an organischer Substanz, sauer, niedrige Lagerungsdichte, sandig toniger Lehm – sandiger Ton, sehr gute Durchwurzelbarkeit, gute Wasserhaltekapazität, jede Menge Kohle.

Fallow: Alisol, guter Oberboden, hoher Gehalt an organischer Substanz, sauer, sehr niedrige Lagerungsdichte, Ton, mittlere Durchwurzelbarkeit, gute Wasserhaltekapazität, jede Menge Kohle.

Forschung in Bezug auf die Wachstumsbedingungen von Pflanzen und Bodeneigenschaften ergaben, dass die Mehrheit der Heilpflanzen tolerant auf sauren Boden reagieren. Weiterhin, besonders Pflanzen, welche im dof und do/pine gewachsen sind, wiesen eine Trockenheitstoleranz auf. An den meisten Standorten zeigten die Pflanzen starke Adaption an die vorherrschenden Bedingungen. Ein Beispiel ist *Crucuma zedoaria* (Christm.) Rosc., die laut Dhusentis Interviews zur Behandlung von Blähungen verwendet wird und laut Manuels Untersuchungen nur im do/ pine wuchs. *Crucuma zedoaria* (Christm.) Rosc. braucht Lichteinfall aber auch sauren, trockenen und sandigen Boden. Sie hat eine Knolle, in der sie Wasser und Nährstoffe speichern kann und sie ist in der Lage längere Trockenzeiten und Feuer im Boden zu überstehen. Diese Eigenschaften passen zu den Besonderheiten des Bodens im do/pine.

All diese Ergebnisse zeigen, dass die Böden im Waldgebiet von Huai Hia ein Potenzial zur Erhaltung von natürlichen Lebensräumen aufweisen anstatt dass man sie für die Produktion von Lebensmitteln agrarisch nutzt. Eine Ausnahme ist der Alisol unter der Brache, der nach einer Kalkung nachhaltig bewirtschaftet werden kann solange man angepasste Brache Perioden einhält (etwa 7 Jahre).