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Agrobiodiversity and its use in Naban River Watershed National Nature Reserve: implications for bio-cultural diversity conservation

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Overview of Publications

This thesis is compiled based on the regulations of cumulative PhD thesis of the Faculty of Agricultural Sciences. Several publications resulting from PhD research project have been included in this thesis. As these publications have been edited based on the requirements of different publishers, the layout and quoting style of references may vary between chapters.

Chapter 1:

General introduction of the topic and research objectives.

Chapter 2:

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Chapter 6:

Solveig F. Bucher, Abdolbaset Ghorbani, Gerhard Langenberger, Manfred Küppers and Joachim Sauerborn (2011). *Asparagus* spp. in Traditional Chinese Medicine - wild collection and its sustainability. TRAFFIC Bulletin, 23 (2): 61-63. Own contribution approximately 40% including building the concept, field work establishment, supervision of the research work, co-authorship and proof-reading of the manuscript.

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1 General introduction

1.1 Statement of the problem: Biodiversity, agrobiodiversity and indigenous knowledge loss in tropical regions

Tropical forests host at least two-third of the terrestrial ecosystem's biodiversity and from local to global level, provide significant benefits to humans through the provision of economic goods and ecosystem services (Gardner et al., 2009). Yet tropical forests are worldwide subject to high rates of deforestation and degradation with an estimate of 17 million ha or 1% of total forest area per year (Byron & Arnold, 1999). The main causes of tropical forest biodiversity loss are human interventions including land use changes, deforestation and fragmentation, agricultural activities, over-exploitation of resources, invasive species and climate change (Morris, 2010). Agricultural expansion itself has cleared 27% of the tropical forest biomes already (Foley et al., 2011). Southeast Asia is experiencing the highest relative rates of deforestation and forest degradation in the humid tropics, with 1.5 million ha of forest removed every year from four main islands of Indonesia alone, due to agricultural expansion, logging, habitat fragmentation and urbanization (De Fries et al., 2002). Even protected forests in SE Asia are not safe from deforestation and they are shrinking and fragmenting (Curran et al., 2004). These deforestations cause losses in species due to habitat destruction. Different factors driving deforestation in SE Asia, in particular growing global demands for food, biofuel and other commodities are driving the rapid expansion of large monocultures of oil palm (*Elais guineensis*) and rubber (*Hevea brasiliensis*) plantations at the expense of lowland dipterocarp forests. Given the rate of destruction and the high concentration of endemic species in the region, Southeast Asia could lose 13-42% of local species populations by the turn of the next century, at least 50% of which could represent global species extinction (Koh & Sodhi, 2010). Loss of tropical forests not only harms biodiversity but also human well beings through the damage to ecosystem services (Balmford et al., 2002). They are the main source of livelihoods for many local communities, providing them food, medicine and other non-timber forest products. Many of these produces are collected from degraded, fragmented and secondary forests and habitats. But with the growth of population and increase of demand for these products, much pressure is put on the fragmented and secondary as well as primary forests. To estimate the consequence of these pressures on the resources and also to make conservation and management plans we need to identify these products, understand their ecology, local economic and cultural importance and harvesting pressures.

Agrobiodiversity as defined by the Convention on Biological Diversity (CBD), includes all the components of biological diversity relevant to the food and agricultural production, including agricultural ecosystems (CBD, 2000). It is divided into planned and unplanned agrobiodiversity. Planned agrobiodiversity is the biodiversity of the crops and livestock chosen by the farmer whereas unplanned agrobiodiversity refers to the diversity of organisms other than planted crops or managed livestock by humans in an agroecosystem (Jackson et al., 2007). Tropical agroecosystems are among the most biologically diverse agricultural systems in both food and non-food plants. Many of these non-food species have current or potential uses as home medicines, construction materials, cultural or religious applications or ornamentals. Tropical homegardens for example, are regarded as an ideal production system for *in situ* conservation of crop genetic resources because of high plant diversity and local variety existence in these systems (Kehlenbeck & Maass, 2006). Crop improvement programs benefit from these local varieties, diverse land races and crop wild relatives using their genetic pools to develop greater quality, higher yielding, pest and disease resistant and stress tolerant varieties. However with the introduction of intensified agriculture to the topical areas; traditional crops, proto-domesticates and crop wild relatives are vanishing. With the introduction of new cash crops such as rubber trees, oil palms, high yielding rice varieties, small and more diverse farms are converted into monocultures, eliminating traditional crops and varieties, thus declining agrobiodiversity. But on the other hand these new cash crops generate more opportunities to local people. With improving cash income they provide better living conditions, better educational possibilities and help for the economic development of the area. In general such crops contribute to poverty alleviation and food security, to some extent, by providing more income to the farmers. Higher income from new cash crops enable villagers to afford better housing, medical and health care, education for younger generation and in general better quality of life.

People living in an area normally accumulate and built a body of knowledge about their local environment and ecology, plants and animals and their uses, their culture and traditions. This indigenous or local knowledge which is based on traditional experiences and innovations and approved through trial and error process is an integrated system of knowledge, practices and beliefs which has holistic and generalist views and integrates cultural and religious beliefs. In fact, indigenous knowledge is an accumulation of formal and informal experiences and intimate understanding of the environment in a given cultural context. However globalization, biodiversity loss, deforestation and environmental degradation cause the disappearance of traditional

knowledge, ethnobotanical knowledge and traditional agricultural knowledge (Steinberg, 1998). This knowledge acquired through trial and error experimentation is as important as genetic diversity for the development of sustainable agroecosystems, successful biodiversity conservation and even new drug discovery (Altieri, 1995). Loss of agrobiodiversity and the traditional knowledge associated with it, has negative implications for food security and biodiversity conservation. In a world facing rapid human population growth, climate change and food security concerns, traditional knowledge and biodiversity and as its components agrobiodiversity could play an important role in the resilience of humans to the effects of climate change and food security as well as health security issues.

1.2 Biodiversity use, ethnobotany and ethnomedicine

Many rural people all over the world are dependent on their surrounding biodiversity for their subsistence as such for food, medicine, fuel, shelter, tools, etc. Knowledge on the use and management of this biodiversity is accumulated and transmitted through generations. With the degradation of habitats and local ecosystems and as a consequence local cultures, much of this knowledge is being lost (Pei, 2003). Ethnobotany is the study of this knowledge, specifically, the relationship between people and their surrounding plant world (Berlin, 1992). Over the past twenty years, with recognition of its role in traditional knowledge, biodiversity conservation, natural resource management and rural development, ethnobotany has gained a significant attention and experienced a period of growth (Alexiades, 2003). Scholars in ethnobotany and related fields have played a key role in validating indigenous knowledge by suggesting its potential for biodiversity conservation as well as economic and social development (Alexiades, 2003). Ethnobotanical research by understanding the ways in which people perceive, classify, manage, manipulate and use plant species and communities, can help planners, government authorities, conservation organizations, development agencies and communities to device and implement more sound conservation and development practices (Alexiades, 2003; Pei, 2003; Hamilton, 2002; Cunningham, 2001).

One of the most popular aspects of plant use research among ethnobotanists is the study of medicinal uses or ethnomedicine (also called medical ethnobotany). It focuses on the understanding, documenting and analyzing medicinal uses of plants by a group of people in a certain cultural context. Since medicinal plants have played and still play an important role in healthcare systems all over the world, especially in developing countries, research on these plants in the cultural context and as part of the folk and traditional medicine has gained much

attention. Traditional medicine refers to the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness (WHO, 2008). Folk medicine, indigenous medicine or ethnic medicines are terms which are often used interchangeably with traditional medicine. However folk medicine could be defined as the use of home remedies and procedures as handed down by tradition, normally informally by knowledgeable members of the community and unlike traditional medicine there is no integration into national health care systems (Kayne, 2010).

Although uses of many plant species in different parts of the world is not recorded, still medicinal uses of plants represents the biggest use of biodiversity in terms of species number (Schippmann et al., 2006). Economic value of trade of medicinal plants is also significant. Global average annual trade of medicinal plants for a period of 1991-2003 amounted 467,000 tonnes with a value of US$ 1-2 billion (Lange, 2006). However about 80% of this trade is dominated by only 12 countries (Table1). Major markets for traded medicinal plants are generally in the developed countries while developing countries are the main exporters of bulk raw plant materials, mainly unprocessed or little processed and often collected from wild resources (Lange, 2006). This means that medicinal plant source countries and communities benefit less from this trade than consumer countries due to the added value of product processing. So, with increasing demand on medicinal plants in developed countries and more benefit request in source countries, more pressure will be on the resources of medicinal plants which may lead to overexploitation of these resources.

Table 1- The 12 leading importer and exporter countries of Medicinal and Aromatic Plants for a period of 1991-2003 (Longe, 2006)

Country of import	**Quantity [tonnes]**	**Value [US$]**	**Country of export**	**Quantity [tonnes]**	**Value [US$]**
Hong Kong	59,950	263,484,200	China	150,600	266,038,500
USA	51,200	139,379,500	Hong Kong	55,000	201,021,200
Japan	46,450	131,031,500	India	40,400	61,665,500
Germany	44,750	104,457,200	Mexico	37,600	14,257,500
Rep. Korea	33,500	49,889,200	Germany	15,100	68,243,200
France	21,800	51,975,000	USA	13,050	104,572,000
China	15,550	41,602,800	Egypt	11,800	13,476,000

Italy	11,950	43,006,600	Bulgaria	10,300	14,355,500
Pakistan	10,650	9,813,800	Chile	9,850	26,352,000
Spain	9,850	27,648,300	Moroco	8,500	13,685,400
UK	7,950	29,551,000	Albania	8,050	11,693,300
Malaysia	7,050	38,685,400	Singapore	7,950	52,620,700
Total	320,550	930,524,400	Total	368,100	847,980,800

The reciprocal relationship between biodiversity and indigenous medicine could be seen in medicinal plants. Biodiversity loss diminishes the supply of medicinal plants, most of them collected from wild, for traditional health care systems. In return, indigenous medicine is also disappearing under the impacts of urbanization, cultural changes and declining access to medicinal plant resources. Ethnobotany and more specifically medical ethnobotany play an important role in proper documenting indigenous medicine as well as pointing the most important and potent plants for drug discovery programs and also vulnerable medicinal species for conservation programs.

1.3 Non-timber forest products and sustainability

As defined by FAO, non-timber forest products (NTFPs) are products of biological origin other than wood, derived from forests or woodlands (FAO, 1999). For many people living in and around forests, NTFPs are important components of livelihoods. As an example, direct and indirect contribution of NTFPs to household livelihoods in Laos can reach up to 39% of the household income (Foopes & Ketphanh, 2004). In other places this percentage even reaches up to 60% (Rodriguez et al., 2006). Due to these facts, NTFPs have gained much global attention as potential means of rural livelihood improvement while contributing to biodiversity conservation through conservation of forests. However, commercialization of NTFPs and their sustainability of supply and resources have been challenges to NTFP based conservation programs. In fact little empirical evidence exists on the long term effects of NTFPs harvest and their market value chain for many species and also little is known about the biology, ecology and responses of wild populations of plants to commercial harvest (Belcher & Schenkenberg, 2007; Larsen & Olsen, 2007; Huber et al. 2010). Medicinal, aromatic and food plants are important NTFPs in many countries. Also the market for medicinal and aromatic plants is increasing not only in developing countries but also in developed countries. China is the world's largest exporter and also consumer of medicinal plants (Cunningham et al., 2008). Based on a report by Hong Kong Trade Development Center, since 1994 the global trade of Traditional

Chinese Medicine (TCM) has grown by 8% a year. In 2002, the total global trade of TCM was worth US $ 23,2 billion. (Phillip Security Research, 2003). Most of these plants applied in TCM are collected from wild resources. There are different estimates on the total number of seed plants in the world including 249.500 (Mabberley, 1997), 270.000 (Hammond,1992; May 1992; Groombridge & Jenkins, 2000), 320.000 (Prance & Beentje, 2000) and 422.127 species (Govaerts, 2001). From the largest estimated number of seed plant growing on the earth (422.000) 12.5% are used medicinaly from which 8% is already threatened to extinction (Schippmann et al., 2003; Govaerts, 2001). In China more than 11.146 plant species are used in TCM and ethnic medicines, approximately 41% of the total flora of China (Hamilton et al., 2003; Hamilton, 2004), but only 492 species are under cultivation and the rest which include 96% of plant species used in China are collected from wild resources (Hamilton, 2004). As the wild populations of medicinal plants remain the major sources of supply, concerns about sustainability of commercial harvests become more and more prominent.

1.4 Study area

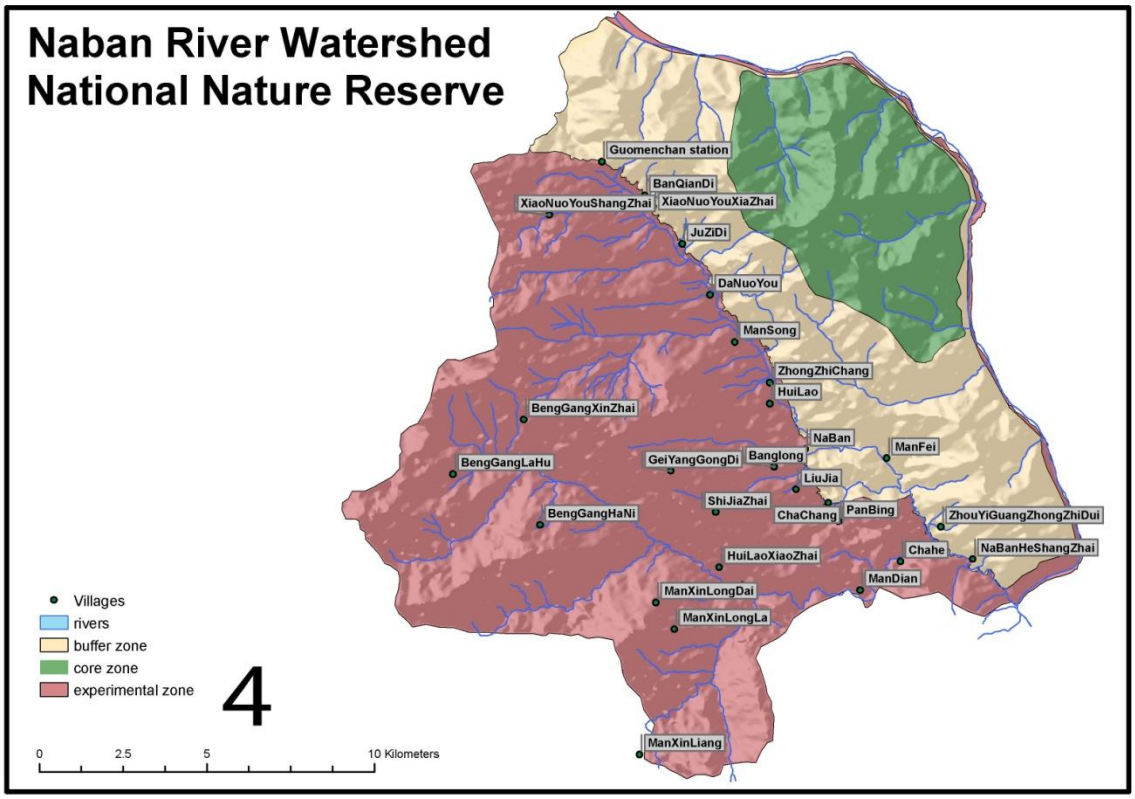
1.4.1 Geography and climate

Xishuangbanna Dai Autonomous Prefecture is located in the southernmost part of the Yunnan Province, bordering Laos and Myanmar. The territory covers an area of 19,125 km2 and ranges from 470 m to 2470 m asl. The Prefecture has a hilly and mountainous topography (94% of cover) with north-south running ridges and is intersected with the Lancang (upper Mekong) river (Xu et al., 2004) (Figure 1). The climate is tropical /subtropical with a rainy season between May and October and a dry season lasting from November to April. Annual precipitation varies from 1200 to 1900 mm in valleys and uplands from which 87% occurs in the rainy season and 13% in the dry season (Liu et al., 2004). The undulating topography produces dense radiation fog with an average of six hours per day occurring 130 days during the dry season, which can supplement the reduction in precipitation (Li, 2001; Hua, 2008; Hua et al., 2006). The mean annual temperature is around 22-23° C and is highest in May/June and lowest in December/January (Cao et al., 2006).

Naban River Watershed National Nature Reserve (NRWNNR), with a total area of 266.6 km^2, is located in the central-north of Xishuangbanna (22° 04´- 22° 17´N & 100° 32´- 100° 44´E) and lies on the west bank of Lancang river approximately 25 km from Jinghong township (Figure 1). Topographically, the western part of NRWNNR is mountainous; the mid part is the Naban River

valley, drained by Naban River, one of the tributaries of Lancang River. The eastern part is formed by the Anmashang Mountain which slopes into Lancang river valley. Most parts of NRWNNR (55%) are above 1000 m altitude with Luhuma peak reaching 2304 m asl. (Yunnan Environmental Protection Bureau, 2006).

Figure 1. Map of the study area, its zonations and villages.



1.4.2 Vegetation and Flora

The area is located amid a transition zone with tropical SE Asia to the south, Subtropical East Asia to the north, and the Sino-Japanese floristic region to the east and the Sino-Himalayan floristic region to the west (Hua, 2008). Because of this position a great diversity of vegetation types including tropical rainforest, seasonal rainforest, montane rainforest and evergreen broadleaf forest occurs in the area (Cao et al., 2006; Zou, 1988). The tropical rainforest in Xishuangbanna is at the northern limit of the tropical rainforests with high diversity of flora and fauna. Flora diversity includes 3340 vascular plant species, belonging to 1176 genera and 182

families, which are the highest species richness in Yunnan (Li et al., 1996; Hua, 2008; Hua et al., 2006; Martin & Hu, 2003). The floristic similarities between the flora of southern Yunnan and those of tropical Asia are more than 80% at the family level and more than 64% at the generic level. This suggests that the tropical flora of southern Yunnan has a close affinity with tropical Asian flora and supports the idea that the flora of southern Yunnan, together with mainland Southeast Asian flora, belongs to the Indo-Malaysian floristic subkingdom of the Paleotropical kingdom (Hua, 2008).

NRWNNR is also rich in vegetation types and plant species diversity. Eight different vegetation types have been recognized in NRWNNR including tropical rainforest, monsoon tropical rainforest, evergreen broadleaf forest, deciduous broadleaf forest, warm coniferous forest, bamboo forest, grasslands and woodlands. More than 1953 species and subspecies and 896 genera of vascular plants from which 50 species are national protected species in China are reported in NRWNNR (Yunnan Environmental Protection Bureau, 2006).

1.4.3 Cultural diversity and land use

Xishuangbanna is known for its cultural diversity, represented by 13 ethnic groups with different traditions. In NRWNNR only, 6 ethnic groups including Dai, Hani, Lahu, Bulang Yi and mountain Han are living there (Figure 2). These ethnic groups mainly live in villages stratified based on altitude. The Dai are living in lowland areas in river basins, with rice (*Oryza sativa*) and rubber cultivation as their major agricultural activity. In NRWNNR the Dai are living in three villages (Mandian, Naban and Manlei) and their agricultural activities include rice cultivation, rubber plantations and small vegetable gardens. The Hani live on the hills and mountainous areas and traditionally were swidden agriculturalist. They live in 6 villages in NRWNNR, consisting 23.5% of the nature reserve total population (Yunnan Environmental Protection Bureau, 2006). The Lahu live in high mountains and in NRWNNR they are living in 15 villages, comprising 49.9 % of the total population in the reserve. The Lahu of Yunnan Province began changing from hunter-gatherer lifestyle to settled village life in 1957 (Huai & Pei, 2004). Lahu and Hani minorities are called hill tribes as their villages are normally located on higher altitudes than other minorities living in the same region. Lahu, Hani and Yi languages belong to the Tibeto-Burman language family and both are oral (Mitchell & Yuan, 2004), however recently some efforts have been done to use Latin scripts for Hani language but Lahu language still has no scripts. Dai language belongs to the Tai (Zhuang-Dong) language family. The Dai have retained a very strong sense of ethnic cultural identity and are one of the ethnic groups best known to the Chinese people

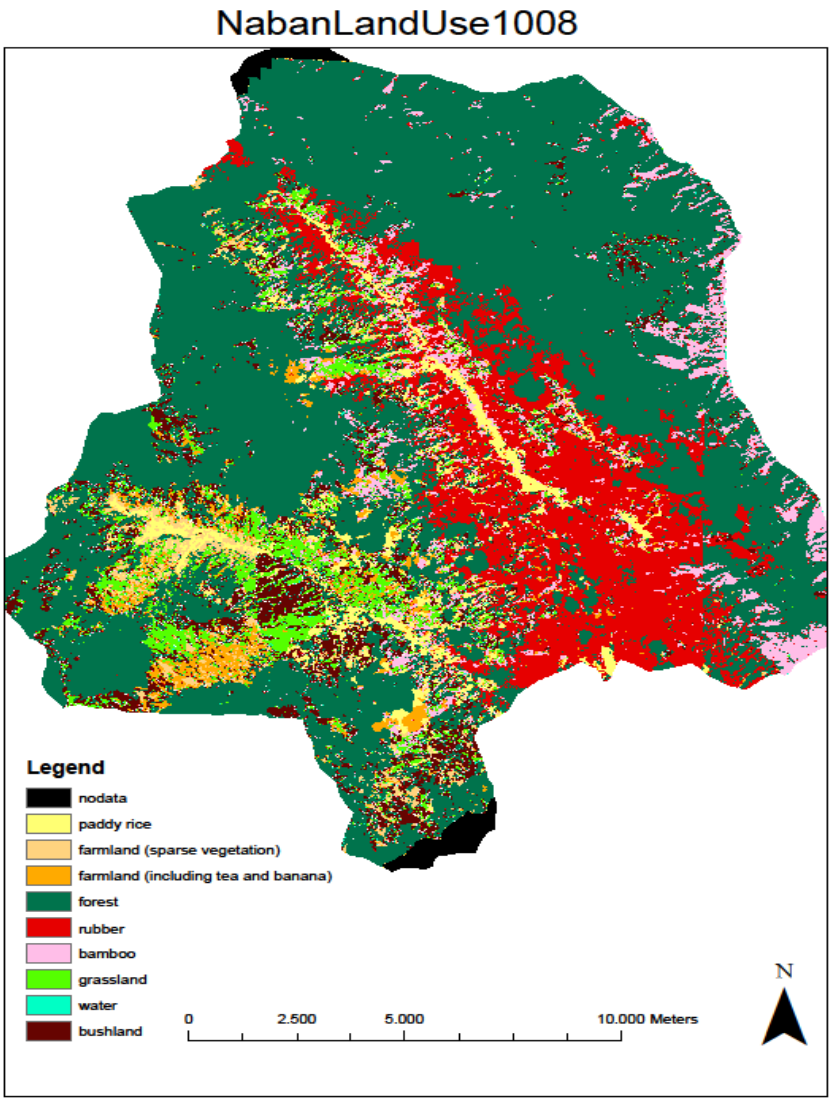
(Mitchell & Yuan, 2004). The Dai in Xishuangbanna have writing scripts that closely resembles the Thai script and they adhere to the Theravada Buddhist tradition.

Figure 2. Ethnic groups and a view of a Dai village in NRWNNR

Before liberation of Xishuangbanna and its integration into China in the 1950s the local economy was depended on traditional agriculture, including rice production in the lowlands and slash-and-burn farming on mountainous slopes (Wehner, 2010). Land use was characterized by interactions of mixed systems, in which forests were maintained by upland communities to supply clean water, timber, and non-timber forest products, as well as hunting and fishing. In the beginnings in the 1950s, local farmers lost their independence and their lands were collectivised and the first plantations of rubber were established. At that time, rubber production was integrated into traditional land use systems and cultivated in mixed-cropping systems, which largely were substituted by monocultures after rubber turned into a high benefit cash crop within the last 20-30 years (Wu et al. 2001).

In the 1980s, when the Household Responsibility System was introduced, rubber was adopted as a cash crop by small-scale farmers. Since then most of the collective forests and fields below 1000 m asl. were converted into rubber plantations. Meanwhile natural forest cover shrank from 60% to 27% by the mid 1990's (Zhang & Cao, 1995). Rubber production accounted for more than 30% of the regional economy in 2007, with an expected long-term increase (Liu et al. 2006).

Figure 3. Land use map of NRWNNR. The map shows clearly the distribution of rubber plantations in central valley. Map provided by K. Berkhoff and S. Herrmann, University of Hannover.



Consequently, land use and vegetation cover of Xishuangbanna changed dramatically within the last decades. From the analysis of satellite images it was found that in 1976, forest cover was approximately 70% of Xishuangbanna, but in 2003 cover was less than 50% (Li et al., 2007). Tropical seasonal rainforest was the forest type most affected by the expansion of rubber plantations, and a total of 139,500 ha were lost. In 1976, forest was the dominant land cover category at all elevations, but by 2003, rubber plantations dominated areas below 800 m, representing the most suitable elevation for rubber cultivation. In total, most of the land below 800-1000 m asl. is already covered by rubber. Furthermore, the number of forest fragments increased from 6,096 to 8,324, and the mean patch size declined from 217 to 115 ha (Li et al., 2007). In addition, an increase in arable land and especially shrublands between 800 and 1300m also reduced forest cover. Because of these threats to tropical forests and their biodiversity nature reserves were established to protect the remaining forests. NRWNNR was established in 1991 based on the UNESCO concept “The Man and the Biosphere” as a Provincial Nature Reserve and approved as National Nature Reserve in 2000. The nature reserve is divided into three functional zones; the core zone which is strictly protected from extractive activities, the buffer zone and the experimental zone which are both used for agricultural activities. However, any land use change in the buffer zone should be permitted by nature reserve management office but this is not the case for the experimental zone.

A typical situation of the present land use of Xishuangbanna at lower elevations is shown from the Naban river valley. The valley (ca. 11,000 ha) is a tributary river of the Mekong and located within the area of the Naban River Watershed National Nature Reserve (NRWNNR) in Xishuangbanna. As shown in Figure 3, most of the valley area is covered by rubber at elevations between 550-1000m. However, rubber plantations do not represent a uniform type of land use, but rather a spatio-temporal dynamic system, ranging from young and open to closed canopy stands of very different ecological conditions and plant species. Stands of different age exist at the same time within a rotation cycle of about 40 years, when the latex production of the trees decreases. Then, the plantations are clear-felled and become substituted by new rubber saplings. The remaining land use types in the valley include secondary and primary forest fragments, grassland and shrubland successions as well as rice fields in the valley bottom along the river. Other field crops are produced around the small villages.

1.5 Objectives

Overall objective of the study was to identify the diversity of medicinal and food plants used by local people living in NRWNNR and documenting their applications. Using ethnobotanical methods this study tend to document details of medicinal uses of plants by ethnic groups and traditional healers as well as their collection practices, preparation methods and habitat preferences. It also intended to understand the role of these plants in local people's livelihood by identifying economically important medicinal and food plants.

1.6 Chapter outline

This dissertation describes the entire process of the research undertaken, from theoretical background to the results obtained and final conclusion. Chapter two gives general results of the ethnobotanical inventory of NTFPs in NRWNNR with focus on medicinal and food plants. It also highlights the role of NTFPs in local people's livelihoods and at the end analysis the vulnerability of some intensively collected NTFPs in the area. Chapter three describes medicinal plants of Hani minority in NRWNNR and introduces the most important medicinal species based on different cultural salience indices. Chapter four explores the medicinal plants of Lahu minority and compares the medicinal plant knowledge of Lahu inhabitants of NRWNNR with Hani people. Chapter five focuses on biodiversity of food plants in the research area and compares food plant use and knowledge of different ethnic minorities in the nature reserve. It also highlights the most important food species for each minority and their sources. Chapter six, as a small case study, discusses the sustainability of *Asparagus* spp. as an important medicinal plant in the area. Chapter seven gives general conclusions. It assesses the general results and gives short recommendations for future research and practices.

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2 Diversity of medicinal and food plants as non-timber forest products in Naban River Watershed National Nature Reserve (China): implications for livelihood improvement and biodiversity conservation

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Outline and overview:

This chapter outlines the state of the art of non-timber forest products in the Naban River Watershed National Nature Reserve with focus on wild food and medicinal plants. It introduces the diversity of NTFPs and analysis their role in local people's livelihoods using bamboo shoots as proxy. It also provides information on the vulnerability status of medicinal and food plants which are collected in the area and marketed.

Diversity of medicinal and food plants as non-timber forest products in Naban River Watershed National Nature Reserve (China): implications for livelihood improvement and biodiversity conservation

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Abstract in Chinese

中国纳板河流域国家级自然保护区内的药用和食用非木材林产品：**生**计改善及生物多样性保护方面的意义

摘要:

非木材林产品在农村生活中发挥着重要作用。**生活在森林之中和周**围的人们的生活和收入有赖于多样的非木材林产**品。本文介**绍了纳板河流域国家级自然保护区非木材林产品中药用和食**用植物的多**样性概况。非木材林产品数据的收集采用了半结构访谈，**自由列表和家庭社会**经济访谈等民族植物学调查方法。**采**访后还采集了植物标本进行鉴定。**以竹笋作**为非木材林产品的代表进行了进一步的分析。**我**们假设竹笋的采集量及其对家庭收入的贡献在所研究的村寨之间**无**显著差异。采用单因素方差分析分析对零假设进行了检验。**采用快速脆弱性分析方法**筛选出了易危和濒危种类。**共**调查到当地居民利用的非木材林产品植物有**117科**，334**属**，480种（占当地记录植物种类的25%）。结果显示不同村寨之间竹笋的采集量及其对家庭收入的贡献有显著**差异。但是**，**竹笋**对人均收入的贡献很小因为采集的竹笋主要用于家庭日常生活。**脆弱性分析**发现大多数药用植物种类处于中等脆弱水平，**大部分食用植物**较低的脆弱水平。此外，结果显示有些药用植物如滇重楼已经被过度采集并且变得稀少。**因此**为了防止对这些种类的过度采集应该实施可**持**续采集及管理策**略**。

关键词：自然资源利用，非木材林产品，快速脆弱性分析，可持续采集

Abstract

Non-timber forest products (NTFPs) have important role in rural livelihoods. People living in and around forests are dependent on a variety of NTFPs for their subsistence and income generation. This paper gives a general overview on the diversity of NTFPs in Naban River Watershed National Nature Reserve with focus on medicinal and food plants. Data on NTFPs use was gathered through ethnobotanical inventory with semi-structured, freelisting and household socio-economic interviews. Interviews were supplemented with plant samples collection for botanical identification. Bamboo shoots were analyzed further as proxy NTPF. It is hypothesized that there is no significant difference between collection amounts of bamboo shoots and their contribution to the household income among studied villages. A one-way ANOVA and a Tukey Post Hoc test were used to test the null hypothesis. A rapid vulnerability assessment (RVA) was conducted to find out vulnerable and threatened species. A total of 480 plant species (25% of recorded flora) from 117 families and 334 genera are used as NTFPs by the local people. Results revealed that there is a significant difference on the collection and contribution of bamboo shoots in household income among the villages. However their contribution to per capita income is very low and they are mainly used in households. Vulnerability assessment shows that most of the medicinal species have the moderate vulnerable status and most of the food species have less vulnerable status. Furthermore, findings show that some medicinal plants such as *Paris polyphylla* var. *yunnanensis* (Franch.) Hand.–Mazz. are overexploited and getting scarce. Sustainable harvest and management strategies should be implemented to prevent overexploitation of these species.

Keywords: Natural resource use, NTFPs, Rapid vulnerability assessment, Sustainable harvest

2.1 Introduction

Non-timber forest products (NTFPs) are increasingly becoming a major subject of international concern and attention as means of poverty alleviation, development, participatory conservation, and food security (Ros-Tonen, 2000). It is argued that NTFPs contribution to local people's livelihoods and their exploitation is ecologically less destructive than timber harvest or other land use changes for agricultural production. Hence, NTFPs can add to the value of forests, increasing the incentives to retain the forest (Arnold & Perez, 2001; Hall & Bawa, 1993).

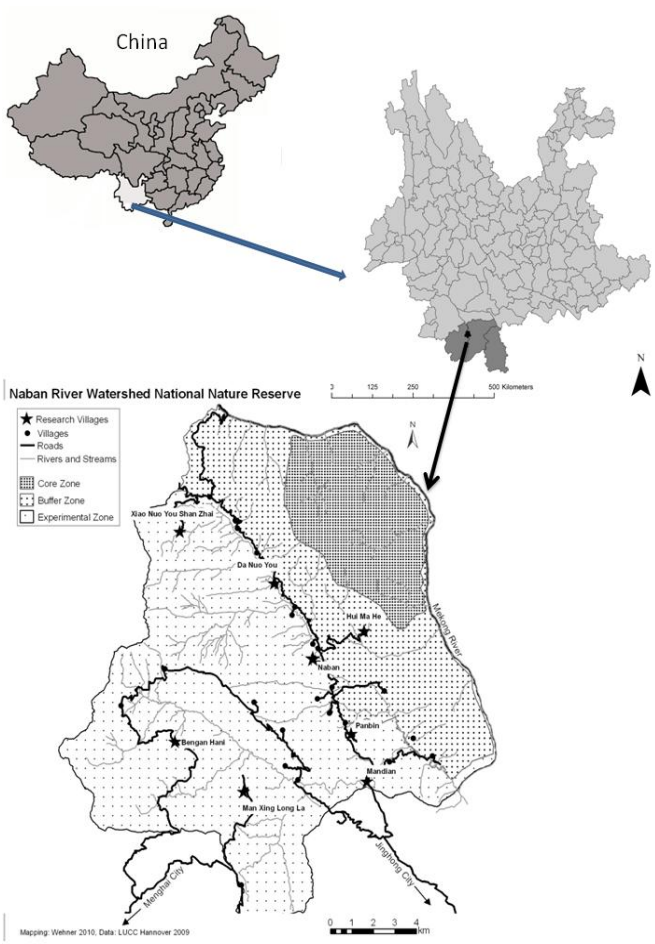
Local people do not value all locally used plant species equally and some species groups, genera and families are more important than others (Bennett & Husbay, 2008). Identifying these groups of plants and reasons for their utilization may help in defining and implementing priorities for conservation and sustainable management strategies (Vodouhe et al., 2009). Local people living in Naban River Watershed National Nature Reserve (NRWNNR) use large number of forest products in their daily life. These products could be categorized as medicinal, food, firewood and construction materials. Edible NTFPs could be divided into vegetables, mushrooms and bamboo shoots. Zhang et al. (2004) reported 182 species of food plants in NRWNNR. They recognized bamboo shoots and mushrooms as main NTFPs for income generation; however vegetables were collected mainly for self-consumption. Since early 2000, a market for dried bamboo shoots has also developed which resulted in high exploitation of natural resources. Therefore, nature reserve administration office set regulations on the access to the resources based on village boundaries and also proposed biannual collection scheme (Zhang et al. 2004). Mushrooms are also harvested at commercial level. However, there is no comprehensive record on NTFPs in the nature reserve and their harvest and trade is not fully understood.

Within the framework of a Sino-German cooperation project on rural development through land use diversification (Langenberger et al. 2009), this work aims to introduce NTFPs harvested in NRWNNR with focus on medicinal and food plants and highlights their role in the livelihood of

local people. It is hypothesized that collection amount and contribution of bamboo shoots as a proxy for commercially collected NTFP species, does not differ significantly between villages. Bamboo shoots are chosen as a proxy NTFP since it was possible to collect reliable data on harvest amount and trade. Since there was no assessment on the sustainable harvest practices of NTFPs in the area, additionally we identified the most vulnerable NTFPs based on rapid vulnerability assessment (RVA) analysis to make suggestions for sustainable harvest and conservation of these species.

2.1.1 Study area

Naban River Watershed National Nature Reserve is located in Xishuangbanna Dai Autonomous Prefecture in the southernmost part of Yunnan province. Xishuangbanna is part of the Indo-Burma biodiversity hotspot, hosting 16% of China's higher plant species, despite covering only 0.2% of the country's land area (Zhang & Cao, 1995; Hua et al., 2006). Xishuangbanna is one of the few areas in China suitable for rubber (*Hevea brasiliensis* Müll. Arg.) cultivation. Rubber was introduced on large State Farms in the 1950s. In the 1980s, when the Household Responsibility System was introduced, rubber was adopted as a cash crop by small-scale farmers. Since then most of the collective forests and fields below 1000 m asl. were converted into rubber plantations. Meanwhile natural forest cover shrank from 60% to 27% by the mid 1990's (Zhang & Cao, 1995). To conserve the remaining forests and biological diversity, nature reserves like Xishuangbanna National Nature Reserve (XNNR) and Naban River Watershed National Nature Reserve (NRWNNR) were established. With a total area of 266.6 km^2, NRWNNR is located in the central- north Xishuangbanna and lies on the west bank of Lancang (Mekong) river, approximately 25 km from Jinghong Township (Map 1).



It was established in 1991 based on the UNESCO's "Man and Biosphere" concept. The nature reserve is divided into three functional zones; the core zone which is strictly protected from extractive activities, the buffer zone and the experimental zone which are both used for agricultural activities. However, any land use change in buffer zone should be permitted by Nature reserve management office but this is not case for experimental zone. NRWNNR harbors a plethora of non-timber forest products due to its biological as well as cultural diversity. Five different ethnic groups including the Dai, Hani, Lahu, Yi, Bulang, and Han with a total population of 5538 people are living in 30 villages throughout the area (Yunnan Environmental Protection Bureau, 2006). These ethnic minorities mainly live in villages stratified based on altitude. The Dai live in low elevations; Hani and Yi reside at middle elevations and Lahu and Bulang at higher elevations. Traditional lifestyle is still common in the area and people get many benefits from forest products.

2.2 Material and Methods

2.2.1 Data collection

Data on NTFPs was collected through an ethnobotanical inventory. Ethnobotanical inventories give a broad overview and information about NTFP resources used by local population (Wong, 2000). Semi-structured, freelisting, and household interviews were conducted from January 2008 to January 2010. Informants were selected randomly for freelisting and semi-structured

interviews and key informants by the snowball method (Stepp, 2005; Berlin & Berlin, 2005; Quinlan, 2005). Same questions were asked from all interviewees. Household interviews were conducted in 6 villages (Table 1). Na Ban, Pan Bing, and Da Nuo You are surrounded by rubber plantations as main cash crop and household incomes are relatively high. In Xiao Nuo You Shang Zhai and Ben Gang Hani, tea (*Camellia sinensis* (L.) Kuntze), hemp (*Cannabis sativa* L.) and corn (*Zea mays* L.) are grown as main crops and in MangXin Long La tea and corn are main cash crops (Wehner, 2007, 2010). The income and living standard in these three villages is lower compared with the rubber-growing villages. However the degree of subsistence economy is higher and the sources of income are more diverse (Wehner, 2010).

Interviews were also conducted with NTFP traders. All interviews were supplemented with field and forest walks and collection of plant samples for botanical identification. Plant specimens were prepared, dried, and identified with the help of experts from Xishuangbanna Tropical Botanical Garden (XTBG). One set of voucher samples was stored at the Herbarium of NRWNNR and one set was deposited at the Herbarium of XTBG (HITBC). Nomenclature follows Flora of China, Checklist of Flora of China, TROPICOS database of the Missouri Botanical Garden, and local checklists (Flora of China, 1994 to present; Li et al., 1996).

Table 1. Details of villages chosen for NTFP collection interviews.

Village	Ethnicity	Altitude (asl.)	No. of households	No. of NTFP collection interviews
Na Ban	Dai	690 m	42	10
Pan Bing	Hani/Akha	770	38	21
Da Nuo You	Lahu	800	90	24
Xiao Nuo You Shang Zhai	Lahu/Han	1630	33	13
Ben Gan Hani	Hani/Akha	1870	172	14
Mang Xin Long La	Lahu	1860	39	20

2.2.2 Data analysis

Information on NTFP collection and use was stored in an Access databank (MS Office 2007). A one-way ANOVA and a Tukey Post Hoc test were used to test whether there is a difference between villages regarding the collection of bamboo shoots and their contribution to household income. An Arcsinh transformation was used on collection amounts of bamboo shoots to get a normalised distribution. A test of normality (Kolmogorov-Smirnow and Shapiro-wilk) was conducted for all data. The monetary value of NTFPs was calculated based on fresh and dry weight prices at the village gate. Use frequency of plant species was calculated based on the proportion of each plant citation in the free lists to the total number of informants and varies between 0 with no use and 1 with high use frequency.

To address the vulnerable and threatened NTFPs, a rapid vulnerability assessment (RVA) was conducted. RVA is used in the case of ecological data and time limitations to determine if the use of a species is sustainable by integrating indigenous knowledge, published literature, and field observations (Wild & Mutebi, 1996; Aryal & Pelz, 2008; Wong et al., 2001). The assessment of the potential sustainability can be used as a basis for selecting species for further assessment work. Marketed NTFP species were scored based on ecological, socio-economic, and management criteria. These eighteen criteria and their explanation are given in table 1. For each criterion, two levels of vulnerability were assigned (high vulnerability= 1, low vulnerability= 2). All species in the list were scored for each criterion and scores are summed. Species with scores 18 and less are highly vulnerable; with scores between 19 to 27 moderately vulnerable and with scores 28 to 36 are less vulnerable. Highly and moderately vulnerable species have less potential for harvest and may need detailed studies to sustain the harvest and to ensure ecological sustainability.

Table 2- Rapid vulnerability assessment criteria checklist (adapted from Aryal & Pelz, 2008; Messerschmidt et al, 2001; Wong, 2000).

Criteria	Vulnerability level	
	Low vulnerability = 2	High vulnerability = 1
Ecology	High abundance	Low abundance
	Fast growth	Slow growth
	Fast reproduction	Slow reproduction
	Sexual & vegetative reproduction	Sexual reproduction only
	Habitat non-specificity	Habitat specificity
	High distribution range	Low distribution range
	Response to harvesting: fast re-growth, recovery	Response to harvesting: slow re-growth, recovery
Life form	Herb, grass	Tree, shrub and epiphyte
Part used	Leaf, flower, bark, stem, fruit	Root, rhizome & bulb
Harvesting methods & management	Particular size/age classes selected for harvesting	Particular size/age classes not selected for harvesting
	Seasonal harvesting	No time restriction
	Traditional conservation practices	No traditional conservation practices
	Domesticated animal-human-collector etc. pressure on habitat- No	Domesticated animal-human-collector etc pressure on habitat- Yes
Economy	Subsistence use / less commercialization	Collection mainly for sale
	Demand (quantity harvested + frequency of harvest) low	Demand (quantity harvested + frequency of harvest) high
	Substitute species- Yes	Substitute species- No
	Access to resources not easy	Access to resources easy
	Law enforcement capacity- Yes	Law enforcement capacity- No

2.3 Results and discussion

2.3.1 Non-timber forest products in the NRWNNR

Based on our ethnobotanical inventory in NRWNNR a total of 480 plant species (25% of recorded flora) from 117 families and 334 genera are used by the local population. From these, 378 species (19%) belonging to 102 families and 277 genera are used as medicine and 161 species (8%) representing 68 families and 116 genera are used as food plants (Figure 1). These food plants included wild vegetables, fruits, tubers, shoots, and spices which are used raw or processed. Medicinal species included 11% that are endemic to China, 14% are common weeds or exotic species and the rest are common species occurring in the area. For food species, 14% are endemic, 14% are common weeds and exotics, and 72% are common to the area. In both cases, local people are utilizing a higher number of local floras than exotic plant species. Most common growth forms for medicinal plants are herbs (50%), shrubs (23%), trees (13%), lianas (5%), vines (5%), epiphytes (3%) and clump (1%). Also with food plants, herbs (37%) are the most common growth forms followed by trees (28%) and shrubs (17%), lianas (9%), clump (6%) and vines (3%). Commonly collected and applied plant parts for medicinal purposes are subterranean parts (33%), leaves (31%), stems (14%), aerial parts (i.e. all aboveground parts used together without separation) (10%), while the rest include fruits, bark, seeds and flowers. Among the food plants, leaves (29%) are the most common used part followed by fruits (28%), subterranean parts (14%), stems (13%) and aerial parts (5%). The widespread use of subterranean parts for medicinal species implies that the collection of these plant parts is fatal for the individual plant and in long term may affect the whole population. Although weeds and exotic species include a small percentage of utilized species, some of them are used in high frequencies (sometimes daily) by villagers and make a high contribution to their diet.

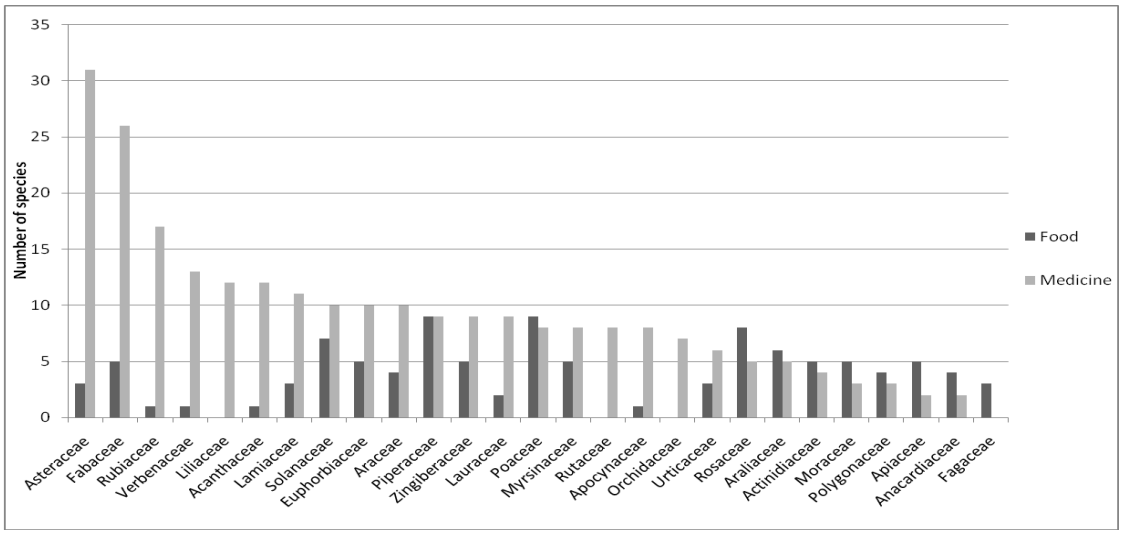


Figure 1- Families representing a high number of medicinal and food plants in NRWNNR.

2.3.2 Non-timber forest products and local people's livelihood

Most of the households are involved in some NTFP collection activities to a certain extend. NTFPs collected for cash generation could be grouped into bamboo shoots, mushrooms, and medicinal plants. In higher elevations or economically poorer villages, the medical health system is based more on traditional medicine and medicinal plants.

Wild food plants, including wild vegetables, fruits, bamboo shoots and mushrooms are harvested for self-consumption. However mushrooms and bamboo shoots are also sold in the market mainly to the Jinghong town. Species such as *Diplazium esculentum* (Retz.) Sw. (use frequency 0.7), Musa accuminata Colla (0.7), *Houttuynia cordata* Thunb. (0.49), *Ficus auriculata* Lour. (0.41), *Oenanthe javanica* (Blume) DC. (0.45), *Solanum americanum* Miller (0.41), *Piper longum* L. (0.4), *Elatostema acuminatum* (Pair.) Brongn. (0.37), *Elsholtzia kachinensis* Parin (0.34) and *Bauhinia variegata* L. (0.31) are the most frequently used food plants in the area. Some economically important wild food plants are listed in table 3.

Bamboos are multi-use plants also collected for sale in some villages. Estimation of the mean value of income from bamboo shoot collection per household and per capita with confidence

interval of 95% and its percentage of total per capita income of six different villages are given in table 4. Figures shown in this table do not include the amount of bamboo shoots consumed in the household. The highest mean value of bamboo shoot harvest was recorded in village Ben Gang Hani followed by Mang Xing Long La and Xiao Nuo You Shang Zhai. However, the highest contribution of bamboo shoots to per capita income was in Mang Xing Long La followed by Xiao Nuo You Shang Zhai and Ben Gang Hani. All of these villages have easy access to the forest and are located at an elevation of more than 1400 m a.s.l, where rubber can not be planted and villagers' cash income is based on other cash crops instead. The collective forests are under less pressure from land use change and villages have reforested some of their collective land over the last decade. In Pan Bing, Na Ban and Da Nuo You, villagers are more dependent on rubber plantations as main source of cash income resulting in forest loss around the villages. Thus, the collection of NTFPs occurs in the adjacent state forests despite prohibitory regulations. However Ben Gang Hani which had the highest bamboo shoot collection and income from bamboo per household showed lower contribution from bamboo (1.1%) to per capita income because of higher mean family size. Pan Bing had the lowest contribution of bamboo (0.16%) to per capita income because of the family size and highest per capita income mainly from rubber. In general bamboo shoot contribution of total per capita income in all villages is very small and household's income comes mainly from cash crops. However these figures do not include the amount of bamboo consumed in the households and indirect contribution of bamboo shoots and other NTFPs in household income should be considered to make a clear statement on the role of NTFPs in villagers' livelihoods. Also the role of NTFPs as safety nets especially for poor households who do not have enough agricultural land should not be overlooked. Main species for bamboo shoot collection are *Dendrocalamus membranaceus* Munro, *D. brandisii* (Munro) Kurz, *D. hamiltonii* Nees & Arn. ex Munro, *D. semiscandens* J.R. Xue & D.Z. Li, *Gigantochloa nigrociliata* (Buse) Munro, *Pleioblastus amarus* (Keng) Keng. F. and *Indosasa sinica* C. D. Chu & C. S. Chao.

ANOVA tests showed that there was a significant difference among villages in collecting bamboo shoots ($F_{(5,99)}$= 4.57, p = 0.001). Tukey Post Hoc test showed that there was a significant difference among means of bamboo shoot collection between Da Nuo You and Pan Bing (p= 0.014), Da Nuo You and Ben Gang Hani (p= 0.002) and Ben Gang Hani and Na Ban (p= 0.02). Factors affecting these differences might be the conversion of collective forests into rubber plantations, hence reducing access to forest resources. This shows that the relationship between villagers and NTFPs use varies based on availability of forest resources and livelihood sources. As an example, Na Ban village is surrounded by rubber plantations and does not have good access to forest. So, here access to the NTFP resources acts as an important factor affecting collection and use of NTFPs. However in Pan Bing which is close to the state forest, villagers get a large part of their cash income from rubber production and as they get wealthier, they tend to use imported produces from town than using wild collected ones. Fu et al. (2009) also found that size of rubber plantation of the household is an important factor related to the collection of NTFPs in Baka village.

Table 3 also lists the most important medicinal plants traded in NRWNNR with their collection parts and price per unit traded in 2008. Based on the interviews with villagers about plants that they collect for sale, *Dendrobium* spp, *Paris polyphylla* var. *yunnanensis* (Franch.) Hand.-Mazz., *Aristolochia* sp*., Asparagus* spp. and *Stemona tuberosa* Lour. were mentioned among the important exploited medicinal plants. Bucher (2011) found that collection and sale of 4 selected medicinal plants (2 *Asparagus* spp., *Stemona tuberosa* Lour., and *Paris polyphylla*) together makes 7.4% of the average household income in Xiao Nuo You Shang Zhai, 2.3% in Mang Xing Long Dai, 9.1% in Ben Gang Hani, and 1.4% in Da NuoYou. Orchid species are important high value medicinal plants also grown as ornamental plants. Species of *Dendrobium* namely *D*. *chrysotoxum* Lindl., *D*. *crepidatum* Lindl. & Paxton, *D*. *chrysanthum* Wall ex Lindl., *Cymbidium* spp. and *Eria* spp. which have colorful and showy flowers are transplanted from the forest to homegardens and grown as ornamentals.

Medicinal plant collection is mostly practiced by upland villagers in NRWNNR who still have access to forests and do not produce rubber. Villager living in lower elevations (such as Man Dian, Cha Cahng and Na Ban) that also grow rubber did not mention sale of any medicinal plant during interviews. An interesting point which could be seen in table 3 is that some of the traded medicinal plants have very small use frequency. In fact some plants such as *Drynaria* and *Asparagus* are not commonly used herbal medicines by villagers and most of the villagers don't know about medicinal uses and properties of these species. This means that these species are collected mainly for commercial purposes and the collection is demand-driven and instigated through traders that have trained the local people to collect the plants.

Mushrooms are also important NTFPs in the area, mainly collected from the forest during the rainy season and consumed locally or sold in local and national markets. In Hui Ma He (811 m a.s.l.) which is a Hani/Akha village located in the buffer zone close to the core zone, villagers are involved in commercial collection of mushrooms. Villagers start early in the morning when it is still dark to be the first to collect mushrooms. A kind of *Russula* sp. (Hogn gu) could be sold at Chinese Yuan (CNY) 20-30 kg^{-1} of fresh material. Mushrooms are important NTFPs of Yunnan Province. Export of matsutake mushroom for example, reached the value of USD 44 million in 2005, mainly exported to Japan (Yang et al., 2008). In Shaxi valley mushroom collection is an important income source for mountain people (Huber et al. 2010). In NRWNNR however, matsutake is not occurring instead main mushroom groups are *Russula* spp. and *Lactarinus* spp. (*Russulaceae*) and *Auricularia* spp.

Table 3. Important wild food and medicinal plants traded in NRWNNR. Plants are ordered based on use frequency.

Scientific name	Family	Locale name	Plant part collected	Collection period	Price (CNY/ unit)[1]	Use frequency
Food plants						
Musa acuminata Colla	*Musaceae*	芭蕉花	Flower blossom	All year round	2-3 (each)	0.7
			Stem heart	All year round	1-1.5 / kg	0.7
Diplazium esculentum (Retz.) Sw.	*Woodsiaceae*	蕨菜	Young frond	All year round	0.5-0.8/ bunch 3-3.5/ kg	0.7
Houttuynia cordata Thunb.	*Saururaceae*	鱼腥草	All parts	All year round	0.5-1 / bunch (ca.20-30 plant)	0.49
Oenanthe javanica (Blume) DC.	*Apiaceae*	水香菜	All parts	All year round	1.5-2 / bunch	0.45
Ficus auriculata Lour.	*Moraceae*	藤箦笋	Fruit	Feb-Apr	2-3 / bunch	0.41
Solanum americanum Miller / *Solanum nigrum* L.	*Solanaceae*	小苦子果	Aerial parts	All year round	1-2/ bunch	0.41
Elsholtzia kachinensis Prain	*Lamiaceae*	水香菜	Aerial parts	All year round	1.5-2 / bunch	0.34
Bauhinia variegata L.	*Fabaceae*	白花	Flower	Feb-Mar	2/ bowl	0.31
Docynia delavayi (Franch.) C.K. Schneid	*Rosaceae*	哆依果	Fruit	Aug-Sep	1-1.5 / bunch (5-7 / fresh)	0.24
Parabaena sagittata Miers	*Menispermaceae*	梨板菜	Young leaves, stem	All year round	1 / bunch	0.22
Dioscorea alata L.	*Dioscoreaceae*	山药	Root	Jan-Mar	5-8/ kg	0.2
Caryota monostachys Becc.	*Arecaceae*	棕笋	Young shoot	n.a	5/ kg	0.17
Livistona saribus (Lour.) Merr ex A. Chev.	*Arecaceae*	大白叶笋	Stem heart	All year round	5 / kg	0.15
Solanum torvum Sw.	*Solanaceae*	苦子果	Fruit	Mar-Apr	1-2 / bunch	0.15
Dendrocalamus sp.	*Poaceae*	笋子	Young shoot	All year round	20/ kg (dry), 4/ kg (fresh)	0.13
Indosasa sinica C.D. Chu & C.S. Chao	*Poaceae*	笋子	Young shoot	All year round	5 / kg	0.11
Eryngium foetidum L.	*Apiaceae*	大芫细	Leaf	All year round	0.2-1 / bunch	0.07
Canarium tonkinense Engl.	*Burseraceae*	青果	Fruit	Jun-Aug	3-4/ kg	0.05
Medicinal Plants						
Aristolochia sp.	*Aristolochiaceae*	大白解	Root	Aug-Sep	n.a	0.24
Chloranthus spicatus (Thunb.) Makino	*Chlorantaceae*	叶子兰	Root	n.a	n.a	0.09

Tacca chantrieri André	*Dioscoreaceae*	黑冬叶根	Root	All year around	1 / kg (fresh)	0.09
Acorus calamus L.	*Acoraceae*	水菖蒲	All parts	All year round	n.a	0.06
Litsea garrettii Gamble	*Lauraceae*	大树萝卜	Root	All year around	n.a	0.05
Paris polyphylla var. *yunnanensis* (Franch.) Hand. -Mazz.	*Melanthiaceae*	七叶一枝花	Root	Sep-Mar	80-90 / kg (dry)	0.05
Piper boehmeriifolium Wall.	*Piperaceae*	大疙瘩根 /	Root-stem	All year round	n.a	0.04
Piper sarmentosum Roxb.						0.01
Argyreia velutina C. Y. Wu	*Convolvulaceae*	红白芥	Root	n.a	n.a	0.03
Dendrobium sp.	*Orchidaceae*	小米草	All parts	All year around	n.a	0.03
Stemona tuberosa Lour.	*Stemonaceae*	白布	Root	Oct-Apr	5 / kg (dry)	0.03
Chloranthus holostegius (Hand. - Mazz.) S.J. Pei & Shan	*Chloranthaceae*	细星	Root	n.a	3/ kg (dry)	0.025
Rauvolfia verticillata (Lour.) Bail.	*Apocynaceae*	矮砣砣	Root	All year around	n.a	0.02
Dendrobium crepidatum Lindl. & Paxton	*Orchidaceae*	黄姜	Stem	All year around	20 / kg (fresh)	0.02
Asparagus filicinus Buch.-Ham. ex D. Don	*Asparagaceae*	天冬	Root	Oct -Apr	13-15/ kg (dry)	0.017
Asparagus subscandens F.T. Wang & S.C. Chen						0.014
Spatholobus suberectus Dunn	*Fabaceae*	老灌藤/老洼肚肚果	Stem / Fruit	Aug-Oct	1 / kg (dry)	0.013
Polygonatum cirrhifolium (Wall.) Royle	*Asparagaceae*	马尾根	Root	Oct-Feb	5 / kg (dry)	0.003
Capparis yunnanensis Craib & W.W. Sm.	*Capparaceae*	双钩	Stem	n.a	n.a	0.003
Gynostemma pentaphyllum (Thunb.) Makino	*Cucurbitaceae*	胶股兰	Stem	n.a	4 / kg (dry)	0.003
Anoectochilus sp.	*Orchidaceae*	金丝草	All parts	Aug-Sep	n.a	0.003
Orchidaceae	*Orchidaceae*	细黄草	All parts	All year around	250 / kg (fresh)	n.a
Drynaria propinqua (Wall. ex Mett.) Bedd.	*Polypodiaceae*	毛节节	Stem	Oct-May	2.5 / kg (dry)	n.a

[1]CNY= Chinese Yuan; Bowl is the normal bowl which is used for eating rice in the area; each bunch consists of 15-20 plant individuals or fruits. In case of different number of individuals of plant per bunch the number is given in the table. [2]na: Plant traded but data is not available.

Table 4. Mean annual income from bamboo shoot harvest in NRWNNR (exchange rate at 30 December 2009 CNY 1= USD 0.1462).

Village	Income			
	HHI / bamboo shoot (CNY)	per capita income/ bamboo shoot (CNY)	Total per capita income 2007 (CNY)*	% contribution of bamboo shoot into total per capita income
Da NuoYou	52.51 ± 15.54	12.11 ± 3.87	1681	0.7
Pan Bing	182.76 ± 8.97	38 ± 1.87	3423	0.16
Mang Xing Long La	246.97±2 0.58	54.28 ± 4.52	1439	3.8
Ben Gang Hani	956.36± 9.63	16.53 ± 1.66	1537	1.1
Na Ban	68.70 ± 42.45	14.06 ± 9.22	2700	0.5
Xiao Nuo You Shang Zhai	258.69 ± 31.43	43.78 ± 5.32	1667	2.6

HHI= household income (* Wehner, 2010)

2.3.3 Non-timber forest products and sustainability

Rapid vulnerability assessment (RVA) was conducted among the most important and frequently harvested species. Results from RVA are provided in table 5. Based on RVA analysis one species falls in the high vulnerable category, 35 species in moderate vulnerable category and 14 species in low vulnerable category. Most of the species in moderate vulnerable category are mainly medicinal species used in Traditional Chinese Medicine (TCM). Only *Argyreia velutina* C. Y. Wu falls in the category of highly vulnerable. However in the assessment, the data for three criteria (ecological criteria) was not available for this species. Most of the criteria without sufficient data in RVA are ecological criteria. This shows the lack of ecological studies on most of the harvested species. Less vulnerable species are mainly food species which are used very frequently by local people. Due to their high abundances, distribution, and the fact that they are

not limited to any specific habitats, makes them less vulnerable to collection practices. In fact, these species are weed species or very common species which grow in habitats influenced by humans. Also, since collected parts of the most of these species are leaves and stem/shoot tips, harvest practices are not fatal for individual plants.

However most of the villagers mentioned the decline in the abundance of NTFP resources over the last ten years because of habitat destruction and overharvesting especially of medicinal species. This can be corroborated by the fact that for many of traded medicinal plants in the area, underground parts such as rhizomes, tubers and roots are extracted. So the harvest is fatal for the respective plant but also negatively affects the regeneration potential of populations. Commercial collection of some medicinal species started about ten years ago in the area. Under the regulation of Nature Reserve Administration, commercial collection of NTFPs, especially medicinal plants is prohibited. However these regulations have not been enforced. Compliance of villagers is low, particularly in regards to the extraction of plants for medicinal purposes. A regulation of sustainable collection of bamboo shoots has been set up, demanding a rotation period of two years. This regulation has not been implemented so far and villagers hardly follow these rules. Many villagers even complain about trespassers from other villages who exploit the resources from collective forests but there are no mechanisms to persecute these infringements.

Table 5. List of species integrated in Rapid Vulnerability Assessment analysis. Plants are ranked based on use categories and use frequencies. Numbers given in criteria without data (CWD) column are referring to 18 original criteria in table 1 for which adequate data could not be found for species.

Species	Family	Local name	Score	CWD	Use frequency
Food plants					
Diplazium esculentum (Retz.) Sw.	*Woodsiaceae*	蕨菜	28	0	0.7
Musa acuminata Colla	*Musaceae*	芭蕉花	30	0	0.7

Houttuynia cordata Thunb.	*Saururaceae*	鱼腥草	29	0	0.49
Oenanthe javanica (Blume) DC.	*Apiaceae*	水香菜	29	0	0.45
Ficus auriculata Lour.	*Moraceae*	藤箦笋	29	0	0.41
Solanum americanum Miller	*Solanaceae*	小苦子果	30	0	0.41
Solanum nigrum L.	*Solanaceae*	小苦子果	30	0	0.41
Elatostema acuminatum (Poir.) Brongn.	*Urticaceae*	渐尖楼梯草	22	2	0.37
Elsholtzia kachinensis Prain	*Lamiaceae*	水香菜	28	0	0.34
Bauhinia variegata L.	*Fabaceae*	白花	26	1	0.31
Docynia delavayi (Franch.) C.K. Schneid	*Rosaceae*	哆依果	25	1	0.24
Phyllanthus emblica L.	*Phyllanthaceae*	余甘子	28	0	0.22
Parabaena sagittata Miers	*Menispermaceae*	梨板菜	30	0	0.22
Dioscorea alata L.	*Dioscoreaceae*	山药	25	2	0.2
Caryota monostachys Becc.	*Arecaceae*	棕笋	23	2	0.17
Livistona saribus (Lour.) Merr ex A. Chev	*Arecaceae*	大白叶笋	25	0	0.15
Solanum torvum Sw.	*Solanaceae*	苦子果	29	0	0.15
Dendrocalamus sp.	*Poaceae*	笋子	25	2	0.13
Indosasa sinica C.D. Chu & C.S. Chao	*Poaceae*	笋子	25	1	0.11
Eryngium foetidum L.	*Apiaceae*	大芫细	29	0	0.07
Centella asiatica (L.) Urb.	*Apiaceae*	积雪草	30	0	0.06
Canarium tonkinense Engl.	*Burseraceae*	青果	24	1	0.05
Dendrocalamus brandisii (Munro) Kurz	*Poaceae*	勃氏甜龙竹	27	1	0.04
Dendrocalamus hamiltonii Nees & Arn. ex Munro	*Poaceae*	版纳甜龙竹	27	1	0.04
Pleioblastus amarus (Keng) Keng. F.	*Poaceae*	苦竹	27	1	0.04
Eleutherococcus trifoliatus (L.) S.Y. Hu	*Araliaceae*	白簕	28	0	0.04
Solanum violaceum Ortega	*Solanaceae*	苦果	30	0	0.04
Hodgsonia macrocarpa (Blume) Cogn.	*Cucurbitaceae*	油渣果	24	1	0.03
Castanopsis mekongensis A. Camus	*Fagaceae*	湄公锥	26	0	0.03

Dendrocalamus membranaceus Munro	*Poaceae*	黄竹	27	1	0.03
Medicinal plants					
Aristolochia sp.	*Aristolochiaceae*	大白芥	20	2	0.24
Chloranthus spicatus (Thumb.) Makino	*Chloranthaceae*	叶子兰	19	1	0.09
Tacca chantrieri André	*Dioscoreaceae*	黑冬叶根	26	0	0.09
Acorus calamus L.	*Acoraceae*	水菖蒲	23	0	0.06
Paris polyphylla var. yunnanensis (Franch.) Hand.-*Mazz*	*Melanthiaceae*	七叶一枝花	21	0	0.05
Litsea garrettii Gamble	*Lauraceae*	大树萝卜	25	0	0.05
Piper boehmeriaefolium Wall.	*Piperaceae*	大疙瘩根	24	2	0.04
Dendrobium sp.	*Orchidaceae*	小米草	23	0	0.03
Stemona tuberosa Lour.	*Stemonaceae*	白布	23	1	0.03
Argyreia velutina C. Y. Wu	*Convolvulaceae*	红白芥	18	3	0.03
Chloranthus holostegius (Hand. - Mazz.) S.J. Pei & Shan	*Chloranthaceae*	细星	19	1	0.025
Dendrobium crepidatum Lindl. & Paxton	*Orchidaceae*	黄姜	23	0	0.02
Rauvolfia verticillata (Lour.) Bail.	*Apocynaceae*	矮砣砣	24	0	0.02
Asparagus filicinus Buch.-Ham. ex D. Don	*Asparagaceae*	天冬	24	0	0.017
Asparagus subscandens F.T. Wang & S.C. Chen	*Asparagaceae*	天冬	24	0	0.014
Spatholobus suberectus Dunn	*Fabaceae*	老灌藤/老洼肚肚果	19	2	0.013
Piper sarmentosum Roxb.	*Piperaceae*	大疙瘩根	24	2	0.01
Capparis yunnanensis Craib & W. W. Sm.	*Capparaceae*	双钩	20	2	0.003
Anoectochilus sp.	*Orchidaceae*	金丝草	21	0	0.003
Polygonatum cirrhifolium (Wall.) Royle	*Asparagaceae*	马尾根	21	1	0.003
Gynostemma pentaphyllum (Thunb.) Makino	*Cucurbitaceae*	胶股兰	24	2	0.003
Drynaria propinqua (Wall. ex Mett.) Bedd.	*Polypodiaceae*	毛节节	22	0	-

2.4 Conclusions

Villagers in NRWNNR use one quarter of available flora as food and medicinal plants to meet their subsistence needs and to generate additional income. Only a few of the products contribute directly to the cash income of households. Many NTFPs contribute indirectly to the villager's livelihood through their subsistence needs. In the case of bamboo shoots in the study area, direct contribution to per capita income was very low and in some villages, where most of the collective forests have been converted to rubber plantations, was negligible. However in some villages medicinal plants contribute high proportion of household's income. A more detailed study is necessary to quantify the household consumption of bamboo shoots and other NTFPs such as wild vegetables to be able to show the real role of NTFPs in villagers' livelihoods. In our study the scope was general covering a large number of NTFPs but if the focus is given to some economically important species, more detailed information will be collected on the harvest and cash income contribution. On the other hand, NTFPs are one of the ecosystem services which could contribute to incentives for preserving forests from other land use conversions. Xi and Moinuddin (2009) concluded that NTFPs as an ecosystem service in Naban River-Mangao biodiversity corridor contribute high portion to the households' incomes. Important NTFPs with a large contribution to the cash income of households were medicinal plants and food plants which consisted mainly of bamboo shoots and edible mushrooms.

Though NTFP collection has lost its importance in some villages, it is still important in the others. For example, in Man Dian (a Dai village) wild vegetables and fruits have lost their importance in every day life of villagers because they earn more income from rubber plantations and prefer to buy vegetables from market. Another reason for abandoning NTFP collection could also be the reduced availability of resources due to conversion of community forests into plantations. Moreover, the rubber cultivating villages seem to be very interested in changing their livelihood towards a more modern lifestyle. Folk medicine, plant collection activities and

wild food on the table might have lost their attractiveness. Modern medicine and consumption of produced food and other goods is more appealing, particularly for the younger generation.

Based on RVA analysis, most of the important NTFPs are in danger of overexploitation. Sustainable harvest and management strategies should be implemented to prevent overexploitation which may result in the local extinction of important and vulnerable NTFP species. In order to develop a sustainable NTFP exploitation system, it is important to know the ecological parameters regarding target species. However, to develop sustainable management strategies which are adopted by the local people, it is also important to consider the local indigenous knowledge and social and economic conditions. More data on ecological and population matrixes and the impact of harvest of major NTFPs on wild populations is necessary to show the sustainable harvest thresholds. Considering the increasing demand for medicinal plants used in traditional medicine and limited amount of natural resources, cultivation of medicinal plants in the area could reduce the pressure on plant populations and also diversify the local livelihood strategies by generating additional income for households.

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Outline and overview:

This chapter introduces and discusses the medicinal plants used by Hani ethnic group. It analyse the cultural importance of medicinal species using different importance indices and compares these indices together to show the weak and effective points of each index. It also analysis the importance of different land use types based on the importance values of species that each land use type provides for the local people. Medicinal uses of plants by Hani ethnic group is also analized from different aspect including medical use categories, plant parts used and preparation methods and are compared with the results of other research publications form the area.

Ethnobotanical study of medicinal plants utilised by Hani ethnicity in Naban River Watershed National Nature Reserve, Yunnan, China

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Abstract

Aim of the study: This study was conducted in the Naban River Watershed National Nature Reserve to identify and analyse the knowledge and use of wild plants for medicinal purposes by Hani ethnicity and to search out culturally as well as economically important plant species and land use types.

Material and methods: Ethnobotanical data was collected using freelisting interviews with randomly selected informants and semi-structured as well as field interviews. Plant specimens were collected, identified and deposited at the Herbarium of Xishuangbanna Tropical Botanical Garden, Mengla, Yunnan Province, China. Data were analysed by use-reports, in addition important indices like relative frequency of citation (RFC) and cultural importance index (CI) were calculated. Smith's salience index was assessed using Anthropac 4.08. Consensus analysis was applied to measure informant agreement on plants used in different medicinal use categories.

Results: A total of 199 medicinal plants belonging to 73 families were recorded. Dominant families are *Asteraceae* (5.5%), *Piperaceae* and *Verbenaceae* (4.5%), *Fabaceae*, *Liliaceae* (4.0%) and *Euphorbiaceae*, *Lamiaceae* and *Solanaceae* (3.5%). Most culturally salient species from freelisting analysis were *Dendrobium crepidatum* Lindl. ex Paxt. (Smith's SI=0.41), *Aristolochia* sp. (0.306), *Microstegium ciliatum* (Trin.) A. Camus (0.129), *Eupatorium coelestinum* L. (0.119), *Litsea martabanica* (Kurz) Hook. F. (0.116) and *Psidium guajava* L. (0.103). The majority of the utilised species were collected from forest (51.9%), followed by fallow land (22.52%), arable fields (14.5%), and homegardens (11.08%).

Conclusions: It became clear that the knowledge of medicinal plants is not homogenously distributed among Hani. Based on the percentage of collected medicinal plants from four habitat types, forest is the most important source of medicinal plants for Hani but when considering the cultural importance of species it seems that homegardens are slightly more important than other habitats.

Keywords: Medicinal plant, Ethnobotany, Hani minority, Bioeconomy, NTFP

3.1 Introduction

Xishuangbanna Dai Autonomous Prefecture is located in the southernmost part of the Yunnan Province, bordering Laos and Myanmar. The territory covers an area of 19,125 km^2 and ranges from 470 m to 2470 m asl., the Prefecture has a hilly and mountainous topography (94% of cover) and is intersected with the Lancang (upper Mekong) river (Xu et al., 2004) (Figure 1). The climate is subtropical with a rainy season between May and October and a dry season lasting from November to April. Annual precipitation varies from 1200 to 1900 mm in valleys and uplands from which 87% occurs in the rainy season and 13% in the dry season (Liu et al., 2004). The undulating topography produces dense radiation fog with an average of six hours per day occurring 130 days during the dry season, which can supplement the reduction in precipitation (Li, 2001; Hua, 2008, 1997). The area is located amid a transition zone with tropical SE Asia to the south, subtropical East Asia to the north, and the Sino-Japanese floristic region to the east and the Sino-Himalayan floristic region to the west (Hua, 2008). Because of this position a great diversity of vegetation types including tropical rainforest, seasonal rainforest, montane rainforest and evergreen broadleaf forest occurs in the area (Cao et al., 2006; Zou, 1988). The tropical rainforest in Xishuangbanna is at the northern limit of the tropical rainforests with high diversity of flora and fauna. Flora diversity includes 3340 vascular plant species, belonging to 1176 genera and 182 families, which are the highest species richness in Yunnan (Li et al., 1996; Hua, 2008; Hua et al., 2006; Martin & Hu, 2003).

Along with this biological diversity the region is inhabited by 13 ethnic groups, including Dai, Hani, Jinou, Bulang, Yao, Yi and Lahu who have been settled in the area for centuries. These ethnic groups have their own culture and language and throughout the history developed their own knowledge systems regarding use, management and conservation of natural resources and ecosystems surrounding them. Hani people are traditionally swidden agriculturalist living transboundarily in highlands of Myanmar, Thailand, Laos, Vietnam and China. They are the

second largest ethnic group with about 19% in Xishuangbanna Prefecture. Hani have kept close relationship with the forest and developed a rich knowledge of forest resources use and their management (Zhijun, 2003; Fu et al. 2003; Xu et al., 1997; Anderson, 1986; Inta et al., 2008). For a long time they have lived in harmony with nature and along with shifting cultivation managed to conserve biodiversity in their environment. But with growth in population and introduction of cash crops and new policies, this harmony is changing in sake of biodiversity loss. Nevertheless, Hani villagers still depend on the forest for their food and medicine and some traditional knowledge of medicinal plants has kept in most of the villages among the villagers and also traditional healers. But with the fast changes happening in land use systems and cash crop cultivation and also deforestation and degradation of natural environments, the valuable ecological and botanical knowledge which accumulated through history and transmitted from one generation to the next is in danger of vanishing.

This study was conducted in the framework of a Sino-German co-operation project on rural development through land use diversification (LILAC). Specifically the study reported here were conducted to analyse knowledge and use of wild medical plants by Hani ethnicity in NRWNNR and to search out culturally as well as economically important plants. This information would be useful for biodiversity conservation, and sustainable harvest of forest products and cultivation of medicinal plants in the area to generate additional income for villagers.

3.2 Study site and methodology

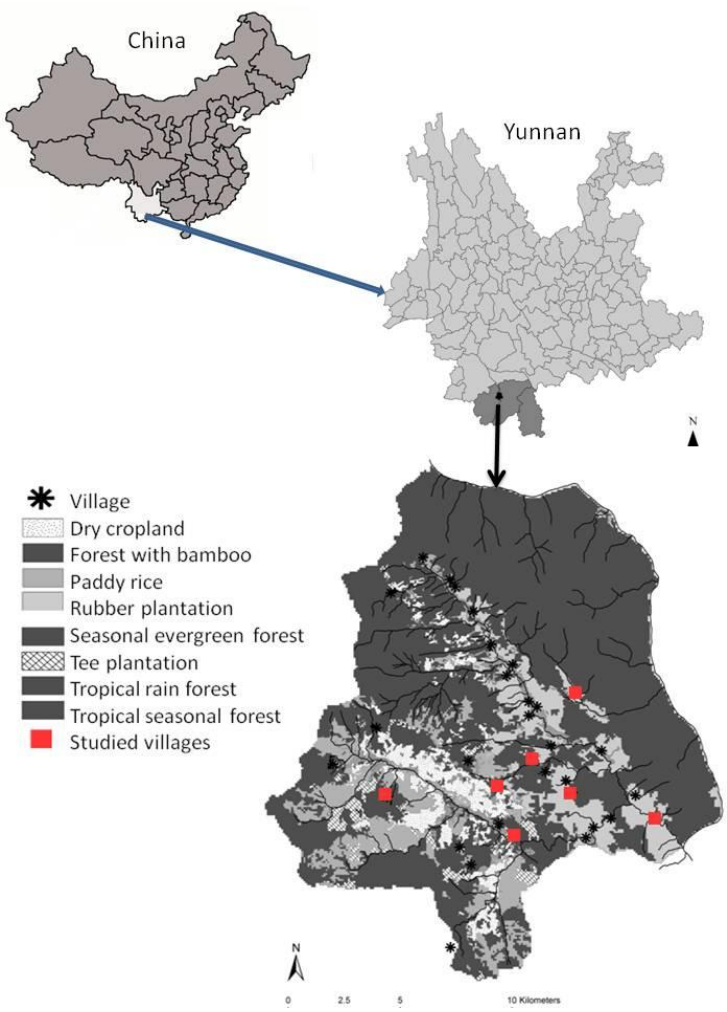
3.2.1 Geography and flora

Naban River Watershed National Nature Reserve (NRWNNR), with a total area of 266.6 km^2, is located in the central-north of Xishuangbanna (22° 04´- 22° 17´N & 100° 32´- 100° 44´E) and lies on the west bank of Lancang river approximately 25 km from Jinghong township (Figure 1). Topographically, the western part of NRWNNR is mountainous; the mid part is the Naban River valley, drained by Naban river, one of the tributaries of Lancang river. The eastern part is formed by the Anmashang Mountain which slopes into Lancang river valley. Most parts of NRWNNR (55%) are above 1000 m altitude with Luhuma peak reaching 2304 m asl. (Yunnan Environmental Protection Bureau, 2006). NRWNNR was established in 1991 based on the UNESCO concept “The Man and the Biosphere” as a Provincial Nature Reserve and approved as National Nature Reserve in 2000. The nature reserve is rich in vegetation types and plant species diversity. There exist more than 1953 species and subspecies and 896 genera of vascular plants from which 50 species are national protected species in China (Yunnan

Environmental Protection Bureau, 2006). In addition, it comprises an impressive cultural diversity. Five different ethnic groups including Dai, Hani/Akha, Lahu, Yi, Bulang, and Han with a total population of 5538 are living in 30 villages distributed in the area. Dai villages are located in the lowlands and their economy is mainly depending on subsistence agriculture such as paddy rice, corn and vegetables, animals like short ear pigs and chickens, and cash crops such as rubber. Hani and Lahu are living in the highlands, growing tea, corn, rice, hemp, and rubber and raising farm animals such as water buffalos, local pig and chickens. Although rubber plantations are expanding and villagers are trying to convert any piece of land to cash crop production, NTFPs still play an important role in people's life in NRWNNR. Zhang et al. (2004) for example, showed that the majority of Lahu villagers get their daily vegetables from natural sources. Bamboo shoots, wild banana blossom, wild mushrooms, *Mayodendron igneum* (Kurz) Kurz, *Piper sarmentosum* Roxb. and *Callipteris esculenta* (Retz.) J. Sm. ex T. Moore & Houlston are most common forest products used by villagers (Zhang et al. 2004).

Hani / Akha (Akha is a subsume of Hani minority), animist in their believes, are living in seven villages (BongangHani, Panbing, Bonglong, Mojiangzhai, Huimahe, Shijiazhai and Huilaoxinzhai) in the boundary of NRWNNR comprising 23.5% of total population. These villages are located at an altitude range of 770 to 1400 m. They believe on ancestral spirits and consider all the wild animals and plants to belong to the spirits. Hani/Akha do not have written scripts and the Hani language which is a member of Yi language subgroup of Tibeto-Burman language family is only oral (Mitchell & Yuan, 2004). Most of the young Hani people could speak Chinese but elder people could not speak and understand Chinese very well. It is hypothesized that Hani in NRWNNR make use of high percentage of local flora for their health problems and secondary forest is the main source of medicinal plants for Hani in NRWNNR.

Figure 1- Location of NRWNNR in Xishuangbanna and in China and studied villages.



3.2.2 Ethnobotanical data collection

Prior to starting the field work, research and plant collection permits have been issued by governmental officials and NRWNNR management office. Research groups for the whole project (LILAC) were introduced to the village leaders by NRWNNR officials and objectives of the project were explained to obtain consent from village leaders and elders. Field survey was started in January 2008 and lasted for twelve months. Ethnobotanical data was collected through freelisting interviews with randomly selected informants and semi-structured and field interviews with key informants selected after freelisting or by snowball sampling (Stepp, 2005; Berlin & Berlin, 2005; Quinlan, 2005). Key informants include traditional healers, herbalists and plant collectors. Interviews supplemented with field walks, forest walks and plant collection during which informants were asked to show the useful plants and describe the uses.

Information regarding plant local names, their uses, utilised parts, method of preparation and administration, habit, habitat and place of collection were recorded. Overall, 62 persons, 34 male (54.8%) and 28 female (45.2%) for semi-structured interviews and 66 persons, 34 female (51.5%) and 32 male (48.5%) for freelisting have been interviewed. Most of the interviews were conducted in Hani language but some interviews especially with younger people were conducted in Chinese language (local dialect) since the informants could speak Chinese. Plant specimens were collected and prepared and after drying were identified with the help of experts from Xishuangbanna Tropical Botanical Garden (XTBG). One set of voucher samples were stored at the Herbarium of NRWNNR and one set were deposited at the Herbarium of XTBG (HXTBG). Nomenclature follows Flora of China, checklist of Flora of China, local checklists and TROPICOS of the Missouri Botanical Garden (http://www.tropicos.org; Li et al., 1996; Flora of China, 1994 to present).

3.2.3 Data analysis

Data on recorded medicinal plants was analysed by use-reports. Informant *i* mentions the use of the species *s* in the use-category *u*, the event resulting from the combination of these three variables has been defined as a use-report (Kufer et al., 2005; Tardío & Pardo-de-Santayana, 2008). Each mention of use for a plant by an informant was considered as a single use record. For example if plant A was mentioned by informant X for treating headache, a single use was recorded and if plant A was mentioned by informant X for headache and stomachache, two citations were recorded and so on (Collins et al., 2006). Medicinal uses were categorized in different use categories following Cook (1995). We applied quantitative analysis of the data through the use of certain synthetic indices. These indices have been used to find the cultural importance of plants. We compared different indices together to better understand the pattern of plant knowledge and use by Hani. One of the measured indices is “relative frequency of citation” (RFC). RFC is an importance index which does not consider the use-category (variable u) and calculated by dividing the number of informants who mentioned the use of species *i* (FC_i) by the total number of informants (N) (Tardío & Pardo-de-Santayana, 2008).

$RFC_i = FC_i/N$

RFC varies from 0 when nobody refers to the plant as useful to 1 when all informants mention the use of the species (Tardío & Pardo-de-Santayana, 2008). Another index which is used here is cultural importance index (CI) calculated by the following formula

$$\mathrm{CI}i = \sum_{u=u1}^{u\mathrm{NC}} \sum_{i=i1}^{iN} \mathrm{URui}/\mathrm{N}$$

where*u* is the category of use, u_{NC} is the total number of different use categories (u_1, u_2, …u_{NC}), UR is the total number of use-reports for the species *i* and N is the total number of informants (Signorini et al., 2009;Tardío & Pardo-de-Santayana 2008). CI is an additive index which takes into account the spread of the use (number of informants) for each species as well as its various uses. The theoretical maximum value for the index is the total number of use-categories (NC) (Tardío & Pardo-de-Santayana 2008). For species with only one use, the index is equal to RFC. Salience index (Smith's S) is also calculated for freelisting interviews using Anthropac 4.08 (Borgatti, 1996a). Salience index accounts for frequency of mentions and position of items in freelists and ranges from 0 to 1, showing the highest salience at 1.

$S_j=1\ r_j1/n1,\ S_j= nr_j/n1$

Where r_j is position of item j in the list, and n is the number of items in the list. To compute the overall saliency index, we just take the average S_j across all respondents (Smith, 1993; Borgatti, 1996b).

For consensus analysis, "informant consensus factor" (FIC, Trotter & Logan, 1986), also called "informant agreement ratio" (IAR, Inta et al., 2008; Collins et al., 2006), has been used to measure the agreement between informants concerning what plants are used for specific use categories.

$\mathrm{IAR}= n_{ur} – n_t / n_{ur} – 1$

Where n_{ur} is the number of citations in each use category and n_t is the number of taxa which are used in that use category. IAR ranges between 0 and 1 and a value of 1 indicates that few taxa are used by informants for that category of use which refers to high degree of consensus and a well-defined medicinal plant tradition (Heinrich et al., 1998). Salience index was compared with two other indices to check the effectiveness and accuracy of this index.

3.3 Results and discussion

3.3.1 Plant species and life forms

A total of 199 medicinal plants used by Hani were recorded from which 10 were identified to genera level (which are considered as single species here). They belong to 73 families and 152

genera. Species found are listed in table 1. Their common names (Hani name & local Chinese name), the species usage, parts used, mode of preparation and administration, frequency of records and smith's salience index are given as well. From used species, 22 (11.05%) are endemic to China, 21 (10.5%) are common weeds, 4 (2.01%) are semi-cultivated and naturalized and the rest (76.39%) are native to the flora. Dominant families are *Asteraceae* (11 spp., 5.5%), *Piperaceae* and *Verbenaceae* (9 spp., 4.5%), *Fabaceae*, *Liliaceae* (8 spp., 4.0%) and *Euphorbiaceae*, *Lamiaceae* and *Solanaceae* (7 spp., 3.5%) (Figure 2). Most of the families are represented by single or two species which shows that medicinal plants used by Hani are not concentrated only in a few families and genera. Inta et al. (2008) recorded 60 species used by Akha in Mongsong county in Xishuangbanna which has 14% in common with our species. Most of the documented species are herbs (43.2%) followed by shrubs (25.1%), trees (14.5%) and climbers (6.1%) (Figure 3). This pattern is often found in ethnobotanical studies (Steep & Moerman, 2001). From the mentioned species *Solanum americanum* Mill. and *Solanum nigrum* L. are considered one ethno-species and *Asparagus filicinus* Buch. -Ham. ex D. Don and *Asparagus subscandens* F.T. Wang & S.C. Chen are also considered under one ethno-species.

Figure 2. Plant families with highest percentage of cited species.

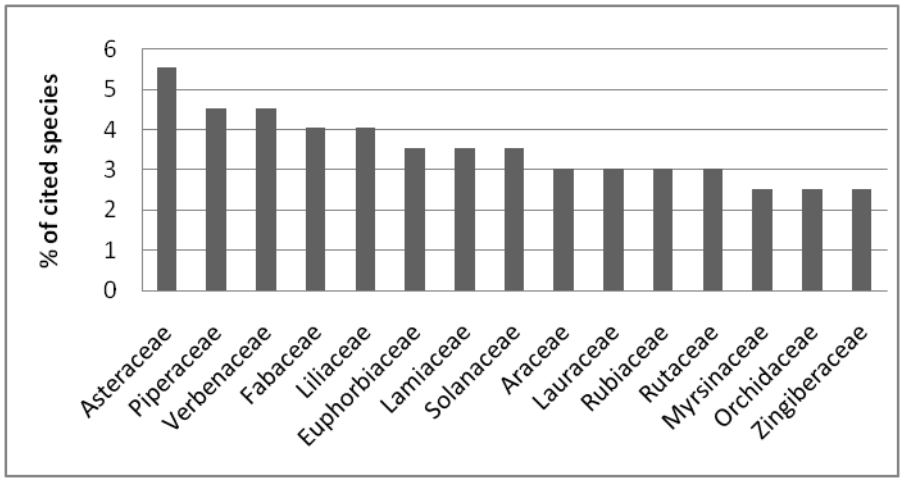


Table 1. List of medicinal plants used by Hani in NRWNNR. URs = use reports, SI = Salience index, plant part: R = root, L = leaf, St = stem, Rh = rhizome, P = petiole, Fl = flower, Fr = fruit, Ap = aerial parts, Se = seed, Ba = Bark. (Species without any uses mentioned in the table are recorded as medicinal by informants but they could not recall the detailed uses)

Scientific name	Family	Hani name	Local Chinese name	Habit	Plant part	Uses	Preparation	Administration	URs	SI
Acorus calamus L. (A.G. 221)	*Acoraceae*	long xia	石菖蒲	Herb	R, L	Stomachache, indigestion, dysuria, carminative	Decoction or chewing raw	Orally	11	0.051
Acorus tatarinowii Schott (A.G. 2046)	*Acoraceae*	lo xia	水上蒲	Herb	R, L	Stomachache	Decoction	Orally	5	0.035
Adhatoda vasica Nees (A.G. 2056)	*Acanthaceae*	-	懒叶为查叶	Shrub	R	Stomachache	Decoction	Orally	1	-
Baphicacanthus cusia (Nees) Bremek. (A.G. 1822)	*Acanthaceae*	-	靛根	Herb	R	Bone fractures	Decoction	Orally	1	-
Gendarussa ventricosa Nees (A.G. 2030)	*Acanthaceae*	lo go mian la	泡酒	Herb	R, L	Stomachache, rheumatism, bone fracture	Decoction, tincture, crushed and heat by fire	Orally, dressing	4	0.011
Lepidagathis incurva Buch.-Ham. ex D. Don (A.G. 2020)	*Acanthaceae*	dan da la pi	-	Herb	L	Rheumatism, arthritis	Mashed and heat by fire	Dressing	1	-
Saurauia cerea Griff. ex Dyer (A.G. 1823)	*Actinidaceae*	ho na ha qi	-	Tree	R	Diarrhea	Decoction	Orally	1	-
Saurauia punduana Wall. (A.G. 1739)	*Actinidaceae*	-	鼻涕果	Tree	Ba	Kidney stone	Decoction	Orally	1	-
Amaranthus viridis L. (A.G. 1552)	*Amaranthaceae*	wo ji	-	Herb	R	Hypertension	Decoction	Orally	1	-
Deeringia amaranthoides (Lam.) Merr. (A.G. 2010)	*Amaranthaceae*	ya zha	-	Shrub	L, St	Inflammation	Decoction	Orally	1	-
Iresine herbstii Hook. (A.G. 1606)	*Amaranthaceae*	miao miao nei	红苋	Herb	R, L	Bone fracture, gynecological problems	Decoction, mashed	Orally, dressing	2	0.021
Curculigo capitulata (Lour.) Kuntze (A.G. 1885)	*Amaryllidaceae*	-	猴子背金叶	Herb	Ap	Rheumatism, stomachache	Decoction	Orally	2	0.01

Mangifera indica L.	*Anacardiaceae*	-	芒果	Tree	Ba	Food poisoning	mix with juice of *Enste*	Orally	1	-
Rhus chinensis Mill. (A.G. 2388)	*Anacardiaceae*	-	盐酸果树	Shrub	R, Fr	Inner heat (flushing)	Decoction	Orally with garlic	1	0.007
Fissistigma acuminatissimum Merr. (A.G. 1721)	*Annonaceae*	-	黑皮跌到	Climber	St	Back pain / arthralgia	Decoction	Orally with wine	1	0.011
Centella asiatica (L.) Urb. (A.G. 2269)	*Apiaceae*	-	马蹄草	Herb	Ap	Inner heat	Decoction, infusion	Orally	1	-
Eryngium foetidum L. (A.G. 1735)	*Apiaceae*	ya ma ya suo	大芫细	Herb	L	Centipede bite	Crushed	dressing	1	0.011
Alstonia scholaris (L.) R. Br. (A.G. 1768)	*Apocynaceae*	-	灯台树	Tree	St	Cough	Decoction with honey	Orally	1	0.004
Rauvolfia verticillata (Lour.) Baill (A.G.2007)	*Apocynaceae*	qi ha	矮砣砣	Shrub	R	Diarrhea, hypertension	Decoction	Orally	2	0.014
Rauvolfia verticillata var. *oblanceolata* Tsiang (A.G. 2172)	*Apocynaceae*	qi ha	矮砣砣	Shrub	R	Diarrhea, cough	Decoction	Orally	2	0.03
Ilex tephrophylla (Loes.) S. Y. Hu (A.G. 2252)	*Aquifoliaceae*	shi zhong	-	Shrub	L	Bone injuries, inflammation	mashed	Dressing	1	0.01
Alocasia sp. (Ph 300)	*Araceae*	-	大黑附子	Herb	P	Traumatic injury	Mashed and mixed with alcohol	Dressing	1	-
Pothos repens (Lour.) Druce (A.G. 2197)	*Araceae*	ni qia ma	-	Epiphyte	L	Bone fracture	Mashed	Plaster	1	0.007
Rhaphidophora decursiva (Roxb.) Schott (A.G. 1741)	*Araceae*	-	爬树龙	Liana	R, L, St, Ap	Bone fractures	Mashed	Plaster	4	0.037
Rhaphidophora hongkongensis Schott (A.G. 2234)	*Araceae*	xue ga	爬树龙	Herb	L	Bone fractures	Mashed	Plaster	1	0.011
Rhaphidophora lancifolia Schott (A.G. 2159)	*Araceae*	shao ga		Herb	L	Bone fractures	Mashed	Plaster	2	-
Steudnera colocasiifolia K. Koch (A.G. 1706)	*Araceae*	a yan		Herb	L, St	Tracheitis, sore skin	Decoction, heat by fire	Orally, liniment	2	-
Eleutherococcus trifoliatus (L.) S.Y. Hu (A.G. 1705)	*Araliaceae*	zhu do	五加刺(刺五加)	Shrub	L, St	Inner heat, bone fracture	Soup, eat raw, crushed	Orally, plaster	3	0.018

Schefflera brevipedicellata Harms (A.G. 2136)	*Araliaceae*	wo mia	树头菜	Shrub	R, L, St	Abortion, headache	Decoction, mashed	Orally, dressing	2	0.004
Schefflera chinensis (Dunn) H. L. Li (A.G. 2171)	*Araliaceae*	lo ben	风湿	Tree	L	Rheumatism, bone fractures	Mashed and heat by fire	Plaster, dressing	3	-
Trevesia palmata (Roxb. ex Lindl.) Vis (A.G. 2193)	*Araliaceae*	-	-	Shrub	-	-	-	-	0	0.015
Caryota monostachys Becc. (A.G. 2070)	*Arecaceae*	-	-	Tree	-	-	-	-	0	0.005
Aristolochia sp.	*Aristolochiaceae*	ho non ho qi	大白芥	Herb	R	Stomachache, diarrhea	Decoction, infusion or eaten raw	Orally	21	0.306
Artemisia argyi H. Lév. & Vaniot (A.G. 2351)	*Asteraceae*	a ka di do	青蒿枝	Herb	R, L	Stomachache, inner heat, malaria treatment, (stop) bleeding	Decoction , mashed	Orally, dressing	10	0.058
Aster subulatus Michx. (A.G. 1730)	*Asteraceae*	-	-	Herb	A.p.	-	-	-	0	0.009
Bidens pilosa L. (A.G. 1728)	*Asteraceae*	-	叉叉草	Herb	R	Appendicitis	Decoction	Orally	1	0.007
Blumea balsamifera (L.) DC. (A.G. 2090)	*Asteraceae*	o so so ma	-	Shrub	R, L	Headache, diarrhea	Crushed, decoction, infusion	Inhale, Orally	2	-
Blumea sp.	*Asteraceae*	-	真金叶(金片叶)	Herb	L	Indigestion, carminative	Decoction	Orally	1	0.001
Dichrocephala integrifolia (L. f.) Kuntze (A.G. 1793)	*Asteraceae*	le pi le cong	鱼眼草	Herb	R, L, St	Cold, vermifuge	Decoction	Orally	2	0.005
Eupatorium coelestinum L. (A.G. 2299)	*Asteraceae*	si chuan ya mo	解放草	Herb	L	Dropsy, (stop) bleeding	Mashed	Dressing	8	0.119
Galinsoga parviflora Cav. (A.G. 1734)	*Asteraceae*	-	同锤草	Herb	Ap	Analgesic	Decoction	Orally	1	0.008
Gerbera piloselloides (L.) Cass.	*Asteraceae*	ba miao	-	Herb	R	Typhoid fever	Decoction	Orally	1	0.001
Gnaphalium pensylvanicum Willd. (A.G 2268)	*Asteraceae*	a ha la nei	大鸡心草	Herb	L	Useful for heart	Cook with pig heart	Orally	1	0.002
Laggera pterodonta (DC.) Benth. (A.G. 1690)	*Asteraceae*	wo son wo ma	臭铃铛	Herb	R, L	Inner heat, lymph nods inflammation	Decoction	Orally	2	0.008

Alnus nepalensis D. Don (A.G. 1950)	*Betulaceae*	-	水冬瓜	Tree	L	-	-	-	0	0.01
Mayodendron igneum (Kurz) Kurz (A.G. 2280)	*Bignoniaceae*	ye tong	芭拉花	Tree	-	-	-	-	0	0.001
Oroxylum indicum (L.) Kurz (A.G. 2084)	*Bignoniaceae*	jao hai/zhui ai	海船	Tree	L, Fr	Stomachache	Roasted or raw	Orally	2	0.019
Lobelia clavata E. Wimm. (A.G. 2176)	*Campanulaceae*	duo yo	-	Herb	L	Furuncle	Mashed	Dressing	1	-
Pratia nummularia (Lam.) A. Braun & Asch. (A.G. 1743)	*Campanulaceae*	-	小红果藤	Herb	Ap	Hepatitis, common cold	Decoction	Orally with wine or black pepper	2	0.006
Capparis yunnanensis Craib & W. W. Sm. (A.G. 2219)	*Capparidaceae*	-	双钩	Vine	R, L	Typhoid fever	Decoction	Orally	1	0.013
Sambucus chinensis Lindl. (A.G. 2022)	*Caprifoliaceae*	pa a	-	Herb	L	Rheumatism, arthritis	Mashed and heat by fire	Dressing	1	0.013
Chloranthus spicatus (Thunb.) Makino (A.G. 2435)	*Chloranthaceae*	bo cang mie, bo so mie	叶子兰	Subshrub -Herb	R, L, Ap, St	Bone fracture, fractures, traumatic injuries, rheumatism, stomachache, appetizer, fever, inner heat	Decoction, tincture, smash and heat by fire	Orally, dressing	19	0.067
Rourea minor (Gaertn.) Leenh. (A.G. 2111)	*Connaraceae*	ha ji me wo	-	Liana	L	Polio	Mashed	Dressing	1	-
Argyreia velutina C. Y. Wu (A.G. 2285)	*Convolvulaceae*	-	红白芥	Shrub	R	Diarrhea	Decoction	Orally	2	0.02
Solena amplexicaulis (Lam.) Gandhi (A.G. 2080)	*Cucurbitaceae*	a ji lo ha ton ho	-	Herb	R	Stomachache	Decoction	Orally	1	-
Carex baccans Nees (A.G. 1917)	*Cyperaceae*	a ji lo ha qie xi	-	Herb	R	Gynecological problems	Decoction	Orally	1	0.003
Scleria laevis Retz. (A.G. 2038)	*Cyperaceae*	se sa	-	Herb	R	Gynecological problem	Decoction	Orally	1	0.003
Davallia formosana Hayata (A.G. 2393)	*Davalliaceae*	lo ma da ha	-	Climber	Rh	Bone fracture, fall injuries	Mashed	Plaster, dressing	2	-
Dioscorea sp. (A.G. 2581)	*Dioscoreaceae*	-	三叶豆	Climber	R, L	(Stop) bleeding	Mashed	dressing	1	-
Diospyros kaki Thunb. (A.G. 1701)	*Ebenaceae*	zhu ai, diu wai	爬海船	Tree	R, L	Inner heat, stomachache	Decoction, eat raw	Orally	2	0.01

Equisetum diffusum D. Don (A.G. 2258)	*Equisetaceae*	niu zha	笔管草	Herb	Ap	Bone injuries, inflammation	Mashed	dressing	2	0.011
Equisetum debile Roxb. ex Vaucher (A.G. 2211)	*Equisetaceae*	nie zha		Herb	St	Bone fracture	Mashed	dressing	1	0.01
Aporosa yunnanensis (Pax & K. Hoffm.) F.P. Metcalf (A.G. 2365)	*Euphorbiaceae*	-	-	Shrub	-	-	-	-	0	0.015
Breynia rostrata Merr. (A.G. 1997)	*Euphorbiaceae*	wu yu ge lei jie	-	Shrub	R	Toothache, urinary tract stone	Decoction	Orally	2	-
Croton cf. hutchinsonianum Hosseus (A.G. 1980)	*Euphorbiaceae*	na pi na long	大树跌打	Shrub	R	Bone fracture	Mashed	Plaster	1	0.013
Jatropha curcas L. (A.G. 2272)	*Euphorbiaceae*	ma wu	小桐子	Shrub	L, Ba	Rheumatism, insect stings	Mix with *Chloranthus*, mashed	dressing	3	0.006
Ostodes katharinae Pax (A.G. 2121)	*Euphorbiaceae*	na pi na lan	-	Tree	L	Bone fracture	Mashed	Plaster	1	-
Phyllanthus emblica L. (A.G. 1604)	*Euphorbiaceae*	qi qia	橄榄果	Tree	Ba, Fr	Heart disease, fever	Decoction, eat fresh	Orally	2	0.03
Ricinus communis L. (A.G. 1834)	*Euphorbiaceae*	-	蓖麻	Herb	L	Burns	Mashed	Dressing	1	-
Caesalpinia sappan L. (A.G. 1865)	*Fabaceae*	tu gag	苏木	Tree	R, L, St, Ba	Traumatic injuries, gynecological problems, (stop) bleeding	Tincture, powder	Orally, liniment	3	0.008
Crotalaria assamica Benth. (A.G. 2078)	*Fabaceae*	a bie que lei	-	Herb	R	Stomachache	Decoction	Orally	1	0.005
Crotalaria albida Heyne ex Roth (A.G. 1637)	*Fabaceae*	a be qiu le wu lu	大狗灵	Herb	R	Cough, pain	Decoction	Orally	2	0.003
Crotalaria pallida Aiton (A.G. 1924)	*Fabaceae*	-	小狗铃	Herb	Ap	Inner heat	Decoction	Orally	1	0.015
Crotalaria ferruginea Graham ex Benth. (A.G. 2089)	*Fabaceae*	a bie que lei you di jie	-	Herb	R	Stomachache	Decoction	Orally	1	0.005
Indigofera stachyodes Lindl. (A.G. 2023)	*Fabaceae*	song ho nu pia	马鹿豌豆	Shrub	R	Fever	Decoction	Orally	1	-

Pueraria edulis Pamp. (A.G. 2122)	*Fabaceae*	nen zai	骨马藤	Climber	R, L	Inner heart, bleeding	Decoction, mashed	Orally, dressing	2	0.008
Spatholobus suberectus Dunn (A.G. 2199)	*Fabaceae*	ba ni lo wo	老灌藤	Vine	R, L, St	Dysentery, diarrhea, stomachache	Decoction, raw	Orally	7	0.018
Aeschynanthus hookeri C. B. Clarke (A.G. 2170)	*Gesneriaceae*	ba tu	-	Herb - epiphyte	L	Ear pain, burn, injuries, bone fracture	Fermented, mashed	externally, dressing	4	0.014
Aeschynanthus mimetes B. L. Burtt (A.G. 2236)	*Gesneriaceae*	ba tu ma	-	Herb - epiphyte	L	Inflammation	Mashed	Dressing	1	0.001
Illicium modestum A. C. Sm. (A.G. 2047)	*Illiciaceae*	-	野八角	Shrub	R	Fever	Decoction	Orally	1	-
*Ajuga macrosperm*a Wall. ex Benth. (A.G. 2106)	*Lamiaceae*	nai zhi ma, wu hui	野芝麻	Herb	R, L	Inflammation of gum, toothache, inflammation, pain (analgesic), (stop) blooding	Chewing raw, mashed, for toothache heat by fire and keep in the mouth	Orally, dressing	9	0.037
Clerodendranthus spicatus (Thunb.） C. Y. Wu ex H. W. Li	*Lamiaceae*	-	肾茶	Herb	L, St	Kidney pain	Infusion	Orally	1	-
Elsholtzia blanda (Benth.) Benth. (A.G. 2077)	*Lamiaceae*	nie men xi	野芝麻	Herb	R, L	Inflammation, stomachache	Decoction, crushed	Orally, dressing	5	0.028
Elsholtzia winitiana Craib (A.G. 1727)	*Lamiaceae*	lai pi lai cong	扫把茶	Herb	L, Fl	Measles, headache, common cold	Infusion with wine	Orally	3	0.01
Leonurus japonicus Houtt. (Ph. 250)	*Lamiaceae*	-	益母草	Herb	L	Painful menstruation	infusion	Orally	2	0.011
Leucosceptrum canum Sm. (A.G. 2118)	*Lamiaceae*	shi qia ba ho	-	Shrub	Ba	Stomachache	Decoction	Orally	1	-
Pogostemon glaber Benth. (A.G. 2082)	*Lamiaceae*	A pia se ma, a pa sai man	-	Herb	R, L	Bone fracture, malaria	Decoction	Orally	4	0.015
Cinnamomum bejolghota (Buch.-Ham.) Sweet (A.G. 1932)	*Lauraceae*	ma cang	-	Tree	R, L, Ba	Bone fracture, wound healing	Smash and heat by fire	dressing	3	0.017
Cinnamomum iners Reinw. ex Blume (A.G. 2109)	*Lauraceae*	ma qiao	-	Tree	L	(Stop) bleeding	Smash and heat by fire	dressing	2	0.035
Litsea cubeba (Lour.) Pers. (A.G. 2146)	*Lauraceae*	shi bi	木姜子	Shrub	Ba, R	Measles, malaria, common cold	Decoction	Orally	5	0.022
Litsea martabanica (Kurz) Hook. f. (A.G. 2095)	*Lauraceae*	pi li pi ha	大树萝卜	Tree	R, L	Bone fracture, bleeding, wounds, poisoning	Decoction, mashed	Orally, dressing	9	0.116

Litsea semecarpifolia (Wall. ex Nees) Hook. f. (A.G. 2174)	*Lauraceae*	bao can she	-	Tree	Ba	Malaria	Decoction	Orally	1	-
Machilus rufipes H.W. Li (AG. 2179)	*Lauraceae*	nu qai/qe mi de	-	Tree	L	Bone fracture	Mashed	Plaster	1	-
Asparagus filicinus Buch. - Ham. ex D. Don (A.G. 2093)	*Asparagaceae*	di xi mao son	-	Herb	R, L	Stomachache, injuries	Decoction, mashed	Orally, dressing	2	-
Asparagus subscandens F.T. Wang & S.C. Chen (A.G. 2246)	*Asparagaceae*	di xiu mo shou	天冬	Herb	R	Diarrhea, bone injuries	Decoction, mashed	Orally, dressing	5	0.045
Aspidistra typica Baill. (A.G. 2049)	*Asparagaceae*	dui bu dui qie qie a ba	-	Herb	R	Stomachache	Decoction	Orally	1	
Dianella ensifolia (L.) DC. (A.G. 2004)	*Asparagaceae*	ge a ke	-	Herb	R	Stomachache, indigestion	Decoction, tincture	Orally	2	-
Disporopsis longifolia Craib (A.G. 1742)	*Liliaceae*	zi zi dui dui ma jia jie	扁竹青	Herb	R	Inner heat, rheumatism	Decoction, mashed	Orally, dressing	1	0.014
Disporum cantoniense (Lour.) Merr. (A.G. 2225)	*Liliaceae*	-	寒病	Herb	R	Common cold	Decoction	Orally	1	0
Ophiopogon intermedius D. Don (A.G. 2050)	*Asparagaceae*	sen ha gu qi	-	Herb	Rh	Stomachache	Decoction	Orally	2	-
Paris polyphylla var. *yunnanensis* (Franch.) Hand.-Mazz. (A.G. 2466)	*Trilliaceae*	-	七叶一枝花	Herb	L, Rh	Stomachache, bleeding, sore skin	Decoction, powder	Orally, dressing	6	0.037
Peliosanthes sinica F.T. Wang & T. Tang (A.G. 2226)	*Liliaceae*	-	?胃不好	Herb	Rh	Stomachache	Decoction	Orally	1	0.001
Buddleja officinalis Maxim. (A.G. 1647)	*Buddlejaceae*	an po ha	-	Herb	L	Rheumatism	Mash and heat by fire	dressing	1	-
Gelsemium elegans (Gardner & Champ.) Benth. (A.G. 2184)	*Loganiaceae*	xian she	-	Climber	R, L	Bone fracture, stomachache, kidney pain	Roast, mashed	Orally, dressing	3	-
Scurrula atropurpurea (Blume) Danser (A.G. 2543)	*Loranthaceae*	De le	-	Epiphyte, woody hemi-parasite	Ap	Rheumatism, fever	Decoction	Orally	4	0.003
Lygodium japonicum (Thunb.) Sw. (A.G. 1744)	*Lygodiaceae*	-	斑鸠窝	Herb -fern	R	Urethritis	Decoction	Orally with wine	1	0.003

Kadsura coccinea (Lem.) A.C. Sm. (A.G. 2137)	*Magnoliaceae*	mei non la hai	-	Tree	R, L, St	Bone fracture, , gastroenteritis, appetizer	Decoction, mashed	Orally, dressing	9	0.014
Sida szechuensis Matsuda (A.G. 1752)	*Malvaceae*	-	-	Herb	Ba	Wounds	Powder	Orally	1	-
Urena lobata L. (A.G. 2210)	*Malvaceae*	pao cong sa la	拔毒散	Herb	L	Furuncle	Pulped	Ointment	1	0.001
Melastoma affine D. Don (A.G. 2073)	*Melastomataceae*	-	打破完树	Shrub	R	Hematuria	Decoction	Orally	1	0.012
Cissampelos pareira var. *hirsuta* (Buch.-Ham. ex DC.) Forman (A.G. 2031)	*Menispermaceae*	-	?解药	Vine	R	Antidote	Infusion or eat row	Orally	1	-
Fibraurea recisa Pierre (A.G. 2069)	*Menispermaceae*	-	大黄藤	Liana - woody	R, St	Inflammation, common cold	Decoction. mashed	Orally, dressing	2	0.044
Stephania sp.	*Menispermaceae*	-	山乌龟	vine - woody	R	Common cold, cough	Soup	Orally	2	-
Cudrania fruticosa (Roxb.) Wight ex Kurz (A.G. 2394)	*Moraceae*	a gan bei la	-	Shrub	L	Enhance blood circulation	Smashed	Dressing	1	-
Ensete glaucum (Roxb.) Cheesman	*Musaceae*	-	芒果	Shrub	Ju	Food poisoning	Mashed	Dressing	1	-
Ardisia thyrsiflora D. Don (A.G. 2132)	*Myrsinaceae*	ya sa ku ma yer	-	Shrub	R, Ba	Measles, cough	Decoction	Orally	2	-
Ardisia virens Kurz (A.G. 2128)	*Myrsinaceae*	ya sa ke ma yer	-	Shrub	R	Measles, malaria, food poisoning	Decoction	Orally	3	-
Embelia laeta (L.) Mez (A.G. 1722)	*Myrsinaceae*	a na le go zi	-	Shrub	R	Diarrhea	Decoction with brown sugar	Orally	1	0.009
Embelia parviflora Wall. ex A. DC. (A.G. 2124)	*Myrsinaceae*	wu jia na ba	爬树龙	Shrub	R, L	Bone fracture, wounds, stomachache, bleeding	Decoction, mashed and heat by fire	Orally, dressing	5	0.031
Embelia scandens (Lour.) Mez (A.G. 2148)	*Myrsinaceae*	a chu a ha	-	Shrub	Ba	Ascariasis	Decoction	Orally	1	-
Psidium guajava L. (A.G. 1703)	*Myrtaceae*	dai ma dai she	马梨甘	Tree	R, L, Ba, Fr	Diarrhea, stomachache, peptic ulcer	Decoction, raw	Orally	17	0.103
Syzygium tetragonum (Wight) Wall. ex Walp. (A.G. 2098)	*Myrtaceae*	shi wo	-	Tree	L, R	Inflammation, diarrhea, blood dilution	Decoction	Orally	3	0.019

Erythropalum scandens Blume (A.G. 2209)	*Olacaceae*	nibu	泥部	Liana	-	-	-	-	0	0.017
Jasminum polyanthum Franch. (A.G. 2194)	*Olacaceae*	xian piu	-	Shrub	R	Dysmennorrhoea	Roasted, decoction	Orally	1	-
Cymbidium bicolor Lindl. (A.G. 2248)	*Orchidaceae*	a san she	-	Herb - epiphyte	L	Painful urination	Decoction	Orally	1	0.002
Dendrobium crepidatum Lindl. ex Paxt. (A.G. 2276)	*Orchidaceae*	be le	黄姜, 黄草	Herb - epiphyte	Ap, St	Diarrhea, stomachache, poisoning, inflammation, tuberculosis, bone fracture	Decoction, mashed	Orally, dressing	6	0.41
Dendrobium sp.1 (A.G. 2233)	*Orchidaceae*	-	树芭蕉	Herb - epiphyte	Ap	Urinary stones	Decoction mixed with *Obernia*	Orally	1	0.006
Dendrobium sp. 2	*Orchidaceae*	mon pa do mi	小米草	Herb - epiphyte	Ap	Inflammation	Decoction	Orally	1	-
Oberonia sp.	*Orchidaceae*	-	树扁竹	Herb	L	Urinary tract stones	Decoction	Orally	1	-
Oxalis corniculata L. (A.G. 2378)	*Oxalidaceae*	-	老鼠腌菜	Herb	Ap	Fatigue	Infusion with brown sugar	Orally	1	0.008
Dactylicapnos scandens (D. Don) Hutch. (A.G. 2133)	*Papaveraceae*	-	豌豆脐	Vine	R, St	Anaesthetic, stomachache, diarrhea	Decoction, chewing raw, mashed	Orally, dressing	6	0.057
Peperomia tetraphylla (G. Forst.) Hook. & Arn. (A.G. 2168)	*Piperaceae*	ba tu ra	-	Herb	L	Bone fractures	Mashed	Plaster	2	0.004
Piper betle L. (A.G. 1731)	*Piperaceae*	-	-	Climber	L	-	Probably chewed with betel nut	Orally	-	0.006
Piper boehmeriifolium (Miq.) Wall. ex C. DC. (A.G. 2201)	*Piperaceae*	pa que	小麻疙瘩	Subshrub	R, Ap	Stomachache, measles, carminative	Decoction	Orally	3	0.03
Piper flaviflorum C. DC. (A.G. 2071)	*Piperaceae*	pa qieqie pi	小疙瘩, 辣藤	Climber	R, St	Inner heat, fatigue	Decoction, pickled	Orally	2	0.006
Piper longum L. (A.G. 1926)	*Piperaceae*	-	-	Climber	-	-	-	-	-	0.014
Piper macropodum C. DC. (A.G. 2178)	*Piperaceae*	be dei lo yer	-	Climber	L, Fr	Stomachache	Raw	Orally	1	-
Piper sarmentosum Roxb. (A.G. 2041)	*Piperaceae*	-	辣藤	Herb	St	Measles, fatigue	Decoction	Orally with wine	2	0.005
Piper semiimmersum C. DC. (A.G. 1719)	*Piperaceae*	-	歪叶子兰	Climber	R, L	Bone fracture, fractures	Decoction, mashed	Orally, plaster	1	0.01

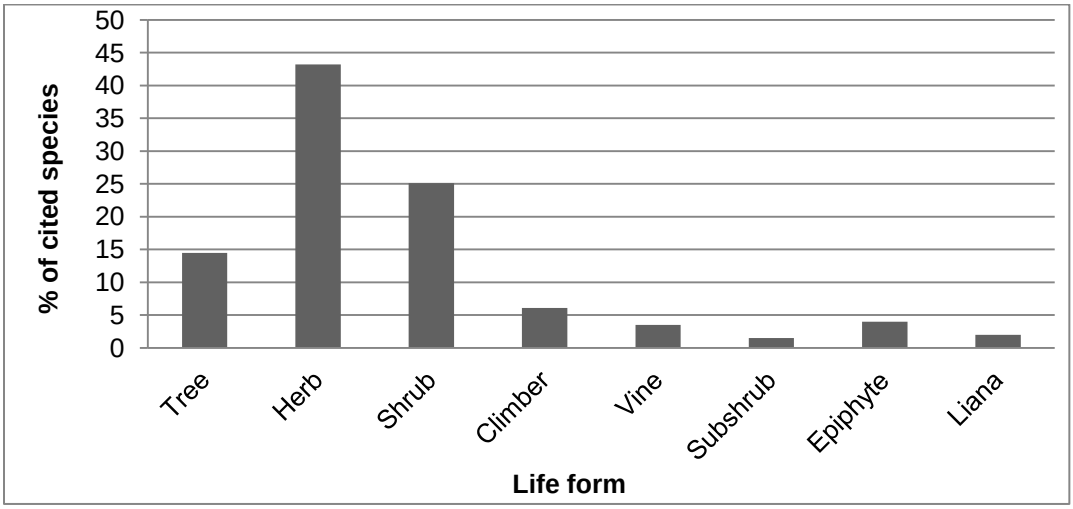
Piper yunnanense Y.Q. Tseng (A.G. 2155)	*Piperaceae*	qie ha	疙瘩草	Subshrub –Herb	L	Bone fractures	Mashed	Plaster	1	-
Plantago erosa Wall. (A.G. 2249)	*Plantaginaceae*	ha pa er za	小车前草	Herb	L, Ap	Inner heat, diarrhea, burns, muscle spasm	Decoction, raw	Orally	5	0.023
Plumbago zeylanica L. (A.G. 1767)	*Plumbaginaceae*	-	紫金龙	Herb	R	Rheumatism	Tincture, mashed	Orally, dressing	1	-
Coix lachryma-jobi L. (A.G. 2408)	*Poaceae*	man nei lao ba	天红地蓝	Herb	R	Stomachache	Decoction	Orally	1	-
Imperata cylindrica (L.) Raeusch. (A.G. 2085)	*Poaceae*	wu ji	茅草	Herb	R, L	Burns, gynecological problems	Decoction, mashed	Orally, dressing	2	0.011
Microstegium ciliatum (Trin.) A. Camus (A.G. 2117)	*Poaceae*	yi zi	-	Herb	L	Bleeding	Chewed or mashed	dressing	6	0.129
Polygala fallax Hemsel. (A.G. 2108)	*Polygalaceae*	ke she	鸡肚子	Shrub	R, L	Postpartum pains, headache, bone fractures	Decoction, mashed and heat by fire	Orally, dressing	5	0.029
Rumex sp. (Ph 356)	*Polygonaceae*	dai ma wo ba	黄连	Herb	R, L	Diarrhea, sore throat, mucolitic	Decoction, raw	Orally	3	0.002
Clematis subumbellata Kurz (A.G. 2025)	*Ranunculaceae*	yi jiu pao ce	-	Vine	R	Stomachache	Decoction	Orally	1	-
Thalictrum foliolosum DC. (A.G. 2116)	*Ranunculaceae*	-	金根黄凉	Herb	R, L, Ba	Stomachache	Decoction	Orally	1	0.011
Cerasus cerasoides (Buch.-Ham. ex D. Don) S.Y. Sokolov (A.G. 2228)	*Rosaceae*	du ai	樱桃	Tree	R, Ba	Diarrhea	Decoction	Orally	2	0.019
Docynia delavayi (Franch.) C.K. Schneid. (A.G. 2100)	*Rosaceae*	-	-	Tree	Ba, Fr	-	-	-	0	0.013
Rubus ellipticus var. *obcordatus* Focke (A.G. 1616)	*Rosaceae*	lai wo	-	Shrub	R	Diarrhea, stomachache	Decoction	Orally	2	0.018
Rubus niveus Thunb. (A.G. 2131)	*Rosaceae*	lai wo pe	-	Shrub	R	Diarrhea, stomachache	Decoction	Orally	2	0.01
Canthium parvifolium Roxb. (A.G. 2279)	*Rubiaceae*	ha da nui	-	Shrub	L	Inflammation, bone injuries	Pulped	dressing	2	0.009
Hedyotis scandens Roxb. (A.G. 2259)	*Rubiaceae*	song na	-	Herb	L	Inflammation, fractures	mashed	dressing	2	0.01
Mussaenda hossei Craib (A.G. 2189)	*Rubiaceae*	ha la ba ba	老虎脸	Herb	R, L, Ba	Cough, burns	Raw, decoction, pulped	Orally	3	0.014
Mussaenda multinervis C. Y. Wu in Hsue & H. Wu (A.G. 1833)	*Rubiaceae*	-	花叶木通	Herb	R	Backache/arthralgia	Decoction	Orally with wine	1	-

Rubia yunnanensis (Franch. ex Diels) Diels (A.G. 2212)	*Rubiaceae*	de er le	-	Herb	R, L	Good for blood, homeostasis	Decoction	Orally	1	0.01
Uncaria laevigata Wall. ex G. Don (A.G. 1908)	*Rubiaceae*	-	双钩	Tree	R, L	Fever, inner heat, bone fracture	Decoction, mashed	Orally, plaster	3	-
Acronychia pedunculata (L.) Miq (A.G.2061)	*Rutaceae*	-	大黄伞	Shrub	R	Fever	Decoction	Orally	1	-
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley (A.G. 2180)	*Rutaceae*	ha sei gu non	三叉叶(围黄叶)	Shrub	R, L	Postpartum inflammation, malaria, measles, bone fracture, inner heat, cold, fever, appetizer	Decoction, heat by fire	Orally, dressing	9	0.035
Tetradium glabrifolium (Champ. ex Benth.) T.G. Hartley (A.G. 2094)	*Rutaceae*	ha sai gong nong	-	Tree	L	Diarrhea, bone fracture	Decoction, mashed	Orally, dressing	2	0.005
Toddalia asiatica (L.) Lam. (A.G. 2222)	*Rutaceae*	wo jia la son	下鱼钩	Shrub	L	Diarrhea, bleeding, anesthetic, carminative, fall injuries , bone fracture	Decoction, mashed, chewed	Orally, plaster, dressing	7	0.095
Zanthoxylum armatum DC. (A.G. 2177)	*Rutaceae*	ne zao	野花椒	Shrub	R, L	Bleeding, headache, toothache, anesthetic	Decoction, chewing raw, crushed	Orally, dressing	4	0.012
Zanthoxylum armatum var. *ferrugineum* (Rehder & E.H. Wilson) C.C. Huang (A.G. 2218)	*Rutaceae*	nai rao	野花椒	Shrub	R, L	Common cold	Decoction	Orally	1	0.007
Houttuynia cordata Thunb. (A.G. 2150)	*Saururaceae*	wo kong wo nong	鱼腥草	Herb	R, Ap	Stomachache, appetizer, cough	Cook, decoction with crystal sugar	Orally	3	0.019
Dichroa febrifuga Lour. (A.G. 2271)	*Saxifragaceae*	ga lo	小三对结	Shrub	L	Headache, bone fracture injuries	Crushed	dressing	3	0.021
Smilax china L. (A.G. 1776)	*Smilacaceae*	-	山堆堆	Climber	R	Diarrhea, anemia	Decoction	Orally	4	0.021
Smilax perfoliata Lour. (A.G. 1620)	*Smilacaceae*	qi ni lao be	-	Climber	R	Stomachache	Decoction	Orally	1	-
Nicotiana tabacum L. (A.G. 2364)	*Solanaceae*	ya ho	老草烟	Herb	L	Bone fracture, bleeding	Heat by fire	Dressing, plaster	2	0.019
Solanum americanum Mill. (A.G. 1505)	*Solanaceae*	-	苦凉菜	Herb	Ap	Inner heat	Soup	Orally	1	0.008
Solanum erianthum D. Don (A.G. 2042)	*Solanaceae*	gongzi gong lan	洗碗叶	Shrub	R, L, Fr	Inner heat, diarrhea, fever, measles	Infusion, decoction	Orally	4	0.034

Solanum myriacanthum Dunal (A.G. 1668)	*Solanaceae*	cho si ba ha	-	Herb	R	Inner heat, toothache	Decoction	Orally	3	-
Solanum spirale Roxb. (A.G. 2039)	*Solanaceae*	ya sa ba ha	-	Herb	R	Inner heat, toothache	Decoction	Orally	3	0.003
Solanum torvum Sw. (A.G. 2376)	*Solanaceae*	shi ha	苦子果	Shrub	R	Inner heat, toothache	Decoction	Orally	2	-
Solanum violaceum Ortega (A.G. 2380)	*Solanaceae*	shi ha /shi ha di	-	Herb	Fr	Inner heat, hypertension	Soup	Orally	3	0.027
Stemona tuberosa Lour. (A.G. 1757)	*Stemonaceae*	a tei mo ha	大白布, 九股牛	Vine	R	Stomachache, bone fractures, inflammation, cough	Decoction, mashed	Orally, dressing	3	0.029
Helicteres angustifolia L. (A.G. 2015)	*Sterculiaceae*	-	野芝麻	Shrub	R	Diarrhea, inner heat	Decoction	Orally	2	-
Sterculia lanceifolia Roxb. (A.G. 2203)	*Sterculiaceae*	ho no ho qi	-	Tree	R	Stomachache	Decoction	Orally	1	0.016
Sterculia lanceolata Cav. (A.G. 2127)	*Sterculiaceae*	ho nan ho qi	-	Tree	L	Bone fractures	Mashed	Plaster	1	0.024
Tacca chantrieri André (A.G. 2063)	*Taccaceae*	bo cong la da, ben ba ma	黑冬叶, 山大黄	Herb	R	Inner heat, diarrhea, stomachache, peptic ulcer, cough,	Decoction with brown sugar	Orally	15	0.091
Eurya groffii Merr. (A.G. 1852)	*Theaceae*	bie sui	-	Shrub	L	Bleeding	Mashed	dressing	1	-
Schima wallichii (DC.) Korth. (A.G. 2175)	*Theaceae*	xi sa	-	Tree	L, Ba	Psoriasis, diarrhea, bone fractures	condensed decoction, raw, mashed and heat by fire	Liniment, orally, plaster	3	0.025
Trema orientalis (L.) Blume (A.G. 1748)	*Ulmaceae*	-	三叉叶(围黄叶)	Tree	L	Indigestion, carminative	Decoction	Orally	1	-
Boehmeria clidemioides Miq. (A.G. 1732)	*Urticaceae*	-	-	Herb	L	-	-	-	0	0.001
Callicarpa sp. (A.G. 2134)	*Verbenaceae*	a chu la chu	-	Shrub	R, L	Dizziness, headache, bone fracture	Grated, decoction	Orally, dressing	3	0.014
Caryopteris paniculata C. B. Clarke (A.G. 2214)	*Verbenaceae*	a jiu la jiu	-	Shrub	R	Dizziness	Decoction	Orally	1	-
Clerodendrum brachystemon C.Y.Wu & R.C. Fang	*Verbenaceae*	-	臭牡丹	Shrub	R, L	Inflammation, antidote	Crushed	dressing	2	0.021
Clerodendrum chinense var. *simplex* (Moldenke) S.L. Chen (A.G. 2205)	*Verbenaceae*	-	臭铃铛	Shrub	R	Kidney stone	Decoction	Orally	1	0.034

Clerodendrum henryi C. P'ei (A.G. 2181)	*Verbenaceae*	ga lo	-	Herb	R, L	Fever, dystecia, food poisoning	Decoction, heat by fire	Orally, dressing	3	-
Clerodendrum serratum (L.) Moon (A.G. 2477)	*Verbenaceae*	go la	大三对结	Shrub	R, L	Rheumatism, arthalgia	Decoction, grated	Orally, dressing	2	0.011
Clerodendrum serratum var. *amplexifolium* Moldenke (A.G. 2196)	*Verbenaceae*	son ba do niu	三台红花	Shrub	R, L	Headache, diarrhea, food poisoning, bone fracture, malaria	Decoction, grated	Orally, dressing	9	0.051
Clerodendrum sp. (A.G. 1771)	*Verbenaceae*	ha kong de qie	臭牡丹	Herb	R, L	Inflammation, fever, pustule	Decoction, heat by fire	Orally, dressing	3	-
Verbena officinalis L. (A.G. 1695)	*Verbenaceae*	a lu da pia	马鞭草, 蝴蝶草	Herb	R	Diarrhea, fever, common cold, pustule, muscle pain, fatigue, urinary retention, wounds, measles	Decoction	Orally	15	0.062
Alpinia blepharocalyx K. Schum. (A.G. 2372)	*Zingiberaceae*	-	野佳苗	Herb	Rh	Carminative	Decoction	Orally	1	-
Amomum villosum Lour. (A.G. 1691)	*Zingiberaceae*	-	砂仁	Herb	Rh, Se	Stomachache, measles	Decoction with clove drunk with wine	Orally	3	0.019
Hedychium spicatum Buch.-Ham. ex Sm. (A.G. 2230)	*Zingiberaceae*	mai qie	-	Herb	Rh	Inflammation, injuries	mashed	dressing	2	0.019
Hedychium villosum var.*tenuiflorum* Wall. ex Baker (A.G. 2208)	*Zingiberaceae*	mai qie	-	Herb	Rh	Injuries from foreign bodies	mashed	dressing	1	0.003
Zingiber neotruncatum T.L. Wu, K. Larsen & Turland (A.G. 1698)	*Zingiberaceae*	-	-	Herb	Rh	-	-	-	0	0.008

Figure 3. Life from of reported species.



3.3.2 Plant parts and collection sites

Roots excluding rhizomes are the most frequently used plant part (37.77%) followed by leaves (33.45%) which normally include tender leaves and stem tips as well as stem and bark (7.19%) (Figure 4). Weckerle et al. (2009) found a similar pattern of plant part use (subterranean parts 43.2%, whole plant 25.6% and leaves 6.2%) among Bai minority in Jianchuan county of Dali Perfecture in NW Yunnan. However in a study by Inta et al. (2008) leaves (54%) were the most commonly used part by Akha in Xishuangbanna and Thailand. Bensky et al. (2004) showed that underground parts normally play an important role for TCM preparations maybe because of the high content of bioactive compounds. But this could also have other implications from conservation perspective especially when it comes to species of commercial interest. When a species of commercial value is in demand and subterranean parts collected, there is a danger of overexploitation, threatening the natural populations. Hence collection management systems and regulations should be implemented to prevent depletion and extinction of natural stands of species. As an example in our study area and also other parts of Yunnan we can mention *Paris polyphylla* var. *yunnanensis* (Franch.) Hand.-Mazz.,*Stemona tuberosa* Lour. and *Asparagus* spp., which are used in TCM formulations and getting more and more scarce in natural environments. In our study plant collection sites were divided into four main categories: arable fields including rice (*Oryza sativa* L.) and field margins; fallow lands of different ages and open scrubs; forest including secondary and collective forest, forest margins and homegardens including village boundaries. The majority of the utilized species were collected from forest (51.9%), followed by fallow land (22.52%), arable fields (14.5%), and homegardens (11.08%).

With degradation of forests and diminishing the diversity of land use types, this pattern will change in future. Based on the importance indices of species, we calculated the mean importance of each habitat type for each index (Table 2). Forest shows the highest smith's salience index (SI) which implies forest is the most important habitat type but with relative frequency of citation (RFC) and cultural importance index (CI), the most important habitat are homegardens and then forest. This might be because of transplanting some important and scarce plant species from forest to homegardens to have permanent access to them.

Figure 4. Mentioned species and their percentage of used plant parts.

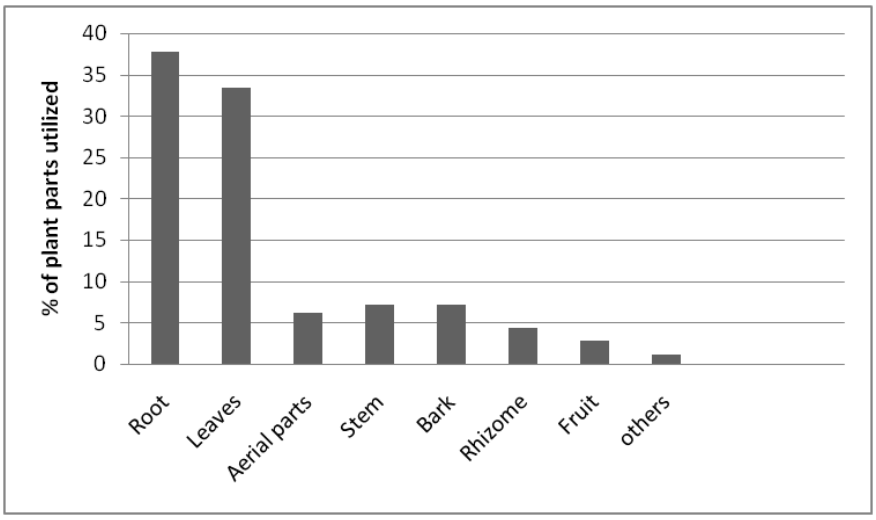


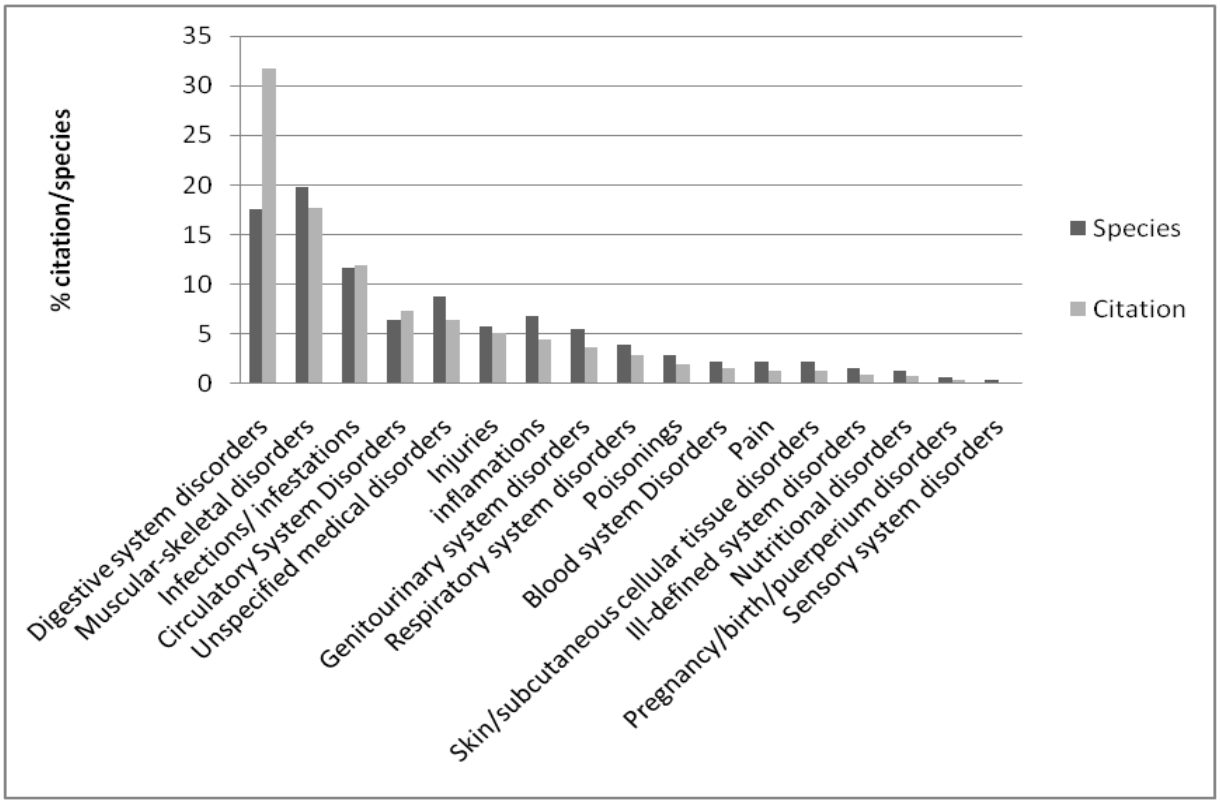
Table 2. Comparison of different importance indices for habitat types.

Habitat	**SI**	**RFC**	**CI**
1- Forest	0.018	0.039	0.045
2- Fallow land	0.015	0.032	0.039
3- Farm land	0.011	0.032	0.038
4- Homegardens	0.015	0.041	0.051

3.3.3 Use records and use categories

A total of 514 use records have been documented. These use records are categorized in 17 different medicinal use categories following Cook (1995). Among use categories, digestive system disorders (31.8%, 55 sp), muscular-skeletal disorders (17.7%, 61sp) and infections / infestations (11.9%, 36 sp) had the highest number of records (Figure 5). We can assume that medicinal use categories with most use records show the most prevalent and common health problems in the villages and more important to local people. Most mentioned health problems were stomachache (85 citations), bone fractures (66), diarrhea (58) and bleeding and cuttings (32). All of these health problems are more related to village life style and farm work. There were some health problems or conditions which are not possible to categorize in any given groups or even define it with modern medical terminology. Inner heat for example is a condition results from eating special kinds of food and might be the symptoms of flushing. Most of the plants are prepared as decoction (53.6%), mashed form (24%) and eating raw (6.4%) followed by infusion (3.8%), crushed (3.3%), chewed (2.9%), soup and tincture (1.7%) and roasted (1.3%). The most common administration method is orally (62.1%), drinking decoction or eating the plant, followed by dressing (27.7%) and plaster (7.9%).

Figure 5- Percentage of species and citations in each medicinal use category.



3.3.4 Cultural importance and consensus analysis

Analysis of freelist interviews showed that the core of medicinal plant domain of Hani consists of *Dendrobium crepidatum* Lindl. & Paxton. (Smith's SI=0.41), *Aristolochia* sp. (0.306), *Microstegium ciliatum* (Trin.) A. Camus (0.129), *Eupatorium coelestinum* L. (0.119), *Litsea martabanica* (Kurz) Hook. f. (0.116) and *Psidium guajava* L. (0.103) (Table 3). There are two species of *Aristolochia* (*A*. *hainanensis* Merr. and *A*. *tagala* Cham.) reported in the area which are used under one ethno-species. As freelist interviews were done with random sample, we can consider the result as a common knowledge of medicinal plants among Hani. Comparing the species list resulted from freelisting with the list from key informant interviews shows that some knowledge of medicinal plants is kept only by local healers and herbalists and other people are not aware of it. Also there were some plants mentioned in freelists but not reported by key informants. These might be unreliable used species since informants could not give any special use for them or might show that knowledge concerning the use of these plants is lost.

Table 3. Comparison of most important medicinal plants of Hani using three indices. List of 25 most salient species following the SI value and plant ranking based on each index.

Species	**Indices**			**Ranking**		
	SI	RFC	CI	SI	RFC	CI
Dendrobium crepidatum Lindl. & Paxton.	0.41	0.112	0.113	1	8	13
Aristolochia spp.	0.306	0.306	0.306	2	1	1
Microstegium ciliatum (Trin.) A. Camus	0.129	0.096	0.096	3	15	17
Eupatorium coelestinum L.	0.119	0.129	0.129	4	6	11
Litsea martabanica (Kurz) Hook. f.	0.116	0.112	0.129	5	11	12
Psidium guajava L.	0.103	0.22	0.241	6	2	3
Toddalia asiatica (L.) Lam.	0.095	0.08	0.112	7	20	14
Tacca chantrieri Andre	0.091	0.21	0.225	8	3	5
Chloranthus spicatus (Thunb.) Makino	0.067	0.117	0.274	9	7	2
Verbena officinalis L.	0.062	0.193	0.241	10	4	4
Artemisia argyi H. Lev. & Vaniot.	0.058	0.112	0.161	11	9	7
Dactylicapnos scandens (D. Don) Hutch.	0.057	0.096	0.096	12	14	16

Acorus calamus L.	0.051	0.08	0.161	13	16	6
Clerodendrum serratum var. *amplexifolium* Moldenke	0.051	0.096	0.129	14	13	10
Asparagus subscandens F.T. Wang & S.C. Chen	0.045	0.048	0.064	15	27	24
Fibraurea recisa Pierre	0.044	0.032	0.032	16	56	72
Paris polyphylla var. *yunnanensis* (Franch.) Hand.-Mazz.	0.037	0.096	0.096	17	12	15
*Ajuga macrosperm*a Wall. ex Benth.	0.037	0.08	0.145	18	17	8
Rhaphidophora decursiva (Roxb.) Schott	0.037	0.064	0.064	19	24	29
Acorus tatarinowii Schott	0.035	0.08	0.08	20	16	18
Cinnamomum iners Reinw. ex Blume	0.035	0.032	0.032	21	49	61
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley	0.035	0.08	0.08	22	18	20
Clerodendrum chinense var. *simplex* (Moldenke) S.L. Chen	0.034	0.016	0.016	23	109	119
Solanum erianthum D. Don	0.034	0.048	0.064	24	38	32
Embelia parviflora Wall. ex A. DC.	0.031	0.064	0.064	25	21	26
Kadsura coccinea (Lem.) A. C. Sm.	0.014	0.112	0.145	62	10	9
Polygala fallax Hemsley	0.029	0.08	0.08	29	19	21
Plantago erosa Wall.	0.023	0.064	0.064	35	23	27
Litsea cubeba (Lour.) Pers.	0.022	0.064	0.08	36	22	19
Spatholobus suberectus Dunn	0.018	0.064	0.08	51	25	22
Aeschynanthus hookeri C. B. Clarke	0.014	0.048	0.064	69	26	23
Elsholtzia blanda (Benth.) Benth.	0.028	0.048	0.064	32	31	25

Informant agreement ratios for use categories are shown in Table 4. For five use categories the value of IAR was zero, i.e. each of the informants mentioned a different plant for that use category and there was no agreement between them on the use of a species. For the last use category IAR was not applicable because only one citation was recorded for this category. One category might have a high number of citations but also a high number of species is applied. In this case the agreement between informants on use of these species will be low. For instance

muscular-skeletal disorders use category showed the second highest citation number (17.7%) but also the highest number of reported species (61 sp, 19.74%) so the IAR value was less than the other six categories.

Table 4. Informant agreement ratio for different use categories.

Usage category	**IAR**
Digestive System Disorders	0.668
Circulatory System Disorders	0.486
Infections/ Infestations	0.416
Injuries	0.32
Respiratory System Disorders	0.214
Unspecified Medical Disorders	0.187
Muscular-Skeletal Disorders	0.184
Genitourinary System Disorders	0.111
Poisonings	0.111
Blood System Disorders	0.111
Inflammations	0.09
Pain	0.000
Skin/Subcutaneous Cellular Tissue Disorders	0.000
Ill-Defined System Disorders	0.000
Nutritional Disorders	0.000
Pregnancy/Birth/Puerperium Disorders	0.000
Sensory System Disorders	UND

Table 3 shows the comparison of three applied indices. Although RFC and CI show some similarities but there are clear differences in the species ranking resulting from each index. *Aristolochia* spp. is ranked first with RFC and CI but ranked second with SI. This plant was mentioned by high number of informants and SI and RFC are directly dependent on the number of informants but CI also considers the diversity of use but in this case informants had more

agreement on the use of this plant as well. Based on these indices *Aristolochia* spp. is one of the most important species for Hani. *Dendrobium crepidatum* Lindl. & Paxton. which is ranked first by SI, were ranked 8th and 13th by RFC and CI indices respectively. This species has a use record of 7 and frequency of citation (FC) of 7 and there was not much agreement among informants on the use of this plant but because of its importance in TCM and also its scarcity might be cited more and ranked in top of freelists which results in a high SI ranking. *Fibraurea recisa* Pierre, *Clerodendrum chinense* var. *simplex* (Moldenke) S.L. Chen, *Cinnamomum iners* Reinw. ex Blume and *Solanum erianthum* D. Don which are ranked among the 25 most important plants by SI, do not include in top 25 plants by two other indices. The results show that the knowledge of medicinal plants among more professional villagers and healers is different than the common knowledge of medicinal plants among the majority of Hani. We can conclude that there is a set of knowledge which is commonly shared by the majority of Hani and a big portion of medicinal plant knowledge are kept by healers and herbalists. It is important to document the knowledge of healers and herbalists and find a proper way transferring to younger generation. Table 6 includes some rare as well as some very common and weed species which are also important medicinal plants for Hani. This implies that Hani are not only depending on rare plants and they might change the use pattern of medicinal plants to common species to have a secure access to the plant resources.

3.4 Conclusions

Hani use a wide variety of medicinal plants and the traditional knowledge of plant use is still practiced among the villagers. However the trend of knowledge loss could be seen as some plants are mentioned to be medicinal but informants could not recall any uses. This shows that the local knowledge concerning use of these plants is vanishing and this trend might accelerate with the current rate of deforestation and land use change as well as cultural influence of dominant Han Chinese culture and also economic development of China. Comparison of knowledge among key informants and other villagers shows differences on the use of plants and their cultural importance. It also implies that the knowledge of medical plants is not homogenously distributed among Hani in the study area.

Normally it is assumed that the cultural importance of a plant depends on the frequency of mentions or number of informants mentioning use of this plant (FC) and number of uses (NU). SI considers the frequency of citations as well as informants ranking of a particular plant. Number of uses depends on the number of use categories applied according to the researcher's

criteria in defining them, tending to be more subjective (Tardío & Pardo-de-Santayana, 2008). FC itself depends on the sample size. Among the indices, CI seems to be more objective as Tardío & Pardo-de-Santayana (2008) also expressed. It is correlated with FC but also considers the diversity of uses. Tardío & Pardo-de-Santayana (2008) found CI to be an efficient tool for highlighting species with a high agreement among people under study and to recognize the shared knowledge of these people.

With knowing culturally important species we can also define the most important habitats and vegetation types or land use types considering providing most important plants for a culture. Based on the percentage of collected medicinal plants from four habitat types, forest is the most important source of medicinal plants for Hani but when we take the cultural importance of species into account it seems that homegardens are slightly more important than other habitats. This is a preliminary result and detailed analysis of vegetation and land use types with some ecological measurements of density and frequency of species with taking account the cultural importance value of species will reveal a clear understanding of culturally important land use types concerning providing useful plant species for local people.

It is always discussed that medicinal plants as a component of Non-timber Forest Products (NTFPs) play an important role in generating additional income as well as helping to satisfy daily subsistence needs of households. Most of the medicinal plants utilized by Hani are collected from the wild. What people collect for their subsistence use does not have such a big effect on natural stands and threatens the natural populations but when economic interests on some medicinal plants rise, it can be a threat to the existence of such species. Medicinal plants can constitute a real economic potential and more income for households but if it is not harvested in a sustainable way, will have a negative effect on species population and hence on biodiversity in the area. Based on observations in the studied area, we have seen that some plant species which were not ranked of high importance by Hani were collected in huge amounts in response to the external demand of these species and even some of these species were not mentioned by Hani as useful. As an example *Stemona tuberosa* Lour., *Polygonatum cirrhifolium* (Wall.) Royle, *Asparagus subscandens* F.T. Wang & S.C. Chen, *Spatholobus suberectus* Dunn, *Paris polyphylla* var. *yunnanensis* (Franch.) Hand.-Mazz. *Gynostemma pentaphyllum* (Thunb.) Makino, *Drynaria propinqua* (Wall. ex Mett.) Bedd are collected in big amounts in the area and sold to the traders but they do not have high cultural importance for Hani. It is necessary to implement harvesting regulations and management of natural stands of these species with the help of local people to conserve and preserve the natural stands from depletion.

3.5 Acknowledgements

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4 Indigenous healing and medicinal plant use among Lahu ethnic group in SW China

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Outline and overview:

This chapter analyses and discusses the medicinal plant knowledge of Lahu ethnic group in the research area. Lahu group comprise larg proportion of population in the research area and they are considered as being closer to the nature and more knowledgeable about natural environment. The same methodology was used to collect record and analyse the data. Furthermore the medicinal plant knowledge of Lahu was compared with Hani group to see the differences and similarities and discuss the resons for these differences and similarities.

Indigenous healing and medicinal plant use among Lahu ethnic group in SW China

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Abstract

This study was conducted in the Naban River Watershed National Nature Reserve to analyse the indigenous medicinal knowledge and medicinal plant use of Lahu ethnic group. Results also were compared with medicinal plant knowledge of Hani ethnicity living in the same area.

Data on medicinal plant uses was collected using freelisting and semi-structured interviews with randomly selected informants. Plant specimens were collected, identified and deposited at the Herbarium of Xishuangbanna Tropical Botanical Garden. Data were analysed by use-reports. Importance indices including relative frequency of citation (RFC) and cultural importance index (CI) were calculated. Smith's salience index was assessed using Anthropac 4.08. Consensus analysis was applied to measure informant agreement on plants used in different medicinal use categories and statistically compared between Lahu and Hani.

A total of 229 medicinal plants belonging to 185 genera and 90 families were used by Lahu. Chiefly utilised families were *Asteraceae* (8.3%), *Fabaceae* (6.9%) and *Lamiaceae* (3.9%). Most culturally salient medicinal species among Lahu were *Aristolochia* spp. (Smith's SI=0.25), *Fibraurea recisa* Pierre (0.12), *Eupatorium coelestinum* L. (0.10), *Chloranthus spicatus* (Thumb.) Makino (0.09) and *Helicteres angustifolia* L. (0.09). Infections/infestations use category showed highest percentage of use reports (22.5%) and highest degree of consensus among Lahu. Blood system disorders and circulatory system disorders categories showed the second and third highest degrees of consensus.

The diversity of medicinal species utilised by the two ethnic groups show 30% overlap. However, there were similarities and differences in the patterns of medicinal plant knowledge. It seems that medicinal plant use, plant part, plant habit and habitat selection of Lahu and Hani is determined by ecological conditions and culture has more effect on the other aspects of plant use such as plant family selection.

Keywords: medicinal plants, folk medicine, traditional knowledge, cross-cultural comparison, comparative ethnobotany, Xishuangbanna

4.1 Introduction

Medicinal plants are crucial components of traditional and folk medicine. For many people living in developing countries they are the only available medicine for their health problems (Colfer, 2008). People living in different environments have adapted themselves to these environments and have learnt to get benefits from the surrounding biological diversity. Ethnobotanical studies try to document these adaptations and analyse the relationships between people and plants (Schultes & Reis, 1995). However, many early ethnobotanical studies were descriptive compilations of useful plant inventories (Frei et al., 1998; Giday et al., 2003; Lykke, 2000), but recent works focus more on the quantitative analysis of the patterns of plant use and cross-cultural comparisons of ethnobotanical data (Heinrich et al., 1998; Moerman et al., 1999; Shepard, 2004; Collins et al., 2006; Inta et al., 2008; Tardio & Pardo-de-Santayana, 2008; Vandebroek, 2010). Quantitative analysis of ethnobotanical knowledge involves the use of indices to evaluate the cultural or relative popularity and salience or usefulness of plant species or habitats (Albuquerque et al., 2006; Benett & Prance, 2000). Cross-cultural comparison can focus on quantitative evaluation of the plant taxa shared by studied groups and specific uses of these taxa among different groups.

Lahu and Hani minorities are called hill tribes as their villages are normally located on higher altitudes than other minorities living in the same region. They are transboundary ethnic groups living in Yunnan Province of China, Myanmar, Laos, Thailand and Vietnam (Mitchell & Yuan, 2004). Lahu and Hani languages belong to the Tibeto-Burman language family and both are oral (Mitchell & Yuan, 2004). However, recently some efforts have been made to use Latin scripts for Hani language, yet Lahu language still has no scripts. The Lahu of Yunnan Province began changing from hunter-gatherer lifestyle to settled village life in 1957 (Huai & Pei, 2004). They have rich knowledge of plants and their uses, and there are some ethnobotanical records for both minorities in Yunnan (Pei, 1985; Huai & Pei, 2004a & b; Huai et al., 1998; Huai et al., 2000; Lee et al., 2008; Inta et al., 2008; Ghorbani et al., 2011). However cross-cultural comparison of ethnobotanical knowledge between these two groups has not been investigated yet. Cross-cultural comparison could help us to better understand the relationship between people and plants and their uses and to find out if the use of these plants is a reflection of the

ecological conditions and surrounding vegetation in which people are living or it is a more cultural bound phenomena. Since Lahu and Hani are living under similar ecological conditions, if their plant use patterns are determined by the availability of plant resources, then little difference in plant use patterns between two groups is expected (ecological divergence). On the other hand, if the plants use traditions are culturally bound, then large differences between two groups is expected (cultural coherence). This paper aims to analyse quantitatively the medicinal plant knowledge of Lahu and compare it with secondary data on medicinal plant use of Hani minority living in the same geographical area (Naban River Watershed National Nature Reserve) using Totter and Logan's (1986) "informant agreement ratio". Also salience indices are used to compare the habitat preference of two cultures.

4.2 Material and Methods

4.2.1 Study area

Naban River Watershed National Nature Reserve (NRWNNR) is located in Xishuangbanna Prefecture (22° 04´- 22° 17´N & 100° 32´- 100° 44´E), lying on the west bank of Lancang (Mekong) river, covering a total area of 266.6 km^2 (Fig. 1). It was established in 1991 based on the UNESCO's "Man and Biosphere" concept as a Provincial Nature Reserve and approved as National Nature Reserve in 2000. The nature reserve is rich in biological and cultural diversity with six main vegetation types (tropical seasonal rainforest, tropical montane evergreen broadleaf forest, deciduous broadleaf forest, warm coniferous forest, bamboo forest, and shrublands) and five different ethnic groups (Dai, Hani, Lahu, Yi, Bulang) (Yunnan Environmental Protection Bureau, 2006; Zhu, 2008). A total population of 5538 people is distributed in 30 villages in the area. These ethnic groups live mainly in different villages. Lahu people in NRWNNR are living in 15 villages, comprising 49.9 % of the total population in the reserve whereas Hani are living in 6 villages, consisting 23.5% of the nature reserve total population (Yunnan Environmental Protection Bureau, 2006). The nature reserve is divided into three functional zones; the core zone which is strictly protected from extractive activities, the buffer zone and the experimental zone which are both used for agricultural activities. Since introduction of rubber (*Hevea brasiliensis* Müll. Arg.) in the 1980s, most of the agricultural lands and collective forests suitable for rubber cultivation were converted into rubber plantations which resulted in the reduction of forest cover in the experimental as well as buffer zone except at higher altitudes (Tang et al., 2010). These highland areas are mainly home to Lahu and Hani.

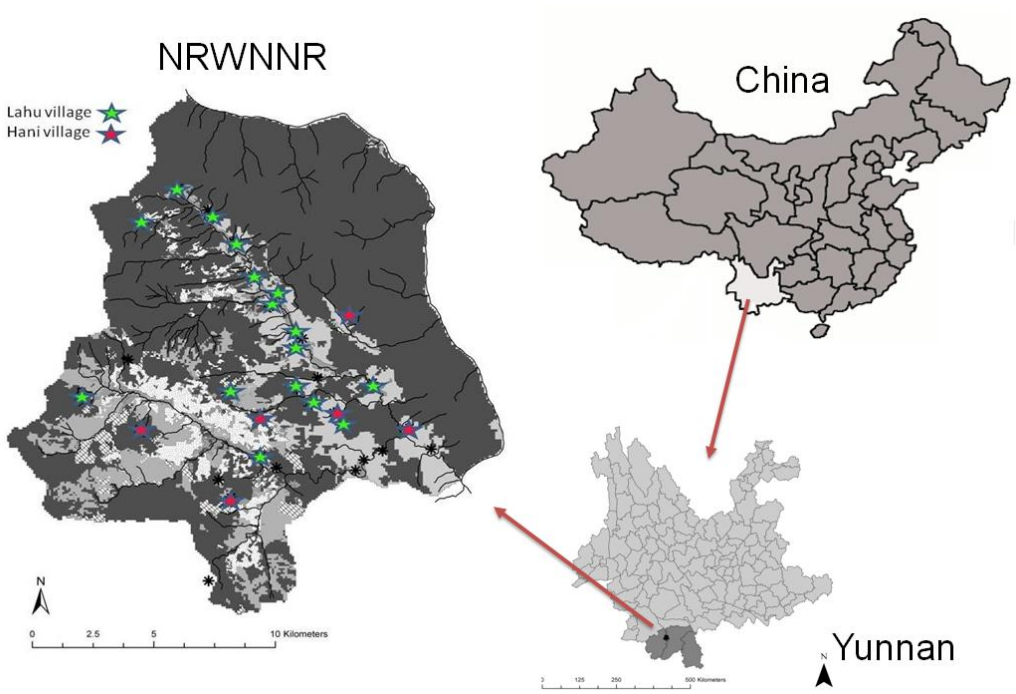


Figure 1. Map of the study area and villages.

4.2.2 Ethnobotanical data collection

Prior to starting the field work, research and plant collection permits have been issued by governmental officials and NRWNNR administration office. Research groups were introduced to the village leaders by NRWNNR officials and objectives of the project were explained to obtain consent from village leaders and elders. Field survey was started in January 2008 and lasted for twelve months. Same methodologies were used for data collection and data analysis for both ethnic groups and research was conducted at the same time period. Ethnobotanical data was collected through freelisting interviews with randomly selected informants and semi-structured and field interviews with key informants selected after freelisting (Stepp, 2005; Berlin & Berlin, 2005; Quinlan, 2005). Key informants include traditional healers, herbalists and plant collectors. Interviews were supplemented with plant sample collection during which informants were asked to describe the uses of plants. A total number of 133 Lahu persons, 52 female (39.1%) and 81 male (60.9%) for freelisting and 83 persons, 53 male (63.9%) and 30 female (36.1%) for semi-structured interviews were interviewed. Plant specimens were collected and identified with the help of experts from Xishuangbanna Tropical Botanical Garden (XTBG). One set of voucher samples were stored at the Herbarium of NRWNNR and one set were deposited at the Herbarium of XTBG (HXTBG). Nomenclature follows the Flora of China, checklist of the Flora of

China, local checklists and Tropicos® (Missouri Botanical Garden 2011, Li et al. 1996, Flora of China 1994 to present).

4.2.3 Data analysis

Data on recorded medicinal plants was analyzed by use-reports: the event resulting from informant *i* mentioning the use of the species *s* in the use-category *u* is defined as a use-report (Kufer et al., 2005; Tardío & Pardo-de-Santayana, 2008). For example, if species *s* was mentioned by informant *i* for treating headache, a single use was recorded and if species *s* was mentioned by informant *i* for headache and stomachache, two citations were recorded and so on (Collins et al., 2006). Medicinal uses were categorized following Cook (1995). Quantitative analyses were conducted using synthetic indices. Different indices were compared to better understand the pattern of plant knowledge and use. Relative frequency of citation (RFC) is an importance index which is calculated by dividing the number of informants who mentioned the use of species *s* (FC_s) by the total number of informants (N) (Tardío & Pardo-de-Santayana, 2008).

$RFC_s = FC_s/N$

RFC varies from 0 (nobody refers to the plant as useful) to 1 (all informants mention the use of the species) (Tardío & Pardo-de-Santayana, 2008). Another applied index is the cultural importance index (CI) calculated by the following formula:

$$\mathrm{CI}s = \sum_{u=u1}^{u\mathrm{NC}} \sum_{s=s1}^{sN} \mathrm{UR}us/\mathrm{N}$$

where *u* is the category of use, u_{NC} is the total number of different use categories (u_1, u_2, …u_{NC}), UR is the total number of use-reports for the species *s* and N is the total number of informants (Signorini et al., 2009; Tardío & Pardo-de-Santayana, 2008). The theoretical maximum value for CI is the total number of use-categories (NC) (Tardío & Pardo-de-Santayana, 2008). For species with only one use, the index is equal to RFC. Smith's salience index (Smith, 1933) was calculated using Anthropac 4.08 (Borgatti, 1996a). It identifies the most frequently cited species in a given cultural domain and ranges from 0 to 1, showing the highest salience at 1.

$S_j=1\ r_j1/n1$ and $S_j= nr_j/n1$

Where r_j is position of item *j* in the list, and *n* is the number of items in the list. To compute the overall salience index, the average S_j across all respondents is taken (Smith, 1993; Borgatti,

1996b). Informant agreement ratio (IAR) (Trotter & Logan, 1986) was used to measure the agreement between informants concerning what plants are used for specific use categories.

IAR= N*ur* – N*t* / N*ur* – 1

Where N*ur* is the number of citations in each use category and N*t* is the number of taxa which are used in that use category. IAR ranges between 0 and 1 and a value of 1 indicates high degree of consensus for given use category and a well-defined medicinal plant tradition (Heinrich et al., 1998). Chi-square analysis (significance at $p > 0.05$) was used to compare patterns of medicinal plant use between Lahu and Hani. SPSS software version 16 has been used for statistical analysis.

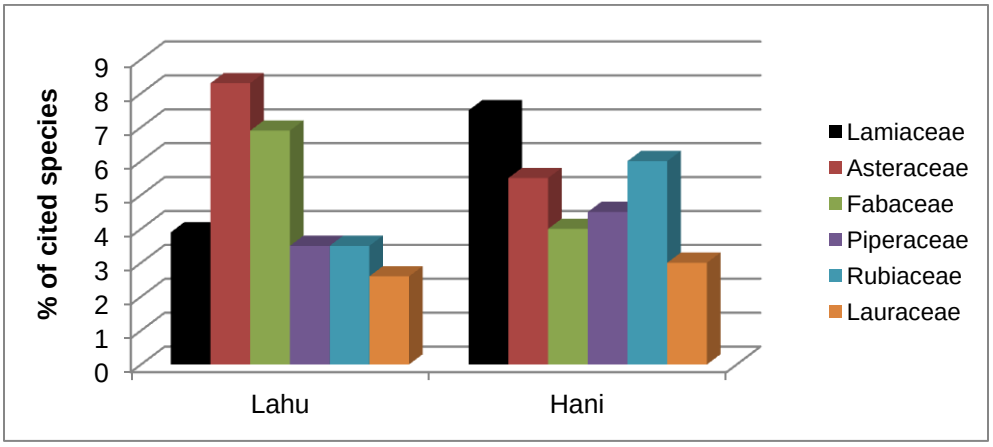
4.3 Results and discussion

4.3.1 Plant species and plant parts used

A total of 229 species belonging to185 genera and 90 families were used by Lahu in NRWNNR. A list of species and their uses are given in table 1. Most of these species used (76%) were from common flora of area and 8.1% of species used were endemic to China while the rest (15.9%) were weeds or naturalized species. For Hani, 199 species were recorded for their medicinal purpose (Ghorbani et al., 2011). The Lahu and Hani share 101 medicinal species which mean 30.7% overlap between plant species used by the two ethnic groups. Huai et al. (2000) found only 2.99% and 8.82% overlap of medicinal plants used by Lahu in China and Thailand. Inta et al. (2008) found only 16.8% of overlap between medicinal plant species of Akha communities in China and Thailand. These studies were comparing two communities of the same ethnicity in different geographical areas. They suggested ecological diversification (resulting in different regional medicinal ethnoflora) as reason for this low overlap, which means that the environment might have a higher effect on the selection of species than cultural background. Communities with the same cultural background but living in different geographical areas try to replace their pharmacopeias with available similar species (botanically or effectiveness) to the ones used before. However, for Lahu and Hani in NRWNNR, 30% overlap could be expected as they are living in the same environment although they have different cultural backgrounds. Major utilized plant families by Lahu in NRWNNR were *Asteraceae* (8.3%), *Fabaceae* (6.9%) and *Lamiaceae* (3.9%). Comparison of main plant families for Lahu and Hani is given in Figure 2. Nearly fifty percent (47.19%) of families were represented by a single species, 39.32% by two to four species and 13.48% by five and more species. Roots

were the most common plant part (31.7%) used by Lahu followed by leaves (23.6%), whole plant (16.4%), stems (15%), barks (5.8%) and aerial parts, fruits and flowers (together 7.5%). Similar patterns were seen for Hani however, root and leaf use were more dominant compared to the use by Lahu. Huai and Pei (2004) also found that leaves and roots were the most frequently used parts among Lahu in Jinping Miao County.

Figure 2. Plant families with highest percentage of cited species for Lahu and Hani.



4.3.2 Plant life forms and habitats

The percentage of plant life forms commonly used by Lahu and Hani also show a similar pattern, as herbs were the most common life form (53.5% and 43.2%) followed by shrubs (17.4% and 25.1%), trees (13.9% and 14.5%) and lianas and climbers (8.7% and 7.1%) respectively. Medicinal plants used by Lahu were mainly collected from the forest (51.2%) but also from fallow lands (20.4%) and arable land (18.8%) while only a small percentage was collected from homegardens (9.4%) or young rubber plantations (1.2%). The preferred locality of collection by Hani was similar to Lahu, with 51.9% of plants being collected from forest, 22.5% from fallow land, 14.5% from arable land and 11.1% from homegardens. However, Hani did not report rubber plantations as source of medicinal plants and they tend to grow more medicinal plants in homegardens than Lahu.

4.3.3 Use records and use categories

In total, 568 use reports were documented, which were categorized in 20 use categories (Table 2). The category infections/infestations had the highest percentage of use reports (22.5%) and were presented by 64 species. This use category had with an IAR value of 0.5, the highest degree of consensus. Blood system disorders (0.87%, 3 spp) and circulatory system disorders

categories (4.3%, 15 spp) showed the second and third highest degrees of consensus among informants (IAR= 0.5 and 0.41 respectively). Comparison of IAR values for different use categories among Lahu and Hani is given in Table 2. Often similar species of the same genus, which are used for the same purpose, are considered as one species by local people, thereby reducing the value of IAR by increasing the number of species in the given use category. To avoid this ethnospecies effect, an IAR at the genus level was calculated for each use category. Four use categories have the IAR value of zero which means no consensus among informants for the use of species in these categories. Highest consensus amongst Hani was shown on digestive system disorders (0.668), circulatory system disorders (0.489) and infections/infestations category (0.416). Use categories mentioned by Lahu were more diverse than Hani (20 versus 17), which could be interpreted as having more knowledge on the health conditions or medicinal plant use as they also use more medicinal species than Hani. In addition, some plants were reported to be used in veterinary medicine. If we assume that use categories with the highest number of use reports are the most prevalent health problems in the community, then infections and infestation problems are more common or more important health problems for Lahu than Hani. A paired sample t-test was used to determine if there was any difference among the average IAR of use categories between Lahu and Hani. Categories with undefined value were excluded from this analysis. Results showed no significant difference (t Stat= 1.3583, $p > 0.05$, df= 14) between IAR values of Lahu and Hani. Inta et al. (2008) also used similar analysis and did not find significant differences in IARs of Akha communities in China and Thailand which they interpreted as similar medicinal plant traditions between two communities. They conclude cultural coherence as the main ground for medicinal plant knowledge which adapted with different ecological conditions of communities to shape the medicinal plant knowledge of each community. However, Collins et al. (2008) found significant differences on medicinal plant use traditions between Laklei and Idate villagers of East Timore, although they were living in similar monsoon forested area. Shepard (2004) also found that two Amazonian neighbor communities use different medicinal species selected from the same set of plant families.

Table 2. Informant agreement ratio values for different use categories among Lahu and Hani.

Use category*	**IAR**		
	Lahu		Hani
	Genera	Species	Species
Infections/ Infestations	0.57	0.508	0.416

Blood System Disorders	0.5	0.5	0.111
Circulatory System Disorders	0.417	0.417	0.486
Digestive System Disorders	0.46	0.393	0.668
Unspecified Medical Disorders	0.453	0.375	0.187
Muscular-Skeletal Disorders	0.405	0.319	0.184
Pain	0.277	0.222	0
Respiratory System Disorders	0.187	0.166	0.214
Nutritional Disorders	0.333	0.166	0
Inflammations	0.193	0.161	0.09
Genitourinary System Disorders	0.156	0.125	0.111
Injuries	0.166	0.055	0
Mental Disorders	0	0	N/A
Skin/Subcutaneous Cellular Tissue Disorders	0	0	0
Poisonings	0	0	0.111
Pregnancy/Birth/Puerperium Disorders	0	0	0
Sensory System Disorders	0	0	UND
Endocrine System Disorders	UND	UND	N/A
Ill-defined System Disorders	UND	UND	0
Nervous System Disorders	UND	UND	N/A

UND= undefined, N/A= not applicable, * after Cook (1995)

4.3.4 Importance indices

Analysis of freelists revealed that the most salient species among Lahu include *Aristolochia* sp. (SI= 0.255), *Fibraurea recisa* Pierre (0.121), *Eupatorium coelestinum* L. (0.109), *Chloranthus spicatus* (Thumb.) Makino (0.099) and *Helicteres angustifolia* L. (0.09). The values of Smith's salience index shows that there are fewer consensuses on the important plants among Lahu than Hani, as the values for SI for Hani are larger than those of Lahu (Table 3). Some common weed species were seen as important medicinal species of Lahu. The importance (Smith's SI) of shared medicinal plants, i.e., the plant preference between Lahu and Hani was not significantly different (t Stat= -0.225, $p > 0.05$, df= 258) and the importance of medicinal plants seems to be more determined by a similar environment than by a cultural differences. Plant part used (Chi-squared= 45, $p= 0.271$, df= 40), plant habit (Chi-squared= 42, $p= 0.227$, df= 36) and

plant habitat (Chi-squared= 20, *p*= 0.22, df= 16) were not significantly different between Lahu and Hani (Table 4). This means that Lahu and Hani share a similar knowledge of plant part use, plant habit and selection of plants from similar habitats. This might show the effect of similar environment on the above defined aspects of plant use. However, there was a significant difference (at the plant family level) concerning the selection of plant families between Lahu and Hani (p <0.001). This could be interpreted as the effect of culture, i.e. the cultural background has more influence than the availability of plant resources on the selection of medicinal plants by Lahu and Hani. In a study on Andean and Amazonian societies, Vandebroek et al. (2004) concluded that other variables like the healing tradition of the households in each community rather than plant diversity in the studied area are important for medicinal plant knowledge of traditional healers. Inta et al. (2008) also reflected the role of cultural background in their results. They found some differences on the species and their uses between two communities of Akha in China and Thailand. However, IAR values were similar between the two communities. They suggested cultural coherence and ecological divergence for reasons of this similarity and differences respectively.

Table 3. Comparison of three importance indices and species ranking for Lahu and Hani.

Species	Lahu						Hani	
	Indices			Ranking			SI	Ranking
	SI	RFC	CI	SI	RFC	CI		
Aristolochia sp.	0.255	0.12	0.12	1	1	3	0.306	2
Fibraurea recisa Pierre	0.121	0.084	0.144	2	4	1	0.044	15
Eupatorium coelestinum L.	0.109	0.108	0.108	3	2	4	0.119	4
Chloranthus spicatus (Thumb.) Makino	0.099	0.096	0.144	4	3	1	0.067	9
Helicteres angustifolia L.	0.09	0.048	0.072	5	7	7	N/A	N/A
Crotalaria albida Heyne ex Roth	0.086	0.072	0.072	6	5	7	0.003	43
Crotalaria pallida Aiton	0.083	0.096	0.108	7	3	4	0.015	35
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley	0.082	0.096	0.132	8	3	2	0.035	17
Tacca chantrieri Andre	0.08	0.084	0.096	9	4	5	0.091	8
Verbena officinalis L.	0.077	0.084	0.108	10	4	4	0.062	10
Alstonia scholaris (L.) R. Br.	0.067	0.072	0.096	11	5	5	0.004	43
Paris polyphylla var. *yunnanensis* (Franch.) Hand.-Mazz.	0.063	0.048	0.06	12	7	8	0.037	16
Acorus tatarinowii Schott	0.053	0.06	0.072	13	6	7	0.035	17
Psidium guajava L.	0.051	0.096	0.096	14	3	5	0.103	6
Acorus calamus L.	0.049	0.048	0.06	15	7	8	0.051	13

Table 4. Differences in medicinal plant use patterns of Lahu and Hani. * *p* value is significant

Category	Pearson Chi- square	Degrees of freedom	*p* value
Plant part used	45.00	40	0.271
Plant Habit	42.00	36	0.227
Habitat	20.00	16	0.220
Plant family selection	531.704	120	0.000*

Table 1. . List of medicinal plants used by Lahu in NRWNNR. URs = use reports, plant part: R = root, L = leaf, St = stem, Rh = rhizome, Fl = flower, Fr = fruit, Ap = aerial parts, Ba = Bark, Wp = Whole plant. [1] The information given in brackets at the end of each species name refers to the collector and the number of the voucher specimen as deposited at XTBG

Scientific name [1]	Lahu name	Local Chinese name	Habit	Part used	Uses	Preparation	Administration	URs
Acanthaceae								
Baphicacanthus cusia (Nees) Brem. (A.G. 1822)	-	板蓝根	Shrub	Wp	Inner heat (flushing)	Decoction	Orally, drink	1
Gendarussa ventricosa (Wall.) Nees (A.G. 1971)	-	天红地蓝, 五金草	Shrub	L, R	Woman infertility, broken bone	Decoction, mashed	Drink, liniment	3
Justicia adhatoda L. (A.G. 2337)	-	绿兰子	Shrub	L	Ascariasis, broken bones, tuberculosis	Decoction, mashed and dressing on the belly	Dressing, orally drink	3
Phaulopsis dorsiflora (Retz.) Santapau (A.G. 1862)	-	肾炎草	Herb	R	Nephritis, lithiasis	Decoction	Orally drink	1
Acoraceae								
Acorus calamus L. (A.G.2404)	-	水上蒲	Herb	L, R, Wp	Stomachache, indigestion, inner heat, typhoid fever, tuberculosis	Decoction and infusion	Orally drink	7
Acorus tatarinowii Schott (A.G. 2046)	-	石上蒲	Herb	Wp	Stomach bloating, indigestion, inner heat, tuberculosis	Decoction	Orally drink	6
Actinidiaceae								
Actinidia umbelloides C. F. Liang (A.G. 2293)	a qiu det		Shrub	R	Dysmenorrhea	Decoction	Orally drink	1
Saurauia napaulensis DC. (A.G. 2338)	-	平地木	Tree	Wp	Tuberculosis, pneumonia	Decoction	Orally drink	1
Adiantaceae								
Adiantum capillus-veneris L. (A.G. 1931)	-	马蹄草	Herb	Ap	Stomachache, common cold	Decoction	Orally drink	2
Adoxcaceae								
Sambucus chinensis Lindl. (A.G. 1808)	-	栒风草	Herb	L	Vaginal itching one month after labor	Decoction	Bath	1
Anacardiaceae								
Choerospondias axillaris (Roxb.) B.L. Burtt & A.W. Hill (A.G. 2460)	ci jie	苦拐枣	Herb	L	Stomachache	Mashed	Dressing	1
Pegia nitida Colebr. (A.G.1772)	-	野枸木香藤	Liana	L	Wounds from gunshot	Mashed	Plaster	1

Rhus chinensis Mill. (A.G. 2442)	-	盐酸果	Shrub	L	Wounds from dog bit	Mashed	Dressing	1
Annonaceae *Fissistigma acuminatissimum* Merr. (A.G. 1779)	-	大力王	Liana	L, St, Ba	Dysmenorrhea, common cold, influenza, fever, meningitis, cough, body pain, broken bone	Decoction, mashed	Drink and plaster	9
Fissistigma polyanthum (Hook. f. & Thomson) Merr. (A.G. 2548)	-	香木料藤	Liana	R	Inflammation	Decoction	Drink	1
Apiaceae *Centella asiatica* (L.) Urb. (A.G. 2345)	-	马蹄菜	Herb	Wp	Dyspepsia, gastroenteritis	Decoction or eating raw	Drink	2
Oenanthe javanica (Blume) DC. (A.G. 2260)	na zhu	野芹菜, 水芹菜	Herb	Wp	Blood pressure	Decoction	Drink	1
Apocynaceae *Aganosma siamensis* Carib (A.G.2286)	wo ga gu tei	接筋草	Liana	L, St	Broken bone, fractures	Decoction	Drink	1
Alstonia scholaris (L.) R. Br. (A.G. 1768)	-	灯台树	Tree	L, St, R, Ba	Dysmenorrhea, common cold, influenza, fever, meningitis, whooping cough, body pain	Decoction and infusion	Drink	10
Amalocalyx microlobus Pierre (A.G. 2468)	-	野酸扁果树	Liana	R, St	Cardiovascular complains, malaria	Decoction	Drink	2
Rauvolfia verticillata (Lour.) Baill (A.G. 2547)	-	矮陀陀	Shrub	R	Dysentery	Decoction	Drink	1
Trachelospermum sp. (A.G. 2344)	-	龙金平	Shrub	St	Hepatitis	Decoction	Drink	1
Aquifoliaceae *Ilex umbellulata* (Wall.) Loes (A.G. 2339)	-	羊屎果树	Shrub	Ba	Diarrhea, hematochezia	Decoction	Drink	1
Araceae *Arisaema inkiangense* H. Li (A.G. 2467)	-	半夏	Herb	R	Rheumatism	Decoction	Orally	1
Lasia spinosa (L.) Thw. (A.G. 1928)	-	大刺芭菜, - 刺菜, 马桑官	Herb	St	Bronchitis, tonsillitis	Decoction	Drink	2
Rhaphidophora decursiva (Roxb.) Schott (A.G. 1956)	-	爬树龙	Liana	L, Wp	Broken bone, rheumatism and body numbness	Mashed	Plaster	2

Rhaphidophora hongkongensis Schott (A.G. 2553)	-	翠银草	Liana	Wp	Tonic for liver and lung	Decoction	Drink	2
Rhaphidophora hookeri Schott (A.G. 2567)	-	过山龙	Liana	St	Anemia, diarrhea	Decoction	Drink	2
Araliaceae *Aralia armata* (Wall.) Seem. (A.G. 1774)	-	桑官草	Shrub	L	Bronchitis, pneumonia, inflammation, tonsillitis	Decoction	Orally	4
Eleutherococcus trifoliatus (L.) S.Y. Hu (A.G.1705)	-	无家菜,无家菜	Shrub	L, St	Diarrhea, rheumatism, tuberculosis, injuries from fall	Decoction or raw, mashed	Drink or eat raw, plaster	4
Macropanax undulatus var. simplex H. L. Li (A.G. 1927)	-	七叶灵	Tree	St, Ba	Common cold, flu	Decoction	Drink	2
Schefflera chinensis (Dunn) H. L. Li (A.G. 1951)	-	龙爪树	Tree	Wp	Broken bones	Mashed	Plaster	1
Trevesia palmata (Roxb. ex Lindl.) Vis (A.G. 1943)	-	山月排	Shrub	St, R	Indigestion, conspitation, rheumatism, stomachache, pneumonia	Decoction	Drink	4
Aristolochiaceae *Aristolochia* sp.	-	大白芥	Vine	R	Stomachache, toothache, inner heat	Decoction or infusion and chewing	Orally drink	10
Asclepiadaceae *Cryptolepis buchananii* Schultes (A.G. 2344)	-	接筋藤	Liana	L	Tendon tension	Mashed	Plaster	1
Asparagaceae *Asparagus filicinus* Buch. -Ham. ex D. Don (A.G. 1922)	-	天冬	Herb	R	Tonic	Cooked with chicken	Orally, eat as meal	2
Asparagus subscandens F.T. Wang & S.C. Chen (A.G. 2246)	hong ai po	天冬	Herb	R	Tonic	Cooked with chicken	Orally, eat as meal	1
Aspidistra typica Baill. (A.G. 2416)	-	种子叶	Herb	L	Indigestion	Decoction	Drink	1
Polygonatum cirrhifolium (Wall.) Royle (A.G. 2241)	la ha ma ge	马尾根	Herb	Rh	Tonic	Decoction	Drink	1
Aspleniaceae *Neottopteris nidus* (L.) J. Sm. (A.G. 1814)	-	白弦尾	Herb	L	Difficulty and pain in breathing	Decoction	Drink	1

Asteraceae *Artemisia argyi* H. Lev. & Vaniot. (A.G. 2351)	-	青嵩, 蒿枝	Herb	L, R	Detoxification, stomachache, inner heat	Decoction, heating near fire and putting on belly	Externally dressing and orally as drink	4
Bidens pilosa L. (A.G. 1845)	-	叉叉草, 鬼针草	Herb	R, Ap, Wp	Vomiting, bleeding, fever, inner heat, sedative	Decoction	Dressing and bath	4
Centipeda minima (L.) A. Br. Et Asches (A.G. 1942)	-	恨地龙	Herb	Wp	Dermatitis	Decoction	Wash	1
Dichrocephala integrifolia (L.f.) O. Ktze (A.G. 1793)	-	鱼眼草	Herb	Wp	Fever, common cold, inflammation	Decoction	Drink	3
Eclipta prostrata (L.) L. (A.G. 2336)	-	河角莲	Herb	Wp	Tuberculosis	Decoction	Drink	1
Eupatorium coelestinum L. (A.G. 1672)	gu cha ,mo beel, na kai mu	解放草	Herb	Ap	Cuts , (stop) bleeding	Mashed	Plaster or dressing	9
Eupatorium japonicum Thunb. (A.G. 1756)	-	册兰	Herb	Ap	Fever, common cold	Decoction	Drink	1
Eupatorium odoratum L. (A.G. 1750)	a chu ge	肾茶, 飞机草	Herb	L, R	Kidney complains, homeostatic	Decoction	Drink	4
Hemistepta lyrata Bge (A.G. 1936)	-	白虎草	Herb	Wp	Stomachache, tuberculosis (only for men)	Decoction	Drink, liniment	5
Laggera pterodonta (DC.) Benth. (A.G. 1516)	-	臭铃铛	Herb	L, R, Ap	Inflammation, inner heat, sore throat	Decoction, mashed	Drink and plaster	4
Siegesbeckia orientalis L. (A.G. 1915)	-	泡布草(粘粘果)	Herb	R	Dyspepsia	Decoction	Drink	1
Sonchus arvensis L. (A.G. 1770)	-	下苦草, 苦马菜	Herb	L, Ap	Bleeding, burns, inner heat		Dressing and liniment	2
Sphaeranthus indicus L. (A.G. 1935)	-	大火红	Herb	Wp	Fever, stomachache	Decoction	Drink, wash	2
Spilanthes callimorpha A. H. Moore (A.G. 1846)	-	斑鸠窝	Herb	Wp	Rheumatism, paralysis of whole body	Mashed	Dressing	2

Vernonia cumingiana Benth. (A.G. 1851)	-	大参麻	Herb	R	Flu, injuries, rheumatism, malaria, common cold	grinded, decoction	liniment, drink	7
Vernonia saligna (Wall.) DC. (A.G. 1765)	chu pa	野草英, 大发散药	Herb	R, L	Bleeding, malaria, inflammation, stomachache	Mashed, decoction	Plaster, drink	5
Betulaceae *Alnus nepalensis* D. Don (A.G. 1950)	-	水冬瓜	Tree	L, Ba	Rheumatism, inner heat	Infusion as drink and also wrapped on the body	Externally and orally	2
Bignoniaceae *Mayodendron igneum* (Kurz) Kurz (A.G. 1916)	-	小海船	Tree	L, St, R	Tacheitis, pneumonia	Decoction	Drink	1
Oroxylum indicum (L.) Kurz (A.G. 2250)	-	海船	Tree	L, St, Ba	Inflammation, back injuries, inner heat	Decoction	Plaster, liniment	4
Campanulaceae *Campanumoea javanica* Blume (A.G. 2556)	na kai do ma	野人参/布冬根, 金钱豹	Herb	R	Tonic	Tincture or preparing with chicken stew	Orally, drink or eat as meal	1
Lobelia clavata E. Wimm (A.G. 1947)	-	大将军	Herb	R	Measles	Roasted and decoction	Drink	1
Cannabaceae *Trema orientalis* (L.) Blume (A.G. 1748)	a chu ge	亚罗青, 三叉叶	Tree	L, R	Inner heat, kidney problems	Decoction or infusion	Drink	3
Caryophyllaceae *Myosoton aquaticum* (L.) Moench (A.G. 1809)	-	田鸡黄莲	Herb	Wp	Inner heat	Decoction	Drink	1
Celasteraceae *Celastrus monospermus* Roxb. (A.G. 1976)	-	紫金藤, (大红疙瘩)	Shrub	L, St	Broken bone and bone injuries	Mashed	Plaster	2
Chenopodiaceae *Chenopodium ambrosioides* L. (A.G. 1939)	-	细地留	Herb	Wp	Dermatitis	Decoction	Wash	1
Chloranthaceae *Chloranthus holostegius* (Hand. -Mazz.) P ei et Shan (A.G. 2239)	-	细星	Shrub	R	Common cold, malaria	Decoction	Drink	4
Chloranthus spicatus (Thumb.) Makino (A.G. 1782)	a chu ka xi	叶子兰	Herb	R, Sr, L	Gynecological problems, cold, fever, injuries from fall, broken bone and fractures, rheumatism,	Decoction of root, roots are mashed and used as plaster	Drink, Plaster	16

					food poisoning, inner heat			
Cibotiaceae *Cibotium barometz* (L.) J. Sm. (A.G. 2281)	da ga	大重	Herb	R	Mental problems	Decoction	Drink	1
Combretaceae *Combretum latifolium* Blume (A.G. 2546)	-	野黄山藤	Liana	L, St	Gastroenteritis and indigestion, rheumatism	Decoction	Drink	2
Convolvulaceae *Argyreia velutina* C. Y. Wu (A.G. 2285)	-	合包叶（红白芥）	Shrub	R	Stomachache, inner heat	Decoction	Drink	2
Cuscuta chinensis Lam. (A.G. 1838)	-	无根藤	Herb	Wp	Edema	Decoction	Wash	1
Cucurbitaceae *Cucumis hystrix* Chakrav. (A.G. 2516)	-	老鼠黄瓜	Vine	R, Fr	Indigestion, gastroenteritis and abdomen over-heat	Decoction	Drink	3
Cyperaceae *Carex baccans* Nees (A.G. 1917)	-	麻鸡饭	Herb	R	Inner heat	Decoction	Orally	1
Cyperus kyllingia Endl. (A.G. 2295)	-	四棱草	Herb	Wp	Common cold and cough	Decoction	Drink	1
Dioscoreaceae *Tacca chantrieri* André (A.G. 2514)	qia bei nan	黑冬叶根	Herb	R	Stomachache, inner heat,	Decoction or infusion	Drink	8
Dryopteridaceae *Polystichum christianae* (Jenman) Underw. & Maxon (A.G. 1937)	-	细盐草(节节长)	Herb	Ap	Dermal wounds, soreness	Grind	Plaster	1
Ebenaceae *Diospyros kaki* Thunb. (A.G. 1781)	-	海船,野柿花	Tree	R	Antidote	Decoction	Drink	1
Equisetaceae *Hippochaete debilis* (Roxb. ex Vaucher) Holub (A.G. 1854)	-	笔管草	Herb	Ap	Menstrual disorders, menses, edema	Decoction or infusion	Drink	3
Euphorbiaceae *Baccaurea ramiflora* Lour. (A.G. 1837)	-	小红孩, 三丫果	Tree	R	To open child appetite	Decoction	Drink	1
Ricinus communis L. (A.G. 1834)	-	蓖麻子	Herb	St	Children ear inflammation (septic)	Heat by fire and blow into ear	Inhale	1
Fabaceae *Acacia pennata* (L.) Willd. (A.G. 2341)	Ga dei, mai gan	臭菜, 大竹	Shrub	R, St	Insomnia	Decoction	Orally	1

Albizia kalkora (Roxb.) Parin (A.G. 1863)	-	樱嵩树	Tree	R, L	Injuries from falls, tuberculosis, rheumatism	Leaf decoction wrapped and root decoction as drink	Externally as dressing and orally as drink	3
Bauhinia aurea H. Levl. (A.G. 2446)	-	鸡血藤	Liana	St, R	Anemia, rheumatism, enrich the blood	Decoction	Orally	4
Bauhinia variegata L. (A.G. 2120)	-	白花铁打藤	Tree	St, Ba	Diarrhea, rheumatism	Decoction	Orally and externally as dressing	2
Caesalpinia sappan L. (A.G. 1825)	-	苏木	Tree	L, St, R	Gynecological problems, edema, injuries, backache	Decoction	Dressing and drink	5
Codariocalyx motorius (Houtt.) H. Ohashi (A.G. 1810)	-	葫芦草	Shrub	R	Nephritis	Decoction	Drink	1
Crotalaria albida Heyne ex Roth. (A.G.2346)	-	大狗灵	Herb	Wp	Relieving constipation, cough, inner heat	Decoction	Drink	6
Crotalaria pallida Aiton (A.G. 1924)	-	小狗灵	Herb	St, R, Wp	Fever, common cold, intestine and stomach dryness, inflammation, inner heat	Decoction	Drink, liniment	9
Dalbergia pinnata (Lour.) Prion. (A.G. 1786)	-	接骨丹	Shrub	L, St	Broken bones, burn	Mashed and juice used as lotion for burns	Plaster, lotion	2
Dendrolobium triangulare (Retz.) Schindl. (A.G. 1923)	-	三台红花, 野饭豆	Shrub	R, wp	Typhoid fever, malaria	Decoction	Drink	2
Flemingia macrophylla (Willd.) Kuntze ex Merr. (A.G. 2440)	-	小兰花	Shrub	Ba	Inner heat	Decoction	Drink	1
Phylacium majus Collett & Hemsl. (A.G. 2545)	-	小过山龙	Herb	Wp	Rheumatism	Decoction	Drink	1
Pueraria phaseoloides (Roxb.) Benth. (A.G. 1857)	-	小割马藤	Herb	R	Alcoholic intoxication	Decoction	Drink	1
Shuteria involucrata (Wall.)Wight & Arn. (A.G. 1858)	-	豪猪草（铜钱草）	Herb	St	Cough, common cold, fever	Decoction	Drink	2

Spatholobus suberectus Dunn (A.G. 2438)	la ma dei	老灌藤	Vine	R, St, L	Diarrhea	Decoction	Drink	2
Gleicheniaceae *Dicranopteris linearis* (Burm. f.) Underw. (A.G. 1933)	-	节节排	Herb	Ap	Rheumatism and joint complains	Decoction	Liniment	1
Gnetaceae *Gnetum montanum* Markgr. (A.G. 1953)	-	苦链子藤	Liana	St, Ba	Knee fracture, arthritis, rheumatism	Grinded and concentrated decoction	Plaster	2
Hydrangeaceae *Dichroa febrifuga* Lour. (A.G. 2202)	-	三台红花	Shrub	R	Malaria	Decoction	Drink	1
Hypoxidaceae *Curculigo capitulata* (Lour.) Kuntze (A.G. 1885)	-	猴子背金叶	Herb	R	Stomachache, common cold	Decoction	Drink	2
Lamiaceae *Clerodendrum brachystemon* C.Y.Wu & R.C. Fang (A.G. 1771)	-	臭牡丹	Herb	L	Infection, burning	Mashed	Plaster	2
Clerodendrum bungei Steud. (A.G. 1843)	mie mu ma	白牡丹花	Herb	R, St	Stomachache, indigestion, vomiting, gynecological problems, headache, inner heat, food poisoning	Decoction	Drink	7
Clerodendrum serratum (L.) Moon (A.G. 2346)	-	大三对结	Herb	L, R	Malaria, tuberculosis	Decoction	Drink	2
Colebrookea oppositifolia Sm. (A.G. 1911)	-	黑头草	Shrub	L	cuts, infected wounds	Mashed and heated by fire	Plaster	1
Microtoena patchoulii (C. B. Clarke ex Hook. f.) C. Y. Wu & S.J. Hsuan (A.G. 1813)	-	藿香	Herb	L	Cough	Infusion	Drink	1
Ocimum basilicum L. (A.G. 1519)	-	小绿篱	Herb	L, Ap	Inner heat	Infusion, raw	Drink, eat raw	2
Lauraceae *Cinnamomum bejolghota* (Buch.- Ham.) Sweet (A.G. 1932)	-	小年香树	Tree	Ba	Broken bone, cuts	Mashed	Plaster and liniment	2
Lindera sp. (A.G. 1849)	-	鱼金藤	Shrub	Ba	Poison for fishing, dermatitis	Decoction	Wash	1
Litsea cubeba (Lour.) Pers. (A.G. 1580)	-	木姜子	Tree	St, R, Ba	Dysmenorrhea, cold, nose run, fever, meningitis, body pain	Decoction	Drink	8

Litsea martabanica (Kurz) Hook. f. (A.G. 2450)	-	大树萝卜	Tree	Fr	Pneumonia in children	Decoction	Drink	1
Neocinnamomum caudatum (Nees) Merr (A.G. 1773)	-	清香树	Tree	L, St, R	Dysmenorrhea, inner heat, fever, common cold, influenza, body pain, meningitis, inflammation,	Decoction, mashed	Drink, plaster	7
Liliaceae *Disporopsis longifolia* Craib (A.G. 1940)	-	扁竹青, 藤林草	Herb	L, St	Inflammation, cough, bronchitis	Decoction	Drink	2
Ophiopogon japonicus (L. f.) Ker Gawl. (A.G. 2562)	-	甜蜜草	Herb	Wp	Eye disease, eye sore and eye dazzle, malaria	Cook with refined sugar and egg or make stew	Eat as meal	2
Loranthaceae *Scurrula atropurpurea* (Blume) Danser (A.G. 2543)	-	寄生草	Epiphyte	Wp	Heart complains, gynecological problems, infertility, rheumatism	Decoction	Drink	3
Lycopodiaceae *Lycopodiella cernua* (L.) Pic. Serm. (A.G. 1803)	-	脆盐草	Herb	Wp	Hemorrhoid, dermatitis	Decoction	Wash	2
Lygodiaceae *Lygodium japonicum* (Thunb.) Sw. (A.G. 1802)	-	斑鸠窝, 海金草	Herb	Ap	Rheumatism, paralysis of whole body	Decoction	Drink	2
Magnoliaceae *Lirianthe henryi* (Dunn) N.H. Xia & C.Y. Wu (A.G. 1784)	zhu bei jie	大年香树, 大叶玉兰	Tree	L, Ba, R	Enhances mother lactation, broken bone	Grinded and heat by fire	Plaster and liniment	2
Schizandra plena A. C. Sm. (A.G. 2331)	-	通情香	Tree	St, R	Common cold, cough	Decoction	Drink	2
Malvaceae *Abelmoschus sagittifolius* (Kurz) Merr. (A.G. 1860)	-	拔毒散	Herb	L, R	Diarrhea, callosity	Decoction, Grind and make into powder and put on skin	Orally, externally as plaster	2
Helicteres angustifolia L. (A.G. 1839)	-	野芝麻	Shrub	R	Stomach, constipation, diarrhea, gastroenteritis, dysentery, malaria, typhoid fever, inner heat	Decoction	Drink	8
Sida szechuensis Matsuda (A.G. 1915)	-	小拔毒散	Herb	R, L	Inflammation, common cold, fever	Leaf used as dressing, root for decoction	Dressing, drink	3

Marattiaceae *Angiopteris* sp. (A.G. 1764)	-	马蹄根	Herb	Frond base	Hepatitis, inner heat	Decoction	Drink	3
Melanthiaceae *Paris polyphylla* var. *yunnanensis* (Franch.) Hand.-Mazz. (A.G. 2466)	pu ba a po	七月一枝花	Herb	Rh	Bleeding, stomachache, typhoid fever, inner heat	Powdered, infusion	Plaster, drink	5
Melastomataceae *Melastoma malabathricum* L. (A.G. 2292)	a nie, guai jie	洋户官	Herb	L, R	Broken bone, ache of waist, dysmenorrhea	Decoction, mashed	Drink , plaster	3
Meliaceae *Cipadessa baccifera* (Roth) Miq. (A.G. 1914)	-	亚罗牵	Herb	L,R	Dysmenorrhea, common cold, influenza, fever, Meningitis, whooping cough, body pain	Decoction	Drink	7
Menispermaceae *Cissampelos pareira* L. (A.G. 2031)	-	解药,三大黄	Vine	R	Stomachache	Decoction	Drink	1
Fibraurea recisa Pierre (A.G. 1910)	-	大黄藤	Vine	St, R	Heart complains, dysmenorrhea, diarrhea, influenza, fever, body pain, meningitis, malaria, inflammation, bone injuries, rheumatism, inner heat	Decoction, mashed	Drink and plaster	14
Parabaena sagittata Miers (A.G. 1807)	-	梨板叶	Herb	L,St	Wound swelling	Mashed	Dressing	1
Moraceae *Ficus auriculata* Lour. (A.G. 2053)	-	象蹄叶	Tree	Wp	Inner heat	Decoction	Drink	1
Ficus hirta Vahl (A.G. 2555)	ma nao xi	鸡束果叶	Tree	R, Wp	Stomachache, nipple inflammation and nipple lump-formation	Dried and pulverised	Eat with honey	2
Ficus hispida L.F. (A.G. 1801)	-	火通树	Tree	St	Abdominal bloating, indigestion	Decoction	Drink	1
Ficus semicordata Buch.-Ham. ex Sm. (A.G. 2026)	-	鸡束果	Tree	Fr	Diarrhea	-	Eat raw	1
Musaceae *Ensete glaucum* (Roxb.) Cheesman	-	大屁股芭蕉	Herb	L	Governance edema	Mashed	Plaster or dressing	1
Musa acuminata Colla	-	芭蕉心	Clum	St	Wounds from gunshot	Mashed	Plaster	1
Musa sp.	-	芭蕉香	Clum	R	Common cold, tuberculosis	Decoction	Drink	2

Myrsinaceae *Embelia ribes* Burm. f. (A.G. 1841)	no go dei, jie jie fa ton	野山苔, 泡筒果	Shrub	L, St, R	Gastroenteritis and dysentery, diarrhea, pink eye, enteritis	Decoction	Drink	4
Myrtaceae *Psidium guajava* L. (A.G.1703)	jiu baqi jie	马梨甘	Tree	L	Diarrhea	Infusion or decoction	Eat raw, drink	8
Syzygium szemaoense Merr. & L.M. Perry (A.G. 1912)	-	羊屎果	Shrub	L, R	Gum swelling, toothache	Leaves are chewed or mashed and put on the teeth, root used for decoction	Chew and drink	2
Dendrobium crepidatum Lindl. & Paxton (A.G. 2276)	-	大黄草	Epiphyte	Wp	Common cold, cough, heat in lung	Decoction	Drink	2
Dendrobium sp. (A.G. 2233)	-	细黄草	Epiphyte	Wp	Common cold, cough, inner heat, rheumatic pains	Decoction	Drink	4
Dendrobium terminale E. C. Parish & Rchb. f. (A.G. 1812)	-	细螃蟹腿	Epiphyte	Wp	Rheumatism	Decoction	Drink	1
Vanda coerulescens Griff (A.G. 1859)	-	秀竹兰	Epiphyte	Wp	Cough, heat in lung	Decoction	Drink	1
Oxalidaceae *Oxalis corniculata* L. (A.G. 1517)	-	老鼠芫细	Herb	Ap	Fever, inflammation	Mashed	Dressing	2
Papaveraceae *Dactylicapnos scandens* (D. Don) Hutch. (A.G. 2133)	-	豌豆齐	Herb	L, R	Cuts	Mashed	Plaster	1
Passifloraceae *Passiflora wilsonii* Hensl. (A.G. 2434)	-	半截观音	Vine	R	Syphilis	Decoction	Drink	1
Pentaphylaceae *Eurya groffii* Merr. (A.G. 2540)	-	野茶树	Shrub	L, R	Dermal problems, infections, sore throat	Decoction	Drink and bath	2
Ternstroemia gymnanthera (Wight & Arn.) Bedd. (A.G.1785)	-	野八角	Shrub	St, R	Dysmenorrhea, cold, influenza, fever, meningitis, body pain, inner heat	Decoction	Drink	8
Phyllanthaceae *Phyllanthus emblica* L. (A.G. 1918)	-	橄榄树	Tree	St, Ba, Fr	Dysmenorrhea, inner heat, fever, common cold, influenza, body pain, meningitis, inflammation, headache	Decoction	Drink	6

Piperaceae *Piper boehmeriifolium* (Miq.) Wall. ex C. DC. (A.G. 1726)	-	小麻疙瘩, 大疙瘩	Shrub	L, R	Broken bones, fractures	Mashed	Plaster	3
Piper chaudocanum C. DC. (A.G. 2240)	-	小歪兰(歪叶子兰)	Liana	L, R	Fever, common cold, malaria,	Decoction	Drink	3
Piper dolichostachyum M.G. Gilbert & N.H. Xia (A.G. 2439)	-	香红疙瘩	Herb	R	Listless (weak)	Decoction	Drink	1
Piper flaviflorum DC. (A.G. 2558)	-	辣藤, 小疙瘩	Liana	R,St, L	Typhoid fever, broken bone, rheumatism, arthritis, bruise, common cold	Decoction, tincture, mashed	Plaster, drink	8
Piper longum L. (A.G. 1926)	-	紫金藤	Liana	St, Wp	Injuries from falls, backache, rheumatism	Mashed	Plaster	3
Piper sarmentosum Roxb. (A.G. 1586)	pa bai	辣藤, 绿子叶	Herb	L, R	Gynecological problems, common cold, broken bone, rheumatism	Mashed and heated by fire, decoction	Plaster, liniment, drink	4
Piper semiimmersum C. DC. (A.G. 1719)	-	大歪叶子兰	Herb	L	Fever	Decoction	Drink	1
Plantaginaceae *Plantago erosa* Wall. (A.G. 1799)	hanjigu	毛草根, 车前草	Herb	L, R	Children measles, fever, kidney, anti-infection, pneumonia, inner heat, vaginal itching one month after labor	Decoction	Bath, drink	8
Plantago major L. (A.G. 1800)	-	车前草, 大张包	Herb	Wp	Infection, relaxation of bowels, common cold, fever, detoxification, inner heat	Decoction	Bath, drink	6
Scoparia dulcis L. (A.G. 1769)	-	田甘草	Herb	Wp	Cough, bronchitis, toothache	Decoction, infusion	Drink, wash	4
Poaceae *Apluda mutica* L. (A.G. 1870)	-	水绿茅	Herb	Ap	Headache, head whirled and vomiting	Decoction	Orally	2
Coix aquatica Roxb. (A.G. 2499)	-	山落果	Herb	Wp	Dysentery, menstrual irregularities	Decoction	Drink	2
Imperata cylindrica (L.) Raeusch. (A.G. 1760)	-	毛草根	Herb	R	difficulty in urination, malaria	Decoction	Drink	2
Neyraudia reynaudiana (Kunth) Keng ex Hitchc. (A.G. 1760)	-	泡绿猜	Herb	R	Edema	Decoction or	Drink	1

						infusion		
Oplismenus compositus (L.) P. Beauv.	-	竹叶草	Herb	Wp	Vaginal itching one month after labor, malaria, cough, bronchitis	Decoction	Bath and drink	4
Pogonatherum crinitum (Thunb.) Kunth. (A.G.1840)	-	山竹香	Herb	Wp	Sedative	Decoction	Bath	1
Polygonaceae *Polygonum caespitosum* Blume (A.G. 2340)	ji zhu ga	老金丹	Herb	R	Cough, irregular menstruation	Decoction	Drink	2
Polygonum capitatum Buch. -Ham. ex D. Don (A.G. 1919)	-	老金丹	Herb	R, St	decreasing blood pressure, homeostatic, hypertension, diarrhea	Decoction	Drink	3
Polygonum hydropiper L. (A.G. 2433)	Fai pie ma	野香了	Herb	L	Eczema	Infusion with lime	Drink	1
Primulaceae *Ardisia virens* Kurz (A.G. 2365)	-	花梅树, 小和尚果	Shrub	Ba, L	Broken bones and tendon tension	Dressing	Externaly	1
Maesa indica (Roxb.) A. DC. (A.G. 1778)	la zhu jie	野茶(小姑娘茶)	Shrub	L, R	Vaginal itching one month after labor, yellow urine	Decoction	Bath	1
Maesa permollis Kurz (A.G. 1784)	-	大年香	Shrub	Ba	Broken bones	Mashed	Plaster	1
Ranunculaceae *Clematis fulvicoma* Rehder & E.H. Wilson (A.G. 1948)	-	毛木通	Herb	R	Body pain	Decoction	Drink	1
Rosaceae *Docynia delavayi* (Franch.) C.K. Schneid. (A.G. 2092)	a bu jia	哆依果尖	Tree	L	Cuts	Mashed	Dressing	1
Duchesnea indica (Andr.) Focke (A.G. 1938)	-	黄龙尾	Herb	Wp	Tuberculosis	Decoction	Drink	1
Rubus ellipticus var. *obcordatus* Focke (A.G. 2059)	-	黄泡刺叶	Shrub	L, R	Diarrhea, sore throat	Decoction	Drink	2
Rubiaceae *Hedyotis scandens* Roxb. (A.G.2542)	-	结子兰	Herb	Wp	Inflammation and bone fractures	Decoction, mashed	Drink, dressing	1
Hedyotis sp. (A.G. 2541)	-	接骨丹		Wp	Inflammation and bone fractures	Decoction, mashed	Drink, dressing	1
Hedyotis verticillata (L.) Lam. (A.G. 2554)	-	小益母草	Herb	Wp	Irregular menstruation	Decoction	Drink	1

Mussaenda hossei Craib (A.G.2445)	-	玉叶金花	Herb	R	Diarrhea	Decoction	Drink	1
Mussaenda multinervis C. Y. Wu ex H. H. Hsue & H. Wu (A.G. 1833)	-	鸡蛋白花叶	Herb	R	Diarrhea	Decoction	Drink	1
Rubia cordifolia L. (A.G. 1946)	-	小红参	Herb	R	Tonic	Cook with chicken and pig fat	Eat as food	1
Uncaria laevigata Wall. ex G. Don (A.G. 1777)	-	双钩	Tree	L, R	Broken bone, diarrhea	Mashed, decoction	Plaster, drink	3
Zanthoxylum armatum var. *ferrugineum* (Rehder & E.H. Wilson) C.C. Huang (A.G. 1967)	-	野花椒	Shrub	R, L	Rheumatism, backache, tuberculosis	Grinded, decoction	Plaster, drink	3
Rutaceae								
Clausena excavata Burm. f. (A.G. 2287)	xiang cong		Shrub	0	Typhoid fever	Decoction	Drink	1
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley (A.G. 1791)	-	小黄伞	Shrub	St, L, R	Dysmenorrhea, inner heat, fever, common cold, influenza, body pain, meningitis, inflammation,	Decoction	Drink	13
Tetradium glabrifolium (Champ. ex Benth.) T.G. Hartley (A.G. 1983)	-	五醋叶	Tree	L, St, R	Common cold	Decoction	Drink	2
Salicaceae	-	杨柳树	Tree	L, Ba	Broken bones	Mashed	Plaster	1
Salix tetrasperma Roxb. (A.G. 1811)								
Saururaceae	qi bo gai	狗青菜（鱼腥草)	Herb	Wp	Pediatric pneumonia, fever, common cold, tuberculosis	Decoction	Drink, eat raw	3
Houttuynia cordata Thunb. (A.G. 1640)								
Smilacaceae	-	老虎刺苔	Liana	R	Broken bones	Pulverised and decoction	Liniment	1
Smilax china L. (A.G. 1776)								
Smilax hypoglauca Benth. (A.G. 2561)	-	三角白叶	Liana	R	Stomachache, dysmenorrhea	Decoction	Drink	2
Smilax perfoliata Lour. (A.G. 1909)	-	老虎刺苔	Liana	R	Broken bones	Pulverised and decoction	Liniment	1
Solanaceae	-	野辣子	Herb	Wp	Inflammation	Decoction	Drink	2
Lycianthes neesiana (Wall. ex Nees) D'Arcy & Zhi Y. Zhang (A.G. 2551)								
Solanum myriacanthum Dunal (A.G. 1668)	a cuo xi ma	黄刺果根	Herb	R, Fr	Inner heat	Decoction	Drink	3

Solanum spirale Roxb. (A.G. 1973)	-	苦溜溜	Herb	Wp	Inner heat	Decoction	Drink	1
Solanum torvum Swartz (A.G. 2254)	a chu xi	苦子果	Herb	R, Fr	Inner heat, diarrhea	Decoction or infusion	Drink	2
Stemonaceae *Stemona tuberosa* Lour. (A.G. 1757)	a nan ga pon	九股牛, 白布	Vine	R, St	Whooping cough, edema, repellant of lice, dermatitis	Decoction	Bath and drink	4
Urticaceae *Elatostema acuminatum* (Poir.) Brongn. (A.G. 1858)	-	光棍菜	Herb	Ap	Indigestion	Decoction or raw	Drink or eat raw	1
Oreocnide rubescens (Blume) Miq. (A.G. 1850)	-	水麻	Shrub	St	Inner heat	Decoction	Drink	1
Pouzolzia sanguinea (Blume) Merr. (A.G. 1816)	-	小华叶	Clum	R,St	Tuberculosis, dermal soreness	Grind with soybean, decoction	Plaster, drink	2
Verbenaceae *Verbena officinalis* L. (A.G. 1755)	a ka kai	马便草	Herb	Wp, R	Inner heat, fever, common cold, malaria	Decoction or infusion with a little salt	Drink	9
Vitaceae *Leea guineensis* G. Don (A.G. 1836)	-	八棱马	Shrub	R	Diabetes	Decoction	Drink	1
Leea indica (Burm.f.) Merr. (A.G. 1850)	-	八棱马	Shrub	R	Enteritis and athermalisation, dysentery, common cold, injuries from falls, backache	Decoction	Drink	5
Xanthorrhoeaceae *Dianella ensifolia* (L.) DC. (A.G. 1934)	-	野冰竹	Herb	Fl	Fever, cramps	Decoction	Wash and liniment	2
Zingiberaceae *Alpinia galanga* (L.) Willd. (A.G. 2544)	-	大砂仁/大姜苗	Herb	Rh	Gastroenteritis, flu, rheumatism	Decoction	Orally, drink	3
Amomum maximum Roxb. (A.G. 1787)	-	香佳喵	Herb	Rh	Influenza, dysmenorrhea, common cold, fever, meningitis, body pain, inner heat, stomachache	Decoction	Orally, drink	9
Amomum villosum Lour. (A.G. 1835)	-	砂仁	Herb	Rh	Common cold, fever, aids digestion, body pain, dysmenorrhea, influenza, cough	Decoction	Orally, drink	9

4.4 Conclusions

Like Hani, Lahu also use a wide diversity of plant species for medicinal purposes. However it seems that Lahu ethnopharmacopeia is more diverse than Hani. Comparison of medicinal plant use patterns among the two groups could help to understand the factors determining plant use knowledge among these two cultures. Since these ethnic groups live in neighboring villages in the same area, it was expected that a large proportion of their medicinal plant knowledge is shared. The diversity of medicinal species utilized by the two ethnic groups show 30% overlap. Statistical analysis revealed that their medicinal plant use patterns were similar in most tested aspects. Patterns of plant part use, selection of plant growth form and habitat and medicinal uses were similar between Lahu and Hani but patterns of selection of plant families as a source of medicinal plants were different. This means that medicinal plant use knowledge of Lahu and Hani is more determined by ecological conditions. Inta et al. (2008) showed that two communities of Akha living in different geographical and ecological environments have similar medicinal plant knowledge patterns. But these two communities had the same cultural background. This highlights the role of culture and cultural background as one of the main determinants of medicinal plant use knowledge. In our case, the two studied groups have different cultural background but live in the same environment yet showing similar patterns of medicinal plant knowledge. Thus, IAR might not be a good indicator for comparison of medicinal plant knowledge between different communities and comparison at the species level with comparing use details of each species among the subject ethnic groups might result in proper comparisons. There should be also other factors affecting the patterns of medicinal plant knowledge among different groups such as effects of dominant culture's traditional medicine (in our case TCM). In general, different factors affect the patterns of medicinal plant knowledge and use; some aspects of these patterns are determined by culture and some aspects by ecological environment.

4.5 Acknowledgments

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5 A comparison of the wild food plant knowledge of ethnic minorities in Naban River Watershed National Nature Reserve, SW China

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Outline and overview:

This chapter discusses the knowledge of food plants among four ethnic groups in the research area. It introduces the diversity of food plants in the area and analyzes the different aspects of food plant use among ethnic groups and compares the knowledge of wild food plants among them. It also underlines the differences among the ethnic groups and possible explantations for these differences. Next, this chapter looks on the relationship of food plant knowledge and local people attributes such as age and gender and further compares the results with available literature on this aspect.

A comparison of the wild food plant knowledge of ethnic minorities in Naban River Watershed National Nature Reserve, SW China

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Abstract

Background: Wild food plants (WFPs) contribute to the nutrition, economy and even cultural identity of people in many parts of the world. Different factors determine the preference and use of WFPs such as abundance, availability, cultural preference, economic conditions, shortage periods or unsecure food production systems. Understanding these factors and knowing the patterns of selection, use and cultural significance and value of wild food plants for local communities is helpful in setting priorities for conservation and/or domestication of these plants. Thus in this study patterns of wild food plant knowledge and use among four ethnic groups in Xishuangbanna were documented and analyzed to find the similarity and difference among their plant knowledge.

Methods: Data on wild food plant use was collected through different interview methods including freelisting, semi-structured and field interviews. Botanical plant sample specimens were collected, prepared, dried, and identified.

Results: A total of 173 species and subspecies from 64 families and one species of lichen (*Ramalina* sp.) are used as WFP. There were differences on the saliency of wild food plant species among four ethnic groups. Consensus analysis revealed that wild food plant knowledge of each ethnic group differs from others with some variation in each group. Among informant attributes only age was related with the wild food plant knowledge, whereas no significant relationship was found between gender and age*gender and informants wild food plant knowledge.

Conclusion: Wild food plants are still used extensively by local people in the NRWNNR, some of them on a daily base. This diversity of wild food plants provide important source of nutrients for the local communities with much of their caloric intake comes from one or few crops. The results also show the role of culture on the preference and use of wild food plants. There is a big

potential for harvesting, participatory domestication and marketing of WFPs especially in the tourism sector in the area.

Keywords: Edible plants, biodiversity use, cultural importance, foraging

5.1 Background

Wild food plants (WFP) are plant resources that are harvested or collected from uncultivated and unmanaged resources for human consumption [1]. They are bestowed with one or more parts that can be used for nutrition if gathered at the proper growth stage and prepared appropriately [2]. WFP collection and use is still practiced in many parts of the world even among agricultural societies that rely mainly on domesticated plants and animals for their diet. In fact gathering wild plants is an internal part to livelihood strategies throughout the world [3]. WFPs are an important source of vegetables, fruits, tubers and nuts which are relevant for many people in ensuring food security and balancing the nutritional value of diets [1]. As an example, consumption of wild leafy vegetables as a source of micronutrients in many tropical areas is significant in small children's diet to ensure normal growth and intellectual development [4]. However, different factors affect preference and use of WFPs such as abundance, availability, cultural preference, economic conditions, shortage periods or unsecure food production systems. Several WFPs are used only during food shortage or famine periods. Some are used on a daily base in one region or by a community while being considered as weed in other areas or by other communities. Understanding patterns of WFP use and cultural significance and value is helpful in setting priorities in conservation and/or domestication. It has also implications for rural development through marketing potential species and for people's nutritional health by identifying nutritious species or promoting the use of wild food species. To achieve this, cultural domain studies are important. Cultural domains are starting point for studying people's perception of the natural world and are important aspects of local knowledge by which cultural organizations are understood [5]. Elements of a particular cultural domain (here WFPs domain) can be recorded and analyzed through free-listing interview methods [5,6].

The study area resides in Xishuangbanna Dai Autonomous Prefecture which is part of the Indo-Burma biodiversity hotspot, hosting 16% of China's higher plant species, despite covering only 0.2% of the country's land area [7,8]. The region is also culturally diverse with 13 different ethnic groups living within its territories. Because of this biocultural diversity many wild species are

used by local population among them wild food plants. Xu et al. [9] reported 284 wild vegetables in Xishuangbanna comprising 6.1% of the total vascular plant flora. Chen et al. [10] reported 123 species of wild edible fruits in Xishuangbanna.

Local people living in the Naban River Watershed National Nature Reserve (NRWNNR) benefit from a large number of forest products in their daily life. More than 182 species of food plants have been reported in NRWNNR [11]. Main wild food plant resources can be divided into vegetables, mushrooms and bamboo shoot categories. Zhang et al. [11] reported collection of bamboo shoots and mushrooms for income generation but vegetables were collected mainly for self-consumption. However information on the cultural importance of WFP species, patterns of WFPs use and knowledge variation among different ethnic groups living in the NRWNNR area is not available. This study aims to inventory and document WFP knowledge in the NRWNNR and to compare WFP knowledge and use among four ethnic groups in the area and measure cultural importance and economic values of WFP species.

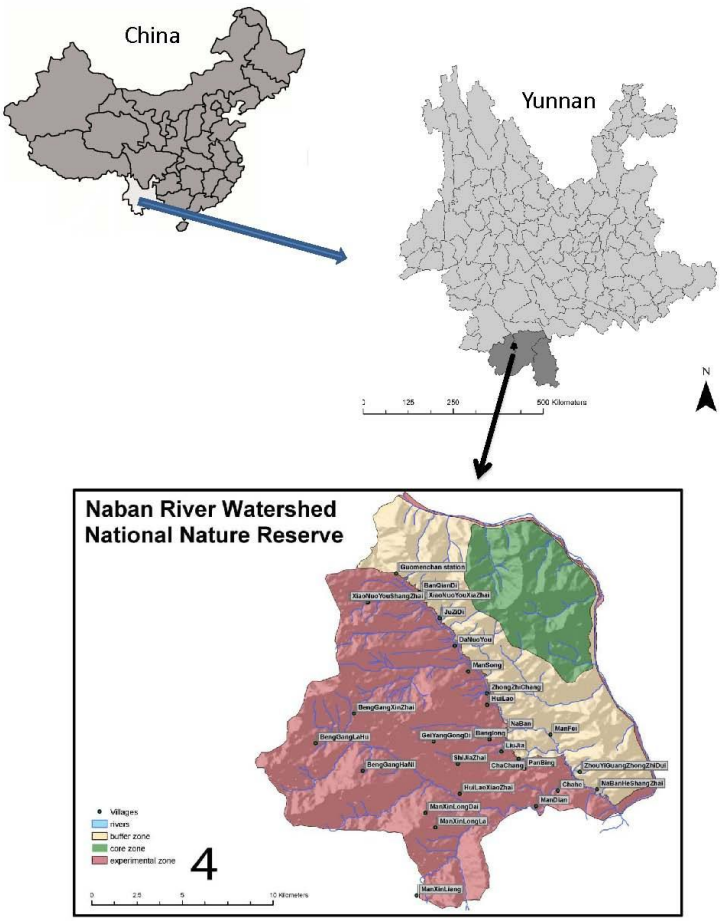
5.2 Materials and methods

5.2.1 Study area

With a total area of 266.6 km^2, NRWNNR is located in the central- north Xishuangbanna and lies on the west bank of Lancang (Mekong) river, approximately 25 km from Jinghong Township (Map 1). It was established in 1991 based on the UNESCO's "Man and Biosphere" concept. The nature reserve is divided into three functional zones; the core zone which is strictly protected from extractive activities, the buffer zone and the experimental zone which are both used for agricultural activities. However, any land use change in the buffer zone needs to be permitted by the nature reserve management office, which is not so for the experimental zone. NRWNNR harbors a plethora of biological as well as cultural diversity. More than 2345 species and subspecies of higher plants, 156 species of non-vascular plants, 437 species of vertebrates and 327 species of invertebrates are reported from NRWNNR [12]. Six different ethnic groups including the Dai, Hani, Lahu, Yi, Bulang, and Han with a total population of 5538 people are living in 30 villages throughout the area [13]. These ethnic minorities mainly live in villages stratified based on altitude. The Dai live in low elevations; Hani and Yi reside at middle elevations and Lahu and Bulang at higher elevations. Staple food is rice (*Oryza sativa*) which is used along with different local vegetables and meat as protein source. Traditional lifestyle is still common in the area and people get many benefits from forest products.

5.2.2 Data collection

Prior to starting the field work, research and plant collection permits have been applied for and issued by governmental officials and NRWNNR administration bureau. The research group was introduced to the village leaders and elders by NRWNNR administration officials and the objectives of the project were explained to obtain consent from them. Field survey was started in January 2008 and lasted for twelve months. Ethnobotanical data was collected through different interview methods [14-16]. Freelisting interviews with randomly selected informants were conducted. Freelists give information on saliency, perception, classification and ranking of objects within a cultural domain in question, here WFPs [5,17]. Semi-structured and field interviews were followed to record data on the details of WFP local names, uses, collection, preparation and trade. Plant sample specimens were collected, prepared, dried, and identified with the help of experts from Xishuangbanna Tropical Botanical Garden (XTBG). One set of voucher samples was stored at the Herbarium of NRWNNR and one set was deposited at the Herbarium of XTBG (HITBC). Nomenclature follows Flora of China, Checklist of Flora of China, TROPICOS database of the Missouri Botanical Garden, and local checklists [18,19].



Map 1. Location of the study area and zone division in the NRWNNR.

5.2.3 Data analysis

Use frequency for each species was assessed by calculating citation frequency of species with respect to total number of interviews. Freelists were analyzed at the whole area level and at minority group level; according to frequency, average rank, salience and consensus using Anthropac 4.8. Anthropac calculates the frequency with which each plant is listed and its average rank in the freelists of each respondent then combines these to produce a measure of cultural importance or salience for each plant [20]. Species cited by at least two informants were considered for further analysis [20]. Freelist data then was dichotomized and a table of similarities with positive matches for plant species was constructed. Consensus analysis was conducted to analyze cultural variations among informants. Anthropac consensus analysis produces a hypothetical model of what correct answer to the freelist question would be or the shared knowledge of the group about WFPs. Then, the knowledge of informants is compared with this model and the degree of agreement to this model is calculated. If the reliability of the model is significant and the variation among informants is not high, the model represents the typical answer of a member of that population. Anthropac gives a reliability value (pseudo-reliability) and the closer is the value to 1.0 the higher the consensus among informants. The analysis was conducted for each ethnic group separately and also generally for the area. The results were compared between different ethnic groups. The relation between informant's attributes (age and gender) and WFP knowledge was analyzed by ANOVA and further with Scheffe post-hoc test among 6 age groups. Sørensen similarity index was calculated among the different pair groups by EstimateS 7.5 and the similarity matrix was applied to conduct unweighted pair-group method using arithmetic average (UPGMA) cluster analysis using PC-Ord software to cluster ethnic groups. Microsoft Office Excel and SPSS 16 were used for statistic analysis.

5.3 Results and discussion

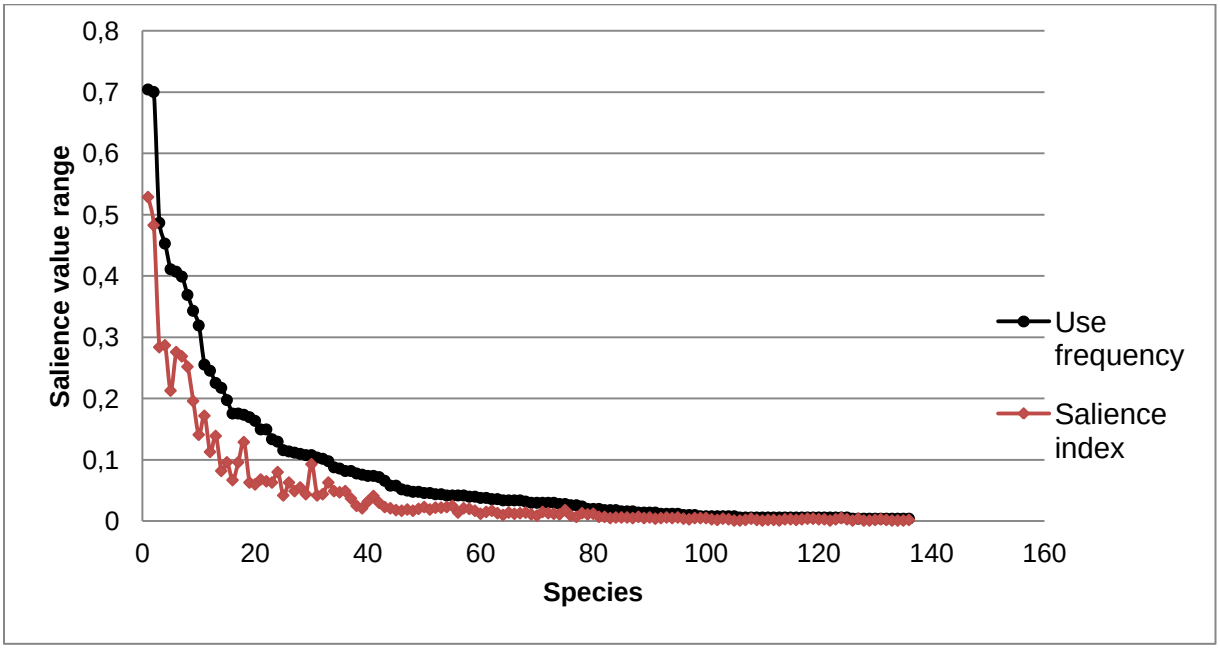
5.3.1 Wild food plant diversity and frequently utilized species

A total of 173 species and subspecies belonging to 64 families and one species of lichen (*Ramalina* sp.) were mentioned by all four ethnic groups as WFP. *Rosaceae* was the most represented family (9 species) followed by *Zingiberaceae* (8 species) and *Araceae*, *Solanaceae*, *Poaceae* (7 species each). 38 species were commonly known by the ethnic groups surveyed. 75% of species were common to the flora of China, 13% were endemic species and 12% were

exotic and weed species. Most of the used plants are herbs (38.8%) followed by trees (24.8%), shrubs (19.7%), lianas (7%) and vine and culms (9.5%).

Each informant mentioned 10.8 species in the list on average. More than 17% of the species were quoted only by one informant each. These low frequency species are considered either in passive use or used only in some idiolects [21]. The list of species cited by more than one informant is given in Appendix 1. Plant species which showed highest frequency of use include: *Diplazium esculentum* (Retz.) Sw. (use frequency= 0.7), *Musa accuminata* Colla (0.7), *Houttuynia cordata* Thunb. (0.48), *Ficus auriculata* Lour. (0.40), *Oenanthe javanica* (Blume) DC. (0.45), *Solanum americanum* Miller (0.40), *Piper longum* L. (0.39), *Elatostema acuminatum* (Pair.) Brongn. (0.37), *Elsholtzia kachinensis* Parin (0.34) and *Bauhinia variegata* L. (0.31). The top ten frequently mentioned WFP and their salience among different ethnic groups are given in Table 1. These are also the most salient species. Frequently utilized species are generally corresponding with culturally important species (Figure 1). However there were some slight variations. For example, value of Smith index for *Ficus auriculata* Lour is less than *S. americanum* Miller, *P. longum* L, *E. acuminatum* (Pair.) Brongn (Table1). This means that *F. auriculata* is used more frequently than the other three species but that these species are culturally more important than *F*. *auriculata* and ranked higher in the freelists. Most frequently utilized WFPs have also vast distribution range. Many WFP studies also show similar trend [22-25]. In fact these are common species which could be found easily around villages, crop fields and hedges. The Lahu WFPs include 95 species from which 18.9% are singly cited species and the average length of list was 9 species. Hani use 123 species of WFPs from which 23.5% are cited by only one informant and the average length of list was 13.9 species. Dai instead use 95 species of WFPs, 20.2% of which cited by single informants and the average length of list was 10.5 species. Han use 64 species, 28% mentioned only by one informant and the average list length was 10.9 species.

Figure 1. Comparison of consistency between use frequency and saliency of species.



5.3.2 Species saliency

There was variation on the saliency of species among groups when data was analyzed at group level. *Musa accuminata* Colla (Smith's S index = 0.56), *Diplazium esculentum* (Retz.) Sw. (0.52) and *Houttuynia cordata* Thunb. (0.34) are top three salient species for Lahu (table 1). However among Hani, *D. esculentum* (Retz.) Sw. (0.51), *Oenanthe javanica* (Blume) DC. (0.49) and *Solanum americanum* Miller (0.38) are the most salient species. Among Dai, *D. esculentum* (Retz.) Sw. (0.62), *M. accuminata* Colla (0.54) and *Piper longum* L. (0.47) are the most important species and for Han *Schefflera brevipedicellata* Harms (0.54), *Elatostema acuminatum* (Pair.) Brongn. (0.53) and *P. boehmeriifolium* (Miq.) Wall. ex C. Dc. (0.5) are the most salient species. These are also species which showed highest frequencies. The reason behind these variations might be the cultural preference of each ethnic group for special WFP. Pardo-de-Santayana et al. [23] compared the WFP knowledge in Iberian Peninsula and concluded that the patterns of WFP usage depends on socio-cultural factors rather than biological factors such as diversity of WFP flora and climate. Chen et al. [10] also found that different ethnic groups in southern Yunnan consume wild fruits differently from each other. However, they conclude that environmental differences (and as a result difference in accessibility) and levels of agricultural productivity are reasons for different patterns of wild fruit

use among ethnic groups. Geographical and environmental differences in southern Yunnan is coincident with ethnic group separation as Dai are living in valleys and at lower elevations consuming less wild fruits than other ethnic groups like Hani who are living in mountainous regions [10]. Termote et al. [26] by comparing the wild edible plant knowledge of three ethnic groups in Tshopo district of DRCongo found that the use and knowledge of WFPs is culturally defined with high diversity between ethnic groups. In our study area, most of the salient species have vast distribution and are easily accessible. Nevertheless, it seems that differences in the ranking and saliency of species among ethnic groups are more related to the socio-cultural background than accessibility. So use patterns of WFPs are strongly affected by culture. As an example, in the Amazonia or Eastern Europe wild green vegetables play a minor role whereas in East Asia and India, they are highly prized and large numbers of species are used [27].

5.3.3 Plant part, growth form and use categories of WFPs

Leaves of WFPs are the most common plant part (37.2%) mentioned to be used by Dai, however for the other three ethnicities fruits are the main plant part used (Figure 2). Fruit is the second commonly used plant part (27.4%) by Dai followed by stems (15.7%), flowers (6.8%) and aerial parts (4.9%). The other three ethnicities share almost similar pattern together as fruits being the most common used plant part followed by leaves and stems (Figure 2). WFP use categories also showed a similar pattern as Dai was different from other three groups. Leafy vegetables was the most common used category (41.7%) among Dai followed by other kind of vegetables (25.2%), fruits (21.9%) and spices (4.39%) (Figure 3). Lahu and Han WFP use showed a similar pattern. Among Hani the most common use category was fruits (35.1%) followed by leafy vegetables (29.01%), other vegetables (18.3%) and spices (10.6%). Selection of WFP's life form among ethnic groups was in consistent with the use categories. That means the Dai who prefer leafy vegetables, tent to select herbs (42%) as WFPs while for the other ethnic groups, trees are the most commonly used life form (Figure 4). Cultural differences and habits as well as accessibility to the resources might be the reasons behind these differences. Because the Dai are living in lower elevations and most of their surrounding forests are almost converted to rubber plantations, they don't have easy access to wild fruit trees in the forest. Some WFPs are known to be bound with cultural identity. For example, in the study area *Bauhinia variegata* L. is part of Dai culture and Dai people are known to eat flowers of this tree. *Rhus chinensis* L. is known to be part of Hani culture WFP.

Figure 2. Comparison of plant part use of wild food plants among four ethnic groups (values represent percentage).

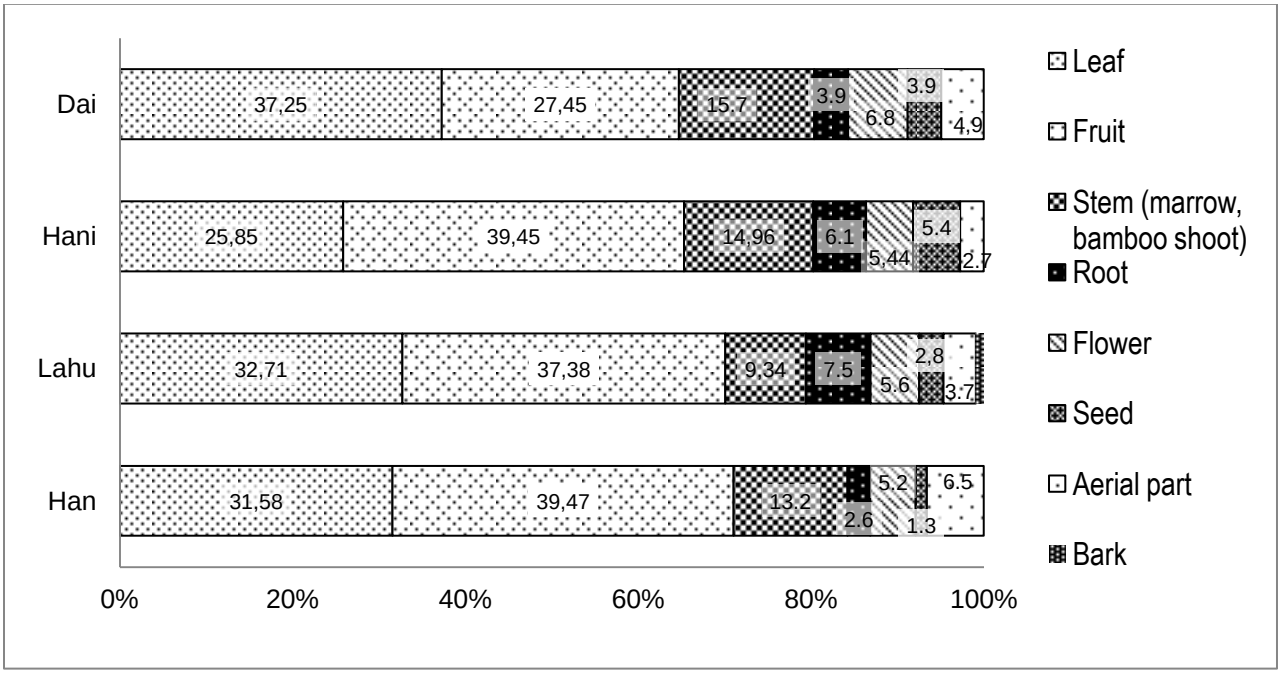
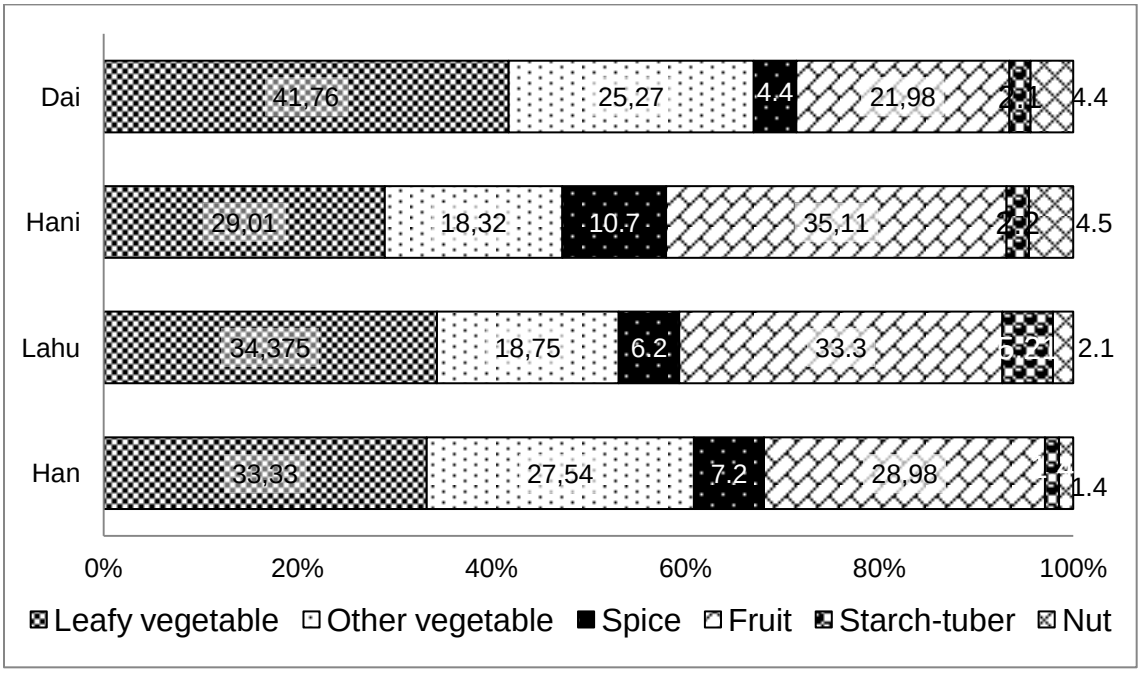


Figure 3. Comparison of wild food plant use categories among four ethnic groups (values represent percentage).



5.3.4 Similarity of WFP species between groups

The Sørensen similarity index, calculated between ethnic groups based on incidence of common species revealed that Lahu and Han have highest values (0.713) which shared 56 species together. The Dai and Hani showed the lowest index value (0.544). Figure 5 shows the result of unweighted pair-group method using arithmetic average (UPGMA) cluster analysis based on Sørensen similarity index. The dendrogram (Figure 5) indicates that Lahu and Han are grouped together and then Hani joins the cluster. This means that Lahu and Han share more WFPs maybe because they are living in the same village (XiaNoYou village) thus there should be an active knowledge exchange regarding WFPs. Then Hani joins the cluster. The Hani are also living in the higher elevations and having more or less the same access to the WFP resources. The Dai are living in lower elevations and in the rubber cultivation zone, so they might have different access to the WFPs than other groups.

Figure 4. Comparison of plant growth forms used among four ethnic groups (values represent percentage).

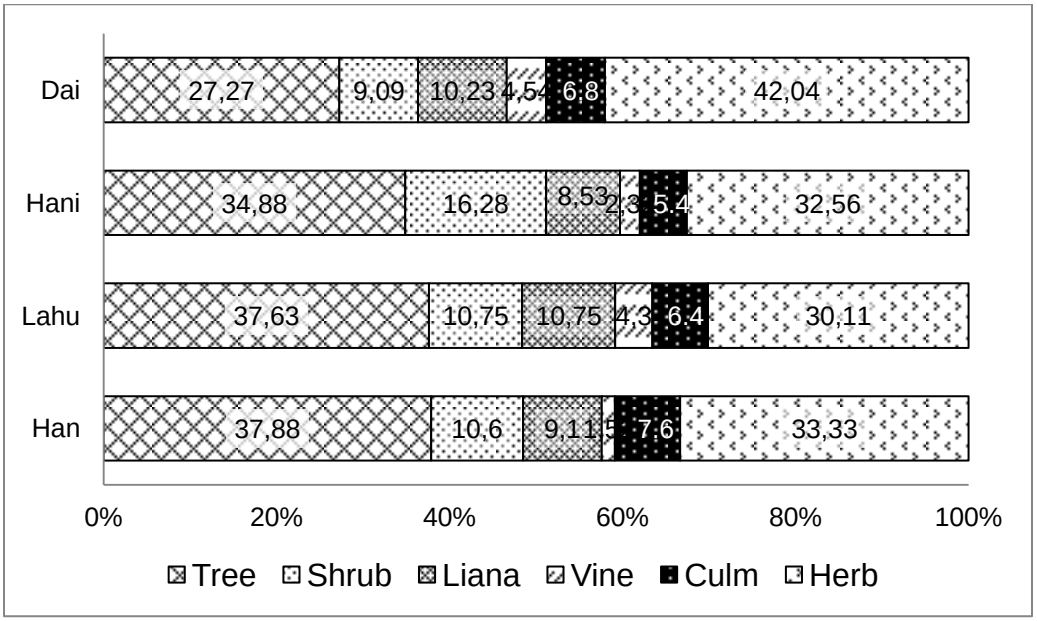
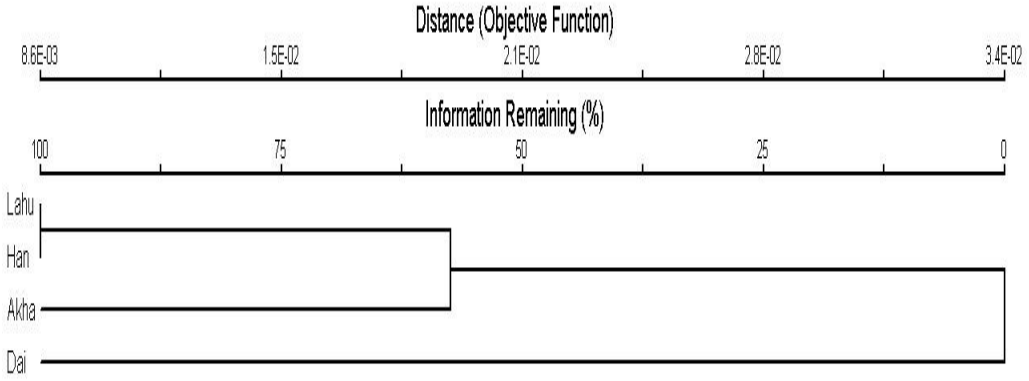


Figure 5. Dendrogram showing the result of clustering of four studied ethnic groups based on incidence of wild food species using UPGMA clustering.



5.3.5 Informant consensus

Consensus analysis is a method of analyzing patterns of agreement among informants and finding the culturally correct answers to a set of questions. In Antropac, the knowledge of informants on WFPs is compared with a model and the degree of agreement is calculated. Table 2 shows the result of consensus analysis and also a list of key species used in the consensus model. The Lahu showed highest consensus (pseudo-reliability= 1) and higher mean estimated knowledge of 0.86±0.06 and the Dai showed lowest mean estimate of knowledge (0.76±0.09) indicating more diversity among the informants than the other three groups (Table 2).

Table 1. Top ten frequently mentioned wild food plants and their salience at the whole area level and at ethnic group level. Species are ranked based on the Smith's S index and ordered based on S index at the area level. S = Smith's S index, Use freq.= use frequency

Species	**General**			**Lahoo**			**Hani**			**Dai**			**Han**		
	S	Use freq.	Rank	S	Use freq.	Rank	S	Use freq.	Rank	S	Use freq.	Rank	S	Use freq.	Rank
Diplazium esculentum (Retz.) Sw.	0.53	0.7	1	0.562	0.68	2	0.50	0.7	1	0.61	0.78	1	0.32	0.51	5
Musa acuminata Colla	0.48	0.7	2	0.561	0.76	1	0.35	0.56	4	0.54	0.77	2	0.47	0.73	4
Oenanthe javanica (Blume) DC.	0.287	0.45	3	0.25	0.39	6	0.42	0.59	2	0.30	0.54	4	0.30	0.51	6
Houttuynia cordata Thunb.	0.284	0.49	4	0.30	0.57	3	0.32	0.52	7	0.17	0.34	7	0.22	0.45	8
Solanum americanum Miller	0.27	0.41	5	0.24	0.3	7	0.38	0.54	3	0.27	0.46	5	0.14	0.18	11
Piper longum L.	0.26	0.4	6	0.21	0.35	5	0.10	0.18	21	0.46	0.58	3	0.32	0.49	5
Elatostema acuminatum (Pair.) Brongn.	0.25	0.37	7	0.30	0.46	4	0.23	0.34	9	0.05	0.11	22	0.53	0.65	2
Ficus auriculata Lour.	0.21	0.41	8	0.20	0.34	8	0.24	0.45	8	0.16	0.32	9	0.18	0.41	9
Elsholtzia kachinensis Parin	0.19	0.34	9	0.14	0.26	9	0.33	0.49	6	0.15	0.43	10	0.13	0.24	13
Bauhinia variegata L.	0.14	0.32	10	0.09	0.24	13	0.19	0.44	10	0.13	0.31	12	0.24	0.47	7

Table 2. Result of consensus analysis including freelist length, estimated informant knowledge, reliability value and species included in consensus key.

Ethnic group	**Number of informants**	**Number of species mentioned**	**Mean freelist length**	**Mean estimate of informant Knowledge**	**Pseudo-reliability**	**Number of species included in consensus model**	**Species fitting the consensus model**
Lahu	217	95	9	0.86±0.06	1	3	*Diplazium esculentum* (Retz.) Sw., *Houttuynia cordata* Thunb., *Musa acuminata* Colla
Hani	129	123	13.9	0.82±0.08	0.99	5	*Diplazium esculentum* (Retz.) Sw., *Houttuynia cordata* Thunb., *Musa acuminata* Colla, *Oenanthe javanica* (Blume) DC., *Solanum americanum* Miller
Dai	90	95	10.5	0.82±0.09	0.99	5	*Diplazium esculentum* (Retz.) Sw., *Musa acuminata* Colla, *Oenanthe javanica* (Blume) DC., *Piper longum* L.
Han	49	64	10.9	0.76±0.09	0.98	6	*Elatostema acuminatum* (Poir.) Brongn., *Musa acuminata* Colla, *Oenanthe javanica* (Blume) DC., *Piper boehmeriifolium* (Miq.) Wall. ex C. DC., *Piper longum* L., *Schefflera brevipedicellata* Harms

However all groups showed high pseudo-reliability (close to 1) meaning that informants have a higher consensus in the respective consensus key species. Factor loadings in eigenvalues table along with high pseudo-reliability imply that informants in each group are driven from a single culture [5]. Mengistu & Hager [28] also find similar results analyzing wild edible fruit knowledge of the Amhara region of Ethiopia. There was also overlap between salient species among each group and the ones included in the consensus model. In fact these are the species that are known to many people or used more often.

To find out the influence of informant attributes including age and gender on the knowledge of WFPs, an analysis of variance was conducted. Length of freelist was considered as knowledge proxy. The result illustrated that there was a significant relationship between age and the length of freelists, whereas no significant relationship was found between gender and age*gender (p> 0.05). Further multiple comparisons of age groups using Scheffe post- hoc test revealed that knowledge of WFPs between age groups of 1 (10-20 years old) and 4 (41-50 y) and 5 (51-65 y) and also between 3 (31-40 y) and 4 (41-50 y) was significantly different (p <0.05) . There was a clear difference on the mean of freelist lengths in each age group. Age group 4 and 5 had a similar mean list length of 12.2 species and age group 1 showed the lowest list length (9 spp). This could be interpreted as that younger people have less knowledge of WFPs and middle age people have more knowledge maybe because they are active in the collection and use of these species. It is a common believe that women have more knowledge of WFP than men because they are responsible for preparing household meals in many cultures, but our results show that in our study area there was no significant difference on the knowledge of WFPs between genders. Mengistu & Hager [28] also found age as the only attribute influencing wild fruit knowledge of the informants in Ethiopia. However, Watkins [29] documented that although knowledge scores of respondents were not significantly affected by gender and age among nomadic Turkana of northern Kenya, further analysis of male and female WFP lists showed interesting differences. These differences were related to WFP preparation methods. Male respondents mentioned WFPs which require little preparation while females mentioned WFPs that require special knowledge and more time to prepare.

5.3.6 Trade of WFPs

More than 45 species of WFPs are sold to the local market occasionally (Appendix 1). However most of the WFPs are consumed in households and are not commercialized. Among the most dominant WFPs sold to the market are bamboo shoots of different species and *Eryngium*

foetidum L., *Houttuynia cordata* Thunb., *Musa accuminata* Colla and *Bauhinia variegata* L. Xu et al. [9] found 70 species of wild vegetables which are sold in the markets of Menglun, Xishuangbanna. These species of wild vegetables accounted for 30% of the total income from vegetable sales. They also found that most of the traders (95%) of wild vegetables in the market were women. Chen et al. [10] also recorded 17 species of wild fruits which are sold in local markets of southern Yunnan.

5.4 Conclusions

Wild food plants are still used extensively by local people in the NRWNNR. This study provides an insight into the WFP knowledge and use patterns including culturally important and frequently used WFPs among four ethnic groups of the region. The area is rich in WFPs and our study also shows the dependency of WFP preference and use on culture, despite the WFP sharing among different ethnic groups. Although the studied groups are living in spatially different villages and this implies different accessibility to WFP resources, but the actual geographical distance between different villages is not so much that cause such a big geographical distance (Map 1). On the other hand, species which are common among ethnic groups show different saliency ranking for each group (Table 1). This suggests the role of culture on the preference of WFPs.

Findings also show that highly salient species for the most part overlap with frequently used species. These are also the species most traded. There is a big potential for harvesting, participatory domestication and marketing of WFPs especially in the tourism sector in the area. Only in Jinghong City more than 100 restaurants cater wild vegetables for tourists [9]. Zhang et al. [11] also concluded that wild vegetable exploitation in NRWNNR could help for the economic development of the area. However this exploitation should be in a sustainable way and policies and regulations on exploitation of WFPs should be established. More investigation on the distribution patterns, population density and regeneration of these species could help planning and establishing harvest regulations that assure sustainable supply of plant materials.

5.5 Competing interests

The authors declare that they have no competing interests.

5.6 Author's contributions

AG conceptualized and designed the study, carried out field work and data collection and prepared manuscript. **GL** helped with the plant material identification and manuscript preparation. **JS** participated in study designing and manuscript preparation.

5.7 Acknowledgements

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Appendix1. Wild food plants used by four ethnic groups in Naban River Watershed National Nature Reserve.

Family	Scientific name	Local name	Growth form	Parts used	Use category	Preparation	Ethnicity (used by)	Trade
Acanthaceae	*Thunbergia grandiflora* (Roxb. ex Rottel.) Roxb.	藤子花	Vine	L	Leafy veg	Fried / boil	L, Da	-
Actinidiaceae	*Actinidia umbelloides* C. F. Liang	-	Shrub	Fr	Fruit	Eaten raw	Hi	-
Actinidiaceae	*Saurauia funduana* Wall	鼻涕果	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Actinidiaceae	*Saurauia napaulensis* DC.	小鼻涕果树, 平地木	Tree	Fr	Fruit	Eaten raw	L, Hi	-
Actinidiaceae	*Saurauia tristyla* DC.	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Amaranthaceae	*Amaranthus spinosus* L.	革命菜 (刺革命草)	Herb	L	Leafy veg	Fried / boil	Hi, Da	Y
Amaranthaceae	*Amaranthus viridis* L.	玉米菜	Herb	L	Leafy veg	Fried / boil	Hi, Da, Ha	-
Anacardiaceae	*Mangifera sylvatica* Roxb.	林生芒果	Tree	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	Y
Anacardiaceae	*Rhus chinensis* Mill.	盐酸果, 盐酸果树	Shrub	Se	Spice	Added to the foods or chili sauce	Hi, Da	-
Anacardiaceae	*Spondias pinnata* (L.) Kurz.	-	Tree	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	-
Annonaceae	*Annona squamosa* L.	-	Shrub	Fr	Fruit	Eaten raw	Da	-
Annonaceae	*Fissistigma polyanthum* (Hook. f. & Thomson) Merr.	香木料藤	Shrub	Fr	Fruit	Eaten raw	L, Ha	-
Apiaceae	*Centella asiatica* (L.) Urb.	马蹄草	Herb	Ap	Leafy veg	Boiled or eaten raw, used to make cold dish	L, Hi, Da, Ha	-
Apiaceae	*Eryngium foetidum* L.	大芫细	Herb	L	Leafy veg, Spice	Boiled or stir-fried	L, Hi	Y
Apiaceae	*Oenanthe javanica* (Blume) DC.	水芹菜	Herb	Ap, L	Leafy veg	Eaten raw with chili sauce, boiled or barbeque with fish	L, Hi, Da, Ha	Y
Apocynaceae	*Amalocalyx microlobus* Pierre	酸扁果	Liana	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	Y
Aquifoliaceae	*Ilex umbellulata* (Wall.) Loes	羊屎果树	Shrub	Fr, L	fruit, leafy veg	Eaten raw with chili sauce or boiled	L, Hi, Ha	-
Araceae	*Alocosia* sp.	-	Herb	Tu	Starch-tuber	Boiled	L, Da	Y

Araceae	*Amorphophallus pachystylis* Hett	山药	Herb	Tu	Starch-tuber	Boiled	L, Hi	-
Araceae	*Arisema* sp.	鸡爪菜	Herb	L	Leafy veg	Fried	Da, Ha	-
Araceae	*Homalomena occulta* (Lour.) Schott	野水芋	Herb	St, L	Leafy veg	Cooked or roasted in bamboo	Da	-
Araceae	*Homalomena pendula* (Blume) Bakh.f.	-	Herb	St, L	Leafy veg	Cooked with *P. flaviflorum* or roasted in bamboo	Da	-
Araceae	*Lasia spinisa* (L.) Thw.	大刺苞菜, 刺菜, 马桑宫	Herb	L, St	Leafy veg	Boiled or steamed	Hi, Da, Ha	-
Araliaceae	*Aralia armata* (Wall.) Seem.	小刺苞菜, 大刺苞菜, 饿饭果	Shrub	L	Leafy veg	Boiled	L, Da	Y
Araliaceae	*Eleutherococcus trifoliatus* (L.) S.Y. Hu	无家菜, 无家菜	Shrub	L	Leafy veg	Boiled or stir-fried, eaten with chili sauce	L, Hi, Da	Y
Araliaceae	*Macropanax undulatus* (Wall.) Seem	七叶灵	Tree	L	Leafy veg	Boiled	L, Hi, Ha	-
Araliaceae	*Schefflera brevipedicellata Harms*	-	Shrub	L	Leafy veg	Boiled and eaten with chili sauce, or pickled (about one week)	L, Hi, Da, Ha	-
Araliaceae	*Schefflera chinensis* (Dunn) H. L. Li	树头菜, 龙爪树, 风湿药	Tree	L	Leafy veg	Boiled /eaten raw	L, Ha	-
Araliaceae	*Trevesia palmata* (Roxb. ex Lindl.) Vis	山月排, 马桑管果	Shrub	Fl, Fr	Veg, Spice	Cooked or raw	L, Hi, Da, Ha	Y
Arecaceae	*Caryota monostachya* Becc.	棕笋	Tree	Fr	Fruit	Boiled / eaten raw	L, Hi, Da, Ha	-
Arecaceae	*Livistona saribus* (Lour.) Merr ex chev	大白叶果	Tree	Se, Fr, St	Nut, Fruit, Veg	Eaten raw / fried	L, Hi, Da, Ha	-
Asteraceae	*Crassocephalum crepidioides* (Benth.) S. Moore	老胖草, 九柳光	Herb	L, Ap	Leafy veg	Boiled or stir-fried and then eaten with chili sauce	L, Hi, Da, Ha	Y
Asteraceae	*Enydra fluctuans* Lour.	-	Herb	L, St	Leafy veg	Eaten raw	Da	-
Asteraceae	*Sonchus arvensis* L.	苦马菜	Herb	Ap	Leafy veg	Cooked	L, Ha	-
Asteraceae	*Bidens pilosa* L.	-	Herb	L	Leafy veg	Eaten raw	Ha	-
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	-	Herb	L	Leafy veg	Boiled or stir-fried, eaten with chili sauce	L, Hi, Da, Ha	Y
Balsaminaceae	*Impatiens aquatilis* Hook.f	土各菜, 马鹿菜	Herb	L	Leafy veg	Eaten raw with chili sauce	L, Hi, Ha	-
Begoniaceae	*Begonia dryadis* Irmsch.	水葫芦	Herb	L, St	Veg	Cook with fish	L, Hi, Da	-

Bignoniaceae	*Markhamia stipulata* (Wall.) Seem.	毛尾木	Tree	Fl	Veg	Boiled and stir-fried	L, Hi, Da	Y
Bignoniaceae	*Mayodendron igneum* (Kurz) Kurz	马桑官果树, 芭拉花, 野枳木香藤	Tree	Fl	Veg	Boiled and stir-fried	L, Hi, Da, Ha	Y
Bignoniaceae	*Oroxylum indicum* (L.) Kurz	海船	Tree	Fr	Veg	Boiled and stir-fried, eaten with chili sauce	L, Hi, Da, Ha	Y
Boraginaceae	*Trichodesma calycosum* Coll. ex Hemsl.	鸡蛋花	Herb	L	Leafy veg	Cooked or fried with egg and meat	L, Hi, Da	-
Boraginaceae	*Trigonotis peduncularis* (Trevis.) Benth. ex Baker & S. Moore	-	Herb	Fl, St	Veg	Fried	Da	-
Burseraceae	*Canarium tonkinense* Engl.	青果	Tree	Fr	Fruit	Smashed with chili /eaten raw	L, Hi, Da	-
Capparaceae	*Stixis suaveolens* (Roxb.) Pierre	-	Vine	Fr	fruit	Eaten raw	Hi	-
Chenopodiaceae	*Chenopodium ambrosioides* L.	盐巴菜，细地留	Herb	L	Fruit	Eaten raw	L, Da	Y
Clusiaceae	*Garcinia cowa* Roxb.	-	Tree	Fr	Fruit	Eaten raw (sour taste)	Hi	-
Cucurbitaceae	*Cucumis hystrix* Chakr.	-	Herb	Fr, L	Leafy veg, Veg	Boiled or eaten raw	L, Hi, Da	Y
Cucurbitaceae	*Hodgsonia macrocarpa* (Blume) Cogn.	野面瓜	Liana	Se	Nut	Roasted and mixed with rice	L, Hi, Da	-
Cucurbitaceae	*Thladiantha grandisepala* A. M. Lu et Z. Y. Zhang	皮肤病	Herb	L	Leafy veg	Boiled	Da	-
Dioscoreaceae	*Dioscorea alata* L.	山药	Liana	Tu	Starch-tuber	Roasted / boiled / steamed / and then fried	L, Hi, Da, Ha	Y
Ebenaceae	*Diospyros kaki* L.f.	海船, 野柿花	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Elaeagnaceae	*Elaeagnus conferta* Roxb	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Elaeocarpaceae	*Elaeocarpus austroyunnanensis* Hu	-	Tree	Se	Nut	Eaten raw	Hi	-
Euphorbiaceae	*Aporusa yunnanensis* (Pax & K. Hoffm.) F.P. Metcalf	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Euphorbiaceae	*Baccaurea ramiflora* Lour.	小红孩, 三丫果	Tree	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	-

Euphorbiaceae	*Manihot esculenta* Crantz	木薯	Shrub	Tu	Starch-tuber	Boiled	L, Hi	-
Euphorbiaceae	*Phyllanthus emblica* L.	橄榄树	Shrub	Fr, Ba	Fruit, Spice	Fruit pickled, bark mixed with pork meat	L, Hi, Da, Ha	Y
Euphorbiaceae	*Sauropus androgynus* (L.) Merr.	-	Shrub	L	Leafy veg	Eaten raw	L, Hi	-
Fabaceae	*Acacia concinna* (Willd.) DC.	酸棘棘	Tree	L	Leafy veg	Boiled with egg / fried with egg	Da	-
Fabaceae	*Acacia pennata* (L.) Willd.	臭菜, 大竹	Tree	L	Leafy veg	Boil with egg / fried with egg	L, Hi, Da	Y
Fabaceae	*Bauhinia tomentosa* L.	白花	Tree	Fl	Veg	Boiled or stir-fried	L, Hi, Ha	Y
Fabaceae	*Bauhinia variegata* L.	白花	Tree	Fl	Veg	Boiled or stir-fried	L, Hi, Da	Y
Fabaceae	*Entada phaseoloides* (L.) Merr.	-	liana	Se	Nut	Pickled	Hi	-
Fagaceae	*Castanopsis clarkei* King ex J. D. Hooker	-	Tree	Se	Nut	Eaten raw	Da	Y
Fagaceae	*Castanopsis mekongensis* A. Camus	大竹溜	Tree	Se	Nut	Eaten raw	L, Hi, Da, Ha	Y
Flacourtiaceae	*Flacourtia ramontchi* L'Héritier,	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Gnetaceae	*Gnetum montanum* Markgr.	-	Liana	Fr, Se	Fruit, Nut	Boiled, eaten raw	Hi	-
Lamiaceae	*Elsholtzia kachinensis* Prain	水香菜	Herb	L	Leafy veg	Eaten raw with chili sauce or boiled, cooked with dog meat or beef	L, Hi, Da, Ha	Y
Lamiaceae	*Pogostemon glaber* Benth.	牛膝盖藤, 牛膝盖草	Herb	L	Spice	Add to the dishes	Hi	-
Lauraceae	*Litsea cubeba* (Lour.) Pers.	木姜子	Tree	Fr	Spice	Add to the dishes	Hi	-
Lauraceae	*Phoebe puwenensis* W. C. Cheng	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Liliaceae	*Polygonatum cirrhifolium* (Wall.) Royle	-	Herb	Rh, L	Veg	Boiled then eaten with chili sauce	Hi	-
Marattiaceae	*Angiopteris caudatiformis* Hieron.	-	Herb	R	Veg	Boiled	L, Da	-
Marattiaceae	*Angiopteris helferiana* Pres.	马蹄根	Herb	R	Veg	Boiled	L	-
Melastomataceae	*Melastoma malabathricum* L.	炸炮肚子果, 洋户官, 打破碗花树	Herb	L	Leafy veg	Boiled	L, Hi, Ha	-
Meliaceae	*Toona sinensis* (A. Juss.) Roem.	-	Tree	L	leafy veg	Smashed with chili / pickled	Ha	-
Menispermaceae	*Parabaena sagittata* Miers	梨板菜, 梨板叶	Herb	L	Leafy veg	Eaten raw or fried or make soup	L, Hi, Da, Ha	-
Moraceae	*Ficus auriculata* Lour.	象蹄叶, 象蹄菜, 五眼果	Tree	L, Fr	Leafy veg, veg	Eaten raw or boiled	L, Hi, Da, Ha	Y
Moraceae	*Ficus hirta* Vahl	鸡束果,	Tree	L, Fr	Fruit	Boiled or eaten raw	L, Hi, Ha	-

		小饿饭果树						
Moraceae	*Ficus oligodon* Miq.	-	Tree	L, Fr	Fruit	Boiled or stir-fried	L, Da	-
Moraceae	*Ficus semicordata* Buch.-Ham. ex Sm.	鸡束果	Tree	L, Fr	Fruit	Boiled or stir-fried	L, Hi, Ha	-
Musaceae	*Musa acuminata* Colla	芭蕉花	Herb	Fl, Fr, St	Veg	Boiled and fried	L, Hi, Da, Ha	Y
Myricaceae	*Myrica esculenta* Buch. - Ham. ex D. Don	杨梅果树	Tree	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	Y
Myrsinaceae	*Ardisia crenata* Sims	-	Shrub	Fr	Fruit	Eaten raw	Hi, Da	-
Myrsinaceae	*Ardisia virens* Kurz	小和尚果	Shrub	Fr	Fruit	Eaten raw	L, Hi	-
Myrsinaceae	*Embelia ribes* Burm. f.	泡筒果藤, 泡筒果	Shrub	St, Fr	Veg	Eaten raw	L, Hi	-
Myrsinaceae	*Embelia scandens* (Lour.) Mez	酸头果	Shrub	St, Fr	Veg	Eaten raw	Hi	-
Myrtaceae	*Psidium guajava* L.	马梨甘	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Myrtaceae	*Syzygium szemaoense* Merr. & L.M. Perry	羊屎果树	Tree	Fr	Fruit	Eaten raw	L, Hi, Da	-
Myrtaceae	*Syzygium tetragonum* (Wight) Wall. ex Walp.	干天果	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Passifloraceae	*Passiflora edulis* Sims	西番莲	Vine	Fr	Fruit	Eaten raw	L	-
Piperaceae	*Piper boehmeriifolium* (Miq.) Wall. ex C. DC.	小麻疙瘩, 大疙瘩	Liana	L	Leafy veg	Eaten raw or boiled	L, Hi, Da, Ha	-
Piperaceae	*Piper flaviflorum* C. DC.	小疙瘩, 辣藤, 小疙瘩	Liana	L	Leafy veg	Eaten raw or boiled	L, Hi, Da	Y
Piperaceae	*Piper longum* L.	辣藤, 绿子叶	Liana	L	Leafy veg	Eaten raw, fried with beef or pork, barbecued with bamboo or make soup	L, Hi, Da, Ha	Y
Piperaceae	*Piper sarmentosum* Roxb.	辣藤, 绿子叶	Herb	L	Leafy veg	Eaten raw or fried with pork, make soup	L, Hi, Da, Ha	Y
Piperaceae	*Piper yunnanense* Y.Q. Tseng	-	Herb	L	Leafy veg	Eaten raw, roasted, boiled, eaten with chili sauce	L, Hi	-
Poaceae	*Dendrocalamus brandisii* (Munro) Kurz	黄竹笋	Culm	St	Veg	boiled, stir-fried of pickled, eaten with chili sauce	L, Hi, Da, Ha	Y
Poaceae	*Dendrocalamus hamiltonii* Nees & Arn. ex Munro	-	Culm	St	Veg	boiled, stir-fried of pickled, eaten with chili sauce	L, Hi, Da, Ha	Y
Poaceae	*Dendrocalamus membranaceus* Munro	泡竹笋	Culm	St	Veg	boiled, stir-fried of pickled, eaten with chili sauce	L, Hi, Da, Ha	Y
Poaceae	*Dendrocalamus* sp.	-	Culm	St	Veg	boiled, stir-fried of pickled, eaten with chili sauce	L, Hi	Y
Poaceae	*Gigantochloa nigrociliata* (Buse) Munro	薄竹	Culm	St	Veg	Boiled and pickled	Da	Y
Poaceae	*Indosasa sinica* C.D. Chu & C.S. Chao	苦笋	Culm	St	Veg	Boiled	L, Hi, Da,	Y

							Ha	
Poaceae	*Pleioblastus amarus* (Keng) Keng f.	刺竹笋	Culm	St	Veg	Boiled then eaten with chili sauce pickled then fried	L, Hi, Da, Ha	Y
Polygonaceae	*Fagopyrum dibotrys* (D. Don) H. Hara	-	Herb	L	Leafy veg	boiled or stir-fried, fried with egg, made soup with tomato and pork	L, Da	-
Polygonaceae	*Polygonum caespitosum* Bl.	老金丹	Herb	L, St	Leafy veg	Eaten raw	Hi	-
Polygonaceae	*Polygonum capitatum* Buch. -Ham. Ex D. Don	老金丹	Herb	L	Leafy veg	Eaten raw	Hi	-
Pontederiaceae	*Eichhornia crassipes* (Mont.) Solms	干天果	Herb	L	Leafy veg	Eaten raw with chili sauce	Da	-
Pontederiaceae	*Monochoria vaginalis* (Burm. f.) C. Presl ex Kunth	-	Herb	St, L	Leafy veg	Boiled then fried	L,Da	-
Pteridaceae	*Pteris wallichiana* J. Agardh	-	Herb	L	Leafy veg	Boiled then fried and eaten with sauce	Hi	-
Rhizophoraceae	*Carallia brachiata* (Lour.) Merr.	斑鸠屎果	Tree		Fruit	Eaten raw	L, Hi, Ha	-
Rosaceae	*Cerasus cerasoides* (Buch.-Ham. ex D. Don) S.Y. Sokolov	樱桃	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Rosaceae	*Docynia delavayi* (Franch.) C.K. Schneid.	哆依果	Tree	Fr	Fruit	Pickled and eaten with chili sauce	L, Hi, Da, Ha	Y
Rosaceae	*Pyrus pashia* Buch.-Ham. ex D. Don	-	Tree	Fr	Fruit	Eaten raw	L, Hi, Ha	-
Rosaceae	*Rubus ellipticus* var. *obcordatus* Focke	-	Shrub	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	-
Rosaceae	*Rubus alceifolius* Poir.	-	Shrub	Fr	Fruit	Eaten raw	Da	-
Rosaceae	*Rubus pluribracteatus* L.T. Lu & Boufford	麻桑果	Shrub	Fr, St	Fruit	Eaten raw	L	-
Rosaceae	*Rubus rufus* Focke	-	Shrub	Fr, St	Fruit, Veg	Eaten raw	Hi, Ha	-
Rubiaceae	*Toddalia asiatica* (L.) Lam.	下鱼钩 小狗叶果	Tree	Fr	Fruit	Eaten raw	Hi	-
Rutaceae	*Zanthoxylum myriacanthum* Wall. et Hook. f.	-	Shrub	Se	Spice	Cooked with food	Hi	-
Sapindaceae	*Nephelium chryseum* Blume	毛李子果	Tree	Fr	Fruit	Eaten raw	L, Hi, Da	Y
Saururaceae	*Houttuynia cordata* Thunb.	鱼腥草 (狗青菜)	Herb	Ap	Leafy veg	Eaten raw or boiled, cold food, eaten with chili sauce	L, Hi, Da, Ha	Y
Schisandraceae	*Kadsura coccinea* (Lem.) A.C. Sm.	-	Tree	Fr	Fruit	Eaten raw	Hi	-
Smilacaceae	*Smilax china* L.	山堆堆 老虎刺苔	Vine	L, Fr	Leafy veg, Veg	Boiled or stir-fried	L,Da	-
Smilacaceae	*Smilax perfoliata* Lour.	老虎刺苔	Vine	L	Leafy veg	Eaten raw with chili sauce	Hi, Ha	-
Solanaceae	*Cyphomandra betacea* (Cav.) Sendt.	-	Shrub	Fr	Fruit	Eaten raw	Hi	-

Solanaceae	*Solanum americanum* Miller	-	Herb	L, Ap	Leafy veg	Boiled or stir-fried and used to make soup	L, Hi, Da, Ha	Y
Solanaceae	*Solanum spirale* Roxb.	小苦了了	Herb	Fr	Spice	Fried and smashed then added to chili sauce or added to the soup	L, Da, Ha	-
Solanaceae	*Solanum torvum* Swartz	小苦果, 刺果树, 苦子果	Herb	Fr	Spice	Fried and smashed then added to chili sauce	L, Hi, Da, Ha	Y
Solanaceae	*Solanum violaceum* Ortega	小苦果, 苦果	Herb	Fr	Veg	Fried and smashed then added to chili sauce	L, Hi	-
Urticaceae	*Elatostema acuminatum* (Poir.) Brongn.	马鹿耳朵菜, 野巧菜	Herb	L	Leafy veg	Boiled, raw or fried then eaten with chili sauce	L, Hi, Da, Ha	-
Urticaceae	*Oreocnide rubescens* (Blume) Miq.	水麻	Shrub	St	Veg	Boiled and then eaten with chili sauce	Hi	-
Urticaceae	*Pilea cadierei* Gagnepain & Guillemin	-	Herb	L. Ap	Leafy veg	Boiled and then eaten with chili sauce	Da	-
Urticaceae	*Pilea villicaulis* Hand.-Mazz.	马鹿菜	Herb	L, Ap	Leafy veg	Eaten raw	L, Hi, Da, Ha	Y
Vitaceae	*Tetrastigma obovatum* (M.A. Lawson) Gagnep.	扁担果	Vine	Fr	Fruit	Eaten raw	L, Hi, Da, Ha	-
Zingiberaceae	*Alpinia kwangsiensis* T.L. Wu & S.J. Chen	-	Herb	Fr, marrow	Spice	Eaten raw or fried	Hi	-
Zingiberaceae	*Amomum sericeum* Roxb.	姜苗果	Herb	Se	Spice	Add to the foods	L, Hi, Da, Ha	Y
Zingiberaceae	*Zingiber neotruncatum* T.L. Wu, K. Larsen & Turland	野姜	Herb	Rh	Spice	Cooked	L, Hi	Y
Zingiberaceae	*Zingiber trumcatum* S.Q Tong	-	Herb	Rh	Spice	Smashed with chili and used to make sauce	Hi	Y

Used parts: Ap= aerial parts, L= leaves, Fl= flower, Fr= fruit, Se= seed, St= stem, Rh=rhizome, R= root, Tu= tuber, Ba= bark. Use categories: Veg= vegetable, Leafy veg= leafy vegetable. Ethnicity: Da= dai, Ha= han, Hi= hani, L= lahu. Trade: Y= traded

6 *Asparagus* spp. in Traditional Chinese Medicine - wild Collection and Its Sustainability

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Outline and overview:

This chapter presents the result of a case study on the harvest sustainability of a medicinal plant in the research area. This medicinal plant species used in Traditional Chinese Medicine but its use is not very common among the local ethnic groups. This study shows the role of market as a driving force for the overharvesting of the plants and shows that the current harvest practices for this plant is not sustainable. At the end it gives some suggestions for legislation and further research to protect this plant from overexploitation and depletion of the natural population in the area.

Asparagus spp. in Traditional Chinese Medicine - *Wild Collection and Its Sustainability*

Solveig F. Bucher, Abdolbaset Ghorbani, Gerhard Langenberger, Manfred Küppers and Joachim Sauerborn

6.1 Introduction

More than 80% of the world's population relies on traditional medicine for their primary healthcare–mostly in the form of medicinal plants (Hamilton *et al.*, 2003; Sun *et al.*, 2007). Traditional and herbal medicines are popular and are increasingly being paid attention to by the scientific world.

The volume of traditional Chinese medicine (TCM) in trade has been growing since 1994 at an annual rate of eight per cent and was worth USD23.2 billion in 2002 (Cunningham *et al.*, 2008). Eighty seven percent of the ingredients used in TCM comprise 4941 plant species, 96% of which are still collected from the wild (Cunningham *et al.*, 2008; Hamilton, 2004; Ji *et al.*, 2004; Leaman, 2006). Prevailing practices of plant collection are often not sustainable which not only threatens plant populations and ecosystem diversity but also endangers the livelihoods of the collectors who depend on the collection as a source of income. Moreover, increasing demand for medicinal plants along with the destruction of natural habitats through deforestation and fragmentation leads to overharvesting and a decline in plant populations (Cunningham *et al.*, 2008; Lee *et al.*, 2008). Assessment of the sustainability of the harvest of medicinal plants and associated methods used is therefore important.

In this study, the wild collection of two *Asparagus* species in Yunnan Province, China – namely *Asparagus filicinus* Buch-Ham. ex D. Don and *Asparagus subscandens* F.T. Wang & S.C. Chen– was examined in order to determine the current status of the harvest and to estimate whether it is sustainable. In TCM, the drug derived from the plants' tuberous roots is "sweet" and "cold" in nature, consumption of which purports to clear the "lung heat", nourish the "Yin"–especially in the lungs and kidneys–and reduce "dryness" (see Wu, 2005; Yang, 2010). In local folk medicine, the roots are used to treat stomach ache, diarrhoea and bone injuries (Ghorbani *et al.,* 2011).

6.2 Methods

The study was conducted in five villages in the Naban River Watershed National Nature Reserve in Xishuangbanna, Yunnan, south-west China. The nature reserve comprises approximately 30 villages and a total population of more than 5000 people. Former studies indicate intense collection took place in the selected villages (Ghorbani *et al.,* 2011). In order to assess the current distribution of the two *Asparagus* species, strip transects in fallow land and forest areas where collection was practiced in past years have been conducted representing the natural habitat of the species. The present study used International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP, now part of the FairWild Standard Version 2.0) Resource Assessment guidance to evaluate the status of populations and harvest. Harvest intensity was estimated via interviews with approximately five villagers per village, amounting to a total of 29 interviews. The fieldwork was carried out during a three-month period from March to June 2010 by two researchers and supported by local assistants who also translated the interviews, which were conducted in local Chinese.

6.2.1 Distribution and Status

Both *Asparagus* species are perennial herbs of the *Asparagaceae* family. They are treated as a single so-called "ethnospecies[1]" in the area and are known and traded as TianDong (天门冬) or Asparagi radix.

Asparagus subscandens can only be found in the province of Yunnan and is categorized as an endangered ("vulnerable") species (VU A2c) in the Red List of China, whereas *A. filicinus* is widely distributed in South-east Asia and is not listed as being threatened. Neither species has been evaluated using the IUCN Red List categories and criteria.

Studies on the active compounds were mostly performed on *A. filicinus* due to its wider distributional range and its widespread medicinal application in other folk medicines, e.g. that of Nepal and northern India. Little is known about the chemical compounds of *A. subscandens* of which the major proportion of harvest originates in the study area. Hence it is not certain whether it is appropriate to view both species as having identical pharmaceutical properties.

[1] Ethnospesies are biologically different species which are considered as one species by local people and used for same purposes.

6.2.2 Legislation

In general, the commercial collection of medicinal plants and other forest products for sale is prohibited in the Naban River Watershed National Nature Reserve. Collection of *Asparagus filicinus* and *A. subscandens* is permitted for personal consumption although the amounts allowed for such purposes has not been determined. For some non-timber forest products (NTFPs) such as bamboo shoots or timber for housing, permission can be granted by the administration office of the nature reserve. However, currently there is no strict control of collection and trade of medicinal plant species. Compliance of villagers to the existing regulations is low. Officially collection is assumed to be non-existent although amounts of up to 70 kg harvested per household per year have been recorded.

6.3 Results

The harvest of both *Asparagus* species is destructive as the whole plant is dug out in order to reach and collect the root tubers. Each year, the average amount collected is approximately 3000 plants (equivalent to circa 23 kg of dried plant material) per collector. Villagers report declining harvest amounts due to the scarcity of the *Asparagus* species. These two species should only be harvested after a period of approximately five years in order to allow the plant to become established and grow. In former times, a huge proportion of collected material derived from fallow land areas but this amount is declining in parallel with a decline in the period of time in which land is left to lie fallow. The calculated number of plants per hectare varies from between 1.1 and 174.2 for *Asparagus filicinus* in forest areas and from 50.6 and 80 plants and 0.8 and 162.5 plants per hectare for *A. subscandens* in forest areas and fallow land, respectively. *Asparagus filicinus* could only be found at elevations above 1700 m a.s.l. and therefore only in one out of five villages, whereas *A. subscandens* occurred in all five. The study revealed that as many plants as possible are harvested, with no attention being paid to the recovery of their stands, and that collection is almost solely driven by commercial interest, and sometimes without knowledge of the plants' medicinal properties. However villagers avoid digging out young plants because they yield fewer tubers. The processing of root tubers–boiling, peeling and drying–is conducted in villages as only processed plant material is bought by middlemen visiting the villages.

Currently, many middlemen are involved in the trade of medicinal plants derived from the nature reserve, which demonstrates the economic profitability and makes the general situation quite unclear. Prices paid for dried *Asparagus* tubers vary markedly depending on the position in the market chain: in the villages, one kilogramme of dried matter is sold for USD3.65 (±0.29), on

local markets it fetches USD8.37 (±1.55) and in German pharmacies the same material, without any further processing, is sold for USD155.35 (±1,37). A household is able to generate USD53 per year on average, which accounts for between 1.14% and up to 25.44% of the total annual income of households in different villages. The highest proportion of material is purchased by middlemen.

The estimated number of years for which the current population of plants will last (disregarding any regeneration, for which there are no data), differs between the villages and varies from 0.06 to 38.04 years. Collection is driven by poverty and a lack of other income sources: the number of years is correlated with the average income of the villagers–the higher the average income per household, the less people try to generate money through collection of medicinal plants.

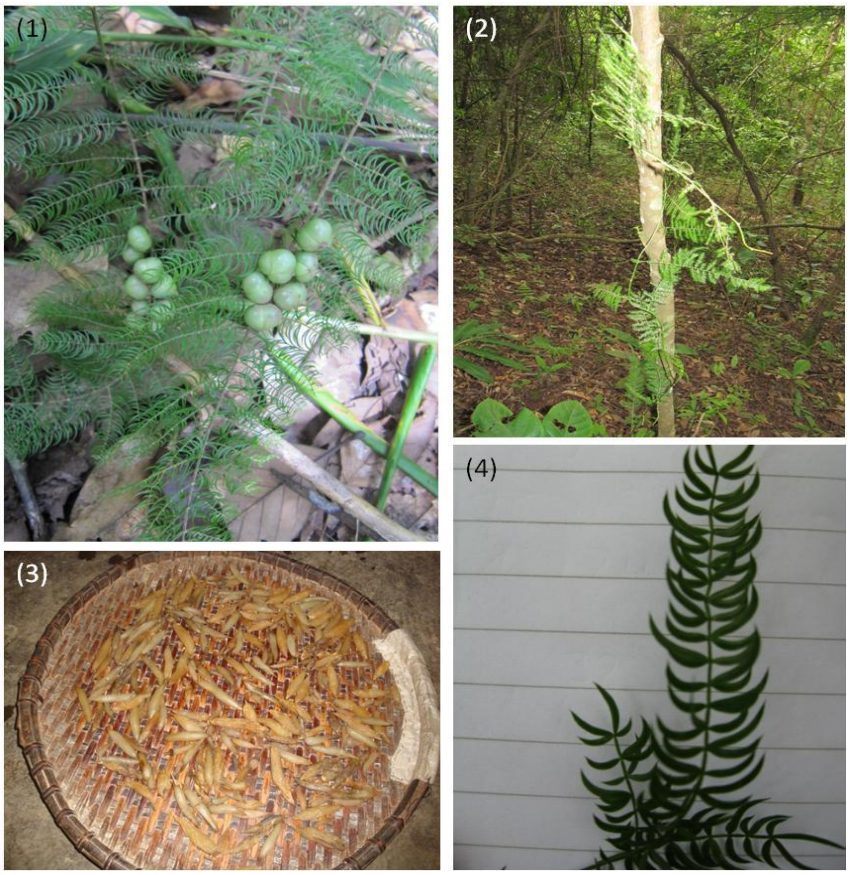

Figure 1: (1) *Asparagus subscandens*, fruiting, (2) *Asparagus subscandens* climbing habit, (3) dried and peeled roots of *Asparagus* spp., (4) *Asparagus filicinus*, leaflets

6.4 Conclusions and Recommendations

Since there is no effective control of harvesting that takes place in breach of legal regulations, some kind of organization for the sustainable wild collection of medicinal plants needs to be

established. Conversely there should be more effort placed on the enforcement of existing regulations which completely prohibit any collection for the purpose of selling. However, as clearly demonstrated by the ample variation in prices between villages, markets and pharmacies, there are potentially huge profits which attract collectors and traders. By establishing trading structures, the local economy could be effectively supported if a suitable local framework is found, although the existing law needs to be changed potentially to allow sustainable wild harvest of the focus species. It is suggested that resource management authorities review results of this study to evaluate the possibilities either for stricter enforcement measures to be imposed or for a change in legislation to allow sustainable wild harvesting, in consultation with local collectors and conservation experts (e.g. through the use of FairWild Standard guidelines). In either case, a management strategy is essential.

Villagers' awareness about the problems of collecting wild plants in an uncontrolled fashion should be raised. Additionally, collection practices should be modified, for example only digging out the root tubers but leaving the rhizome untouched in the soil in order to allow regeneration. Villagers should be made aware that with the current collection pressure and methods used, no sustainable harvesting is possible. One of the major concerns about the harvest of medicinal species is that little is known about the species' ecologies–for example, in relation to regeneration–so evaluations of collection sustainability are generally hard to make (Cunningham, 2001). This is certainly the case for the selected *Asparagus* species, where no recruitment and mortality rates could be found in the literature. Comparison to areas without harvest impact was not possible. This needs to be undertaken in order to judge the status of the current population. Study of the plants' ecology and further research into the sustainability of harvest methods and harvest levels are clearly needed.

Collecting plants from wild stands often leads to over-exploitation therefore scientific study into the potential for cultivating these *Asparagus* species in agro-forestry systems is required. In general, further studies and long-term surveillance of plant populations are needed to fully understand the impacts of collection. Since the distribution of *A. subscandens* is limited to Yunnan, this species should be a priority when planning any conservation interventions. It is important that chemical and pharmaceutical studies are undertaken in order to demonstrate the presence of medicinal properties; should such properties be identified, the feasibility of establishing plantations for this species to take pressure off wild populations needs to be explored. It should also be recognized that some of the poorest people are dependent on the harvesting of these species and thus the socio-economic factors relating to such harvesting need to be taken into account.

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7 General discussion

A large diversity of forest resources are available and used by local people in NRWNNR. These include medicinal plants, food plants, mushrooms, firewood and construction material. However, only few forest products including some medicinal plants have direct contribution to the household's cash economy. Many of the forest products are used at the subsistence level. This diversity of plant products is important because it acts like insurance, smoothing the shortages of one plant product with replacing the others though securing the nutrition and health of villagers. In fact subsistence use of non-timber forest products is the most common use form throughout the world (Shackleton et al., 2011). The role of subsistence and self-consumption in livelihood security and saving households expenditure especially for poor ones is significant. Some researchers tried to estimate the economic value of NTFPs subsistence use and its contribution to total household's income. For example Doive (2004) estimated that the value of NTFPs subsistence use in Bushbuckridge in South Africa is 572 USD/year which accounts to 19.4% of household annual income (cited in Shackleton et al., 2011). In a study in Zimbabwe, Cavendish (2000) showed that value of non-marketed NTFPs for rural households is 436 USD/year, accounting to 28.4% of total annual income. Delong (2005) estimated that in western Thailand each household saves on average 11,505 Baht (USD 302) annually by using wild food plants from forest.

Marketed plant products are few in number which includes some food and medicinal plants. These plants are traded mainly by poor members of the community who have less agricultural land assets. In general direct economic contribution of traded plant products to the household's cash income is not high. In case of bamboo shoots for example, the highest contribution to the household's cash income was in MangXingLongLa village which is 3.8% of the total per capita income. However if we consider household's self-consumption, this figure will be much higher as bamboo shoots are among the most common food plants in the area. In case of medicinal plants, contribution to the cash income of households varies from 1.1% up to 25.4% of the household's total annual income. Economical important medicinal plants are *Paris polyphylla* var. *yunnanensis* (Franch) Hand. -Mazz., *Asparagus filicinus* Buch.-Ham. ex D. Don, *Asparagus subscandens* F.T. Wang & S.C. Chen, *Drynaria propinqua* (Wall. ex Mett.) Bedd. and *Stemona tuberosa* Lour. In Nepal, villagers can get 3-44% of their annual household income from medicinal plant collection (Hertog and Wiersum 2000; Olsen and Larsen 2003) which for poorer households can reach up to 78% (Rijal, et al. 2011). In general economic returns from collection of medicinal plants depend on the species resources, market demand and marketing level (local, regional or international). In our studied area, contribution of medicinal plants to the

villager's economy doesn't sound sustainable since populations of traded plants are decreasing and collectors should spend much more time searching for the plants. The trade amount of these plants when considered at larger scale is significant. In South Africa for example the annual trade of medicinal plants is valued at USD75-150 million (Mander & Le Berton 2006) and in Bangladesh the annual of traded medicinal plants from rural areas worth USD 4.5 million (SEDF/IC 2003, Mukul 2007). In Nepal annual trade of medicinal plants value USD 7-30 million, with around 323,000 households involved in harvesting these medicinal plants mainly from wild (Olsen, 2005).

Wild food plants in the area can be grouped based on harvest and use frequency into different categories. The first group is species with high frequency of use which are generally common species that can be easily collected by villagers without spending much time for searching and collection. This group contributes to the food security of households and also to save the households expenditure as they are consumed frequently. Their role in nutritional health of villagers' especially women and children should not be denied. Local people have good and common knowledge about these species and their uses and they are regular part of the villager's diet. Ease of access might be also an important reason for selection and use of these plants. Second group includes bamboo shoots and mushrooms. They grow in forests and villagers normally do not have as easy access as the aforementioned group. These are also the ones which are traded to some extent. The last group includes a long list of plant species which are not used frequently but mentioned in the interviews as food plants. These are potential food plants which are used only by small proportion of the local population or they might be used during famine or crop failure periods. However the knowledge about these plants and their uses still exists in the community. It is important to differentiate the actual and potential food plants available in the area. Active food plants are the ones in active use in the community. These species are used frequently and includes groups 1 and 2. Actual list of food plants is short but species in this list are in actual and practical use in the research area. These species are mentioned as core of wild food plant cultural domain in chapter 5. However figures regarding the total number of food plants in the area mentioned in chapter 2 include both actual and potential list of the food plants.

In case of medicinal plant, there is also a similar situation. Only a small number of medicinal plants are known to and used by ordinary villagers. These medicinal plants offer free self-medication to the villagers. A large proportion of medicinal species are known and collected by traditional healers or some elderly people knowledgeable in medicinal plants and their applications. A few numbers of medicinal plants are frequently collected and in high amounts by

local people for commercial purposes. Traditional use and medicinal application of these plants are not known by most of the collectors. Examples of these species include *Asparagus*, *Stemona* and to some extent *Paris*. Although use of these medicinal plants is known to traditional healers, majority of villagers which are involved in harvesting and exploitation of these species have barely any knowledge about their medicinal applications. In fact harvest of these species is driven by market demand which is brought to the area by middlemen and retailers visiting the villages.

In general, knowledge of medicinal plants and folk medicine still exists in the area and there are local healers and practitioners who are active and serving villagers. However this knowledge shows some differences among ethnic groups. For example number of medicinal plants used by Lahu and Hani is different and some species are solely known and used by only one ethnic group. Since these ethnic groups live in neighboring villages in the same area, it was expected that a large proportion of their medicinal plant knowledge is shared. The diversity of medicinal species utilized by the two ethnic groups show 30% overlap. Statistical analysis revealed that their medicinal plant use patterns were similar in most tested aspects. Patterns of plant part use, selection of plant growth form and habitat and medicinal uses were similar between Lahu and Hani but patterns of selection of plant families as a source of medicinal plants were different. This means that medicinal plant use knowledge of Lahu and Hani is more determined by ecological conditions. Others also found different patterns comparing medicinal plant knowledge of different communities. For example, among two neighboring Amazonian communities different medicinal species were used from the same set of plant families (Shepard, 2004). Farmers in two East Timore villages had also different medicinal plant use traditions despite of living in the similar environment (Collins et al., 2008). Our finding suggests that Informant Agreement Ratio is not a good indicator for comparison of medicinal plant knowledge between different communities and comparison at the species level with comparing use details of each species among the subject ethnic groups might result in proper comparisons. In general, different factors affect the patterns of medicinal plant knowledge and use; some aspects of these patterns are determined by culture and some aspects by ecological environment. Such differences could be seen in case of food plants as well. Despite the sharing a large proportion of wild food plant knowledge between ethnic groups in the area, our results shows that the preference of wild food plants is dependent on culture. Inta et al., (2008) showed the role of culture among two Akha communities living in China and Thailand as they had similar medicinal plant knowledge bound to similar cultural background.

Our findings also reveal a big potential for harvesting, participatory domestication and marketing of forest products especially in the tourism sector in the area. Though forest products collection has lost its importance in some villages, it is still important in the others. For example in Man Dian (a Dai village), wild vegetables and fruits have lost their importance in everyday life of villagers, because villagers earn more income from rubber plantations and prefer to buy vegetables from the market. Another reason for abandoning forest products collection could also be the reduced availability of resources due to conversion of community forests into rubber plantations. Moreover, the rubber cultivating villages seem to be very interested in changing their lifestyle towards a more modern one. Folk medicine, plant collection activities and wild food on the table might have lost their attractiveness. Modern medicine and consumption of produced food and other goods is more appealing, particularly for the younger generation.

Wild harvest of forest products and economic development brings along the sustainability (ecological and economical) issues with it. Whenever commercial collection becomes common, overexploitation and extinction threats gets more serious. Based on Rapid Vulnerability Assessment of some selected medicinal and food plants which are marketed in the area, most of the important forest products are in danger of overexploitation. Among the wild food resources bamboo shoots and mushrooms are exploited without sustainability measures. Collection of high economically valuable medicinal plants is not sustainable as well because the harvested parts are normally roots and harvest practice results to the death of plant. Sustainable harvest and management strategies should be implemented to prevent overexploitation which may result in the local extinction of important and vulnerable species. In order to develop a sustainable forest product exploitation system, it is important to know the ecological parameters regarding target species. However, to develop sustainable management strategies which are adopted by the local people, it is also important to consider the local indigenous knowledge and social and economic conditions. We cannot address the issue of resource depletion without information about productivity and harvest levels. More data on ecological and population matrixes and the impact of harvest of important species on wild populations is necessary to show the sustainable harvest thresholds. Considering the increasing demand for medicinal plants used in traditional medicine and limitation of natural resources, cultivation of medicinal plants in the area could reduce the pressure on plant populations and also diversify the local livelihood strategies by generating additional income for households. A more detailed study is necessary to quantify the harvest level of forest products especially with regard to species with higher use frequency to be able to address the issue of sustainable harvest.

At the end, our findings highlight plant species which can be proper candidates for cultivation especially in agroforestry systems. There is already a good potential on the improvement of economic gains from some forest products such as mushrooms with value adding by improving drying methods and establishment of village based enterprises. Some of the medicinal plants are already transplanted into homegardens by villagers because of their economic as well as use value. Medicinal plants such as Orchids, *Asparagus spp., Aristolochia sp.* and *Paris polyphylla* var. *yunnanensis* (Franch) Hand. -Mazz. and food plants such as *Gnetum montanum* Markgraf , *Rhus chinensis* L., *Phyllanthus emblica* L. and bamboos are good candidates for cultivation practices in agroforestry systems or TCM herb gardens. More research and practical experiments on the integration of these species in agroforestry system in the area or cultivation in collective forests will help to reduce pressure on natural population of medicinal plants and secure the sustainable supply and income for the villagers.

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8 Summary

Agrobiodiversity and its use in Naban River Watershed National Nature Reserve: implications for bio-cultural diversity conservation

This study was conducted in the Naban River Watershed National Nature Reserve (NRWNNR), Xishuangbanna Dai Prefecture, SW China and aimed at identifying the diversity of medicinal and food plants used by local people living in NRWNNR and documenting their applications. NRWNNR is diverse biologically and culturally and people living in its territories get benefits from their diverse natural environment. However the extension of cash crops such as rubber (*Hevea brasilliens* (Willd. ex A. Juss.) Müll. Arg.) plantations and fragmentation of natural habitats including forests resulted in decreasing biological diversity which could be used by the local people. This also put more pressure on the remaining forests and plant resources. In order to find sustainable alternatives to conserve biodiversity and at the same time helping the development of the area it is necessary to know the available resources in the area. Among important plant resources in the area are non-timber forest products with economic and cultural importance including medicinal and food plants. Therefore, using ethnobotanical methods this study intended to document wild medicinal and food plant resources used by ethnic groups and their use details including their collection practices, preparation methods and habitat preferences. Data on useful plant resources was used to identify the main land use sources of useful plants for local people. The study also intended to understand the role of these plants in local people's livelihood by identifying economically important medicinal and food plants traded in the area. Vulnerability of plant species to resource exploitation and harvest sustainability for selected species were assessed.

To achieve above mentioned objectives, an ethnobotanical inventory of useful wild plant resources was conducted in the area to collect data on wild plant resources and uses. Semi-structured, freelisting, and household interviews were conducted from January 2008 to January 2010. Informants from Dai, Hani, Lahu and Mountain Han ethnic groups were selected randomly for freelisting and semi-structured interviews and key informants by the snowball method. Household interviews were conducted in six villages. Interviews were also conducted with harvesters and traders. All interviews were supplemented with plant sample collection for botanical identification. Plant specimens were prepared, dried, and identified with the help of

local botanists. To address the vulnerability and sustainability of plant harvest, strip-transects were used to estimate the density and distribution of selected species in natural populations.

Results showed that 480 plant species (25% of recorded flora) from 117 families and 334 genera are used by the local population. From these, 378 species (19%) belonging to 102 families and 277 genera are used as medicine and 161 species (8%) representing 68 families and 116 genera are used as food plants. Concerning livelihood contribution, most of these plants are used at the subsistence level and not for income generation. However some households can get from 1.1% up to 25.4% of their total annual income from sale of few medicinal species. Among food plants only bamboo shoots and mushrooms contribute to the cash income of households with the highest share in BenGang Hani village (1.1%).

Knowledge of medicinal plant use and folk medicine still exists in the area and there are local healers and practitioners who are active in some villages. However this knowledge shows some differences among ethnic groups. Number of medicinal plants used by Lahu and Hani is different and some species are solely known and used by only one ethnic group. Since these ethnic groups live in neighboring villages, it was expected that a large proportion of their medicinal plant knowledge is shared. However, the diversity of medicinal species utilized by the two ethnic groups show 30% overlap.

Medicinal plants are grouped into different categories based on frequency of use. 1- Frequently used medicinal plants which are few in number. 2- A large number of medicinal species are only known and collected by traditional healers or some knowledgeable elderly people. 3- A few numbers of medicinal plants are frequently and in high amounts harvested by locale people for commercial purposes and not for self consumption. Examples of these species include *Asparagus subscandens* F.T. Wang & S.C. Chen, *Asparagus filicinus* Buch.-Ham. ex D. Don, *Stemona tuberosa* Lour. and *Paris polyphylla* var. *yunnanensis* (Franch) Hand -Mazz. Although use of these medicinal plants is known to traditional healers, majority of the villagers which are involved in harvesting of these species are not knowledgeable about their medicinal applications. In fact harvest is driven by market demand which is brought to the area by middlemen and retailers visiting the villages.

Wild food plants are also grouped based on harvest and use frequency into different categories. The first group includes species with high frequency of use which have a very common distribution range in the area. Second group includes bamboo shoots and mushrooms which are traded to some extent. The last group includes a large number of species which are not used

frequently but are potential food plants used only by a small proportion of the local population or during famine or crop failure periods.

Based on vulnerability assessment of marketed species in the area, most of the important plants are in danger of overexploitation. However frequently used food plants are not threatened with overharvesting since they are very common in the area. Among the wild food resources bamboo shoots and mushrooms are exploited without sustainability measures. Collection of high economically valuable medicinal plants is also not sustainable as subterranean parts are harvested and collection is fatal for the plant. Sustainable harvest and management strategies should be implemented to prevent overexploitation of these species. Findings also highlight plant species which can be proper candidates for cultivation especially in agroforestry systems. There is already a good potential on the improvement of economic gains from some forest products such as mushrooms with value adding by improving drying methods and establishment of village based enterprises. Cultivation of economically important medicinal plants in herbal gardens or agroforestry systems are recommended since it can reduce pressure on natural population and at the same time diversify and secure the economic gain of villagers.

9 Zusamenfassung

Agrobiodiversität und ihr Nutzen im Naban River Watershed National Nature Reserve: Auswirkungen auf den Schutz von biologischer und kultureller Diversität

Diese Studie wurde im Naban River National Nature Reserve (NRWNNR) in der autonomen Dai Präfektur Xishuangbanna im Südwesten Chinas durchgeführt und hatte die Identifizierung der Vielfalt von Medizinal- und Nahrungspflanzen, die von der lokalen Bevölkerung innerhalb des NRWNNR genutzt werden und die Dokumentation deren Verwendung zum Ziel. Das NRWNNR ist biologisch und kulturell divers und die dort lebenden Menschen profitieren von ihrer reichhaltigen natürlichen Umgebung. Allerdings hat die Ausbreitung von sogenannten Cash Crops wie Kautschuk (*Hevea brasilliens* (Willd. ex A. Juss.) Müll. Arg.) Plantagen und die Fragmentation von natürlichen Habitaten u.a. des Waldes die Abnahme dieser biologischen Diversität, die auch vom Menschen genutzt werden kann zur Folge. Außerdem führt dies zu einem verstärkten Druck auf die noch verbleibenden Wald- und Pflanzenressourcen. Um eine nachhaltige Alternative für den Schutz der Biodiversität zu finden und gleichzeitig die Entwicklung des Gebietes voranzutreiben ist es notwendig, einen guten Überblick über die dort verfügbaren Ressourcen zu bekommen. Unter den wichtigen pflanzlichen Ressourcen mit ökonomischer sowie kultureller Bedeutung befinden sich sogenannte „Nichtholz Forst Produkte“, Produkte, die zwar aus dem Wald stammen wie zum Beispiel Medizinal- und Nahrungspflanzen aber keine Holzprodukte sind. Deswegen wurde versucht, die Medizinal- und Nahrungspflanzen, die von ethnischen Minderheiten genutzt werden mit Hilfe von ethnobotanischen Methoden zu dokumentieren sowie die Einzelheiten ihrer Anwendung, wie zum Beispiel die Art und Weise der Ernte, ihre Verarbeitung und das bevorzugte Habitat der Pflanzen zu ermitteln. Daten über die Ressourcen von Nutzpflanzen wurden genutzt um die wichtigste Landnutzungsform für Nutzpflanzen, die von der lokalen Bevölkerung verwendet werden zu ermitteln. Dadurch, dass wirtschaftlich bedeutende Medizinal- und Nahrungspflanzen, mit denen in der Region gehandelt wird identifiziert wurden, wurde im Zuge dieser Studie versucht, die Rolle dieser Pflanzen für den Lebensunterhalt der lokalen Bevölkerung zu verstehen. Die Vulnerabilität der Pflanzenarten bezüglich ihrer Ernte und ihre nachhaltige Nutzung wurden für ausgewählte Arten bestimmt.

Um die genannten Ziele zu erreichen wurde eine ethnobotanische Bestandsaufnahme von den Ressourcen nützlicher Pflanzen im Untersuchungsgebiet durchgeführt, um Daten über die Populationen sowie deren Nutzung zu erhalten. Zwischen Januar 2008 und Januar 2010

wurden semistrukturierte, freelisting- und Haushalts-Interviews durchgeführt. Informanten für freelisting und semistrukturierte Interviews wurden zufällig aus Mitgliedern der ethnischen Gruppen der Dai, Hani, Lahu und Mountain Han ausgesucht, während Schlüsselinformanten durch die Schneeballmethode ausgewählt wurden. Die Haushalts-Interviews wurden in sechs Dörfern durchgeführt. Zusätzlich wurden auch Sammler und Händler interviewt. Die Interviews wurden mit der Sammlung von Herbarbelegen für die botanische Identifizierung ergänzt. Die Pflanzenproben wurden aufbereitet, getrocknet und mit der Hilfe von ortskundigen Botanikern identifiziert. Um die Vulnerabilität und die Nachhaltigkeit der Sammlung zu erfassen wurden Linientransekte aufgesetzt, um die Größe und Verteilung der Population ausgewählter Pflanzenarten abschätzen zu können.

Es konnte gezeigt werden, dass 480 Pflanzenarten (25% der dokumentierten Flora) aus 117 Familien und 334 Gattungen von der lokalen Bevölkerung genutzt werden. Davon werden 378 Arten (19%) die aus 102 Familien und 227 Gattungen stammen als Heilpflanze genutzt und 161 Arten (8%) aus 68 Familien und 116 Gattungen als Nahrungspflanzen verwendet. Einige Haushalte können indes zwischen 1,1% und 25,4% ihres jährlichen Einkommens durch den Verkauf einiger weniger Heilpflanzen generieren. Unter den Nahrungspflanzen tragen nur Bambussprösslinge und Pilze zum Haushaltseinkommen bei, den größten Anteil findet man im Dorf BengGang Hani (1.1%).

Das Wissen um Medizinalpflanzen und Volksmedizin existiert noch immer im Untersuchungsgebiet und in einigen Dörfern gibt es noch aktive Heiler und Ärzte. Dieses Wissen unterscheidet sich jedoch zwischen den einzelnen ethnischen Gruppierungen. Die Zahl der Heilpflanzen, die von Lahu und Hani benutzt werden ist unterschiedlich; einige Pflanzenarten sind nur bei einer der ethnischen Minderheiten bekannt und werden somit auch ausschließlich von ihr benutzt. Da diese ethnischen Gruppen benachbart sind wäre zu erwarten gewesen, dass das Wissen um Medizinalpflanzen sich ähnelt. Die genutzten Heilpflanzen überschneiden sich jedoch in den zwei ethnischen Gruppen nur zu 30%.

Die Heilpflanzen wurden je nach Häufigkeit ihrer Nutzung in verschiedene Kategorien eingeteilt. 1- Häufig genutzte seltene Arten. 2- Medizinalpflanzen die nur traditionellen Heilern und wenigen weisen älteren Menschen bekannt sind und die auch nur von diesen gesammelt werden. 3- Heilpflanzen, die häufig vorkommen und in großen Mengen durch die lokale Bevölkerung zu ökonomischen Zwecken aber nicht für den Eigenbedarf gesammelt werden. Beispiele für solche Arten umfassen *Asparagus subscandens* F.T. Wang & S.C. Chen, *Asparagus filicinus* Buch.-Ham. ex D. Don, *Stemona tuberosa* Lour. und *Paris polyphylla* var.

yunnanensis (Franch) Hand -Mazz. Obwohl deren Anwendung den traditionellen Heilern bekannt ist, weiß der Großteil der Dorfbevölkerung, der diese Pflanzen sammelt nicht um deren Nutzung. Tatsächlich wird die Ernte dieser Pflanzen durch die Nachfrage des Marktes bestimmt, die durch Mittelsmänner und Händler, die in die Dörfer kommen übermittelt wird.

Wild wachsende Nahrungspflanzen wurden auch in verschiedene Kategorien eingeteilt basierend auf der Häufigkeit ihrer Nutzung. Die erste Gruppe enthält Arten, die häufig genutzt werden und die im Untersuchungsgebiet oft vorkommen. Die zweite Gruppe umfasst unter anderem Bambussprösslinge und Pilze, mit denen mehr oder weniger häufig gehandelt wird. Die letzte Gruppe enthält eine große Anzahl von Arten, die selten genutzt werden aber die dennoch potentielle Nahrungspflanzen sind und die nur von einem kleinen Teil der Bevölkerung genutzt werden bzw. auf die nur bei Hungersnöten und Ernteausfällen zurückgegriffen wird.

Die meisten der bedeutenden Pflanzenarten unterliegen in der Gefahr der Übernutzung. Das belegen Untersuchungen zur Vulnerabilität der gehandelten Arten. Allerdings sind die häufig genutzten Nahrungspflanzen nicht bedroht, da sie im Untersuchungsgebiet recht häufig vorkommen. Unter den wild wachsenden Nahrungspflanzen werden vor allem Bambussprösslinge und Pilze ohne Rücksicht auf Nachhaltigkeit gesammelt. Die Sammlung von ökonomisch wertvollen Heilpflanzen ist ebenfalls nicht nachhaltig, da hier vor allem unterirdische Pflanzenteile genutzt werden und die Ernte somit destruktiv für die Pflanze ist. Nachhaltige Sammlung und Management strategien sollten eingeführt werden, um den Raubbau an diesen Arten zu verhindern. Im Verlauf dieser Studie zeichneten sich auch Pflanzenarten ab, die geeignete Kandidaten für eine Kultivierung in Agroforstsystemen sein könnten. Für einige Produkte, die aus dem Wald stammen wie Pilze, existieren schon gute Möglichkeiten für die Steigerung ökonomischer Gewinne z.B. die Wertsteigerung durch verbesserte Trocknungsmethoden und die Einrichtung von ortsansässigen Betrieben. Der Anbau von wirtschaftlich wichtigen Heilpflanzen in Kräutergärten oder Agroforstsystemen wird empfohlen, da sich so der Druck auf natürliche Populationen verringert und sich gleichzeitig der ökonomische Gewinn in den Dörfern diversifizieren und sichern lässt.

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Academic Training

01.2008-06.2012	**Ph.D.,** University of Hohenheim, Germany, Subject area: Ethnobotany & Agrobiodiversity. Dissertation title: Agrobiodiversity and its use in Naban River Watershed National Nature Reserve (SW China): Implications for bio-cultural diversity conservation. Supervisor: Prof. Joachim Sauerborn
10.2001- 06.2004	**M.Sc.** Plant Systematics & Ecology. Tehran University, Iran
10.1997- 06.2001	**B.Sc.** Plant Biology. Gorgan University of Agricultural Sciences and Natural Resources

Scholarships and Awards

Ph.D. Scholarship from DAAD, German Academic Exchange Service. Research Project: Living Landscapes China; biodiversity conservation and rural development in tropical southwest China.

M.Sc. Ranking the first in the MSc. entrance exam in Plant Biology among Iranian University Students

B.Sc. Awarded as Top Student of Gorgan University

Recognized and awarded as the chosen researcher of Traditional Medicine & Materia Medica Research Center, Iran

Languages:

- English (Speaking, Reading, Writing)
- Persian (Speaking, Reading, Writing)
- German (Speaking, Reading, Writing)
- Turkmeni (Mother tongue)
- Turkish (Speaking)

Research Projects and Teaching Activities

Project Director

- "Value of *Allium paradoxum* for local people's livelihood: sustainable harvest and potentials of a neglected plant" Granted by William L. Brawn Center, Missouri Botanical Gardens, March 2011 to present.
- Ethnobotanical and ethnopharmacological survey of Turkmens in Golestan and Northern Khorasan Provinces, Iran. Traditional Medicine & Materia Medica Research Center, Iran 2004-2006.
- Propagation and phytochemical analysis of *Mandragora turcamanica* Mizg. (Turkmen Mandrak), Traditional Medicine & Materia Medica Research Center, Iran, 2004-2006.

Project Coordinator

- Establishing Iranian medicinal plants databank, Traditional Medicine & Materia Medica Research Center, Iran.
- Ethnobotanical study of edible plants of Golestan province and determination of their antioxidant properties, Traditional Medicine & Materia Medica Research Center, Iran.

- Organizing the first workshop on Tools and Field Methods in Ethnobotany, Traditional Medicine & Materia Medica Research Center (TMRC), Tehran, January 2006
- Organizing the second workshop on Tools and Field Methods in Ethnobotany, Traditional Medicine & Materia Medica Research Center (TMRC), Tehran, July 2006 (attendance from Malaysia, INTROM)

Training and skills

- Workshop: Rural development by land-use diversification: stakeholder based strategies and integrative technologies for agricultural landscapes in mountainous Southwest China, 28 November-1 December 2007, Jinghong, China

- Summer School: Recording, Monitoring and Managing Biodiversity - Implementation Oriented Research; 28Sep. – 05 Oct 2009, University of Kassel, Germany

- Basic knowledge of GIS and work with ArcGIS software

- Knowledge of working with Ecological Community Analysis software's Pc-Ord, PAST, Estimate S

Research interests

▪ Economic Botany / Ethnobotany

▪ Agroecology and Agrobiodiversity

▪ Natural resource management

▪ Non-timber forest products & sustainable harvest

▪ Biodiversity conservation and restoration ecology

▪ Ecosystem services and sustainability

Membership

Society for Economic Botany

International Society of Ethnobiology

Council for Tropical and Subtropical Agricultural Research (ATSAF)

Publications

Books:

1- **Ghorbani, Abdolbaset**, 2006. Medicinal plants of Turkmen Sahra. Shaheed Beheshti University of Medical Sciences publication, Tehran. ISBN: 964-95507-0-4 (in Persian).

Peer-reviewed Papers:

Ghorbani,A., Langenberger,G., Jingxin, L., Wehner, S.. Sauerborn. J. 2012. Non-timber forest products in Naban River Watershed National Nature Reserve (China): their role in local people's livelihood and biodiversity conservation. *Economic Botany* DOI: 10.1007/s12231-012-9188-1.

Ghorbani, A., Langenberger, G., Sauerborn. J. 2012. A comparison of the wild food plant knowledge of ethnic minorities in Naban River Watershed National Nature Reserve, SW China. *Journal of Ethnobiology & Ethnomedicine* 8:17 doi:10.1186/1746-4269-8-17.

Ghorbani, A., Langenberger, G., Sauerborn. J. (expected 2012). Medicinal plant use among hill tribes: Lahu medicinal plant knowledge and its comparison with Hani in SW china. *Journal of Ethnobiology & Ethnomedicine.*

Ghorbani, A., Langenberger, G., Feng, L., Sauerborn, J. 2011. Ethnobotanical study of medicinal plants utilised by Hani ethnicity in Naban River Watershed National Nature Reserve, Yunnan, China. *Journal of Ethnopharmacology* 134(2): 651-667.

Cotter, M., Berkhoff, K., Gibreel, T., **Ghorbani, A.**, Golbon, R., Herrmann, S., Nuppenau, E.A., Wahren, A., Sauerborn. J. 2011. Incentive based compensation for a favorable socio-ecological situation: Designing a scenario for sustainable land management. Submitted to *Ecological Indicators*.

Bucher, S. F., **Ghorbani, A.**, Langenberger, G., Küppers, M., Sauerborn, J. 2011. Asparagus spp. in

Traditional Chinese Medicine: wild collection and its sustainability. *TRAFFIC Bulletin* 23 (2): 9-11.

Taghvaei M., Naghibi F., Mosaddegh M., Moazzami N., **Ghorbani A.**, Fakhari A., 2009. Prophage induction in Escherichia Coli K-12 (l) by some plants from Iran. *Studies on Ehnomedicine* 3(1): 57-59.

Ghorbani, A., Naghibi, F., Mosaddegh, M. 2006. Ethnobotany, Ethnopharmacology and Drug Discovery. *Iranian Journal of Pharmaceutical Science*, 2(2): 109-118.

Ghorbani, A., 2006. An effort for TK preservation: Ghorban Mohammad Khosravi's manuscript. *ISE Newsletter*, 6(1): 14-15.

Naghibi, F., Mosaddegh, M., Mohammadi Motamed, S., **Ghorbani, A.**, 2005. *Labiatae* family in folk medicine in Iran: from ethnobotany to Pharmacology. *Iranian Journal of Pharmaceutical Research*, 4(2): 63-79.

Ghorbani, A. 2005. Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran (Part1): General Results. *Journal of Ethnopharmacology*, 102 (1): 58-68.

Akhani, H., **Ghorbani, A.**, 2003. *Mandragora turcomanica* (Solanaceae) in Iran: a new distribution for an endangered species. *Systematics and Biodiversity*, 1(2): 1-4.

Ghorbani, A., 2003. Challenge for ethnobotanical study in Iran. *ISE Newsletter*, 3(2): 11-12.

Conference Presentations:

Ghorbani, A., Bussmann, R., Arazzadeh, Y., Sauerborn, J., 2012. Wild collection and use of Allium paradoxum (M. Bieb.) G. Don among Turkmens of Northern Iran. Poster presentation, 13th Congress of the International Society of Ethnobiology, Montpellier (France) 20-25 May 2012.

Liu, J., **Ghorbani**, A., Langenberger, G., Sauerborn, J., 2012. Useful plants in the paddy rice fields of Naban River Watershed National Nature Reserve (NRWNNR), Yunnan province of China. Poster presentation in Sustainable Land Use and Rural Development in Mountain Areas, University of Hohenheim, Stuttgart, Germany 16-18 April 2012.

Schaffert, A., **Ghorbani**, A., Martin, K., Sauerborn, J., 2012. Agrobiodiversity and its importance in homegardens of hill tribes in Xishuangbanna, SW China. Oral presentation in Sustainable Land Use and Rural Development in Mountain Areas, University of Hohenheim, Stuttgart, Germany 16-18 April 2012

Ghorbani, A., Langenberger, G., Sauerborn, J. 2011. Comparison of wild medicinal and food plant use among Lahu and Hani ethnic minorities in SW China. (Poster presentation) *Botany 2011: Healing the Planet*. July 9-13, St. Louis, Mo, USA.

Ghorbani, A., Langenberger, G., Sauerborn, J. 2011. Diversity of useful plants in the Naban River Watershed National Nature Reserve (SW China) and their role in local people's livelihoods. (Oral presentation) *Botany 2011: Healing the Planet*. July 9-13, St. Louis, Mo, USA.

Ghorbani, A., Langenberger, G., Jingxin, L., Feng, L., Sauerborn, J. 2010. Non-timber forest products in Naban River Watershed National Nature Reserve (NRWNNR): a case of medicinal and food plants. Symposium on "Land use in the Greater Mekong Subregion–A Challenge for Society, Economy and Biodiversity" 10-14 October 2010, Xishuangbanna Tropical Botanical Garden (XTBG), Yunnan, China.

Bucher, S. F., **Ghorbani A.**, Sauerborn J., Langenberger G. 2010. Sustainable use of wild medicinal plants: a case study in Nabanhe National Nature Reserve, Yunnan / China. 11th Congress of the International Society of Ethnopharmacology, 20-25 September 2010, Albacete, Spain, (Winner of First Poster Award).

Ghorbani A., Sauerborn J., Langenberger G. 2010. Ethnobotanical and Ethnoecological Knowledge of Natural Resource Use and Management: A Case of Hani People from SW China. In Tielkes E. (ed.),

International Research on Food Security, Natural Resource Management and Rural Development: World food systems – A contribution from Europe. Tropentag 2010, 14-16 August, ETH Zurich, Switzerland. Cuvillier Verlag Göttingen, p 209.

Ghorbani A., Sauerborn J., Langenberger G. 2009. Wild resource use among Dai people in Nabanhe National Nature Reserve (NNNR): cultural importance of medicinal and food plants. In: Tielkes E. (ed.), Biophysical and Socio-Economic Frame Conditions for the Sustainable Management of Natural Resources. Tropentag 2009, 6-8 October, Hamburg, Germany. DITSL GmbH, Witzenhausen, Germany, p. 98.

Liu J., Langenberger G., **Ghorbani A.**, Sauerborn J. 2009. Ecological evaluation of small holder rubber plantations based on understory plant inventories in NNNR, Xishuangbanna, China. In: Book of Abstracts of the Joint Meeting of Association for Tropical Biology and Conservation (ATBC) & Society for Tropical Ecology (GTÖ), Impacts of Global Change on Tropical Ecosystems - cross-cutting the Abiotic, Biotic and Human Spheres. 27-30 July 2009, Marburg, Germany. Society for Tropical Ecology (gtö) and Association for Tropical Biology and Conservation (ATBC), Germany, p. 385

Langenberger G., **Ghorbani A.**, Liu J. 2008. Rubber boom in Xishuangbanna - where will it end? P. 185-186. In: Stahr K., Fröhlich H. (Eds.). Interdependencies between Upland and Lowland Agriculture and Resource Management. Stuttgart-Hohenheim, Germany. https://www.uni-hohenheim.de/sfb564/uplands2008/abstracts.html

Ghorbani A., Sauerborn J., Langenberger G. 2008. Plant biodiversity use in South-West China: Preliminary results of an ethnobotanical research. In: Tielkes E. (Ed.), Competition for Resources in a Changing World: New Drive for Rural Development. Tropentag 2008, 7-9 October, Hohenheim, Germany. Cuvillier Verlag Göttingen, Germany, p. 476.

Ghorbani, A., Naghibi, F., Mosaddegh, M. 2006. Pollen, Seed and Flower Morphology, Seed Germination and Phenology of *Mandragora turcomanica* Mizg. from Iran. 14th National and 2nd International Biology Conference, 29-31 August 2006. Tehran, Iran.

Ghorbani, A., 2005. Ethnobotany: Status and Scope. 2nd Congress of Culture and Natural Heritage. Iran Cultural Heritage and Tourism Organization. 1-3 October 2005. Tehran, Iran

Ghorbani, A., Naghibi, A., Mosaddegh, M. 2005. Traditional healing in Turkmen Sahra. IVth International Congress of Ethnobotany (ICEB). 21-26 August 2005, Istanbul, Turkey.

Mosaddegh, M., Naghibi, F., Esmaeili, S., **Ghorbani. A.**, 2005. TMRC program on biological effects of medicinal plants of Iran. 41st Annual scientific seminar on the Malaysian society of parasitology and tropical medicine. 10th-11th Mar 2005.

Naghibi, F., Kamkar, S., **Ghorbani, A.**, Mosaddegh, M. 2005. Introduction of Iranian ethnobotanical information system. 41st Annual scientific seminar on the Malaysian society of parasitology and tropical medicine. 10th-11th Mar 2005.

Ghorbani, A., Mohammadi, S. 2004. Review on the ethnobotany of *Labiatae* family in Iran (poster). 2nd International Congress on Traditional Medicine & Materia Medica. Tehran, I.R. Iran.4-7 October 2004.

Ghorbani, A., Naghibi, F., Mosaddegh, M., 2004. Ethnobotanical and Ethnopharmaceutical study of Turkmens of Golestan and Khorasan Provinces, north of Iran. 2nd International Congress on Traditional Medicine & Materia Medica. Tehran, I.R. Iran.4-7 October 2004.

Ghorbani, A., Akhani, H. 2004. Medicinal Plants of Turkmen Sahra area (north-east of Iran). 9th International Congress of Ethnobiology, 13-17 June 2004, Canterbury, UK.

Stuttgart, 28 June 2012 Abdolbaset Ghorbani Dahaneh