Conservation and Ethnobotanical Knowledge of a Hmong Community in Long Lan, Luang Prabang, Lao People's Democratic Republic

Cory William Whitney, Vang Sin Min (Meej Vaj), Lê Hồng Giang, Vu Van Can, Keith Barber, and Tran Thi Lanh

Research

Abstract

In 2012 and 2013 participatory ethnobotany explorations were undertaken with herbalists from the Hmong ethnic group of Long Lan village, in Luang Prabang, Lao People's Democratic Republic. These investigations into the knowledge and experience of indigenous elders of Long Lan and surrounding villages sought to identify the relationship between the spiritual-cultural practices and livelihood uses of plants and their conservation. Information about 74 plant species of 49 families was recorded, including 25 herbs (17 perennial, 8 annual), 20 trees, 17 shrubs, 10 climbers, and 2 ferns. Analysis of quantitative ethnobotany scores indicated positive trends between uses and conservation practices for plants. The study suggests that the traditional Hmong cultural uses for plants may be a mechanism for the conservation of biodiversity in the rapidly deteriorating forests of Luang Prabang in the Lao People's Democratic Republic.

Tshawb nrhiav nroj tsuag tau muaj kev koom tes nrog cov kws tshuaj ntsuab Hmoob nyob rau zos Long Lan, Xeev Luang prabang, **Los Tsuas Teb chaws tau pib tshawb los rau ntawm lub xyoo** 2012 **thiab** 2013. **Nrhiav txog lub laj lim thiab tswv yim ntawm cov laus neeg nyob zos Long Lan thiab cov zos nyob ib puag ncig twb yog ib qhov sij hawm muaj txiaj ntsig tau paub txog txoj kev cai coj siv nroj tsuag thiab pov hwm nyob nrog lub neej**. **Tau paub txog ntawm** 74 **hom tau muaj** 49 **yam** (**nroj tsuag**) **twb tau muab sau zoo, qhov nov muaj** 25 **yam tshuaj ntsuab** (17 **yam yog cov muaj hnub nyooj ntev thiab** 8 **yam yog cov muaj hnub nyooj luv**), 20 **yam yog cov ua ntoo**, 17 **yam yog cov nroj**, 10 **yam yog cov hmab**, **thiab** 2 **yam yog suab**. **Muab xam tau pom txog nroj tsuag muaj txiaj ntsig zoo heev rau ntawm txoj kev siv yoom thiab pov hwm nyob nrog lub neej**. **Qhov tshawb rhiav no tau ceeb toom txog tias txoj kev siv yoom nroj tsuag raws li txoj cai Hmoob coj yog ib txoj cai zoo rau ntawm kev pov hwm hav zoov hav tsuag rau qhov hav zoov niaj hnub no raug luaj ntov nyob rau xeev Luang prabang**, **los Tsuas Teb**.

Introduction

Land use change from forests to agriculture and industry are the leading cause of deforestation in the tropics and sub-tropics, which contain more than half of the world's forests (FAO 2011). The causes for the high rates of deforestation in the Lao People's Democratic Republic (hereinafter "Laos") are varied and the subject of some debate. Logging has been officially banned since the early 1990s (except in National Production Forest under approved management plans, for reservoir clearance, or for a variety of "special quotas") but still plays a major role in deforestation, in conjunction with pressure from immigration (Thapa 1998). Pioneer shifting agriculture has also recently been banned, but this may lead to more permanent agriculture and greater losses of biodiversity (Fox 2000).

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Whatever its causes, the loss of forest cover and the subsequent loss of biodiversity often go hand-in-hand with the loss of traditional culture and knowledge and decreased food security (Sunderlin *et al*. 2005). With increased market access and industrialization in Laos, some households find themselves in a position to embrace new opportunities while many are left to rely on the disappearing and degraded forest resources (Rigg 2006). This situation is particularly pressing in the Luang Prabang Province of northern Laos where the rich biological and cultural diversity is under tremendous market and globalization pressure (Castella *et al*. 2013).

Forest land-use practices in Laos include shifting cultivation for rice production and various other products as well as hunting and wild collection of Non-Timber Forest Products (NTFPs), which are considered to be among the country's most important export commodities (Ketphanh 1995). These systems are seriously threatened by loss of biodiversity, livelihood insecurity, and lack of sovereignty for ethnic minorities. As livelihoods become more insecure, more pressure is put on forest resources (e.g., Baird 2013, Castella *et al*. 2011, 2013, Rigg 2006, Sunderlin *et al*. 2005).

Mechanisms for the *in situ* conservation of plants in Laos are needed (Castella *et al*. 2013). *In situ* conservation is the preferred mechanism for maintaining biodiversity (Tuxill & Nabhan 2001). Through *in situ* conservation, target species are preserved, along with all associated species. Moreover, *in situ* conservation can be a by-product of wild collection (c.f. Whitney *et al*. 2012), especially when a proper evaluation of the ecosystem (Kacálek *et al*. 2009) and cultural practices (Melloni *et al*. 2008) is considered. Furthermore, as lands are converted from wild to human-oriented use the loss of biodiversity is high, even in agricultural systems with higher biodiversity, e.g., agroforestry and organic farming (Steffan-Dewenter *et al*. 2007). Traditional shifting cultivation, on the other hand, is often augmented by wild collection as well as haphazard polycultivation agroforestry and forest gardens, which have both economic and ecological benefits (Roder *et al*. 1995). In Luang Prabang Province these practices are considered key assets for ecological and community resilience. They help maintain diversity in both landscapes and livelihood systems (Castella *et al*. 2011). Forests in Sangthong District, for example, remained virtually undisturbed until the early 1970s while being used sustainably for food, fodder, fuel-wood, and construction materials. Local people often appreciate local resources and have sustainable forest management systems (Thapa 1998).

To help identify endogenous, small-scale solutions to these problems, the current research took a broad look at the relationship between ethnic communities and high biodiversity agricultural and wild collection systems (c.f. Sheil *et al*. 2006). Through participatory research following theoretical approaches of human ecology, agroecology, and ethnobotany, it looked systematically at the cultural importance of local plant species and indications of their conservation status through biodiversity indices and interviews, with a particular view to the role of traditional practices, cultural management, and customary laws in species conservation. The overall premise was that the indigenous people have clear conservation practices, and that if other parties recognized this they will endeavor to empower, support, and learn from them. In the context of this research the term indigenous refers to the Hmong in Laos, as the mountainous areas in which they live were previously unoccupied and outside the control of any state. The cultural conservation practices discussed here most likely originated *in situ*, influenced by cultural and spiritual factors inherited from previous generations as far back as those in China.

It was hypothesized that the Hmong herbalists of Long Lan village would be holders of traditional knowledge about conservation practices for plants, that by following the methods of ethnobotany we could learn from practicing herbalists about the livelihood and spiritual and cultural significance of plants and also about related conservation practices. The research followed this hypothesis with the broad aim of assessing local plant use and land use, as well as learning the nature and causes of any pressures on biodiversity or cultural practices. In light of need for research that (1) explores interactive systems to identify problematic issues and (2) works together with communities to look for suitable solutions (c.f. Altieri 1989, 2002, Sheil *et al*. 2006), the research was also guided by open-ended questions about why events occur rather than confined to possibilities prescribed by any single or simple agenda or theory (c.f. Hastrup & Walters 2012) under the guiding premise that an adequate understanding of contemporary social-environmental problems can be gained only if they are seen as part of "a complex of interacting causes and effects" (Vayda 1983).

Botanical resources

The flora of Laos is one of the least known in Asia to modern science. However, extensive botanical books of the Ancient Laos Buddhists are written in Pali but remain without translation (P.T. Phongsavath 2012, pers. comm.). French botanists later wrote of Laos botany in the late 19th and early 20th centuries (e.g., Clément Dupuy in Luang Prabang in 1900 and Eugène Poilane in various provinces, 1920s until the 1940s). It was also included in the *Flore Générale de l'Indochine* (Lecomte 1907–1950) and Flore du Cambodge, du Laos et du Viêtnam (Aubréville 1960's (41 volumes)), but the flora was intermingled with that of Cambodia, Thailand, and Vietnam. Since the 1990s Lao botanists have taken up the study of local flora, contributing to accounts of families for the *Flore du Cambodge, du Laos et du Viêtnam* and several broad-based forestry projects. Recently the Pha Tad Ke Botanical Garden has begun collections in Luang Prabang and the surrounding

regions. They have also started working with local and national groups such as the Lao branch of the Center for Human Ecology Studies in the Highlands (CHESH-Laos) and the National University of Laos (NUOL) on several botanical investigations. In general, however, information from botany research is severely lacking in Laos, particularly in Luang Prabang.

The majority of the information that can be found on the use of wild species from the region is in research related to Non-Timber Forest Products (NTFPs) and Non-Wood Forest Products (NWFPs), which are considered to be among the country's most important export commodities (Greijmans & Sāt 2007, Ketphanh 1995).

Work is available which describes the ethnobotanical knowledge of the Hmong people in the U.S.A. (Corlett *et al*. 2003) and in Thailand (e.g., Anderson 1986, 1993, Lemoine & Vidal 1970, Pake 1987, Srithi *et al*. 2012a, 2012b). Pha Tad Ke currently has a small living ethnobotany collection that was expanded through the current investigation. However, a clear description of the ethnobotany and ethnoecological knowledge of Long Lan does not currently exist in writing. These knowledge systems are now seriously threatened by greater market integration, new cash cropping patterns, loss of land to large-scale agriculture, outmigration, and increasing pressure for integration to mainstream culture. Having a full descriptive list of species and their utilization would be a great benefit to future research and conservation practices. This work contributes to that long-term goal of the herbalist networks and wild collectors of the region.

Materials and Methods

Luang Prabang

The province of Luang Prabang (Luang Phabang, Luang Phrabang, or Louang Phrabang, literally meaning "royal Buddha image") is located in North Central Laos, at the confluence of the Nam Khan and Mekong rivers about 425 km north of the national capital Vientiane. The provincial center, Luang Prabang Town (a UNESCO World Heritage site (since 1995) with 50,000 inhabitants), was the royal capital and seat of government of the Kingdom of Laos until 1975. The province is rich in both cultural and natural resources with a total population of just over 400,000 including 12 distinct ethnic groups. The Lowland Lao (the majority ethnic group in Laos) comprises most of the population of Luang Prabang Province. They live primarily in lowland valleys and in Luang Prabang Town. The Hmong are the second most populous ethnic group, of which there are considered to be two groups in Laos: the Hmong Khao (or White Hmong) and Hmong Lay (Striped Hmong) (Chazee 2002). The Hmong people are a highland-dwelling people originating from the mountains of southern China. They migrated to Laos via Vietnam in the 19th century. Most are animists and continue to practice ancestor worship, though some follow Taoism, Buddhism, and Christianity.

Forty km northeast of Luang Prabang Town is the Phu Soung mountain area (Figure 1), an upland area comprising 8440 ha from 1000–1600 masl. There are 5035 ha of forested land accounting for 59.7% of the natural area, 47 ha of which have been designated as a protected "herbal forest." These forests include rare flora and fauna that directly affect the livelihoods and survival of the ethnic groups in the watershed. The local water source is the Long Vai stream, which flows from these highlands into the Mekong to the northwest, and the Nam Pa stream to the south; these are the headwaters of the Phu Soung watershed area. Local rules and customary laws in this mountainous region are aimed at maintaining clean water and protecting the remaining forests to conserve biodiversity.

The study site for this investigation is Long Lan, a White Hmong village, located at the center of Phu Soung (Figure 1), 700–800 masl. It is a collective village of 7 Hmong clans (Zang = 47.6 %; Ly = 34.6%; Ho = 6.5%; Mua = 4.9%; Tho = 3.2%; Song = 1.6%; Vang = 1.6%) who had moved downslope from the surrounding mountaintops in 1977 to live in the relatively lower elevation of Long Lan, a previous Khmu village whose inhabitants had moved further down into the lowlands after the Civil War, near the start of the official rule of the Lao People's Revolutionary Party (LPRP). Long Lan has since been growing and now has around 67 households and just over 500 inhabitants. The community experiences a lot of political, social, and market pressures from the surrounding ethnic groups in the Phu Soung area, from Luang Prabang Town, and from Chinese merchants and Hmong abroad.

Long Lan is considered to be an economically poor village by the Laos government, with many households receiving government support. Informal investigations suggest that average income is increasing but is still well below the Luang Prabang average. The main sources of income are vegetable production and cattle raising for the Luang Prabang markets.

Various actors have been working to make Long Lan an ecological sanctuary in the region with socio-economic development and biodiversity conservation promoted through the preservation of cultural values as well as the maintenance, use, and sustainable development of natural resources via customary law. Since 2000 CHESH-Laos and the Social Policy Ecology Research Institute (SPERI) have implemented several projects in the region to promote culture-based community development; the development of farmer networks for sustainable community activities, customary law, and indigenous knowledge in natural resource management; and collaboration between the herbalist networks of Laos and those of Vietnam. In 2009, during the sacred **Noj Txhooj** (**Noj Looj**) ceremo-

Figure 1. Long Lan village and Phu Soung Mountains in Lao PDR. Inset points indicate locations of plant samples collected around Long Lan village. Map from CartoGIS, College of Asia and the Pacific, The Australian National University. Inset developed in QGIS 2013.

ny the Laos Hmong Association and the Long Lan community agreed to cooperate with the Mekong Community Networking and Ecological Trading (MECO-ECOTRA), CHESH-Laos, SPERI, Young Indigenous Leaders Development Strategy (YIELDS), and SPERI's Farmer Field Schools (FFS) to work toward a UNESCO biosphere in Long Lan. All network members, elders, and villagers later agreed that this ethnobotany research project should take place, and that it could serve as a central part of the development of Long Lan as an ecological sanctuary and biosphere.

Approach

Ethnobotanical research often broaches on bioprospecting and biopiracy, and this is a point of serious ethical consideration (Brush 2007, Murray *et al*. 1991). Therefore, in the current investigation, cautionary steps in the form of community registries to control the access to plant knowledge (c.f. Downes & Laird 1999) and "defensive publishing" (c.f. Mgbeoji 2001) were used. Descriptions of plant resources have been explicitly placed in the public domain with full community support and authorship (SPERI 2013).

The present investigation was a collaborative exercise between SPERI researchers and the Hmong people of Long Lan village aimed at producing outcomes directly relevant to the conservation of both biodiversity and the traditional conservation practices of the Long Lan community, empowering them in communicating their role in forest conservation through the practice of small-scale solutions in sustainable resource management. All the methods involved in this approach and data collection followed long-standing practices of SPERI and MECO-ECOTRA, and were designed to allow the herbalists and villagers to have full voice in the research process and ownership of the final product (SPERI 2013).

At the start of this investigation, before any actual fieldwork in Long Lan, several preliminary meetings were held over the course of two weeks in Luang Prabang between researchers and representatives of MECO-ECOTRA and the Hmong community. This series of meetings covered several issues including how the research could benefit the plans of the Hmong Association and others in the setting up of a Farmer Field School at Long Lan for the transfer of indigenous knowledge from the elders to the younger generation. It was agreed with elders, villagers, and local authorities that the research would gather information about herbal medicine knowledge, handicraft knowledge, and wild local species used in eco-farming.

Upon arrival in the village of Long Lan two more large meetings took place, one with the village elders and another with the whole community. The last ended with a few critical decisions for the research. The community decided that the research should culminate in a book of knowledge for transferring endangered herbal knowledge to the next generation (SPERI 2013). The community also assigned 14 herbalists to teach and work with the research team along with two youth scribes to follow the team and record all information in the Hmong language.

The resulting investigation represents a collaborative consideration of the ethnobotany and conservation status of plants and the varied aspects of the wild collection activities, from collection through to consumption, accounting for associated human and ecosystem interactions. Through the participatory approach the local community was able to offer consensus-based ideas about what plants were being used and what they were being used for, opening the way to other methods such as "observation" and the "principle of pursuing the surprising" (Vayda 1983). It allowed for the exploration and analysis of connections between human actions and environmental changes in location- and time-specific contexts (c.f. Hastrup & Walters 2012) and looked beyond the "the packet of conscious, pre-conscious, and unconscious assumptions" (Vayda 1983) to avoid starting with preconceived judgments, theories, or biases and restrictive questions based on factors, privileged in advance by the investigator (c.f. Hastrup & Walters 2012, Vayda & Walters 1999, Walters 2008, 2012). At the same time this research was mindful of related previous studies and followed the methodologies and experimental design of ethnobotany to generate robust scientific data (Albuquerque & Hanazaki 2009, Belovsky *et al*. 2004).

Data collection

Data collection took place in the month of September 2012 and in January and February of 2013. Fourteen Hmong herbalists (2 female and 12 male between the ages of 24 and 65) were interviewed. The work also included a considerable preliminary phase of meetings with local elders and community leaders, followed by field-work, including observations in the field, visits to wild collection areas, and informal meetings with herbalist leaders as well as individual questions for herbalists and wild collectors. Ethnobotany methods such as in-depth interviews, participant observation (Kremen *et al*. 1998, Prance *et al*. 1987, Reyes-Garcia *et al*. 2006), walk-in-the-woods (Phillips & Gentry 1993a, 1993b), semi-structured questionnaires, and focus groups (Quinlan 2005) were all employed in the data collection. Selected herbalists led the research team around the forests of Long Lan. Hmong author Mr. Vang Sin Min led the fieldwork with other authors serving as technical support (e.g., herbarium collections, recording, translation, photography, mapping). Data collection was intended to function as an introductory investigation into the use and conservation of native species, to support herbalist and wild collectors in Long Lan. It sought to support and utilize contacts and collaboration within MECO-ECOTRA and CHESH-Laos. The research set out to learn all the possible details about the use and harvest of

regional plants including cultural, spiritual, and conservation practices.

The selection and assignment of herbalists for the investigation constituted a purposive sampling of those villagers with the deepest knowledge and most uses for local plants; it was the best possible means of learning the Hmong uses and conservation practices for species. The social context of plant use in Hmong society is such that a specific herbalist has deep knowledge of very specific kinds of plants rather than having common knowledge of plants. The community recognizes the division of ethnobotany knowledge and goes to specific healers for specific treatment (e.g., Pake 1987, Srithi *et al*. 2012a). With selected knowledgeable herbalists as guides and teachers for the investigation, the work went much deeper into the knowledge and resource use practices than could otherwise be hoped.

This investigation took a broad look at the relationship of Hmong herbalists and local ecosystems through the field methods described above and subsequent analysis of that gathered data using quantitative ethnobotany (e.g., Phillips & Gentry 1993a, 1993b, Prance *et al*. 1987) and cultural importance indicators (Tardio & Pardo-de-Santayana 2008). Use categories were determined, in part with the respondents, after the initial review of the study area to offer insights about the level of importance and the level of use, a crucial step (Hoffman & Gallaher 2007) that reflects the variety of ways in which knowledge is expressed (e.g., cookbooks, stories, legends, folklore, rituals, songs, cultural rules, and laws).

Field guides were used for plant identification; cited species were counted and recorded with local and scientific names as well as ecological and agronomic conditions and morphological characteristics. These were collected in a field press and later verified at Pha Tad Ke under the study of the botanist Vu Van Can. All cited species are backed up with existing vouchers found at the Royal Botanic Gardens Kew (K & EBC), Royal Botanic Gardens Edinburgh (E), Botanische Staatssammlung München (M), Herbarium of the Arnold Arboretum (A), South China Botanical Garden SCBG), Herbarium Berolinense (B), and a slide at the Swiss Orchid Foundation (SOF) (Appendix 1).

Data analysis

It is important that methods and experimental design replicate studies that have already been performed to identify similarities and differences in the use of native species (e.g., Albuquerque *et al*. 2006, Belovsky *et al*. 2004). Therefore, the "use values" indices developed by Prance *et al*. (Prance *et al*. 1987) and further developed by Phillips and Gentry (Phillips & Gentry 1993a, 1993b) form the foundation of the quantitative ethnobotany methods employed in this investigation, which also include the cultural importance index (CI) (Tardio & Pardo-de-Santayana 2008), the frequency of citation (FC), and number of uses per species (NU).

Designing appropriate use categories is important to any ethnobotany study (Hoffman & Gallaher 2007). Ethnobotanical knowledge was expressed in many different ways in Long Lan: e.g., medicine, food, spiritual practices, stories, legends, folklore, rituals, and customary laws. Therefore, making indices that fit well to the community involved creating use report categories based on the basic questions that were asked and the diversity of answers that were received.

The "use report" (UR), which occurs when a species is mentioned or observed being used for a certain defined use-category (Kufer *et al*. 2005, Tardio & Pardo-de-Santayana 2008), was a central calculation in the data analysis. The total UR per species is the sum of all the times that individual respondents named the species for a specific use category and the sum of all those categories. The maximum value of UR per species is the total number of people (N) times the total number of use categories (NC). For this study UR represents the active and current use of a species for these Hmong herbalists.

The maximum possible number of use reports (UR) per species for this survey is 154 (respondents (N = 14) multiplied by use categories (NC = 11)). Frequency of Citation (FC) represents the total number of people who mention the use of the species. The maximum value for FC equals the number of respondents (N = 14). Number of uses per species (NU) is the total number of different use categories in which an individual species was mentioned. The maximum value for NU equals the number of use categories (NC = 11). The interviews also gathered count data based on information from the herbalists shared in the interviews regarding conservation practices for plants. This variable is shown in the results presented here as "Cons."

These quantitative ethnobotany values can also be used to find an index for the cultural significance of the species in the study area. The cultural importance (CI) index per plant is UR divided by N, accounting for the spread and the versatility of plant use. It indicates the sum of the proportion of informants that use each species. The maximum value for the CI index per species is the number of use categories (NC = 11). For the purposes of this study the CI index is used only to quantify the most important species and species types. In terms of how the variable functions in the regression formulas and other basic statistics, it is essentially identical to UR and is therefore excluded from more in-depth statistical analysis.

Quantitative factors for ethnobotanical information were recorded and uploaded digitally in the field using Microsoft Excel (Excel for Mac 2011, Version 14.0.0). These data were then digitized and subsequently imported into

Table 1. Use report (UR) categories for 74 indigenous plant species taught by Hmong herbalists in Luang Lan, Luang Prabang, Laos.

Description	Total Uses Reported	%
Symbolic and cultural uses (e.g., ceremony)	74	24%
Internal organs and other internal treatments	44	14%
Human food	43	14%
Useful for ecological benefits	33	11%
Technical uses and sales	29	9%
Specific disease-related treatment	18	6%
Reproductive health for men (e.g., virility) and women (e.g., birth recovery) and fetus/newborn health	17	6%
Topical medicine (e.g., skin treatments, burns)	17	6%
Swelling and temperature-related treatments (e.g., fever)	14	5%
Problems of the head and throat (e.g., sinus infection, headache)	9	3%
Muscular and skeletal treatments (e.g., broken bones, torn muscles)	8	3%

the statistical package R, version 2.15.1 (Copyright 2012, The R Foundation for Statistical Computing), where linear models were created with the program R "ggplot" function from the "psych" package fit to carry out regression, single stratum analysis of variance, and analysis of covariance for the response variables UR, FC, and NU and the explanatory variable conservation practices (Cons). GIS data were recorded with a Garmin eTrex handheld GPS, and maps were generated in QGIS Geographic Information System (QGIS Development Team 2013, Open Source Geospatial Foundation Project).

Determination of Hmong names and spellings was made in the field and in focus groups. The Hmong author Mr. Vang Sin Min verified all spellings along with Hmong members of SPERI, MECO-ECOTRA, and CHESH-Laos.

Results

For the purposes of this study, use reports were grouped into 11 broad categories (Table 1). These categories are representative of responses received during interviews.

Table 2. Quantitative scores for the 16 most important indigenous plant species taught by Hmong herbalists in Luang Lan, Luang Prabang, Laos. *Parentheses indicate names (e.g., suffix, prefix) often omitted. **UR** - use report; **FC** - frequency of citation; **NU** - number of uses per species; **Cons** - conservation practices; **CI** - cultural importance index.

Latin Name	Hmong Name*	UR	FC	NU	Cons	CI
Persicaria chinensis (L.) H.Gross	**Qaub Yag**	18	4	9	6	1.286
Alocasia macrorrhizos (L.) G.Don.	**Qos Tsov**	14	3	7	5	1.000
Uncaria hirsuta Havil.	**Pos Kub Yas Liab, Pos Kub Yag**	9	4	6	10	0.643
Bischofia javanica Blume	**(Ntoo) Qaub Pluas**	8	4	6	4	0.571
Cheilocostus speciosus (J.Koenig) C.D.Specht	**(Ko, Kav) Qeej**	8	2	7	4	0.571
Sterculia lanceolata Cav.	**Seb Kaus Dais, Ntoo Xib**	8	4	4	4	0.571
Myriopteron extensum (Wight & Arn.) K.Schum.	**Hmab Kua Mis, Txiv Kub Tshis**	7	2	5	7	0.500
Alstonia scholaris (L.) R.Br.	**Zej Kaus Ntawv**	7	3	5	8	0.500
Smilax glabra Roxb.	**Hmab Pos Tauj Tsiab**	7	2	5	2	0.500
Sambucus javanica Blume	**Mos Hav**	6	2	5	7	0.429
Toddalia asiatica (L.) Lam.	**Pos Tsib Npuas**	6	2	3	2	0.429
Bombax ceiba L.	**Ntoo Yaj Huab**	6	1	6	4	0.429
Ficus auriculata Lour.	**Txiv (Cev) Ncuav Pias**	6	2	5	5	0.429
Garcinia oblongifolia Champ. ex Benth.	**Txiv Kas**	6	1	6	2	0.429
Plumbago zeylanica L.	**Tshuaj Zoo Ntxhia**	6	1	6	3	0.429
Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.	**Hmab Ko Tshob**	6	2	6	3	0.429

The most common use was symbolic and cultural use (24% of responses), followed by use as food and treatment of internal injuries (14% each), ecological benefits of the plants (11%), and technical uses including sales (10%). Other more specific medicinal uses followed.

A total of 74 plant species were recorded, including 25 herbs (17 perennials and 8 annuals), 20 trees, 17 shrubs, 10 climbers, and 2 ferns (Appendix 1). The 16 plants with the highest CI scores are described in Table 2 by quantitative scores, botanical names, and Hmong names and include 6 trees, 4 shrubs, 4 perennial herbs, and 2 climbers. The species mentioned by the most people for the most uses (UR = 18, FC = 4, NU = 9, CI = 1.29) was *Persicaria chinensis* (L.) H.Gross or Chinese knotweed, a perennial herb of the Polygonaceae, found throughout tropical Asia and known by the Hmong name **qaub yag**.

Trees were the most important species type in Long Lan, followed by perennial herbs and shrubs, while climbers, annual herbs, and ferns played less of an important role (Table 3). Trees and shrubs were also the plant types for which herbalists taught the greatest number of conservation practices. The tree species found are listed below:

- *Alstonia scholaris* (L.) R.Br. (blackboard tree, **zej kaus ntawv**)—found growing up to 40 m tall in the forests of Long Lan; was used by 3 herbalists in 5 of the use categories and was important for 2 of the herbalists for cultural and spiritual uses and had 8 related conservation practices.
- *Bischofia javanica* Blume (Javanese bishopwood, (**ntoo**) **qaub pluas**)—found growing up to 22 m tall in the forests of Long Lan, but most commonly encountered as a sapling on field and trail edges; was taught by 4 herbalists for 6 of the use categories; 2 herbalists taught cultural and spiritual uses; it also had 2 related conservation practices.
- *Bombax ceiba* L. (cotton tree, **ntoo yaj huab**)—easily identified all over Long Lan by its large red flowers; found growing up to 40 m tall in Long Lan forests and standing alone in fields; was taught by 1 herbalist, for uses in 6 of the use categories and with 4 conservation practices and 1 spiritual practice.
- *Ficus auriculata* Lour. (**txiv** (**cev**), **ncuav pias**)—found as a small tree, growing up to 6 m tall in the field edges of Long Lan; was taught by 2 herbalists for uses in 5 of the use categories; had 5 related conservation practices; 1 herbalist taught a spiritual use.
- *Garcinia oblongifolia* Champ. ex Benth. (mangosteen, **txiv kas**)—found growing up to 20 m tall around Long Lan village and in the nearby forest; was taught by just 1 herbalist, but in 6 of the use categories and with 2 conservation practices and 1 spiritual practice.
- *Sterculia lanceolata* Cav. (**seb kaus dais** or **ntoo xib**)—found growing up to 10 m tall in the forests of Long Lan; was taught by 4 herbalists for uses in 4 of the use categories, including 2 spiritual and cultural uses; also had 4 conservation practices.

Table 3. Quantitative ethnobotany scores (**UR** - use report; **FC** - frequency of citation; **NU** - number of uses per species), conservation practices (**Cons**), and cultural importance index (**CI**) for plant types taught by Hmong herbalists in Luang Lan, Luang Prabang, Laos.

Type	UR	FC	NU	Cons	CI
Trees	92	38	76	78	6.571
Perennial herbs	82	26	63	44	5.857
Shrubs	67	27	55	57	4.786
Climbers	37	14	34	17	2.643
Annual herbs	22	11	20	16	1.571
Ferns	6	3	6	4	0.429

Table 4. Basic statistics for conservation practices (**Cons**) and quantitative ethnobotany scores (**UR** - use report; **FC** - frequency of citation; **NU** - number of uses per species) for 74 plant species taught by Hmong herbalists in Luang Lan, Luang Prabang, Laos. *The coefficient of variation (**CV**) represents the ratio of standard deviation (**SD**) to the mean.

	UR	FC	NU	Cons
CV*	0.674	0.523	0.494	0.726
SD	2.786	0.841	1.697	2.118
Mean	4.135	1.608	3.432	2.919
Total	306	119	254	216

Basic statistics on quantitative scores for all plant species are described in Table 4. All the variables tested had a strong positive skew, although they had low-variance in the CV statistic, i.e., a relatively low ratio of the standard deviation to the mean. In order to perform the regression analysis, this skewness was corrected through square-root transformation, as is appropriate for count data. After transformation CV remained low-variance but decreased for FC and NU and increased for UR and Cons. Pearson's product-moment correlation (R) was then chosen as the most robust of the parametric tests for co-linearity. Kendall's rank correlation (T) was chosen over Spearman's rank correlation (Rho) for the non-parametric correlation test to deal with "ties," i.e., when both members of a pair of variables have the same ordinal value.

Correlations were highly significant for all variables, with moderate to high positive correlation (Table 5). Single stratum linear regression analysis of all explanatory variables verified a significant relationship between the use of plants and the practices of plant conservation ($p < 0.05$). UR displayed the strongest correlation (Multiple $R^2 = 0.403$, Adjusted $R^2 = 0.395$, $p = 1.62e-09$), followed by NU (Multiple $R^2 = 0.372$, Adjusted $R^2 = 0.363$, $p = 1.01e-$

Table 5. Correlations for conservation practices (**Cons**) and quantitative ethnobotany scores (**UR** - use report; **FC** - frequency of citation; **NU** - number of uses per species) for 74 plant species taught by Hmong herbalists in Luang Lan, Luang Prabang, Laos. Upper right (blue) = Pearson's product moment correlation (R); lower left = p-value.

	UR	FC	NU	Cons
UR	-	0.667	0.904	0.635
FC	1.17e-10	-	0.394	0.500
NU	< 2.2e-16	5.67e-04	-	0.610
Cons	1.62e-09	6.63e-06	1.01e-08	-

09) and FC (Multiple R^2 = 0.250, Adjusted R^2 = 0.240, p = 6.63e-09).

Discussion

The data presented here suggest that the traditional uses for plants by Hmong herbalists are inherently beneficial to the highland forest ecosystems where they live. Furthermore, conservation practices for plant species concentrate most intensely on trees and shrubs, those plant types which are the most important to maintaining biodiversity and a healthy forest ecosystem (FAO 2011).

This investigation was done in response to the dramatic deforestation of the Phu Soung area of Luang Prabang, Lao PDR, and the related disenfranchisement of the people who use the forests as a part of their culture and for their livelihood. It offers a first step toward a collaborative consideration of the ethnobotany and conservation status of native plants in the Phu Suong area and the role of the Hmong people of Long Lan in using and preserving these plants. The knowledge of these herbalists and their traditional customary practices are now seriously threatened and in need of more support from competent researchers, activists, policy makers, and relevant institutions.

The study worked closely with the community using a human ecology participatory approach (c.f. Hastrup & Walters 2012, Vayda 1983, Vayda & Walters 1999, Walters 2008, 2012) to deal with current issues and produce results that are directly relevant for agroecological practices (Altieri 1989, 2002), customary laws, and forest ecosystems. All community members had a chance to participate in the work of field ethnobotany and in the process of data collection especially youth. All data were recorded in the Hmong language and stayed with the community. Early dissemination of the work was carried out through publications within the MECO-ECOTRA network and through community meetings; it was also formatted into a book with photos of the species and of the herbalists (SPERI 2013).

The research concurred with past findings of Hmong ethnobotany regarding a close relationship between the Hmong community and the local forests and important uses of forests plants (Anderson 1986, 1993, Lemoine & Vidal 1970). Past investigations in Thailand also found medicinal use of *Alpinia galanga* (L.) Willd., *Phrynium imbricatum* Roxb. (Srithi *et al*. 2012b), *Alstonia scholaris* (L.) R.Br., *Plumbago zeylanica* L., *Bryophyllum pinnatum* (Lam.) Oken, and *Phyllanthus niruri* L., as well as species from *Cynoglossum*, *Plantago*, *Kalanchoe* (Srithi *et al*. 2012a), and *Stephania* (Pake 1987). There was also some concurrence with the literature on NTFPs in Laos, with the shared record of *Broussonetia papyrifera* (L.) L'Hér. ex Vent. for technical and medicinal uses, *Coscinium fenestratum* (Goetgh.) Colebr. for medicinal uses, *Dendrocalamus* sp. for technical uses and food, and orchids for medicinal uses (Greijmans & Sāt 2007, Ketphanh 1995).

The 11 categories of use reports represented the teachings of the Hmong herbalists to the team of researchers and young Hmong scribes. Other than the basic ethnobotany questions (e.g., "what is the name of this," "what is it used for"), these respondents were free to teach what they saw fit and taught largely about symbolic and cultural uses (e.g., ceremony), mostly surrounding **Noj Txhooj** (**Noj Looj**) worship. This was the most common thing to be described about a plant species.

All of the trees that were mentioned are considered threatened in the Phu Soung area. Typical conservation activities involving all of these plants included customary laws, clearing of competing vegetation, spreading seeds and seedlings, careful and beneficial harvesting practices, keeping knowledge of the plants secret, and even planting in homegardens.

Conclusion

There is an urgent need for improving the sovereignty of the Hmong people of Long Lan who are under considerable pressure to exploit their natural resources. A core question for research and for the future of Long Lan is about how traditional customary management systems will cope in relation to the rapidly changing context of Luang Prabang. Programs and efforts are needed to promote and secure livelihood and traditional practices of conservation and connection to the local ecology. There is a need for more participatory research approaches in determining the traditional knowledge and the ethnobotany of these communities to find endogenous solutions for conservation of local ecosystem biodiversity.

The data presented are a first step in understanding the ethnobotanical knowledge and practices that are the heart of the Hmong people and their sacred **Noj Txhooj** (**Noj Looj**) worship. It shows that for these Hmong herb-

alists the use of plants is not simply about their utility but is a reciprocal relationship, indicative of a reverence for the forest and plants. The results of the final quantitative data analysis suggest a culture of conservation actions toward species in the Long Lan community. The data set that supports this came through an intensely participatory approach with purposive sampling initiated by the villagers and village elders. This data set gives the most in-depth information possible regarding the practices of Hmong herbalists and the traditional practices of the Hmong people.

As was stated before, a clear description of the ethnobotany and ethnoecological knowledge of Long Lan is proposed as a long-term goal for the herbalist networks and wild collectors of the region. The hope is that this work may form a foundation for, and inspire the work of, a complete list to encourage and preserve these important practices. Furthermore, with the foundation of a Farmer Field School, the strengthening of indigenous networks, and increased efforts in educating youth in the traditions and practices of Hmong ethnobotany, there may be some hope for the future of the forests of Long Lan and the Phu Soung area.

Future research

There is a need for more long-term research involving collaboration between competent botanists, interested young indigenous people, and indigenous herbalists in the field. This requires a careful balance of scientific expertise and indigenous knowledge. The herbalists are extremely knowledgeable, especially those who are aging and unable to travel far from home for the collection of species, preferring instead to go for a short walk and then back to a hut to talk about the species collected. Future investigations might also include informant recall with images and voucher specimens to better involve the oldest herbalists and attempt to have an even sample of male and female herbalists to avoid gender bias.

As was mentioned earlier, the social context of plant use in Hmong society is such that a specific herbalist has deep knowledge of very specific kinds of plants (Pake 1987, Srithi *et al*. 2012a), and other villagers will go to this herbalist for treatment. This is an important methodological point relevant to ethnobotany research with the Hmong people. Future investigations should consider in-depth analysis of traditional herbal treatments with specific species to determine the importance of medicinal plants to all villagers.

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Literature Cited

Albuquerque, U.P. de & N. Hanazaki. 2009. Five problems in current ethnobotanical research - and some suggestions for strengthening them. *Human Ecology* 37(5):653–661. dx.doi.org/10.1007/s10745-009-9259-9

Albuquerque, U.P., R.F.P. Lucena, J.M. Monteiro, A.T.N. Florentino & C.D.F.C.B.R. Almeida. 2006. Evaluating two quantitative ethnobotanical techniques. *Ethnobotany Research and Applications* 4:51–60.

Altieri, M.A. 1989. Agroecology: A new research and development paradigm for world agriculture. *Agriculture, Ecosystems & Environment* 27(1–4):37–46. dx.doi.org/10.1016/0167-8809(89)90070-4

Altieri, M.A. 2002. Agroecology: The science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment* 93(1–3):1–24. dx.doi.org/10.1016/S0167-8809(02)00085-3

Anderson, E.F. 1986. Ethnobotany of hill tribes of northern Thailand. I. Medicinal plants of Akha. *Economic Botany* 40(1):38–53. dx.doi.org/10.1007/BF02858945

Anderson, E.F. 1993. *Plants and People of the Golden Triangle: Ethnobotany of the hill tribes of northern Thailand*. Dioscorides Press, Portland, Oregon, U.S.A.

Baird, I.G. 2013. Shifting contexts and performances: The Brao-Kavet and their sacred mountains in northeast Cambodia. *Asian Highlands Perspectives* 28:1–23.

Belovsky, G.E., D.B. Botkin, T.A. Crowl, K.W. Cummins, J.F. Franklin, M.L. Hunter Jr., A. Joern, D.B. Lindenmayer, J.A. MacMahon, C.R. Margules & J.M. Scott. 2004. Ten suggestions to strengthen the science of ecology. *BioScience* 54(4):345–351.

Brush, S.B. 2007. Farmers' rights and protection of traditional agricultural knowledge. *World Development* 35(9):1499–1514. dx.doi.org/10.1016/j.worlddev.2006.05.018

Castella, J.C., M. Thephavanh, V. Vongkhamsao, K. Mouaxeng-Cha, S. Phonphakdy, Y.R. Fitriana, K. Kongay, S. Phaipasith, J. Ferrand, V. Manivanh & J.-L. Pfund. 2011. Evolving relations between agriculture and forest in Viengkham District, Luang Prabang Province. *The Lao Journal of Agriculture and Forestry* 23:61–89. http://hdl.handle.net/10568/20898

Castella, J.-C., G. Lestrelin, C. Hett, J. Bourgoin, Y.R. Fitriana, A. Heinimann & J.-L. Pfund. 2013. Effects of landscape segregation on livelihood vulnerability: Moving from extensive shifting cultivation to rotational agriculture and natural forests in Northern Laos. *Human Ecology* 41(1):63–76. dx.doi.org/10.1007/s10745-012-9538-8

Chazée, L. 2002. *The Peoples of Laos: Rural and ethnic diversities*. White Lotus Press, Bangkok, Thailand.

Corlett, J.L., E.A. Dean & L.E. Grivetti. 2003. Hmong gardens: Botanical diversity in an urban setting. *Economic Botany* 57(3):365–379. www.jstor.org/stable/4256705

Downes, D.R. & S.A. Laird. 1999. *Community Registries of Biodiversity-related Knowledge: The role of intellectual property in managing access and benefit*. Paper Prepared for United Nations Commission on Trade and Development (UNCTAD) Biotrade Initiative, New York, New York, U.S.A.

FAO. 2011. *State of the World's Forests, 2011*. Food and Agriculture Organization of the United Nations, Rome, Italy.

Fox, J. 2000. How blaming 'slash and burn' farmers is deforesting mainland Southeast Asia. *Asia Pacific Issues* 47:1–8.

Greijmans, M. & M.H. Sāt, eds. 2007. *Non-Timber Forest Products in the Lao PDR. A manual of 100 commercial and traditional products*. National University of the Lao PDR, Vientiane, Lao PDR.

Hastrup, F. & B.B. Walters. 2012. Theory and methodology in causal research: A commentary. *Geografisk Tidsskrift-Danish Journal of Geography* 112(2):206–207. dx.doi.org/10.1080/00167223.2012.741879

Hoffman, B. & T. Gallaher. 2007. Importance indices in ethnobotany. *Ethnobotany Research & Applications* 5:201–218.

Kacálek, D., J. Novák, D. Dušek, J. Bartoš & V. Černohous. 2009. How does legacy of agriculture play role in formation of afforested soil properties? *Journal of Scientific Computing* 55(1):9–14.

Ketphanh, S. 1995. Non-wood forest products in Lao People's Democratic Republic. Pp. 215–226 in *Beyond Timber: Social, economic and cultural dimensions of non-wood forest products in Asia and the Pacific. Proceedings of a Regional Expert Consultation, 28 Nov–2 Dec 1994, Food and Agriculture Organization of the United Nations (FAO) and Regional Office for Asia and the Pacific (RAP), Bangkok, Thailand*. RAP Publication 1995/13. Edited by P.B. Durst, A. Bishop. FAO, Bangkok, Thailand.

Kremen, C., I. Raymond & K. Lance. 1998. An interdisciplinary tool for monitoring conservation impacts in Madagascar. *Conservation Biology* 12(3):549–563. dx.doi.org/10.1111/j.1523-1739.1998.96374.x

Kufer, J., H. Förther, E. Pöll & M. Heinrich. 2005. Historical and modern medicinal plant uses—The example of the Ch'orti' Maya and Ladinos in Eastern Guatemala. *Journal of Pharmacy and Pharmacology* 57(9):1127–1152. dx.doi.org/10.1211/jpp.57.9.0008

Lemoine, J. & J.E. Vidal. 1970. Contribution à l'ethnobotanique des Hmong du Laos. *Journal d'Agriculture Tropicale et de Botanique Appliquée* 17(1–4):1–59.

Melloni, R., E.G.P. Melloni, M.I.N. Alvarenga & F.B.M. Vieira. 2008. Evaluation of soil quality under different forest covers and pasture in southern Minas Gerais state, Brazil. *Revista Brasileira de Ciência do Solo* 32(6):2461–2470. dx.doi.org/10.1590/S0100-06832008000600023

Mgbeoji, I. 2001. Patents and traditional knowledge of the uses of plants: Is a communal patent regime part of the solution to the scourge of bio piracy. *The Indiana Journal of Global Legal Studies* 9(1):163–186.

Murray, H.N.K., H.T.R. Nui A Tawhaki Witana, T.N.W. Witi Mcmath, T.N.P. Poata, K.N.K. Rimene & J.M.K. Hippolite. 1991. Wai 262: *Ko Aotearoa Tēnei ("This is Aotearoa" or "This is New Zealand"): Report on the Wai 262 claim released*. The Waitangi Tribunal July 02, Wellington, New Zealand. www.justice.govt.nz/tribunals/waitangi-tribunal

Pake, C.V. 1987. Medicinal ethnobotany of Hmong refugees in Thailand. *Journal of Ethnobiology* 7(1):13–26.

Phillips, O. & A.H. Gentry. 1993a. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. *Economic Botany* 47(1):15–32. dx.doi.org/10.1007/BF02862203

Phillips, O. & A.H. Gentry. 1993b. The useful plants of Tambopata, Peru: II. Additional hypothesis testing in

quantitative ethnobotany. *Economic Botany* 47(2):33–43. dx.doi.org/10.1007/BF02862204

Prance, G.T., W. Balée, B.M. Boom & R. Carneiro. 1987. Quantitative ethnobotany and the case for conservation in Amazonia. *Conservation Biology* 1(4):296–310. dx.doi.org/10.1111/j.1523-1739.1987.tb00050.x

Quinlan, M. 2005. Considerations for collecting freelists in the field: Examples from ethnobotany. *Field Methods* 17(3):219–234. dx.doi.org/10.1177/1525822X05277460

Reyes-Garcia, V., V. Vadez, S. Tanner, T. McDade, T. Huanca & W.R. Leonard. 2006. Evaluating indices of traditional ecological knowledge: A methodological contribution. *Journal of Ethnobiology and Ethnomedicine* 2:21. dx.doi.org/10.1186/1746-4269-2-21

Rigg, J.D. 2006. Forests, marketization, livelihoods and the poor in the Lao PDR. *Land Degradation & Development* 17(2):123–133. dx.doi.org/10.1002/ldr.719

Roder, W., B. Keoboualapha & V. Manivanh. 1995. Teak (*Tectona grandis*), fruit trees and other perennials used by hill farmers of northern Laos. *Agroforestry Systems* 29(1):47–60. dx.doi.org/10.1007/BF00711281

Sheil, D., R. Puri, M. Wan, I. Basuki, M. van Heist, N. Liswanti, I. Rachmatika & I. Samsoedin. 2006. Recognizing local people's priorities for tropical forest biodiversity. *AMBIO: A Journal of the Human Environment* 35(1):17–24. dx.doi.org/10.1579/0044-7447-35.1.17

SPERI. 2013. *Ethnobotany Book: An approach to biological human ecology theory*. Knowledge Publishing House (Nhà xuất bản Tri thức), Hanoi, Vietnam.

Srithi, K., C. Trisonthi, P. Wangpakapattanawong & H. Balslev. 2012a. Medicinal plants used in Hmong women's healthcare in northern Thailand. *Journal of Ethnopharmacology* 139(1):119–135. dx.doi.org/10.1016/j.jep.2011.10.028

Srithi, K., C. Trisonthi, P. Wangpakapattanawong, P. Srisanga & H. Balslev. 2012b. Plant diversity in Hmong and Mien homegardens in northern Thailand. *Economic Botany* 66:192–206. dx.doi.org/10.1007/s12231-012-9199-y

Steffan-Dewenter, I., M. Kessler, J. Barkmann, M.M. Bos, D. Buchori, S. Erasmi, H. Faust, G. Gerold, K. Glenk, S.R. Gradstein., E. Guhardja, M. Harteveld, D. Hertel, P. Höhn, M. Kappas, S. Köhler, C. Leuschner, M. Maertens, R. Marggraf, S. Migge-Kleian, J. Mogea, R. Pitopang, M. Schaefer, S. Schwarze, S.G. Sporn, A. Steingrebe, S.S. Tjitrosoedirdjo, S. Tjitrosoemito, A. Twele, R. Weber, L. Woltmann, M. Zeller & T. Tscharntke. 2007. Tradeoffs between income, biodiversity, and ecosystem functioning during tropical rainforest conversion and agroforestry intensification. *Proceedings of the National Academy of Sciences* 104(12):4973–4978. dx.doi.org/10.1073/pnas.0608409104

Sunderlin, W.D., A. Angelsen, B. Belcher, P. Burgers, R. Nasi, L. Santoso & S. Wunder. 2005. Livelihoods, forests, and conservation in developing countries: An overview. *World Development* 33(9):1383–1402. dx.doi.org/10.1016/j.worlddev.2004.10.004

Tardio, J. & M. Pardo-de-Santayana. 2008. Cultural importance indices: A comparative analysis based on the useful wild plants of southern Cantabria (Northern Spain). *Economic Botany* 62(1):24–39. dx.doi.org/10.1007/s12231-007-9004-5

Thapa, G.B. 1998. Issues in the conservation and management of forests in Laos: The case of Sangthong District. *Singapore Journal of Tropical Geography* 19(1):71–91. dx.doi.org/10.1111/j.1467-9493.1998.tb00251.x

Tuxill, J.D. & G.P. Nabhan 2001. *People, Plants, and Protected Areas: A guide to in situ management*. Earthscan, New York, New York, U.S.A.

Vayda, A.P. 1983. Progressive contextualization: Methods for research in human ecology. *Human Ecology* 11(3):265–281. www.jstor.org/stable/4602704

Vayda, A.P. & B.B. Walters. 1999. Against political ecology. *Human Ecology* 27(1):167–179. dx.doi.org/10.1023/A:1018713502547

Walters, B.B. 2008. Events, politics, and environmental change. Pp. 67–79 in *Against the Grain: The Vayda tradition in human ecology and ecological anthropology*. Edited by B.B. Walters, B.J. McCay, P. West & S. Lees. AltaMira Press, Lanham. Marlyand, U.S.A.

Walters, B.B. 2012. An event-based methodology for climate change and human and environment research. *Geografisk Tidsskrift-Danish Journal of Geography* 112(2):135–143. dx.doi.org/10.1080/00167223.2012.741890

Whitney, C.W., J. Gebauer & M. Anderson. 2012. A survey of wild collection and cultivation of indigenous species in Iceland. *Human Ecology* 40(5):781–787. dx.doi.org/10.1007/s10745-012-9517-0

Appendix 1. Botanical references cited and Hmong names for 74 indigenous plant species. *Parentheses indicate Hmong suffixes and prefixes often omitted. (Blue = No voucher. Conservation status is CITES II. UNEP WCMC. 2003. Checkl. CITES Sp. 1–339. UNEP World Conservation Monitoring Centre, Cambridge.)

Vouchers	Names		Uses			
	Scientific	Hmong*	Human Food	Medicine	Symbolic and/ or Cultural	Technical and/ or Sale
K000659947	*Abelmoschus moschatus* Medik.	**Paj Qab Ntig**		X	X	
K000295930	*Adenanthera microsperma* Teijsm. & Binn.	**Tviv Taum Nyiaj**		X		
K000849174	*Adenanthera pavonina* L.	**Txiv Taum Nyiaj**		X	X	
K000611839	*Aeginetia indica* L.	**Paj Yeeb Nkab**		X		
K000704838	*Alangium kurzii* Craib	**Qiaj**		X	X	
K000291562	*Alocasia macrorrhizos* (L.) G.Don.	**Qos Tsov**	X	X	X	X
K3344.000	*Alpinia galanga* (L.) Willd.	**Qhaus Soob**		X	X	
K000733066	*Alstonia scholaris* (L.) R.Br.	**Zej Kaus Ntawv**	X	X	X	X
K000733072	*Amalocalyx microlobus* Pierre ex Spire	**Hmab Kub Tshis**		X		X
K000830592	*Argyreia pierreana* Bois	**Hmab Qos Liab Qus**		X	X	
K001056528	*Baccaurea ramiflora* Lour.	**Txiv Toj Leeb**		X	X	
K000780145	*Bauhinia variegata* L.	**Paj Haum Tsav**	X	X	X	X
K000272213	*Bischofia javanica* Blume	**(Ntoo) Qaub Pluas**		X	X	X
K000659993	*Bombax ceiba* L.	**Ntoo Yaj Huab**	X	X	X	X
K001050004	*Broussonetia papyrifera* (L.) L'Hér. ex Vent.	**Cev Ntsuab**		X	X	X
EBC57759	*Bryophyllum pinnatum* (Lam.) Oken	**Nplooj Tuaj Kaus Qaub**		X	X	
K000734209	*Buddleja asiatica* Lour.	**Tshau Toj**		X	X	X
K000592615	*Capsicum annuum* L.	**Kua Txob**		X	X	
K000701884	*Cardiospermum halicacabum* L.	**Hmab Nkig Soob**	X	X		
K000500499	*Carica papaya* L.	**Txiv Taub Ntoos**		X		
K61917.000	*Cheilocostus speciosus* (J.Koenig) C.D.Specht	**(Ko, Kav) Qeej**	X	X	X	
K000940191	*Chromolaena odorata* (L.) R.M.King & H.Rob.	**Nroj Pawm Tshis**		X		
K02723005	*Cissus subtetragona* Planch.	**Tshuaj Zoo Mob Npuag**		X	X	
K000270517	*Clausena excavata* Burm.f.	**Ntoo Tsw Ntxhiab**		X		
K000783980	*Clerodendrum chinense* (Osbeck) Mabb.	**Ntoo Tsw Ntxhiab**			X	
K000785293	*Clerodendrum glandulosum* Lindl.	**Zaub Ntsuab Tshws Loj**	X	X	X	
K000786142	*Combretum indicum* (L.) DeFilipps	**Hmab Xiav**		X	X	
K000644617	*Coscinium fenestratum* (Goetgh.) Colebr.	**Hmab Tsw Qej**		X	X	
K000438236	*Crassocephalum crepidioides* (Benth.) S.Moore.	**Nroj Rog**	X	X		X
K000099956	*Curculigo capitulata* (Lour.) Kuntze	**Qhaib Xyab**	X	X	X	
EBC38672	*Cycas pectinata* Buch.-Ham.	**Hmab Ntshav Ciaj**	X	X		
M0174188	*Cynoglossum zeylanicum* (Vahl) Brand	**Nrhab Lo Dev Tw**		X	X	
K000854814	*Dendrocalamus calostachyus* (Kurz) Kurz	**Xyoob Tuam Tswm Dawb Pob**	X	X		

Vouchers	Names		Uses			
	Scientific	Hmong*	Human Food	Medicine	Symbolic and/ or Cultural	Technical and/ or Sale
K000890189	*Dichrocephala integrifolia* (L.f.) Kuntze	**Cos Kev**		X		
K000099927	*Disporopsis longifolia* Craib.	**Cuav Qwv Qws**		X	X	
K000524338	*Dracaena angustifolia* (Medik.) Roxb.	**Txoob Ntuab**	X	X	X	
K000224258	*Drymaria diandra* Blume	**Zaub Tseej**		X	X	
K000557976	*Drynaria bonii* Christ	**Suab Taw Dav**	X	X	X	
K000729684	*Duabanga grandiflora* (DC.) Walp.	**Siv Lav**		X	X	
K000929592	*Elsholtzia winitiana* Craib	**Hnav Nees**	X	X		
K000639097	*Eryngium foetidum* L.	**Tsheej Kub Pov**		X	X	
K000814597	*Ethulia conyzoides* L.f.	**Zaj Xaws**		X	X	
K000717460	*Euodia simplicifolia* Ridl.	**Zaub Tij Kum**		X		
E00609561	*Eupatorium capillifolium* (Lam.) Small ex Porter & Britton	**Suv Ntsim**	X	X	X	X
K000880224	*Ficus auriculata* Lour.	**Txiv (Cev) Ncuav Pias**	X	X	X	X
K000677572	*Garcinia oblongifolia* Champ. ex Benth.	**Txiv Kas**	X	X	X	X
K000883404	*Gelsemium elegans* (Gardner & Champ.) Benth.	**Qiaj**		X	X	
K000432930	*Geophila repens* (L.) I.M.Johnst.	**Txiv Quav Yaj Teb Loj (Hav Zoov)**	X	X	X	
K000651330	*Harrisonia perforata* (Blanco) Merr.	**Pos Toj Ntxas**		X	X	
K000857916	*Ichnocarpus frutescens* (L.) W.T.Aiton	**Hmab Kua Mis**		X	X	
K000776977	*Jatropha curcas* L.	**Txiv Thooj Ywg**		X		
K000701949	*Lepisanthes senegalensis* (Poir.) Leenh.	**Txiv Ntsav Npua**	X	X	X	X
K000756212	*Maesa japonica* (Thunb.) Moritzi & Zoll.	**Kab Yeeb Tshuaj Loj**	X	X		
M0168501	*Myriopteron extensum* (Wight & Arn.) K.Schum.	**Hmab Kua Mis, Txiv Kub Tshis**	X	X	X	X
K000031813	*Paederia tomentosa* Blume [syn: *Paederia foetida* L.]	**Hmab Tsw Quav, Nplooj Ntev**	X	X		X
K000634487	*Passiflora siamica* W.G.Craib	**Hmab Txiv Huab Lab Qus**	X	X	X	X
K000183435	*Peperomia pellucida* (L.) Kunth	**Zaub Qwj**	X	X		
K000831147	*Persicaria chinensis* (L.) H.Gross	**Qaub Yag**	X	X	X	X
K000308129	*Phrynium imbricatum* Roxb.	**Nplooj Ntse Liab**	X	X	X	X
K60793.000	*Phrynium placentarium* (Lour.) Merr.	**Nplooj Ntse Ntsuab**			X	X
K000573161	*Phyllanthus niruri* L.	**Nroj Nplooj Mos**		X	X	
E00327151	*Plantago asiatica* L.	**Zuab Ntswg Npua Ntsuab Loj**		X		
K000786695	*Plumbago zeylanica* L.	**Tshuaj Zoo Ntxhia**	X	X	X	
K000018454	*Psidium guajava* L.	**Txiv Cuab Thoj**	X	X	X	
K000779281	*Radermachera ignea* (Kurz) Steenis	**Ntoo Paj lab**	X	X	X	
K000832958	*Rauvolfia serpentina* (L.) Benth. ex Kurz	**Cag Txhais Taum**		X	X	X
EBC57765	*Rosa × damascena* Mill.	**Paj Ntshua Nplaim**		X	X	

Vouchers	Names		Uses			
	Scientific	Hmong*	Human Food	Medicine	Symbolic and/ or Cultural	Technical and/ or Sale
K000898097	*Sambucus javanica* Blume	**Mos Hav**		X	X	X
K000792936	*Schefflera leucantha* R.Vig.	**Ntoo Kaus Taw Qaib**		X	X	
B200159665	*Selaginella siamensis* Hieron.	**Suab Qaib Tsws, Suab Tshws**		X	X	X
K000240448	*Sida acuta* Burm.f.	**Maj Qus**		X	X	
K000240413	*Sida rhombifolia* L.	**Ntsia Teb, Paj Qab Ntig**		X	X	
K000820915	*Smilax glabra* Roxb.	**Hmab Pos Tauj Tsiab**	X	X	X	X
K000610975	*Solanum erianthum* D.Don	**Xab Kub Tsab**		X	X	X
K000196631	*Solanum trilobatum* L.	**Pos Lws Nkais**		X		
K000820826	*Stemona tuberosa* Lour.	**Peb Caug Caj Loj**		X	X	
SCBG9449	*Stephania longa* Lour.	**Hmab Ntshav Ciaj**	X	X	X	
K000671717	*Sterculia lanceolata* Cav.	**Seb Kaus Dais, Ntoo Xib**	X	X	X	
K000764125	*Synedrella nodiflora* (L.) Gaertn.	**Paj Daj**		X		
K000772815	*Tetrameles nudiflora* R.Br.	**Ntoo Lag**	X	X	X	X
K31715.000	*Tetrapanax papyrifera* (Hook.) K.Koch	**Pos Lwm Qaib**		X	X	
K000357694	*Thunbergia grandiflora* (Roxb. ex Rottl.) Roxb.	**Hmab Ko Tshob**	X	X	X	
K000644589	*Tinospora crispa* (L.) Hook.f. & Thompson	**Hmab Iab**		X	X	
K000717710	*Toddalia asiatica* (L.) Lam.	**Pos Tsib Npuas**	X	X	X	
K000810317	*Trevesia palmata* (Roxb. ex Lindl.) Vis.	**Pos Lwm Tsiab (Qaib)**	X	X	X	
SOF2068905	*Trichoglottis orchidea* (J.Koenig) Garay	**Tshuaj Lov Npab Lov Tes**		X	X	
A00048879	*Trigonostemon phyllocalyx* Gagnep.	**Tshuaj Ntxiv Ntshav**		X	X	
K000729966	*Uncaria hirsuta* Havil.	**Pos Kub Yas Liab, Pos Kub Yag**	X	X	X	
K000610616	*Urena lobata* L.	**Nrhab Nplaum, Paj Cuaj Hlis**		X		
M0168523	*Zanthoxylum acanthopodium* DC.	**Txiv Siav**	X	X		X
K000255233	*Zingiber mekongense* Gagnep.	**Qoov**		X	X	

Herbarium Collections Cited in Appendix 1.
Herbarium of the Arnold Arboretum (A), Arnold Arboretum of Harvard University, Jamaica Plain, Massachusetts. 2001–2014. www.huh.harvard.edu/collections/arboretum.html Accessed 18 Apr 2014.
Röpert, D. (Ed.) 2000–2014. Digital specimen images at the Herbarium Berolinense (B). Botanic Garden and Botanical Museum, Berlin-Dahlem, Germany. http://search.biocase.org/bgbm/index Accessed 18 Apr 2014.
Royal Botanic Garden Edinburgh (E). 2014. Herbarium Catalogue http://elmer.rbge.org.uk/bgbase/vherb/ Accessed 18 Apr 2014.
Royal Botanic Gardens, Kew (K). 2014. Herbarium Catalogue http://apps.kew.org/herbcat/ Accessed 18 Apr 2014.
Royal Botanic Gardens, Kew, Economic Botany Collection (EBC). 2014. Online database www.kew.org/ecbot/database Accessed 18 Apr 2014.
South China Botanical Garden, Chinese Academy of Sciences (SCBG), Guangzhou, China. 2014. http://herbarium.scib.ac.cn/english/index.asp?id=174 Accessed 18 Apr 2014.
Swiss Orchid Foundation (SOF), Slide © R. van Vugt. 2014. http://orchid.unibas.ch/ phpMyHerbarium/2068905/1/Trichoglottis/orchidea/Konig_Johann_Gerhard/Garay_Leslie_A./specimen.php Accessed 18 Apr 2014.
Triebel, D. & Scholz, P. Botanische Staatssammlung München (M). 2001–2014. IndExs – Index of Exsiccatae http://indexs.botanischestaatssammlung.de Accessed 18 Apr 2014.