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Learning with Elders: Human Ecology and Ethnobotany Explorations in Northern and Central Vietnam

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

This article explores data gathered through an applied human ecology and ethnobotany study of selected elders from the Vietnamese Dao, Hmong, Kinh, Ma-Lieng, Sach, Tai, Tay, and Xinh-Mun ethnic groups. The research catalogued traditional uses and conservation practices related to biodiversity and plant use in northern and central Vietnam. The study utilized a human ecology systems theory approach developed by the indigenous and ethnic minority peoples' networks of the Mekong region. Through ethnobotany field interviews, the study gathered traditional knowledge of plants, including twenty-eight climbers, four ferns, twenty-nine annual and two perennial herbs, twenty-four shrubs, and twenty-four trees. Plant importance was analyzed using quantitative ethnobotany indices. Model tests of plant use and conservation support a human ecology systems model approach and suggest that culture, customary law, spiritual practices, and ethnobotany are important contributors to plant conservation practices.

Key words: human ecology, indigenous knowledge, conservation, quantitative ethnobotany, Vietnam, ethnology, ethnobiology

Cory William Whitney is associated with the Rhine-Waal University of Applied Sciences, Faculty of Life Sciences, Kleve, Germany/University of Kassel, Faculty of Organic Agricultural Sciences, Witzenhausen, Germany. Vang Sin Min is associated with the Young Indigenous Ethnic Leadership Development Strategy/Mekong Community Networking and Ecological Trading, Si Ma Cai, Vietnam. Lê Hồng Giang, Vu Van Can, and Tran Thi Lanh are associated with the Social Policy Ecology Research Institute, Hanoi, Vietnam. Keith Barber is associated with the Waikato University, Faculty of Arts and Social Sciences, Hamilton, New Zealand. *The traditional knowledge discussed here belongs expressly to the following indigenous and ethnic minority people of Vietnam: the Dao elder Trieu Thi Khang, Hmong elder Ly A La, Kinh elder Le Viet Khuong, Ma-Lieng elder Pham Thi Lam, Sach elders Cao Thi Hau and Cao Thi Trang, Black Tai elders Lo Van Sinh and Vi Dinh Van, White Tai elder Luong Van Binh, Tay elders Nguyen Thi Lien and Hoang Van Tai, and Xinh-Mun elder Vi Van Nhac (hereinafter elders) and to their network of ethnic minority farmers, the Mekong Community Networking and Ecological Trading (MECO-ECOTRA). The research was made possible with the generous funding of Brot für die Welt (Bread for the World or BfdW) and the Interchurch Organization for Development Cooperation (ICCO) with support and cooperation of the Communist Party of Vietnam and the Vietnamese People's Army. The field research described was conducted by a large team, including the staff and student body of Human Ecology Practical Area (HEPA), led by the Young Indigenous Ethnic Leadership Development Strategy (YIELDS) members Min Vang Sin, Vu Ly Seo, Su Giang A, Chung Giang Thi, Giong, Ve, and Pha Lee (Hmong ethnic minority community), Viengphet Panoudom, Bua Pha, Inta, Phonh Lamany, Vilay, Anong Soukphaphone (Kho Mu ethnic minority community), Duoc Hoang Van (Tay ethnic minority community), and Dung Nguyen Tien, Dung Bui Tien (Kinh ethnic group); a volunteer from AusAID's Volunteering for International Development (VIDA) David Bauer (Australia), and student volunteer Miriam van Muijlwijk (the Netherlands); interns from the International Network of Engaged Buddhists (INEB), Amit Kumar Shakya (India), Myo Myat (Myanmar); and staff-members of the Social Policy Ecology Research Institute (SPERI) Pham van Dung, Le Van Ca, and Duong Quang Chau.*

Introduction

Vietnam has experienced many rapid changes in recent years, leading to economic growth for the country but also to the loss of biodiversity (FAO 2011b), increased poverty (Mellor and Desai 1996), and food insecurity (FAO 2011a) among the rural poor. Consequently ethnic minority communities are experiencing major challenges in maintaining their way of life within the rapidly industrializing region (Baulch et al. 2007; Lanh 2009). Vietnamese government programs and international organizations focusing on rural development and poverty reduction have had little impact in terms of sustainable community development, particularly for ethnic minorities in highland areas. Typical approaches are often short-term and largely top-down and based on outsiders' ideas about how to reduce poverty (Baulch et al. 2007; Lanh 2009; Wilshusen et al. 2002), particularly regarding land ownership and forest policy (Sowerwine 2004). The consequences are both that the community does not benefit from the efforts and there are unwanted social impacts leading to disempowerment, as the people are made passive rather than active in their own development (Luong 2003; SPERI 2013).

Studies suggest that some ethnic minority societies have the tools and practices necessary for the conservation of biodiversity (Agrawal 1995; Baird 2013b). While not all indigenous peoples are necessarily conservationists (Li 2002; Tsing 1999, 2005), it is evident that, with some communities, empowerment and self-determination to enact their customary laws and practices should be explored as a measure of preserving and restoring indigenous culture and biodiversity (Shengji 1991; Xu et al. 2005). In the Mekong area, this is of critical importance to the great biodiversity and diversity of culture (Baird 2013b; Lanh 2009). Furthermore, indigenous communities around the world have asserted their "inherent rights to self-determination" and the conservation of cultural and ecological resources for future generations (IPO 1991); in their own words, indigenous communities assert that this conservation ethic is not only a responsibility to coming generations but also about a relationship with nature, which is "at the core of our existence" (Kari-Oca Declaration 1992) based on a "distinct spiritual and material relationship" that is "inextricably linked to our survival and to the preservation and further development of our knowledge systems and cultures" (Kimberly Declaration 2002).

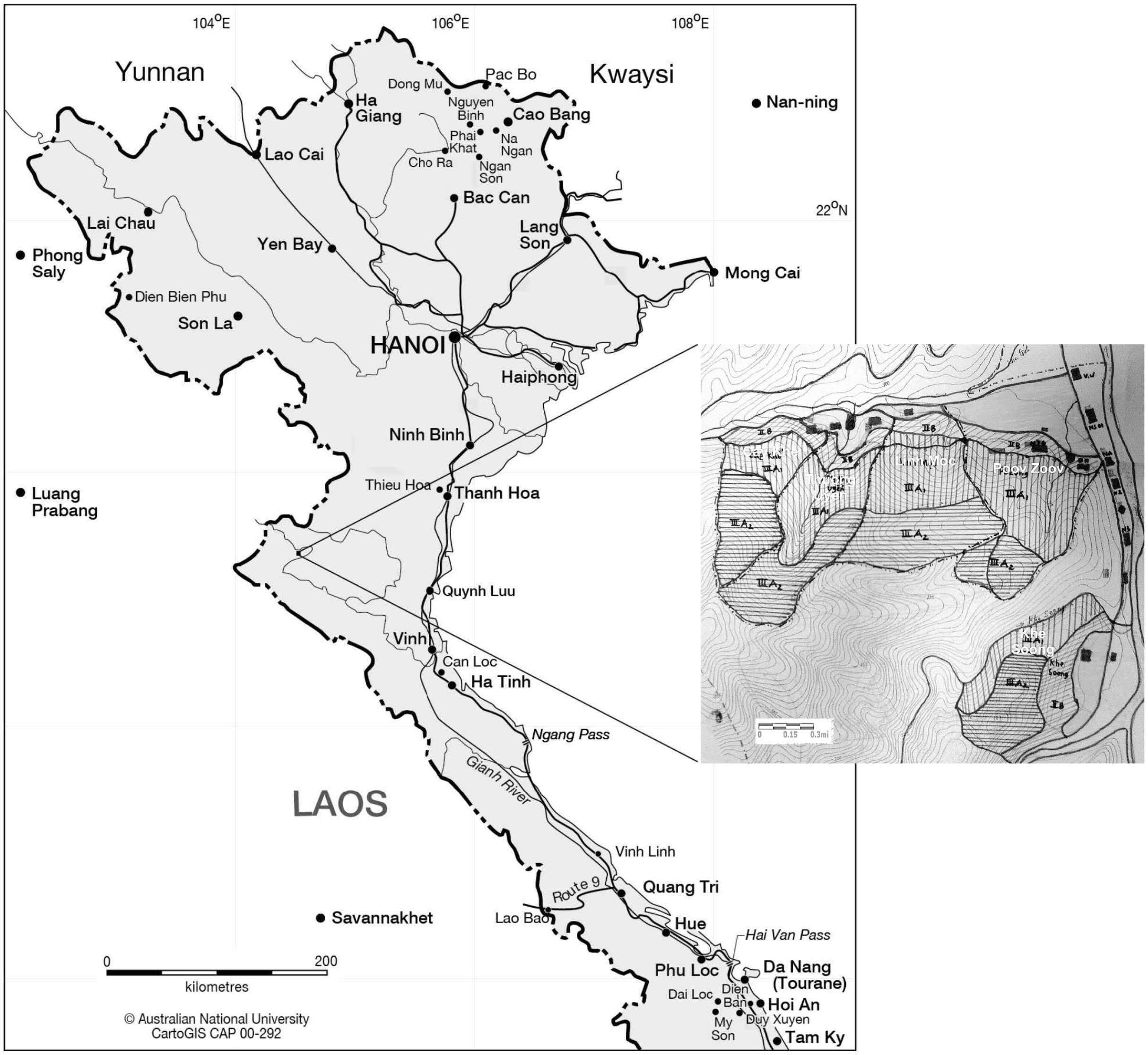
The following work attempts to understand and record the methods and modalities of ethnic minority groups' conservation activities and traditional knowledge as they relate to plants and ecosystems. It looks at the relationship between efforts for conservation and the spiritual and practical use of traditional plants in ethnic minority communities. The elders observed and interviewed in this investigation represent some of the last practitioners of the traditional ethnobotany knowledge and practices of the Dao, Hmong, Kinh, Ma-Lieng, Sach, Tai, Tay, and Xinh-Mun ethnic communities of northern and central Vietnam (SPERI 2013).

Existing research describes the ethnobotany knowledge of ethnic minorities in Vietnam, both on farm (Canh et al. 2005; Trinh et al. 2003) and in the forests, particularly for the Dao people (Sam 2012; Sam, Baas, and Kessler 2008; Sowerwine 1999). In Laos, most ethnobotany information is related to important export commodities (Ketphanh 1995; NAFRI 2007). In Thailand, studies have focused on homegardens and highland communities' use of medicinal plants (Anderson 1986; Anderson 1993; Pake 1987; Srithi et al. 2012a, 2012b; Vidal and Lemoine 1970). Some evidence from research with Cambodian indigenous peoples suggests that unsustainable harvesting of *Scaphium affine* (Mast.) Pierre by cutting down trees for malva nut fruit can be prevented with community support (Baird and Dearden 2003) likewise for *Dipterocarpus* spp. harvesting for wood resin (Baird 2009). These findings warrant deeper investigation. However, with few exceptions, regional studies have not looked specifically at the community role in conservation of the local ecology as a bi-product of plant use nor have they followed a systems approach based on human ecology. This article aims to fill this gap. Furthermore, applied anthropology offers methodologies for promoting traditional knowledge and advancing endogenous development for indigenous societies to cope with outside influences (Balick and Cox 1996; Sillitoe 2006). By identifying the role of traditional knowledge in the use and preservation of plants (Whitney et al. 2012), applied research helps forge a development agenda that considers traditional knowledge first, rather than the typically top-down, bureaucratically imposed approaches (Balick and Cox 1996; Sillitoe 2006).

It is an urgent task to find a suitable approach to the alleviation of poverty while at the same time conserving biodiversity and preserving and respecting cultural diversity for ethnic minority communities (Sheil et al. 2006; SPERI 2013; Sunderlin et al. 2005). This requires a clear understanding of conservation, the needs of the rural poor, and indigenous concepts of wealth and poverty. Solutions to the interconnected problems of rural poverty and biodiversity loss may be interlinked (Sunderlin et al. 2005; Yamane 2003). However, any solutions must, by definition, make sense from the communities' perspective, meet their immediate needs (Altieri 1989, 2002; Inoue 2011; Waylen et al. 2013), and be framed according to these needs and interests rather than solely those of academics (Chapoose et al. 2012) or international financial institutions and development banks. Studies are needed which look specifically at the cumulative, collective body of knowledge, experience, and values held by traditional societies (Agrawal 1995; Brahy 2006). Such studies should be conducted so that communities are involved in the design and implementation of research (Altieri 1989, 2002), and results should respect the origin of the knowledge and sensitivities of its holders (Bannister and Barrett 2001). These studies should be balanced to gather specific data accurately in order to ensure comparable and reliable results; they should demonstrate knowledge of the methodologies and designs of previous related studies (Belovsky et al. 2004; de Albuquerque and Hanazaki 2009) and be open to new ideas outside the bounds of a research framework (Vayda 1983).

The work described here was undertaken at the request of the Mekong Community Networking and Ecological Trading (MECO-ECOTRA), a network of indigenous and ethnic minority farmers that seeks to eliminate the systems that perpetuate poverty and conduct community development work based on respect for local belief systems and traditional community structures. Out of concern for the dying arts of herbalism, wild-crafting, and the traditional knowledge within these communities, MECO-ECOTRA hired the lead author to perform a year-long ethnobotany study of the various ethnic groups who are part of their network under the supervision of the elders and with the support of the indigenous and ethnic

Figure 1. Human Ecology Practical Area (HEPA) FFS in the Ha-Tinh Province of Vietnam
Map: Australia National University CartoGIS; Inset HEPA Ban Dieu Hanh 2012



minority youth network, Young Indigenous Ethnic Leadership Development Strategy (YIELDS). The study concerned the customary law, spiritual practices, and ethnobotany knowledge of plants; the relationship of the elders concerned and their surrounding ecology; and the potential for effective endogenous conservation. The study took place at a Farmer Field School (FFS) learning community, giving elders a chance to teach young people the dying arts and knowledge of traditional conservation practices and sustainable wild harvesting. The study was both a pedagogical and scientific investigation into the relationship between the uses of species and the practices related to conservation, to identify pressures on the relationship, and to seek information about where indigenous and ethnic minority ecological knowledge functions to protect and preserve biodiversity and where it needs more support. The study was carried out in collaboration with indigenous and ethnic minority elders who held a variety of roles in their home communities, as healers, community leaders, farmers, and medicinal practitioners. For the purposes of this study, and to allow for readability, they are all referred to as elders. Indigeneity is a contested concept in Vietnam (SPERI 2013) and, as with the spread of the ideas and language of indigeneity in Laos and Cambodia in the last twenty years (Baird 2011, 2013a, 2015), the terms may not be appropriate for all ethnic minority communities. Furthermore, not all elders considered here are ethnic minorities, that is, the elder L.V. Khuong is from Vietnam's ethnic majority Kinh but here represents a rare and dying art of traditional natural medicine.

Methods

An ethnobotany exploration took place in 2012 and 2013 on the Social Policy Ecology Research Institute's (SPERI) Human Ecology Practical Area (HEPA) FFS in the Ha-Tinh province of northern Vietnam in the foothills of the Annamite mountain range, 600 to 1,000 masl (Figure 1) near the Annamite Range Moist Forests Global Ecoregion. Research happened all over the HEPA's 285-hectares of protected forest and on the five experimental ecological farms in Ha-Tinh province, six km west of the center of Son-Kim-One along the Rao-An River (18° 42.16' N; 105° 22.08' E) fifteen km from the Cau-Treo, the major border crossing between Vinh, Vietnam, and Vientiane, Laos.

The HEPA-FFS serves as a platform for experimenting with traditional indigenous and ethnic minority farming knowledge and techniques in organic and permaculture farming with an ethical and philosophical approach aimed at enriching traditional values. HEPA is an example of the transnational connections that recreate indigenous knowledge-systems (Vandergeest 2006).

The indigenous and ethnic minority peoples' networks that manage and steer HEPA and MECO-ECOTRA identified the thirteen indigenous elders to join the research team from the Hmong, Kinh, Ma-Lieng, Sach, Tai, Tay, and Xinh-Mun communities. The elders chosen were those who were thought to be best able to represent and share the ethnobotany knowledge of their community. This selection constituted a purposive sampling, to ensure that the study gathered the most in-depth ethnobotany knowledge possible. All of these elders traveled to HEPA, most from relatively nearby but some from as far as 150 km north (Table 1). Interpretations of the 2009 Vietnam Population and Housing Census (Epprecht and Heinimann 2004), along with the research of SPERI, offer the clearest overview available for the populations of the ethnic groups represented in this survey (Table 1). All elders came from nearby areas in northern and central Vietnam (Table 1) and were familiar with a similar ecology to HEPA.

Important tracks and locations of major cited plant species are shown in Figure 2. These began with a Dao elder followed by collective work with elders from the Hmong, Kinh, Ma-Lieng, Sach, Tai, Tay, and Xinh-Mun. Fieldwork followed the lead of the elders and the young farmers. Based on the self-defined objectives of research participants, the investigation had the broad aims to both allow for the expression and transfer of traditional knowledge to the young generation for use in farming systems and forest management at HEPA, as well as testing a number of variables regarding the traditional uses of plants and the vulnerability and conservation of those plants. Knowledge transfer and capacity building was a major outcome of the investigations along with a book for sharing with a wider community (SPERI 2013).

Objectives were defined by the HEPA community, who also designed an ethnobotany questionnaire, which was loosely followed in conjunction with participant observation (Kremen, Raymond, and Lance 1998; Prance et al. 1987; Reyes-Garcia et al. 2006), walk-in-the-woods (Phillips and Gentry 1993a, 1993b), and occasional free listing (Quinlan 2005). The interviews were conducted on HEPA farms and forests (Figure 2) through open questionnaires, open discussions between youth and elders, focus groups, and the active application of the principle of pursuing the surprising (Vayda 1983).

Table 1. Populations of Tay, Dao, Sach, Kinh, Tai, Ma-lieng, Hmong, and Xinh-mun Ethnic Communities in Vietnam

English Name	Vietnamese Name	Population in Vietnam (1999)	Distribution in Vietnam
Dao*	Người-Dao	621,000	Ben-En National Park
Hmong†	Người-H'Mông	790,000	North
Ma-Liengß	Người-Mã-Lieng	<600	Minh-Hóa and Tuyen-Hóa, Quảng-Binh
Sachß	Người-Sách	2,000-4,000	Huong-Khe, Ha-Tinh
Tay	Người-Tay (Thô,-T'o, Tai-Tho, Ngan,-Phen, Thu-Lao, Pa-Di)	>1 million	Cao-Bằng, Lang-Son, Bắc-Kan, Thái-Nguyen, Quảng Ninh, Bắc-Ninh, and Bắc-Giang
Taiƒ	Người-Thái	~1 million	North Vietnam
Xinh-Mun (Con-Pua, Pua)	Người-Xinh-Mun (Puộc)	18,000	Son-La and Lai-Chau
Vietnamese (Kinh)	Người-Viet	73 million	All Vietnam

*Members of the Mien/Yao group that originated in Central China and moved south to the mountainous regions of southern China, northern Vietnam, Laos and Thailand
† Originally from China, southward migration out of China in the 18th century due to political unrest and to find more arable land
ß Belong to an officially merged ethnic group together with the Rục, May, and Arem known as the Chut (Vietnamese: Người-Chứt)
ƒ Subgroups include the Tai-La, Tai-You, and Tai-Ya (Tai-Ka and Tai-Sai).

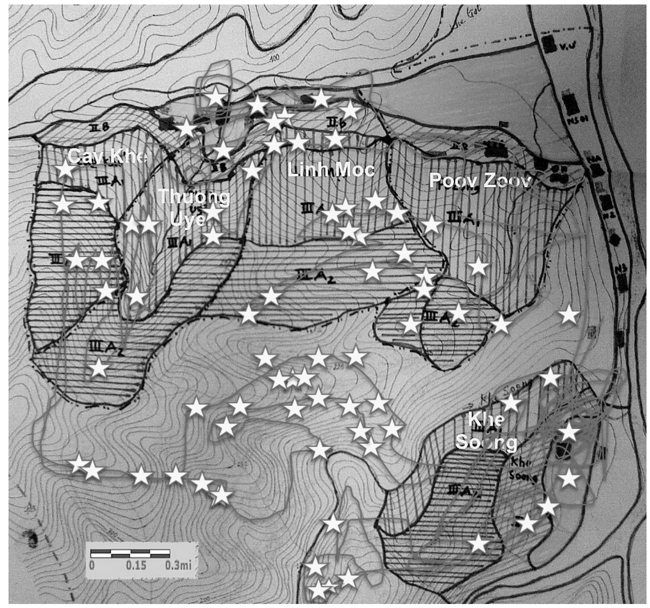
Locations visited by the group through field visits were predetermined with rudimentary mapping systems and pathways through HEPA (Figure 2). Specimen collection and identification followed the standard for botany (Hammer et al. 1991). Field guides were used for plant identification; cited species were counted and recorded with local and scientific names as well as ecological and agronomic conditions and morphological characteristics. Species were collected in a field press and later verified at the study of botanist V. V. Can and SPERI, where they remain as vouchers (Table 10) and many likewise with living samples in HEPA's herb-gardens. Determination of local names and spellings was made in the field and in focus groups.

Approach

The study followed the methods and materials of human ecology (Vayda 1983; Young 1974) in analyzing the relationship between humans and their environments (Hawley 1986). It aimed to record traditional cultural practices in the use and conservation of native plants to benefit farming practices (Altieri 1989, 2002), customary laws, and forest ecosystems. The terms, materials, and methods of ethnobotany were used to gain a clear picture of the relationship between human and plant communities (Alexiades and Sheldon 1996; Carlson and Maffi 2004).

Developing an appropriate model is important for conceptualizing research work with communities (Glaeser 2013). Several models have been proposed, which describe the functioning of human ecology systems (Dow 1976) in indigenous and ethnic minority cultures, particularly in South East Asia (Rambo 1983; SPERI 2013). For the purposes of this study, a spiritual and conservation oriented expansion of the "systems model of human ecology" (Rambo 1983) is used to frame the structure of the fieldwork. In dealing with what they identified as the problems afflicting indigenous and ethnic minorities in the Mekong region (isolation, lack of rights and ownership, and ultimately lack of confidence) that lead to what they term "structural poverty," local indigenous and ethnic minority peoples' networks updated Rambo's model to better acknowledge the role of spirituality and belief. The resulting spiritual and conservation oriented expansion of the "systems model of human ecology," termed "biological human ecology" (Lanh 2009; SPERI 2013) follows applied anthropology, suggesting a "seamless continuum" between the natural and the cultural (Chapoose et al. 2012). According to this animistic way of seeing, ecological systems, species, and structures, for example, keystone species and species interactions, are dependent on human systems for their conservation through prayers, rituals, and customary laws. Likewise, the most fundamental aspects of the cultural system, from belief, purpose, and religion, to health, prosperity, power, and happiness, are dependent on the natural world. According to this model, these systems are connected not only with the exchanges described in Rambo's model, but more critically and foundationally, they exchange meaning and modes of conservation, two essential aspects of each system. The weaknesses of the model are in the recognition of political-economic change and a tendency to overemphasize the conservation oriented aspects of culture. The framework deals with these weaknesses by considering the areas for its application. For example, in rebuilding a community overcome by alcoholism, MECO-ECOTRA starts with the restoration of shrines, religious centers, and local ecology; all other work flows from there.

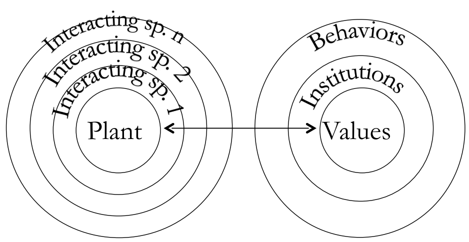
Figure 2. HEPA Important Tracks and Locations Important tracks (grey line) and locations of major cited plant species (stars). Map by HEPA Ban Dieu Hanh 2012, Tracks and waypoints: QGIS 2013



We followed a species-specific version of the biological human ecology model (Figure 3). Elders warned about publishing specific medicinal practices because of the potential dangers to health. H. V. Tai explained, "Herbal medicine is a double-edged sword, sometimes very useful but also very dangerous. It can destroy if used incorrectly." Likewise, they warned against the publication of certain vulnerable plants. Therefore, several species, those considered extremely vulnerable, are left out of this study. To counter these ethical problems and bioprospecting and biopiracy (Brush 2007; Castella et al. 2011; Tribunal Waitangi 2011), cautionary steps were taken in the form of community registries and "defensive publishing" (Mgbeoji 2001) to control the access to traditional plant knowledge (Downes and Laird 1999) with descriptions of plant resources published only at the request of the communities (SPERI 2013).

The research focused on projects that were of direct interest and benefit to MECO-ECOTRA and to the elders of the communities involved, consistent with stated shared

Figure 3. Species-specific Biological Human Ecology Model
Left: Plant = specific plant species of interest; Interacting sp. = dependent plants and animals in the ecosystem. Right: Values = cited spiritual, religious, ethical values for the plant species of interest; Institutions = cited customary law, local rules, cultural rules for the plant species of interest; Behaviors = cited actions toward the plant species of interest



beliefs and values, with their express approval, and based on a relationship of understanding and trust. The elders supported the research process, especially the walk-in-the-woods methodology, which they agreed was the best way to learn. They complained that it has become difficult to transfer knowledge to younger generations, as ways of seeing and knowing have shifted. H. V. Tai explained that youth are "unable to access the knowledge when elders speak of ghosts and spirits." They said publications could help with this process.

Data Analysis

Methods and experimental design replicate past studies to identify similarities and differences in the use of native species (Belovsky et al. 2004; de Albuquerque et al. 2006). The methods employed build upon the methods of quantitative anthropology (Bernard 2011) and quantitative ethnobotany indices (Kufer et al. 2005; Phillips and Gentry 1993a, 1993b; Prance et al. 1987; Tardio and Pardo-de-Santayana 2008) including, most importantly, the use report (UR), which occurs when a species is mentioned or observed being used for a certain defined use-category. The total UR per species is the sum of all the times that individual elders 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*). The frequency of citation (*FC*) is a count of how many people cite a species and the number of uses (*NU*) is a count of different categories of use for a species (Table 2).

$$\mathrm{UR_s} = \sum_{u=u_1}^{u_{\mathrm{NC}}} \sum_{i=i_1}^{i_{\mathrm{N}}} \mathrm{UR}_{ui}.$$

Where NC = number of use categories, u = uses, i = informant, and N = total number of informants. 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). The Cultural Importance index (Ci) is UR/N (Tardio and Pardo-de-Santayana 2008).

Designing appropriate use categories is important to any ethnobotany study (Hoffman and Gallaher 2007). Ethnobotanical knowledge was diverse among the elders and the use categories in Table 2 reflect this diversity.

Data on interactions in the species-specific biological human ecology model were gathered to test for both conservation and the strength of religiosity, spirituality, and customary law in conservation. The variables of interest concern the plant species in focus (Figure 3 left) and the associated cultural values, institutions, and behavior (Figure 3 right). The analysis concentrated on counts of cultural importance of plants based on the predetermined variables: "Uses" refers to the number of use reports (UR) or categorized uses (Table 2) that an elder mentions for a plant; these were most commonly health related. "Conservation" refers to actions in-situ and ex-situ to promote and/or protect the species, for example, cutting away competing herbs, spreading seed, or transplanting the species. Cited conservation practices were most often customary laws

Table 2. UR Categories and Percentages

Category	UR	%
MED (internal/topical medicine and disease treatment)	801	59.16
FOOD (food and drink often as secondary use to medicine or as famine food)	185	13.66
TECH (timber/firewood/dying/fencing)	162	11.96
CUL (culture, stories, poems)	147	10.86
HYG (hygiene, soap, bathing)	36	2.66
ORN (ornamental)	12	0.89
AF (animal feed)	11	0.81
Total	1,354	100%

Table 3. 16 Plant Species with the Highest Cultural Importance Index Score

Botanical Name	NU	Spirit	UR	FC	Ci
Blumea balsamifera (L.) DC.	7	36	46	7	3.538
Homalomena occulta (Lour.) Schott	7	15	46	7	3.538
Dioscorea crirrhosa Lour.	7	24	35	5	2.692
Alpinia globosa (Lour.) Horan.	7	8	28	4	2.154
Bowringia callicarpa Champ. ex Benth.	7	4	28	4	2.154
Antidesma bunius (L.) Spreng.	7	7	22	4	1.692
Aglaonema sp.	7	9	21	3	1.615
Arenga westerhoutii Griff.	7	3	21	3	1.615
Bauhinia sp.	7	8	21	3	1.615
Glochidion eriocarpum Champ.	7	3	21	3	1.615
Maesa membranacea A. DC.	7	6	21	3	1.615
Schefflera heptaphylla (L.) Frodin	7	9	21	3	1.615
Smilax glabra Wall. ex Roxb.	7	6	21	3	1.615
Sterculia lanceolata Cav.	7	9	21	3	1.615
Ficus hirta var. roxburghii (Miq.) King	7	10	20	3	1.538
Millettia cf. *lasiopetala* (Hayata) Merr.	6	9	18	3	1.385
Pandanus ceratostigma Martelli	7	3	18	3	1.385

UR = use reports; FC = frequency of citation; NU = number of use categories; Spirit = count of spiritual practices; Cons = conservation practices; Ci = cultural importance index

governing the use of the plants, for example, when harvesting the Cham-thác tree, *Greenea corymbosa* (Jack) Voigt. L. V. Binh said one should, "[A]void casting a shadow…only take part of the plant and do not destroy it." "Spiritual" refers to citations of customary and spiritual related practices for plants, for example, with the Cham-thác tree, "offer a pig or a chicken…pray before offering a prescription." The variables "Abundance" and "Vulnerability" are continuous counts of informants' local knowledge on the ecological status of plants. All information was recorded and uploaded digitally in the field and subsequently imported into the statistical package R, version 2.15.1. GIS Data was 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). All variables were tested using Pearson's product-moment correlation. Simple linear regression of variance and covariance was used to test predicted interactions of the species-specific biological human ecology model (Figure 3).

Results

The plants species with Ci greater than 1.1 included six trees, six shrubs, one perennial, three annuals, and one climber (Table 3). The medicinal, edible, technical, and culturally important shrub species, *Blumea balsamifera* (L.) DC., was the plant with the greatest Ci value.

The twelve elders (five female and seven male) of the selected ethnic minority communities identified and described 111 different plant species for 1,354 uncategorized uses (Table 4). They shared traditional knowledge about twenty-eight climbers (trailing or scandent habit), four ferns (epiphytic), twenty-nine herbs (annual), two perennials, twenty-four shrubs, and twenty-four trees (Table 10).

Data was organized for all 111 plants into five main variables of interest: (1) "Conservation," 517 cited actions for the conservation and protection of plants; (2) "UR" 560 Use Reports, categorized counts of the 1,354 citations of livelihood utility of plants; (3) "Spiritual," 353 citations of customary and spiritual related practices related to plants; (4) "Abundance" of plant, 139 counts of plants cited by an informant as abundant; and (5) "Vulnerability," eighty counts

Table 4. Sums and Percentages of Plants and Uses by Ethnic Groups

Ethnic Group	Plant Citations		Utility Count	
Tay	45	23.32%	409	30.21%
Dao	45	23.32%	135	9.97%
Sach	36	18.65%	269	19.87%
Kinh	25	12.95%	165	12.19%
Tai	13	6.74%	119	8.79%
Ma-Lieng	12	6.22%	101	7.46%
Hmong	10	5.18%	100	7.39%
Xinh-Mun	7	3.62%	56	4.13%
TOTAL	193	100%	1,354	100%

Plant Citations = number of plants that were described by elders from that ethnic group; Utility Count = uncategorized use reports for the plants described

Table 5. Means and Standard Deviations for Gender and Plant Use

	Informants		Plants		
	Age	Plants Used	UR	Spiritual	Conservation
All	60.07'±10.38	66.11' ±32.62	6.64' ±4.66	1.74' ±1.24	1.28' ±0.57
Female	54.83' ±5.46	54.87' ±31.88	5.76' ±4.62	1.42' ±1.15	2.46' ±1.09
Male	66.2' ±11.4	79.26' ±28.41	7.68' ±4.5	2.11' ±1.24	1.37' ±0.62

Age = age of informants; Plants Used = number of different plant species mentioned; UR = use reports, count of number of specific uses for plants; Spiritual = spiritual purposes/uses; Conservation = conservation practices

Table 6. Means, Standard Devations, and Coefficients of Variation for 111 Plant Species

	Spiritual	Conservation	UR	Abundance	Vulnerability
Mean±SD	2.46 ±3.07	1.8 ±1.52	9.37 ±12.26	0.97 ±0.77	0.56 ±1.11
CV	1.25	0.84	1.31	0.79	1.99

Spiritual = spiritual purposes/uses; Conservation = conservation practices; UR = use reports, count of number of specific uses for plants; Abundance = local knowledge about species abundance; Vulnerability = local knowledge about species vulnerability; CV = coefficient of variation

Table 7. Pearson's Product-Moment Correlations for Variables Regarding Plant Use and Plant Ecology

	Plant Usability					Plant Ecology	
	Spiritual	Conservation	UR	FC	NU	Abundance	Vulnerability
Spiritual	-	0.787	0.924	0.847	0.495	0.709	0.518
Conservation	< 2.2e-16	-	0.792	0.854	0.450	0.660	0.622
UR	< 2.2e-16	< 2.2e-16	-	0.955	0.731	0.699	0.457
FC	< 2.2e-16	< 2.2e-16	< 2.2e-16	-	0.554	0.701	0.544
NU	3.25e-08	7.35e-07	< 2.2e-16	2.80e-10	-	0.4	0.185
Abundance	< 2.2e-16	4.22e-15	< 2.2e-16	< 2.2e-16	1.34e-05	-	0.450
Vulnerability	6.90e-09	4.29e-13	3.85e-09	6.96e-10	0.051	7.88e-07	-

Spiritual = spiritual purposes/uses; Conservation = conservation practices; UR = use reports, count of number of specific uses for plants; Abundance = local knowledge about species abundance; Vulnerability = local knowledge about species vulnerability; Pearson's product-moment correlations R upper right, p-value lower left

of plants cited by an informant as vulnerable (Tables 7-9). Men used more plants and had more uses per plant, but they also had fewer conservation practices (Table 5).

All the variables tested had a strong positive skew and high-variance as shown by the coefficient of variation (*CV* or relative variability). Indicating poor dispersion of variables (independent of measurement units), that is, a relatively high ratio of the standard deviation to the mean (Table 6).

All variables were tested using Pearson's product-moment correlation (*R*), which was chosen as the most robust of the parametric tests for co-linearity. The calculated correlations were highly significant for all variables, with moderate to high positive correlation (Table 7).

Through ethnobotany field interviews, the study gathered traditional knowledge of plants, including twenty-eight climbers, four ferns, twenty-nine annual and two perennial herbs, twenty-four shrubs, and twenty-four trees. Shrubs had the greatest number of conservation practices followed closely by ferns, climbers, and perennials. Trees and annual herb species had fewer conservation practices.

According to the biological human ecology model, human and natural systems are connected not only with the

Table 8. Average Quantitative Ethnobotany Scores, Spiritual and Conservation Practices per Species by Life-Form

Type	UR	FC	NU	Spirit	Cons	Ci
Climber	16.26±7.14	2.53±0.9	5.95±2.09	3.14±5.27	5.46±4.08	1.25±0.55
Perennial	14±9.9	2±1.41	7±0	4.5±4.95	6±2.83	1.08±0.76
Shrub	13.45±6.84	2.31±0.8	4.94±1.99	8.67±2.36	9.23±3.78	1.03±0.53
Tree	12.08±5.95	2.08±0.77	5.1±1.92	4.61±2.36	4.47±2.19	0.93±0.46
Fern	10.5±5.45	2.5±0.58	4±1.41	3.75±1.71	7.5±3.42	0.81±0.42
Annual	8.48±10.03	1.67±1.3	4.37±2.4	2.56±3.5	4.37±6.97	0.65±0.77

Average scores per plant species: UR = use reports, FC = frequency of citation, NU = number of use categories, Spirit = count of spiritual practices, Cons = conservation practices, Ci = cultural importance index

exchange of energy, material, and information, but more critically, they exchange meaning and conservation, two essential aspects of each system. Along with the energy, material, and information, as described by Rambo, the human system gets meaning from the natural system, and the natural system gets conservation from the human system. This happens through the connection between the belief system of the indigenous and ethnic minority cultures (for example, nature worship) and the ecological functions of the natural system.

Single stratum regression of variance and covariance was used to determine the effects of explanatory variables for quantitative ethnobotany, FC, UR, NU, and spiritual practices, on the response variable conservation practices (Cons), in the species-specific biological human ecology model. To account for skewness (Table 6), all explanatory variables were log transformed to *z*-scores. These were then tested with linear regression and ANOVA; all had significant effect (Table 9).

ANOVA tested on the regression models in Table 9 verified a significant relationship (FC, UR, and Spirit, NU $p<0.001$).

Table 9. Single Stratum Regression of Variance and Covariance for the Response Variable Conservation Practices and Explanatory Variables Quantitative Ethnobotany Scores, and Spiritual Practices

	Coefficients*	Adjusted R2	Significance
FC	3.878(0.226)	0.727	***
UR	0.476(0.033)	0.656	***
NU	1.084(0.206)	0.195	**
Spirit	0.844(0.063)	0.617	***

UR = use reports; FC = frequency of citation; NU = number of use categories; Spirit = count of spiritual practices; Significance = p-value of mode 1 (*** <2.2e-16, ** 7.4e-07); Coefficients = standardized regression coefficient; *standard errors in parentheses

In the folk biological classification of the region, many of the plant species are named for their use. As C. T. Hau explained, "If you learn my language, you will know how to use herbs." However, it is not practical to list them all here; instead, only Latin and Vietnamese names for plants are used for ease of listing in Table 10 (full list in SPERI 2013).

Discussion

We worked closely with the community using a human ecology participatory approach (Rambo 1983; Vayda 1983) to deal with current issues and produce results that are directly relevant for agroecological practices (Altieri 1989, 2002), customary laws, and forest ecosystems. We followed the biological human ecology approach (Lanh 2009; SPERI 2013) in analyzing central aspects of ethnic communities and the surrounding ecology. The investigation aimed to both allow for the expression and transfer of traditional knowledge to the young generation, for use in farming systems and forest management at HEPA, as well as to test a number of variables regarding the traditional uses of plants and the vulnerability and conservation of those plants. All data was recorded in local languages and stayed with the MECO-ECOTRA community. Early dissemination was carried out through publications within the MECO-ECOTRA network (SPERI 2013) and through community meetings.

Plant uses by different ethnic groups were diverse, with sometimes very different uses from group to group (Table 4). We often found many different uses for a single plant and many prescriptions for the same symptoms. As the elders noted, herbalists seek the best solution for problems, solutions which were also changing through the study. For example, the Sach people were not aware of the uses of *A. silvestris* although they said it grows well around their home, and they intended to use it after the study.

Due to the unique design of participatory methods for traditional ethnobotany knowledge collection, that is, fieldwork with a group of informants together, the actual uses may be more evenly spread between all communities than the data seems to suggest. According to the results presented

Table 10. Plant I.D., Botanical Names, Vietnamese Names, and Life-forms for 111 Species Found at HEPA

Field Number	Botanical Name	Vietnamese Name	Type
HEPA96	*Acacia pennata* (L.) Willd.	Xà-chùy	Climber
HEPA114	*Aglaonema* sp.	Vạn-niên-thanh	Herb
HEPA110	*Alangium barbatum* var. decipiens (Evrard) Tard.	Tầm-tầm	Shrub
HEPA44	*Alpinia chinensis* (Koenig in Retz.) Rosc.	Hoa-sơn-khương	Herb
HEPA82	*Alpinia globosa* (Lour.) Horan.	Sẹ	Herb
HEPA81	*Amomum* cf. *ovoideum* Pierre ex Gagnep.	Sa-nhân-tròn-trứng	Herb
HEPA16	*Amomum longiligulare* T.L.Wu	Sa-nhân-lưỡi-dài	Herb
HEPA111	*Amomum villosum* Lour.	Sa-nhân	Herb
HEPA31, HEPA98	*Ancistrocladus tectorius* (Lour.) Merr.	Trung-quân-mái-lợp	Climber
HEPA43, HEPA52	*Antidesma bunius* (L.) Spreng.	Chòi-mòi-Bune	Tree
HEPA46	*Aralia armata* (Wall. ex G. Don) Seem.	Quẳng-quẳng	Shrub
HEPA10	*Ardisia crispa* (Thunb.) A.DC.	Bách-lưỡng-kim	Shrub/Semi-Shrub
HEPA1	*Ardisia quinquegona Blume*	Tử-kim-ngưu-cạnh-năm	Shrub
HEPA66	*Ardisia silvestris* Pitard	Khôi	Herb/Small Shrub
HEPA91	*Arenga westerhoutii* Griff.	Báng	Tree
HEPA49	*Baccaurea ramiflora* Lour.	Dâu-da	Tree
HEPA118	*Bauhinia sp.*	*Ngưu-đề-lá-tím*	*Perennial*
HEPA11	*Bauhinia touranensis* Gagnep.	Ngưu-đề-đà-nẵng	Climber
HEPA32	*Begonia* cf. *lecomtei Gagnep.*	Thu-hải-đường-lơ-công	Herb
HEPA97	*Blastus borneensis* var. *eberhardtii* (Guillaum.) C. Hansen	Bán-quả-chuông-ngược	Shrub
HEPA37, HEPA80	*Blumea balsamifera* (L.) DC.	Đại-bi	Semi-Shrub/Herb
HEPA62	*Bowringia callicarpa* Champ. ex Benth.	Chi-chi	Climber Shrub/Climber
HEPA105	*Caesalpinia crispa* L.,	Vân-thực-mào-gà	Climber
HEPA119	*Calamus hepaensis* V.C. Vu et H.G.Lê, sp. nov.	Mây-hepa	Perennial
HEPA109	*Callicarpa brevipes* (Benth.) Hance	Tú-quả-cuống-ngắn	Shrub
HEPA106	*Callicarpa* cf. *cathayana* H.T.Chang	Tú-quả-trung-hoa	Shrub
HEPA24	*Callicarpa* cf. *longissima* (Hemsl.) Merr.	Tú-quả-dài-cực	Shrub/Small Tree
HEPA60	*Callisia fragrans* (Lindl.) Woodson	Lược-vàng	Herb
HEPA77	*Caryota mitis* Lour.	*Đùng*-đình	Tree
HEPA26	*Chromolaena odorata* (L.) R.M.King et H.Rob.	Bớp-bớp	Herb
HEPA18	*Cordyline fruticosa* (L.) Goepp.	Huyết-dụ	Shrub
HEPA84	*Coscinium fenestratum* (Gaertn.) Colebr.	Hoàng-đằng	Climber
HEPA15	*Curculigo capitulata* (Lour.) Kuntze	Tiên-mao-lá-to	Herb
HEPA8	*Curculigo gracilis* (Kurz) Wall. ex Hook.f.	Tiên-mao-hoa-thưa	Herb
HEPA113	*Curculigo orchioides* Gaertn.	Tiên-mao	Herb
HEPA57	*Curcuma longa* L.	Nghệ	Herb
HEPA21	*Curcuma zedoaria (Berg.) Rosc.*	Khương-hoàng	Herb
HEPA103	*Cyrtomium fortunei* J.Sm.	Quán-chúng.	Fern
HEPA104	*Daemonorops jenkinsiana* (Griff.) Mart.	Hèo-tiểu-diệp-nhiều	Vine
HEPA39	*Dioscorea crirrhosa* Lour.	Củ-nâu	Climber
HEPA92	*Dioscorea persimilis* Prain et Burkill	Hoài-sơn	Climber
HEPA22	*Dioscorea* spp.	Lá-rát	Climber
HEPA88	*Drynaria fortunei* (Kuntze) J. Sm.	Cốt-toái-bổ	Fern
HEPA9	*Entada phaseoides* (L.) Merr.	Bàm-bàm	Climber
HEPA14, HEPA53	*Ficus hirta* var. *roxburghii* (Miq.) King	*Ngưu-nhũ*	*Tree*
HEPA70	*Ficus* sp.	Sung-thùy	Tree
HEPA90	*Fissistigma* cf. *bracteolatum* Chatt.	Ngưu-phụ-men-rượu	Climber
HEPA5	*Fissitigma polyanthum* (Hook.f et Thoms.) Merr.	Ngưu-phụ-hoa-nhiều	Climber
HEPA73	*Galinsoga parviflora* Cav.	Cúc-tê	Herb
HEPA93	*Garcinia cochinchinensis* (Lour.) Choisy	Sông	Tree
HEPA40	*Garcinia oblongifolia* Champ. ex Benth.	Bứa	Tree
HEPA68	*Glochidion eriocarpum* Champ.	Mược-quả-lông	Shrub
HEPA4	*Glocidion velutinum* Wight.	Mược-dạng-lông-chiên	Tree
HEPA86	*Gnetum montanum* Markgr.	Gắm-núi	Climber
HEPA108	*Gomphostemma grandiflorum* Doan	*Đại-trùy*	*Shrub*
HEPA112	*Greenea corymbosa* (Jack) K. Schum.	Châm-thác	Tree
HEPA36	*Hedyotis capitellata* var. mollis (Pierre ex Pitard) T.N.Ninh	Dạ-cẩm	Climber
HEPA3	*Heliciopsis lobata* (Merr.) Sleum	Sơn-long-nhãn-giả-phân-liệt	Tree
HEPA2, HEPA65	*Homalomena occulta* (Lour.) Schott	Thiên-niên-kiện	Herb
HEPA100	*Impatiens balsamina* L.	Phượng-tiên	Herb
HEPA83	*Jasminum* sp.	Hùng-đảm-đằng	Climber

HEPA50	*Justicia gendarussa* Burm.f.	Thanh-táo.	Shrub
HEPA95	*Licuala spinosa* Thunb.	Lá-nón	Shrub
HEPA29, HEPA69	*Lophatherum gracile* Brongn. in Duperr.	Đạm-trúc-diệp	Herb
HEPA79	*Lycianthes biflora* (Lour.) Bitter	Hồng-ti-tuyến	Semi-Shrub
HEPA51	*Maesa membranacea A. DC.*	Đơn-nem-chất-màng	Shrub
HEPA28	*Maesa ramentacea (Roxb.) A.DC.*	Hồng-đơn	Big Shrub/Small Tree
HEPA54	*Mallotus apelta* (Lour.) Muell. Arg.	Bai-bai	Shrub/Small Tree
HEPA63	*Medinilla* cf. *assamica* (C.B.Clarke) C. Chen,	Mĩ-đình-át-xam	Tree
HEPA42	*Melodinus brachyphyllus* Merr.	Dom-lá-ngắn	Climber
HEPA94	*Millettia* cf. *lasiopetala* (Hayata) Merr.	Khay	Shrub
HEPA71	*Momordica cochinchinensis* (Lour.) Spreng.	Gấc	Climber
HEPA85	*Morinda officinalis* How	Ba-kích	Climber
HEPA61	*Mussaenda dehiscens* Craib,	Bạch-điệp	Shrub/Small Tree
HEPA117	*Neonauclea purpurea* (Roxb.) Merr.	Vàng-kiêng	Tree
HEPA115	*Neottopteris nidus* (L.) J.Sm.	Điểu-sào	Fern
HEPA87	*Ophiopogon reptans Hook.f.*	Diên-giai-thảo-sinh-căn	Herb
HEPA6, HEPA72	*Pandanus ceratostigma* Martelli	Dứa-dại-lá-đuôi	Tree
HEPA56	*Perilla frutescens* (L.) Britt.	Tía-Tô	Herb
HEPA101	*Persicaria odorata* Soják	Răm	Herb
HEPA41	*Phrynium placentarium* (Lour.) Merr.	Dong-lá	Herb
HEPA78	*Phyllanthus reticulatus* Poir.	Phèn-đen	Shrub
HEPA59	*Phyllanthus urinaria* L.	Diệp-hạ-châu	Herb
HEPA13	*Piper* cf. *arboricola C.DC.*	Tiêu-mộc-thượng	Climber
HEPA89	*Piper* cf. *baccatum* Blume	Tiêu-dạng-quả-mọng	Climber
HEPA17	*Piper* cf. *brevicaule* C.DC.	Lốt-leo	Herb
HEPA12	*Polyalthia nemoralis* DC.	Nhọc-rừng	Shrub
HEPA7	*Pothos repens* (Lour.) Druce	Cam-linh	Climber
HEPA45	*Psychotria rubra* (Lour.) Poir.	Lấu	Shrub
HEPA47	*Pteris semipinnata* L.	Bán-biên-kì	Fern
HEPA38	*Randia spinosa* (Thunb.) Poir.	Găng-lồ	Shrub/Small Tree
HEPA102	*Rhaphidophora chevalieri* Gagnep.	Nhai-đằng-sơ-va-li-ê.	Climber
HEPA67	*Rourea microphylla* (Hook. et Arn.) Planch.	Hồng-diệp-đằng	Shrub
HEPA74	*Rubus alceaefolius* Poir.	Ngấy-ngấy	Shrub
HEPA19	*Rubus cochinchinensis* var. *glabrescens* Card.	Đùm-đũm	Shrub
HEPA58	*Sansevieria trifasciata* Hort. ex Prain	Hỗ-vĩ	Herb
HEPA25, HEPA107	*Saurauia tristyla* DC.	Nhuề	Shrub/Small Tree
HEPA76	*Schefflera heptaphylla* (L.) Frodin	Chim-chim	Tree/Shrub
HEPA116	*Smilax glabra* Wall. ex Roxb.	Thổ-phục-linh	Shrub
HEPA27	*Solanum dulcamara* L.	Âu-bạch-anh	Climber
HEPA99	*Solanum torvum* Swartz	Cà-hoang	Shrub
HEPA30	*Spatholobus* cf. *acuminatus* Benth.	Huyết-đằng-nhọn-dần-dần	Climber
HEPA34	*Stephania rotunda* Lour.	Bình-vôi-tròn	Climber
HEPA55	*Sterculia lanceolata* Cav.	Sảng	Tree
HEPA35	*Streblus ilicifolius* (Vidal) Corner	Ô-rô	Shrub/Small Tree
HEPA48	*Tarenna baviensis* (Drake) Pitard	Trèn-trèn-ba-vì	Shrub
HEPA33	*Tetrapanax papyriferus* (Hook.) C.Koch	Thông-thảo	Shrub/Small Tree
HEPA75	*Tetrastigma* cf. *apiculatum* Gagnep.	Nhai-đằng-mũi-nhỏ	Climber
HEPA23	*Tetrastigma* cf. *beauvaisii* Gagnep.	Nhai-đằng-ưa-vôi	Climber
HEPA20	*Zingber zerumbet* (L.) Smith	Gừng-gió	Herb
HEPA64	*Zippelia begonifolia* Blume ex Schult. et Schult. f.	Tề-đầu-nhung	Herb

All specimens are kept as living herb garden plants and/or pressed samples at SPERI and the study of Vu Van Can in Hanoi.
Several species, which were considered too vulnerable to publish, were left out of this study.

in Table 2, Tay and Dao elders use the greatest portion of the species described, followed by the Sach, Kinh, Tai, Ma-Lieng, and Hmong, with the Xinh-Mun using only seven species. However, actual uses may be more dynamic for four main reasons: (1) identifying species in the field was problematic for some. For example, V. V. Nhac explained, "I make most prescriptions…with dried herbs." (2) At times when the elders did agree with each other, they did not always say; thus, the research team did not catalog all identical uses for different ethnic groups. (3) Elders were hesitant to contradict each other if uses were very different or even opposite from one community to another, with rare exceptions. For example, C. T. Trang shared contradictory uses of *M. apelta* discreetly. (4) While most elders came from close to Ha-Tinh, some traveled from slightly different ecological zones in higher northern altitudes. However, all agreed that the major ecological difference was in the abundance of species, as HEPA is a regenerated forest that has seen little disturbance in the past twenty years.

Some interesting differences exist between male and female elders. N. T. Lien and H. V. Tai discussed the differences relevant to Tables 4 and 5: "We had some similarities but many differences…though we are from the same ethnic group. Even the treatments we used were different." Given the disparity of male to female respondents and the age difference (Table 5), it is a point that could be explored in future investigations, but no conclusions can be drawn from it here.

The data suggests that the correlations were high for all variables except in the case of a plant's perceived vulnerability. When a plant was considered vulnerable, this did not strongly correlate with the plant's abundance; likewise, abundance did not strongly correlate with plant use, meaning that the uses were fewer for these plants or, more likely, that the uses were kept secret because of vulnerability. In the case that a plant was vulnerable, it did however strongly correlate with conservation practices (Table 7). This meant that the more a species was perceived as being vulnerable in the community, the more likely they were to have practices to promote the species and to take action for the preservation of the species, both in-situ, for example, clearing of competing vegetation, and ex-situ, for example, propagation in homegardens.

Table 8 can be viewed as a measurement of land-ethic through the species-specific biological human ecology model with plant life-forms as a proxy for ecosystem importance by functional traits. Plant types that are conserved also reflect the structure and botanical diversity of the region's degraded humid evergreen montane forests (in the Annamites and elsewhere in Northern Vietnam). These regenerating forests support many shrubs, ferns (among other epiphytes), climbers, and perennials, with fewer trees and annual herb species on the forest floor, all providing important habitat to native and many endemic animal species.

Evidence for a statistically significant relationship between factors of use and conservation action, through simple linear regression (Table 9) and correlation coefficient as a measure of this linear relationship (Table 7), fits with the biological human ecology hypothesis: "The cultural use of a species leads to the conservation of that species." As has been shown in Cambodia for the harvesting of *Scaphium affine* (Mast.) Pierre for malva nut fruit (Baird and Dearden 2003) and for harvesting Dipterocarpus spp. for wood resin (Baird 2009). This is also fitting with the underlying foundations' biological human ecology in that the relationship between a people and their surrounding ecology are bound together functionally and by the foundational spiritual beliefs of the community.

The list of plants presented in Table 10 overlaps with previously described ethnobotany knowledge of ethnic minorities in Vietnam both on farm and in the wild. While our investigation was not nearly as extensive as some of the past ethnobotany work, for example, with the Dao, Kinh, Muong, Thai, Tay, and Tho people (Sam 2012; Sam et al. 2008), it has nonetheless yielded a similarly large data set (Table 11). This discussion will, however, not go into too much detail of the overlap with past studies for safety and proprietary reasons.

As in the findings with the ethnic groups in Ben-En and Ba-Vi, much of the useful species in our study were collected from the wild (Sam 2012; Sam et al. 2008). Thus, past studies on Vietnamese home gardens mentioned many species that we did not cover in our study, although they may well have been present at HEPA. Trinh et al. (2003) cited *Abelmoschus*, *Areca*, *Bambusa, Brassica*, *Capsicum*, *Citrus*, *Colocasia*, *Hibiscus*, *Lucuma*, *Luffa*, *Mentha*, *Musa*, and *Xanthosoma* spp. not found in our study. Likewise, Canh et al. (2005) cited *Allocasia*, *Annona*, *Artocarpus*, *Brassica*, *Citrus*, *Cocos*, *Colocasia*, *Dimocarpus*, *Durio*, *Ipomea*, *Litchi*, *Mangifera*, *Morus*, *Musa*, *Nasturtium*, *Nephelium*, and *Xanthasoma* spp. not found in our study. These studies also mentioned ornamentals not found in our study, for example, *Gerbera*, *Gladiolus* (Canh et al. 2005), and *Polianthes* spp. (Trinh et al. 2003). This stands to reason since many of the native ferns, herbs, climbers, and shrubs were cleared in these gardens (Canh et al. 2005), and these are largely cropped species, while our investigation covered more of the native species and forest diversity. However, some interesting similarities with these homegarden studies were with *Amomum* (Canh et al. 2005), *Momordica*, *Piper* (Trinh et al. 2003), *Zingiber* spp. (Canh et al. 2005), and several plants from the *Solanum* genus, although not the same species (Canh et al. 2005; Trinh et al. 2003).

Similarities and differences are too many to list here in detail. However, clearly trees of the *Antidesma*, *Arenga*, *Baccaurea*, *Caryota*, *Ficus*, *Garcinia*, *Medinilla*, *Neonauclea*, and *Pandanus* spp., among others, deserve further investigation. The study also shows similarity with research from Cambodia regarding sustainable harvesting of *Sterculia* (Baird and Dearden 2003) and *Dipterocarpus* spp. (Baird 2009) (Tables 10 and 11).

Vulnerability is a point of concern that elders and communities are well aware of, the most pressing of those mentioned were market pressures from neighboring Kinh and Chinese traders. The communities respond to these pressures largely through customary laws. Thus, customary laws are not strictly traditional but can be reformulated in relation to contemporary resource pressures. This is an important point when considering global ecological issues such as loss of biodiversity and climate change. Several examples were recorded during interviews, for example, responding to economic pressures on the forests; Hmong and Tay communities have instituted bans on the harvesting and sale of vulnerable plants (esp. Orchidaceae spp.) from the community forests.

Economic pressure from neighboring Kinh and Chinese traders is one of the reasons why publishing the actual uses of a species is of ethical concern—the more that a species is known to have a use and hence potential market value, the more that species becomes rare in the ecosystem—for this reason, many uses may have been kept secret during the

Table 11. Similarities of HEPA Ethnobotany with Past Studies in the Region

Study Area	Author and Year	Cited Spp.	Common Spp. to This Study
Vietnam	Trinh et al. 2003	>20	9
	Canh et al. 2005	>100	98
	Sam et al. 2008	230	91
	Sam 2012	257	89
Laos	Ketphanh 1995	>100	20
	NAFRI 2007	>100	15
Thailand	Vidal & Lemoine 1970	320	10
	Anderson 1986	121	20
	Pake 1987	>150	21
	Anderson 1993	>1,000	95
	Srithi et al. 2012a	79	5
	Srithi et al. 2012b	406	90

Several species, which were considered too vulnerable to publish, were left out of this study; however, their numbers are included in the column "Common Spp. to This Study."

interviews. All the ethnic communities have a tradition of being guarded about the usefulness of species. Elders keep useful bark, leaf, and root material in powder form, or in secret compartments, to ensure that users, even other community members, cannot identify plants. They also collect in secret at specific phases of the moon and times of day. Generally, elders will keep species identities from the patients, and other community members, except in special cases where the patient wishes to learn, is perceived to be a good person who will use the plants wisely, and is willing to make an extra (often hefty) payment for the transfer of the knowledge. Knowledge transfer is also a guarded practice within the elders' own families; for example, an elder will teach his or her children only when they are sure that the knowledge will be used well.

In confidence that the research project would yield some useful results, the elders shared important, and normally very secret information, for this study. We believe, and some elders confirmed, that we learned approximately 70 percent of the information that there was to learn about the species we discussed. MECO-ECOTRA itself kept this same guarded culture, with the elders' basic consent, by not allowing the elders or research team to leave the HEPA site during the research, thus thwarting any opportunities for other local people around HEPA to learn of new uses for rare plants that exist in the regenerating forests of the area.

Conclusion

Interviews and fieldwork revealed mechanisms for conservation implicit in the cultural uses of plant species. Results demonstrate the mutual relations between the socioeconomic, ethical, cultural, political, and environmental aspects of the local systems and should be a catalyst for policymakers to consider indigenous and ethnic minority local knowledge and experience as an effective mechanism for the sustainable use and conservation of biodiversity.

All elders, HEPA staff, and young farmers had a chance to participate in the work of field ethnobotany and in the process of data collection. The research team was exceedingly fortunate to have the chance to learn together with these elders and youth, and this was due to the relationship of trust developed over a long period of time among the indigenous and ethnic minority networks that this research served. The trust is evident in the richness of the data collected. Although we only had access to twelve elders, they mentioned altogether more than the 111 plants and 1,354 uses described here. The effectiveness of the knowledge transfer is also evident at HEPA whose staff were trained and have effectively implemented the use of traditional plants in their diets. More than twenty indigenous and ethnic minority youth have diversified their diets to include many of the edible plants found in these explorations and have since planted many of the plants learned from the elders. The HEPA farms now grow more wild plants and manage forests for edible and medicinal plants. The book that was published, along with a few other publications, has supported action by MECO-ECOTRA and SPERI on regional and national government policy. The book also laid the groundwork for more research including a series of explorations of forest biodiversity.

The explicit agenda of MECO-ECOTRA invites accusations of bias, and it may be argued that it puts the study at risk of reification. We argue rather that it intensifies the effectiveness of the investigation, operating within the ethical approach of the MECO-ECOTRA community, while gathering objective data for hypothesis testing and quantitative analysis. In this way, this project offers a model for applied, participatory ethnobotany research that is both scientifically valuable and useful for those working to advance the causes of indigenous and ethnic minority people in their role in direct conservation.

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