ORIGINAL ARTICLE

Assessing medicinal plants as the linkage between healthcare, livelihood and biodiversity: a case study from native villages surrounding a second-tier city in the central Peruvian Amazon

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ABSTRACT   Medicinal plants are still used for healthcare and as medicaments especially in developing countries and some rural areas. The potential and high expectation of medicinal plants for local healthcare and livelihood and as biodiversity management is prevalent globally. This study assesses the extent to which medicinal plants bring benefits in biodiversity management and improve livelihood and healthcare in indigenous villages near a small city, a second tier city in the central Peruvian Amazon, taking into consideration the course of urbanization. A total of 81 people living in two villages were interviewed. The results show that unlike areas surrounding large cities in the Amazon, areas around the second tier city do not have the conditions to commercialize medicinal plants to support livelihood. Therefore, the local utilization of medicinal plants does not deteriorate the forest resources, thus medicinal plants would not be expected to be a driver for biodiversity management. Although medicinal plants still support healthcare of the locals, the reliance on modern medicine is aparent. The distance to the urbanized city and modern facilities influences the use of medicinal plants. While close proximity facilitates the use of modern medicine, it is found that mal-accessibility to modern medicine does not increase the variety of medicinal plant use.

Key words: medicinal plant, forest resource, tropical rain forest, rural urbanization, healthcare

INTRODUCTION

In history, medicinal plants have been a common and important source of medicine throughout the world. They are still used for healthcare and as medicaments especially in developing countries and some rural areas (FAO 2013, Farnsworth et al. 1985, WHO 2002) and as a source of, at least 25% of, modern medicine (Farnsworth et al. 1985, Robinson and Zhang 2011). The potential and high expectation of medicinal plants is prevalent globally. A World Bank report (Lambert 2006) states that medicinal plants and the knowledge of plants possessed by traditional healers can mitigate the dilemmas between health, economy and environment caused by rapid globalization. The Convention on Biological Diversity also cited that medicinal plants are uniquely positioned to link biodiversity, health and sustainable development (Urrea 2010). The biodiversity of medicinal plants is expected to support primary healthcare in developing countries and the appropriate extraction of the plants would fulfil a key role in conservation and provide an important path for sustainable development.

While medicinal plants are broadly used in healthcare, there has been strong global action to provide healthcare services based on modern medicine through the commitment to universal health coverage by all member countries of the World Health Organization (WHO 2013). Medical pluralism has been prevalent, yet the integration between traditional, indigenous or local and modern medicine is not free from problems (Janes 1999). Also, while medicinal plants still play an important role in primary healthcare in some areas (Estomba et al. 2006, Kitula 2007, Lozada et al. 2006, Milliken and Albert 1997), conversely, the reliance on modern medicine increases in other areas (Caniago and Siebert 1998, Vandebroek and Balick, 2012). Janes (1999) and Wayland (2004) state that social and cultural values attached to each medicine by its users influence the choice of medicine type.

Medicinal plants can be also a source of income in developing countries. In Indonesia, medicinal plants support livelihood through market niches (Torri 2012). In other developing countries, the commercialization of medicinal plants is a source of local livelihood (Hersch-Martínez

1995, Rawal 1995, Shanley and Luz 2003, Williams et al. 2000, Vodouhé et al. 2008). In the last two decades, Non-Wood Forest Products (NWFPs), of which medicinal plant is a type, have provided great hope for poverty alleviation of rural people living in the forest. However, the rich literature on NWFPs does not necessary support this hope. For example, the effectiveness of NWFPs could be determined by a landscape, location, land use system (Wiersum 1997, 1999, 2004, Ros-Tonen and Wiersum 2003, Chilalo and Wiersum 2011) or the type of relationship between people and forest (Wiersum 1997, Byron and Arnold 1999). While NWFPs could function as livelihood safety-nets (Shackleton and Shackleton, 2004) they could also increase inequity (Kusters et al. 2006). How NWFPs support livelihood is not yet known because the factors and the extent to which people depend on the forest are not yet understood (Lawrence et al. 2005).

The commercialization of medicinal plants, which could be a source of income, may lead to over-harvesting (Chowdhury and Koike 2010, Kala et al. 2004, Kala 2005, Hersch-Martínez 1995, van Andel and Havinga 2008, Vodouhe et al. 2008). There is growing concern about biodiversity and loss of medicinal plant species, of which 8% are under threat worldwide (Walter and Gillett, 1998). Together with less rainfall, deforestation, land use change, monoculture and other factors (Ramakrishnappa 2002, Shanley and Luz 2003), loss is also compounded by non-sustainable harvesting to meet the demand of the regional and international market (Schippmann et al. 2002).

The loss of medicinal plant knowledge caused by modernization and globalization in developing countries is another concern (Benz et al. 2000, Case et al. 2005, Quinlan and Quinlan 2007, Merétika et al. 2010, Srithi et al. 2009, Voeks 2007, Voeks and Leony 2004). The reliance on a modern healthcare service also contributes to knowledge loss of medicinal plants (Caniago and Siebert 1998, Vandebroek and Balick 2012). Among these studies, Merétika et al. (2010) focus on urbanization as one of the factors for the decrease in plant use and knowledge. Considering economic development and the penetration of urban agglomeration to remote rural and forest areas in developing countries, the degree of urbanization can be assumed to be a factor in modernization as well as an indicator of healthcare service provision, and thus of the role of medicinal plants in health and livelihood. However, among many studies on changes in use and knowledge of medicinal plants, only a few consider the influence of the level of urbanization in rural and forest areas. Studies regarding urbanization in developing countries have concentrated on the rapid agglomeration of metropolitan or secondary cities.

This overshadows other agglomeration strata (Bolay and Rabinovich 2004). Among few studies, Padoch et al. (2008) reveal the unique patterns of consumption and knowledge affecting urban markets yet having rural preferences during the course of rural-urban migration within the Brazilian and Peruvian Amazon. Therefore, it might be useful to take the degree of urbanization into consideration while examining medicinal plant utilization and its effects on biodiversity in the surrounding forest in developing countries, especially in the Amazon region.

The objective of the study is to pursue local people's usage of medicinal plants for healthcare, rather than to obtain ethnobotanical data, taking into account the presence of modern medicine and the level of population agglomeration. This will determine if it can be utilized for forest biodiversity management and provide the commercial potential for improving local livelihood as expected by international societies. Specifically, the study is, first, to determine if medicinal plants are still used in areas where modern medicine is provided; second, to pursue the idea of whether the medicinal plant as a NWFP improves the livelihood of people in a rural forest area; and third to examine if the utilization of medicinal plants for health and commercialization damages biodiversity in the given rural forest area.

STUDY SITE AND METHODOLOGY

Site selection

Contamana, the capital of Ucayali province, the southern frontier of Loreto state, located in the central Peruvian Amazon, was chosen because it is functionally a second-tier city representing the second stratum of population agglomeration. The city with a population of over 20,000 is one of two second-tier-cities situated between two largest cities of the Peruvian Amazon; Iquitos, the state capital of Loreto with population of 440,000, and Pucallpa, the state capital of Ucayali of 200,000; on the Ucayali River, one of the main upper tributaries of the Amazon. The distance from Contamana is 440 km (840 km by river) to Iquitos, and 134 km (285 km by river) to Pucallpa (Figure 1). The preliminary studies in villages around the greater Iquitos area found that while typical livelihood based on agriculture and fishery is very similar to that of the target villages in this study, visiting Iquitos for accessing large markets, pharmacies and healthcare facilities is part of their life and there is a tendency for dependence on modern medicine. The extent to which the situation is different in the villages around the second-tier city from the major city is the focus of this study.
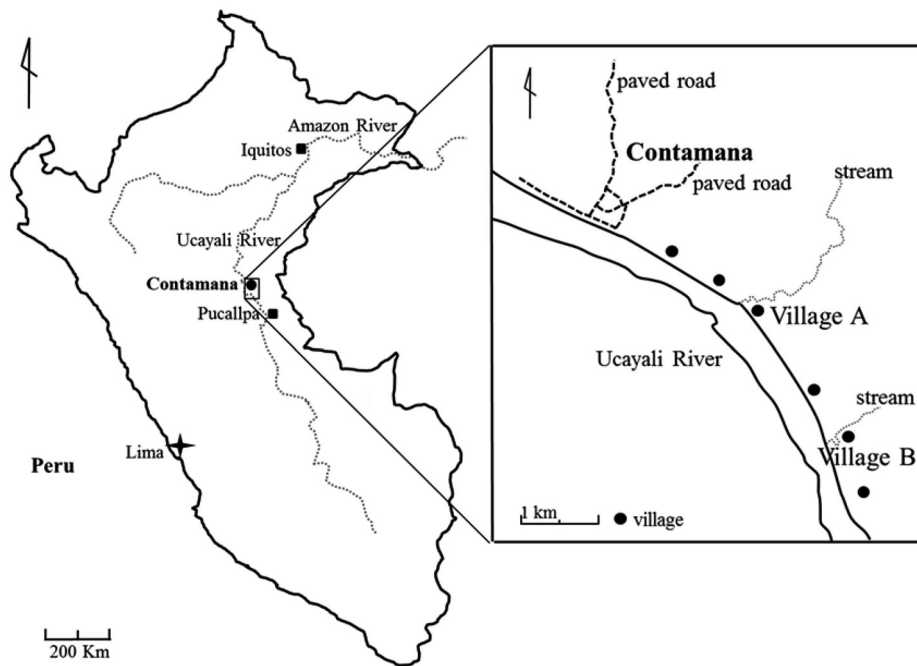
Fig. 1. Study sites in the central Peruvian Amazon.

Site background

The forests surrounding the city of Contamana, part of the richest biodiversity in the world (Gentry 1988, Pyhälä et al. 2006), are tropical moist forest and fall under flooded alluvial forest, which was developed on a flat or depressed land adjacent to the course of a large river, formed by recent accumulation of materials and has drainage problems. (Kometter 2004). Although the typical dominant species in this type of forest are Aguaje (*Mauritia* sp.), Caimitillo (*Pouteria* sp.), Machimango (*Eschweilera* sp.), Shimbillo (*Inga* sp.), etc., the area has different types of vegetation comprised of agricultural intervention, cultivated grasses, secondary forest in different stages of growth and primary forest. The area is zoned as Permanent Production Forest (Kometter 2004), which is one of four forest zonings defined by Law 29763 (GOP 2011) and designated for use of forest resources including timber and non-timber products.

Contamana is only accessed by boat along the Ucayali River from Iquitos and Pucallpa or by small planes. There is no road access to the city from the major cities. Although the roads in the city center are paved and extend several blocks, automobiles are rare; mostly motorcycles and three wheelers, called *moto-carro* are utilized within the city. Construction of a paved road to a hot spring located 29 km from the city was completed in 2014 therefore a few tourism vans run more frequently. There are three markets,

many shops including several pharmacies and several hotels in the city. The Ucayali River plays an important role in transportation and connects the city and villages. Most people in surrounding villages not having terrestrial access to the city are engaged in agriculture and fishery. The majority of agricultural products and fish are delivered and sold in Contamana. In addition to nearby villagers, other people travel 5 or 6 hours to reach the city in order to access the market. The city serves as a significant market center and supports livelihoods and thus the cash income, of people living in villages located in areas remote from the major cities.

A state-provided-hospital is situated in the city and has responsibility for 14 health posts throughout the district covering all the people in Contamana district, one of three district of Ucayali province. According to the statistic from the state of Loreto (Dirección de Epidemiología 2011), cold, fever suspected to be Malaria, urinary tract infection, ascariasis, sore throat, tonsillitis, hypoferric anemia, fever, bronchitis and pulmonary phthisis are the symptoms and diseases most frequently affecting all ages. For people 60 years old and above, hypertension is the most frequent ailment.

Target Villages

Two native communities of *Shipibo* near the city of Contamana, Village A and B were selected because they are

the two largest native communities having differing conditions of distance to the city and accessibility to modern medicine, located south of the city along the Ucayali River (Figure 1). The *Shipibo* is one of the Amazonian indigenous ethnic groups dispersed mainly in Peru along the Ucayali River and partially living in Bolivian and Brazilian territory. They are the dominant ethnic group in the central Peruvian Amazon. The *Shipibo* people around the study area are generally engaged in slash-and-burn cultivation and fishing and limited hunting if they do not possess another job in the city. They traditionally use a variety of plants, many of which are vines or still unknown scientifically (Tournon et al. 2014). Village A and B are registered and titled as a native community under Law 22175 (GOP 1978), which allows free use and dispose of its registered communal territory.

Village A having 1,155 ha and 132 households is located 9 km south of Contamana and it takes about 25 minutes by boat from the city to get there. A distribution system of filtered water from the river is in place but does not function. People use water from a communal well or river water. Electricity is provided. There is a health post staffed by a nurse and a technician. The health post is responsible for the care of 10 other villages in the area including Village B. There is a kindergarten, a primary and secondary school in Village A. In Village B comprising 1,230 ha, 39 households were resident during the survey period. It is located 18 km south of Contamana and it takes about 50 minutes by boat. There is a water distribution system, yet, people often use water from the river. The village has electricity. There is no medical facility in the village and people go to Village A or to the city for medical treatment. The village has a kindergarten and a primary school. In this area including both villages, automobiles and motorcycles are not used. Boat is the sole means of transportation to access the city and most of the nearby villages. The hospital and pharmacies that the villagers visit are located in the city. The major differences in the two villages are the size of community, distance to the city of Contamana, and the presence of a health post (Table 1).

Data collection

Data collection was undertaken after obtaining permission from the head of each village. Information regarding use and practice of medicinal plants and location of the plants extracted was obtained through structured interviews after obtaining signed informed consent following verbal and written explanation of the study. The sample was selected based on household. In Village A, due to the size of the community, 50 households out of 132 were selected

Table 1. Distance to Contamana and medical clinic, and number of educational facility and household in Village A and B

Profile of villages surveyed	Village A	Village B
Distance to Contamana（km）	9	18
Time taken by boat（minute）	25	50
Distance to medical clinic（km）	0	9
Time taken by boat（minute）	0	25
Number of primary school	1	1
Number of secondary school	1	0
Number of household lived during the survey	132	39

through random sampling, and the household head was interviewed in July 2013. However, only 42 household heads were contacted due to absences during the interview times. In Village B, all 39 households were visited and either the household head or his wife was interviewed in July 2014. The interviews were held based on household. However, while the interviews in Village A were held when household heads were at home accompanied by their wives in most cases, the interviews in Village B were held even when household head (male in most cases) were not present (Table 2). The questions included name, type, location of extraction, part and purpose of top medicinal plants used most frequently for self and family. Purchase and sales of medicinal plants, use of other types of healthcare including modern medicine and medicaments, perception towards healthcare alternatives and basic demographic information were also determined.

In addition to the interview in the villages, discussions with a nurse in the health post located in Village A and the director of hospital in Contamana were undertaken to obtain general information regarding medical service provision. The observation at markets in the city was also conducted in order to determine the commercial activity of medicinal plants.

Data analysis

Information obtained was analyzed through simple quantitative methods and interpreted qualitatively. The degree of urbanization for the study has been determined through the study site selection. Also, the different conditions of Village A and B; distance to the urbanized city and accessibility to modern medicine made it possible to compare the two villages. In order to make the comparison, differences in gender and age distribution of two data sets from Village A and B were examined first, using chi-square tests ($p < 0.05$). The impact of medicinal plant utilization on

Table 2. Period of interview, number of respondents, and their average age in Village A and B

Profile of respondents	Village A	Village B
Interview conducted	July-Aug 2013	Jul-14
Total number of respondents (average age)	42 (46.6)	39 (38.1)
Number of male respondents (average age)	42 (46.6)	21 (38.7)
Number of female respondents (average age)	0 (na)	18 (37.4)

na: not applicable

biodiversity is assessed through the type, place of extraction and frequency of plant used, and on livelihood through frequency and value of commercial activities. The local name of plants were obtained and for reference purposes, scientific names were added based on local references provided by Mejia and Rengifo (1995) and IIAP (2010). To determine the impact on healthcare, the frequency of medicinal plant use and alternative healthcare activities including visits to medical facilities and traditional healer namely shaman and purchase of medicine as well as the perception of healthcare means are assessed. The information obtained through discussions with a nurse in the health post and a hospital director as well as observation in the market was used as supplemental information in the data analysis.

RESULTS

Examination of data sets

In order to compare the results between Village A and Village B, first, frequency of medicinal plant use and plant part utilization between male and female respondents in Village B was examined. The two groups were found not significantly different (chi-square test, p＞0.05). Thus, hereafter, the analyses treated all respondents without considering gender differences, and the results of two villages were compared. Second, age distribution of respondents from both villages was examined. The age distribution between the two was found not significantly diverse (chi-square test, p＞0.05).

Utilization of medicinal plants as an assessment of influence on biodiversity

Frequency of medicinal plant use

Questions regarding the top five most frequently used medicinal plants by each respondent and his/her family, which were not purchased or sold, were presented in order to identify the extent to which forest resources are used and
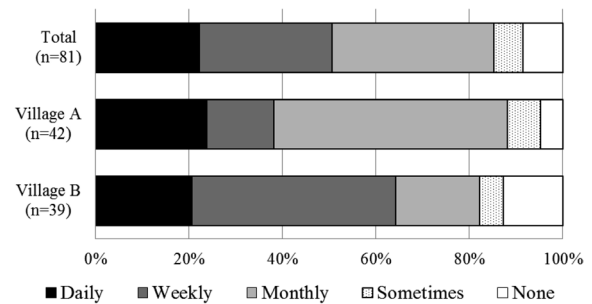

Fig. 2. Frequency of medicinal plant use

the general utilization of plants for healthcare purposes. Among the total of 81 respondents, 74 used medicinal plants for healthcare in the previous year and 7 did not. Those who use medicinal plants daily (daily user) comprise 18 (22.2%) of the total respondents; once a week or more but not daily (weekly user) are 23 (28.4%); once a month or more but less than once a week (monthly user) are 28 (34.6%); and less than once a month are 5 (6.2%). In each village, daily users total 23.8% in village A and 20.5% in Village B; weekly users, 14.3% and 43.6%; monthly users, 50.0% and 17.9% respectively. If daily users and weekly users are assumed to be frequent users, the breakdown for village A is 38.1% and 64.1% for Village B, respectively. In Village A, 50.0% are monthly users compared to 17.9% in Village B. Those who use medicinal plants once a month or more total 88.1% in Village A and 82.1% in Village B (Fig. 2).

Species and type of plants used

The type of plants used and extraction location was identified to determine the extent of forest resource utilization. Sixty five species of medicinal plants were cited by 74 users. The total counts for each species within their top five lists were 305. The most frequently cited plant was Piñón Colorado (*Jatropha gossypifolia*), a shrub, with 61 counts representing 20.0% overall; the second was Malva (*Malachra alceifolia*), a herb with 42 counts or 13.8%. These top two representing 33.8% of the count are mostly planted around houses (Table 3). Sangre de grado (*Croton lechileri*) taking third place, of which only the resin is used, can be

found in the forest but people tend to plant it for their use. Among the top 10 cited plants, parts extracted from the forest are the roots and bark of Chuchuhuasi (*Maytenus macrocarpa*), representing 4.6% of the total utilization and the bark of Uña de Gato (*Uncaria tomentosa*) representing 3.3%. Seven respondents possibly use Chuchuhuasi a few times a week. Four use Uña de Gato a few times a week. Ubos (*Spondias mombin*), whose bark is used, can be found wild, but is planted near houses. The top two species are the same in both villages; in Village A and B, Piñón Colorado comprises 17.7% and 22.4% and Malva, 8.9%, 19.0%, respectively; followed by Chuchuhuasi, 8.2%, Uña de Gato, 5.7%, and Sangre de Grado, 5.1% in Village A and Sangre de Grado, 6.8%, Piripiri, 4.8% and Piñón Blanco 4.8% in Village B (Table 4). The top two species comprises 42.7% in Village B and 26.6% in Village A.

Plant parts utilization

The respondents were asked about all of the plant part use in order to assess possible damage caused by plant extraction or utilization. The total was 346, of which 53.7% comprised leaf; 17.4%, resin; 13.6% bark; 7.8% root; 4.3%, fruit; and 3.2% others (Table 5). Ten out of 27 root counts were derived from tree representing 2.9% of the total. For these, 4 species are utilized; Chuchuhuasi with 7 counts, and Icoja (*Unonopsis floribunda*), Huasai (*Euterpe olera-*

Table 3. Top ten species of the top five most frequently used medicinal plants by eah respondent in Village A and B combined (n = 305*)

Local name	Scientific name	Life form	Habitat	Wild/Planted /Cultivated	Part used	Count	%
Piñón colorado	*Jatropha gossypifolia*	S	NH	cultivated	Rs/L	61	20.0
Malva	*Malachra alceifolia*	H	NH	cultivated	L	42	13.8
Sanger de grado	*Croton lechileri*	T	NH/F	planted/wild	Rs	18	6.0
Chuchuhuasi	*Maytenus macrocarpa*	T	F	wild	Rt/B	14	4.6
Ajo sacha	*Mansoa alliacea*	V	NH	cultivated	L	12	3.9
Piñón blanco	*Jathropa curcas*	S	NH	cultivated	L/Rs	11	3.6
Uña de gato	*Uncaria tomentosa*	V	F	wild	B	10	3.3
Piripiri	*Eleutherine bulbosa*	H	NH	wild/cultivated	L/Rt	10	3.3
Ubos	*Spondias mombin*	T	NH/F	planted/wild	B	9	3.0
Llantén	*Plantago major*	H	NH	wild/cultivated	L	5	1.6
Top ten sub-total						192	63.0
Others						113	37.0
Total						305	100

*Some respondents did not list up five plants. Life form∶ H = herb, S = shurb, T = tree, V = vine. Part used∶ B = bark, L = leaf, Rs = resin, Rt = root. Habitat∶ F = forest, NH = near house.

Table 4. The top five most frequently used medicinal plants of Village A and B

al name	Village A (n = 158)			Village B (n = 147)		
	Rank	Counts	%	Rank	Counts	%
Piñón colorado	1	28	17.7	1	33	22.4
Malva	2	14	8.9	2	28	19.0
Sanger de grado	5	8	5.1	3	10	6.8
Chuchuhuasi	3	13	8.2	＞5		
Piñón blanco	＞5			4	7	4.8
Uña de gato	4	9	5.7	＞5		
Piripiri	＞5			4	7	4.8
Top five sub total		72	45.6		85	57.8
Others		86	54.4		62	42.2
Total		158	100.0		147	100.0

cea) and Ubos with 1. Only Ubos can be planted and the others are extracted from the forest. Twenty six out of 47 bark counts were derived from tree representing 7.2% of the total. Among these, Chuchuhuasi accounts for 11 thus 42.3%; and Icoja for 3, or 11.5%. In Village A, the most frequently used parts are leaf comprising 39.8%, bark, 21.5%, resin, 18.8%, root 10.8%, and others. In Village B, leaf comprises 70.0%, resin 15.6%, bark and root 4.4%, and fruit, 3.7% and others (Fig. 3). Leaves used in Village B are from shrubs and herbs (Table 6) which are usually cultivated.
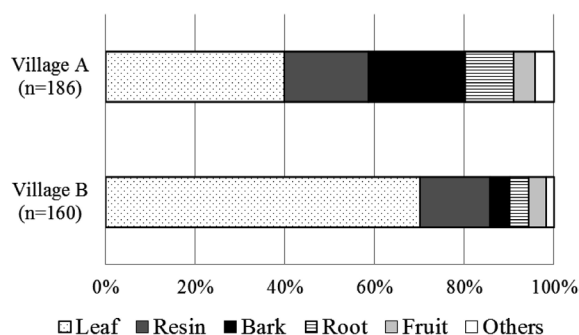

Fig. 3. Plant parts used in Village A and B

Alternative healthcare methods and perceptions

Use of modern medicine

Visiting the health post and purchasing medicaments represented modern medicine usage. Two out of 42 respondents in Village A and 3 out of 39 respondents in Village B had not visited medical facilities during the previous year. Respondents who visited medical facilities themselves or on behalf of family twice a month or more (bi-weekly) and once a month or more and less than twice a month (monthly) comprised 17 which is 40.5% of the total and 19 or 45.2% in Village A. However, in Village B, 3 respondents visited bi-weekly representing 7.7% and 5 respondents visited monthly (Fig. 4). Fever was the most frequent cause of visiting the health post in both villages, followed by aching pain and diarrhea in Village A and followed by headache and diarrhea in Village B. In regard to medicaments, in Village A, 39 out of 42 respondents went to pharmacies in the city of Contamana to purchase medicaments and 17 respondents purchased medicaments monthly. In Village B, 32 out of 39 respondents purchased medicaments in the city and only 2 purchased these monthly. The main reasons for purchasing medicaments in pharmacies were either a lack of medicaments in the health post or the stronger medicaments sold by pharmacies.

Table 5. Plant parts used in Village A and B combined

parts	Counts	%	Tree (%)	Shrub (%)	Vine (%)	Herb (%)	Others (%)
Leaf	186	53.7	2.9	21.1	2.9	25.4	1.4
Resin	60	17.4	9.0	7.8	0.3	0.3	0.0
Bark	47	13.6	7.2	0.3	4.9	0.0	1.2
Root	27	7.8	2.9	1.4	0.3	2.6	0.6
Fruit	15	4.3	3.2	0.6	0.0	0.3	0.3
Others	11	3.2	2.3	0.0	0.0	0.9	0.0
total	346	100.0	27.5	31.2	8.4	29.5	3.5

Table 6. Plant parts used in Village A and B (%)

Parts	Tree		Shrub		Vine		Herb		Others	
Village	A	B	A	B	A	B	A	B	A	B
Leaf	4.3	1.3	17.7	25.0	3.8	1.9	11.3	41.9	2.7	0.0
Resin	9.7	8.1	8.1	7.5	0.5	0.0	0.6	0.0	0.0	0.0
Bark	11.3	2.5	0.6	0.0	7.6	1.9	0.0	0.0	2.2	0.0
Root	4.8	0.6	1.1	1.9	0.5	0.0	3.2	1.9	1.1	0.0
Fruit	3.2	3.1	0.5	0.6	0.0	0.0	0.5	0.0	0.5	0.0
Others	2.7	1.9	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0
Total	36.0	17.5	28.0	35.0	12.4	3.8	17.2	43.8	6.5	0.0
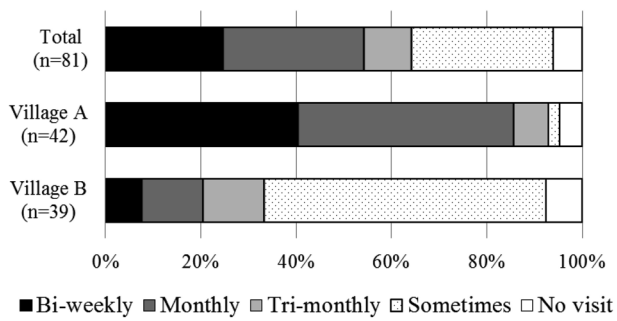
Fig. 4. Frequency of visit to medical facilities

Table 7. Medicinal plant purchase and sales

Activities	Village A n = 42	Village B n = 39
Purchase (remedy) only	14	9
Purchase and sales (remedy)	1	0
Sales (remedy) only	6	3
Sales (plant and remedy) only	0	1
No trade of medicinal plants	21	26
Total	42	39

Use of local medicine in addition to medicinal plants

Another use of local or traditional medicine besides medicinal plants was visiting a shaman. In Village A, 47.6% of respondents had visited a shaman in the previous year as opposed to 46.2% in Village B. Only two respondents in Village B had visited a shaman more than once in three months. The purpose of their visit was mostly for luck or removing evil except for a few respondents who did so because of severe illness or uncured disease. The purposes of medicinal plant use varied widely. Fever, headache, cough, stomach or digestive problems and diarrhea were frequent reasons given by many respondents from both villages.

Perception of healthcare methods

In Village A, 81% of respondents believed that medicinal plants were more efficacious than medicaments compared to 62% in Village B. Ninety three percent in Village A and 85% in Village B wished to know more about medicinal plant knowledge. An additional question in Village B sought to determine if problems occurred through not being able to use medicinal plants. Forty seven percent replied in the negative and of which 50% indicated this was because medicaments and medical facilities are available.

Commercialization of medicinal plants and livelihood

Sales and purchasing activities of medicinal plants in the previous year were determined (Table 7). In Village A, 15 out of 42 respondents purchased medicinal plant remedies (plants soaked in alcohol) in the previous year and only 2 respondents purchased from someone in the village. Others purchased from the market in Contamana except for 1 respondent who purchased from Lima, the capital of Peru. There are four frequent purchasers and one of these purchased twice a month for hernia; 2 respondents, once a month for rheumatism; and 1 person, once every two

months for an internal disorder. Others purchased only once. In Village B, 9 out of 39 respondents purchased medicinal plant remedies and only 3 purchased 3 times a year and others only once. They all purchased them at the market in the city. In Village A, 7 people sold prepared medicinal plant remedies and 1 person whose livelihood is medicinal plant sales sold in the community, but all others sold at the market in the city as their side business. In Village B, 3 respondents sold remedies and 1 sold plants on request from outside the village. The income of these 3 people from remedies accounts for half of their annual income as the remedies were specifically ordered by a foreigner who uses them for shamanic ceremonies for tourism.

DISCUSSION

Impact of medicinal plant utilization on biodiversity and livelihood

General usage and types and medicinal plant parts used as well as a few commercial activities indicate that use of medicinal plants does not adversely affect forest resources and biodiversity. In terms of domestic use, only half the people in both villages are frequent users (daily and weekly) of medicinal plants for healthcare. This result disagrees with some studies in Amazonia showing people's active use of forest medicinal plants (Phillips and Gentry 1993a, 1993b, Milliken and Albert 1996, 1997, Shanley and Luz 2003, Valadeau et al. 2010). Another study suggests that an indigenous people in Bolivian Amazonia do not necessarily highly utilize medicinal plants in the forest (Vandebroek, et al. 2004). However, as *Shipibo* historically utilizes medicinal plants (Tournon et al. 2014) mentioned earlier, the result indicates the possibility that less utilization of forest plants is influenced by modernization as suggested in some studies (Benz et al. 2000, Case et al. 2005, Meréttika et al. 2010). Also, people mainly use cultivated plants such as Piñón Colorado and Malva. In addition, tree roots comprise 2.9%

of the total and bark, 7.2%, which may damage plants in the forest are used in a limited way. The few trees whose bark is utilized are cultivated not wild. Moreover, none of the frequently used medicinal plants identified in this study are listed in IUCN Red List (IUCN 2015).

In terms of purchase and sales of medicinal plants, only four people are frequent purchasers within both villages. This indicates that the commercial potential is not expected or exploited within the village. The precise number of medicinal plant venders in the markets of Contamana was not determined, however, only a few medicinal plant venders in the markets were observed. This also indicates that medicinal plant markets have not been developed in and around the second-tier-city of Contamana. This condition is different from larger cities in Amazonia where the demand for medicinal plants is high and many vendors are in business (Galy et al. 2000, Shanley and Luz 2003). While access to the market is well understood as a key factor that NTFPs play in people's livelihood (Ros-Tonnen and Wiersum 2003), access to the forest is also another factor (Timko et al. 2010). In this case, potential buyers in the city also have access to nature, if not necessarily the forest, where medicinal plants are obtained. As medicinal plants are available for people in close proximity to the villages and the city, it is likely that the market is difficult to establish in Contamana. Only one person occasionally goes to Pucallpa, the second largest city in the Peruvian Amazon, to sell medicinal plants in the markets. Moreover, none of the people living in Village A or B is engaged in selling plants to larger markets on a national or global scale. This is supported by a previous study in Ethiopia showing that rural households do not have direct links to larger cities or markets (Dercon and Hoddinott, 2005).

Considering the area has the richest biodiversity in the world (Gentry 1988, Pyhälä et al. 2006), there is a possibility that medicinal plants found in the area could be subject to a national or global demand. When medicinal plants are demanded not locally but nationally and globally, it would bring benefits to the locals, but may cause overharvesting (Schippmann et al. 2002, Hamilton 2004, Kala 2005, Kathe 2006). In the Peruvian Amazon, Uña de Gato (*Uncaria tomentosa* and *Uncaria guianensis*) mostly extracted from the forest is one of few medicinal plants globally famous and in demand. There is a possibility of overharvesting along with the increase in global demand. While the species are not yet found threatened and planting is also possible (de Jong et al. 1999), Bussmann et al. (2007), in their surveys at medicinal plant markets at the cities in the northern coast of Peru, reported a lack of Uña de Gato expressed by collectors and unsustainability of the plant.

In the study sites, while utilization of medicinal plants would not cause over-harvesting in the forest, the plants offer little opportunity to support the livelihood of people in the villages.

Impact of healthcare and alternative care on medicinal plant utilization

While medicinal plants are continuously used in both villages, reliance on modern medicine seems to be emerging. However, the impact of alternative healthcare on medicinal plant utilization is still not clear. Frequent users (daily and weekly) of medicinal plants comprise half of the total respondents. If the monthly user is included, 85.2% use medicinal plants for some type of healthcare. Although reason for use varies, this indicates at least half of the people, to a certain extent, rely on medicinal plants for healthcare or self-care. At the same time, in Village A, 95.7% of respondents visit medical facilities once a month or more, as opposed to 20.5% from Village B. It is safe to assume that the difference between the villages is due to the distance from the health post as physical distance is one of factors to define access to healthcare services (Peters et al. 2008, Savedoff 2009). There is a health post in Village A, yet people in Village B need to travel 25 minutes to visit the health post. Moreover, they need to arrange a boat for transportation. This may or may not reflect in the differences for medicinal plants usage between the two villages. While the percentage of daily users of medicinal plants are slightly more than 20% and not so different between Village A and B, frequent users including weekly users are 38.1% in Village A and 64.1% in Village B. The difference can be explained by the distance to the health post. The result accords with previous studies concerning the presence of healthcare service and medicinal plant use (Benz et al. 2000, Case et al. 2005, Monteiro et al. 2006, Merétika et al. 2010). However, the percentage of once a month or more users is 88.1% and 82.0% in Village A and B respectively and requires further explanation.

Interestingly, 70.0% of use is from leaves and 4.4% each for bark and root in Village B, while 39.8% is leaves, bark, 21.5% and root 10.8% in Village A. Moreover, the usage of the top two species whose leaves are mainly used is highly concentrated in Village B at 41.4% compared to 26.6% in Village A. This indicates that respondents in Village A use more varieties of medicinal plants than those in Village B and is inconsistent with previous studies that suggest urbanization and the presence of healthcare service erodes the knowledge of medicinal plant use (Benz et al.

2000, Case et al. 2005, Monteiro et al. 2006, Merétika et al. 2010). While people in Village B are located further from healthcare facilities and the city, and use medicinal plants more frequently and visit the health post less frequently than those in Village A, they use less variety of medicinal plants, indicating that medicinal plants knowledge is possibly more eroded than the other village. The conflicting results are worth investigating further.

The majority believes in the efficacy of medicinal plants over medicaments and people wish to learn more about it in both villages. Brierley et al. (2014) reports a different result obtained from different indigenous group in the northern part of the Loreto State where 30.2% of people believed that traditional medicine is better than modern medicine. This conflicting result can be the difference between medicinal plant and traditional medicine signified by visiting healers. About half of the people in Village B think that it is no problem not being able to use medicinal plants, regardless of whether their access to the medical facilities and pharmacies are not as frequent. This can indicate that even if accessibility to medical facilities is limited and there is belief in medicinal plants, a certain reliance on modern medicine is emerging. This is explained by the study by Case et al. (2005) stating that modernization and acculturation is the cause of emerging replacement of medicinal plants usage with modern medicine even if the access is limited. Finally, the majority of people go to the city and purchase medicaments, albeit infrequently. However, as the medical facilities provide or sell medicaments depending on insurance subscription, detailed purchasing behavior needs to be examined further.

Although the impact of alternative healthcare on medicinal plant use is subject to further investigation, the study results reflect the ambivalent healthcare behaviors of people living on the outskirt of the second-tier city.

Distance to the urbanized city and modern facilities

The distance to the healthcare facilities affects the frequency of visit to the facilities, and, it is safe to say, the use of medicinal plants. The distance to the city also influences the different frequency in purchase of medicaments in the city between the two villages. The same assumption applies to the different frequency between the two villages of the purchase and sales of medicinal plant remedies. An interesting result obtained was the conflicting results between frequency and variety of medicinal plants use in relation to the distance to urbanization and the access to modern medicine with previous studies (Benz et al. 2000; Case et al. 2005;

Monteiro et al. 2006, Merétika et al. 2010). Further investigation is required.

CONCLUSION AND LIMITATIONS

The study indicates that the global expectation for medicinal plants in terms of improving livelihood and healthcare is not necessarily applicable as a future direction in the study area. Unlike the areas surrounding the large cities, areas around a second tier city do not have the conditions to commercialize medicinal plants to support livelihood. Although medicinal plants still support the healthcare of local people, reliance on modern medicine is observed. While the local utilization of medicinal plants does not lead to deterioration in forest resources, the expectation for medicinal plant use as a driver for biodiversity management is not applicable here despite global expectations. As a primary attempt to focus on the second level of urbanization in a rural setting, this study suggests important points for consideration. Firstly, the market for certain products cannot be developed easily in small rural urbanized areas due to resource availability for people in the villages as well as the city. Also, remoteness in respect to the larger cities limits market penetration so the products cannot be commercialized. Second, in terms of healthcare, improvement of modern medicine is a government policy and medicinal plants are expected to support and complement this, especially in remote and rural areas. However, public expectation is moving in the opposite direction.

Finally, this study has limitations and thus suggests potential for future research. First, this study is the first attempt to feature the condition of areas around a second tier city in the Peruvian Amazon focusing on medicinal plants and current usage of medicinal plants. Other factors that determine medicinal plant use, such as socio-economic factors, could be examined, though extensive ethnobotanical studies have not brought consistent results. Even though it is obvious that such factors influence utilization, this study attempted to highlight small scale population agglomeration. Consideration of multiple factors within a larger focus will be the next step. Second, comparison of the conditions between larger and smaller cities has not yet been undertaken. As the study shows certain conditions are not present in larger cities therefore comparative studies would be beneficial. Lastly, there are more remote villages in the study area which sell medicinal plants to the national and global market. A study of these villages would provide further insights for medicinal plants utilization in areas around second tier cities in the Peruvian Amazon.

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