ISSN 2189-9126

国際開発研究フォーラム
FORUM OF INTERNATIONAL DEVELOPMENT STUDIES

研究論文
ARTICLE

Uncovering the Hidden Value of Non-timber Forest Products from a Poverty Alleviation Perspective: Evidence from Phnom Prich Wildlife Sanctuary, Cambodia

Phanith CHOU

48-8
名古屋大学大学院国際開発研究科
GRADUATE SCHOOL OF INTERNATIONAL DEVELOPMENT
NAGOYA UNIVERSITY

Forum of International Development Studies. 48–8 (Mar. 2018)

Uncovering the Hidden Value of Non-timber Forest Products from a Poverty Alleviation Perspective: Evidence from Phnom Prich Wildlife Sanctuary, Cambodia

Phanith CHOU*

Abstract

As long as assessed by conventional methods, part of the economic value of non-timber forest products (NTFPs) could be missed, with the result that policymakers would regard forests as being less important. This study clarifies the hidden economic value of NTFPs from the viewpoint of poverty alleviation based on three research questions, as follows: how much hidden economic value do NTFPs have?; does the value of NTFPs contribute to rural poverty alleviation?; and how important are NTFPs for responding to household vulnerability to poverty? Fieldwork was conducted in September 2015, March and April 2016 in Phnom Prich Wildlife Sanctuary using participatory rural appraisals and structured questionnaire interviews with randomly selected 310 households. This study found that the combined value of subsistence use and cash income of NTFPs were US$768, US$296, US$767, US$126, US$180, US$28, US$98, and US$343 per household per year for liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood, respectively. NTFPs prevent households which collected NTFPs from falling into poverty. NTFPs also play the vital role of responding to the potential future vulnerability to poverty of some households.

Keywords: Hidden Value of NTFP, Poverty Alleviation, Phnom Prich Wildlife Sanctuary, Cambodia

1. Introduction

Cambodia has the largest area of pristine tropical forest in mainland Southeast Asia, but its widespread destruction in recent decades has been seen very obvious (Cock, 2016: 1–7). There are many forest management policies and interventions in Cambodia, such as national policy and strategic plans for green growth 2013–2030, the Forestry Law of 2002, amended in 2006 and re-amended in 2010, the National Forest Program 2010–2029, the Protected Area Law (2008), the National Biodiversity Strategy and Action Plan (2002), and the Law on Environmental Protection and Natural Resources (2001).

There are questions about why the goals of Cambodia's forestry reforms were not yet achieved,

*Doctoral Student, Graduate School of International Development, Nagoya University. The author would like to thank Professor USAMI Koichi and two anonymous referees for their helpful guidance and comments.

and despite its high level, why foreign aid from international agencies has little succeeded in reducing deforestation and improving rural livelihoods. This study suspects that policymakers value the forest in the wrong way. Valuation of Cambodia tropical forest for management and development plans has been traditionally based on a financial appraisal of its timber stock or/and conversion for plantation (Cock, 2016: 1–7). This kind of valuing has resulted in the degradation of Cambodia's forests and other economic forms. A recent analysis of global deforestation rates showed that Cambodia has one of the highest national rates in the world, with forest cover loss being over 7% for a decade from 2002–2012 (Milne and Mahanty, 2015: 3). Deforestation in Cambodia negatively affects about 84% of rural people who are heavily dependent on forest resources, especially on non-timber forest products (NTFPs) for domestic consumption and complementary cash income (MoE, 2011).

In rural Cambodia's economy, the role of NTFPs in the livelihood of millions of people has mostly been overlooked by country's ruling elites and forest management planners. Many NTFPs were traded locally and served for subsistence purposes such as food, medicine, construction, and agricultural materials for rural Cambodians (Tola et al., 2010: 32), but their values are less appreciated.

In the general context, with the political economy of forest resources changing around the world, uncovering the hidden value of NTFPs has been debated in the valuation of tropical forests (Mahapatraa and Tewari, 2005: 456). Firstly, Peters et al. (1989: 656) found that the value of NTFPs was ten times greater than timber logged and two times higher than land use conversion in the Amazonian rainforest. However, some studies criticized these findings, as Neumann and Hirsch (2000) assumed that NTFPs are just minor forest products that contribute less to household income and national economy. Other studies found optimistic results about NTFPs' value (Heubach et al., 2011). The value of NTFPs is mostly hidden in subsistence use because local people consume them in different patterns, so those benefits need to be uncovered by the combined value of subsistence use and sale of NTFPs (De Beer and McDermott, 1996: 22). In addition, there is a claim that NTFPs are important for not only combating poverty but also reducing vulnerability to poverty (Paumgarten and Shackleton, 2011: 128), but empirical evidence of these roles remains inadequate.

Furthermore, the International Institute for Environment and Development (IIED, 1995: 14) defined hidden values as wild resources which are collected and consumed directly without passing through markets and/or have generally been ignored by government decision-makers and international development agencies. This institution warned about the danger of ignoring the hidden values of NTFPs, because of which policymakers will treat forests as being unimportant, and allow them to be replaced with other uses. This will incur losses at both local and national levels. Valuing NTFPs helps communities realize incentives to sustainable use and management of NTFPs (De Beer and McDermott, 1996). Assessing economic value of NTFPs lets policymakers recognize how much they should compensate if NTFPs are substituted by other intensive production systems.

To date, a complete valuation of direct use of NTFPs which takes into account both marketed

and subsistence benefits has not been well documented, so this study contributes the calculation techniques on how to use replacement prices to assess subsistence use value. Moreover, most of the literature discussed the role of NTFPs in rural poverty alleviation descriptively, so this study applies different analytical approaches to confirm the importance of NTFPs. Furthermore, the database regarding the economy of NTFPs in Cambodia has not been documented; therefore, this study contributes greatly to the database for improving the quality of future analysis.

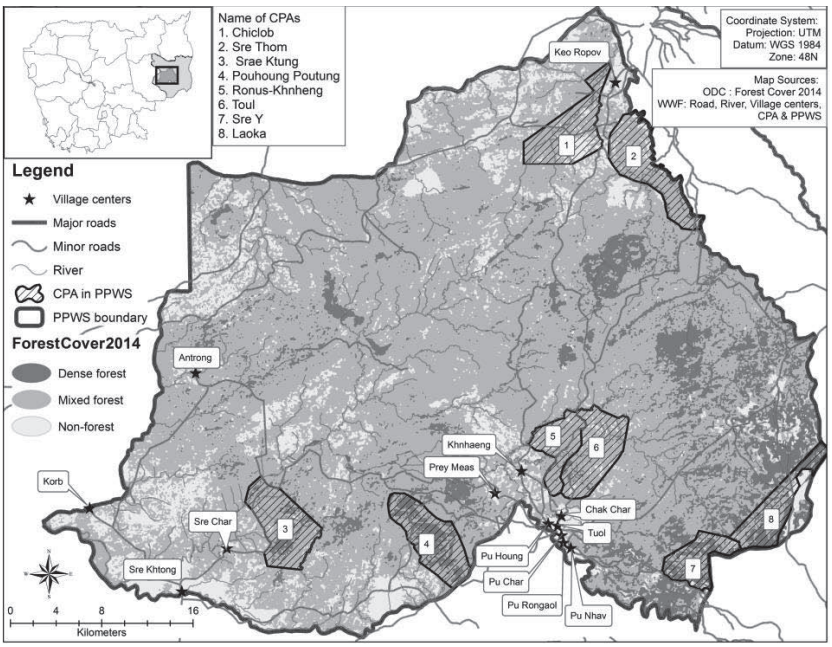
Thus, this study aims to clarify how economically important NTFPs are to rural poverty alleviation and households' vulnerability to poverty. The following three research questions were addressed: (1) How much hidden economic value do NTFPs have?; (2) Does the value of NTFPs contribute to rural poverty alleviation?; and (3) How important are NTFPs for responding to household vulnerability to poverty?

2. Methodology

2.1. Study Site

Phnom Prich Wildlife Sanctuary (PPWS) is located in the west of Mondulkiri province and within the heart of the Eastern Plains Landscape of Cambodia, which is one of the largest remaining relatively undisturbed landscapes in mainland Southeast Asia, as shown in in Figure 1. The whole area of PPWS

Figure 1 Map of Phnom Prich Wildlife Sanctuary, Cambodia



Source: WWF, 2016

Table 1 Households' Characteristics in Phnom Prich Wildlife Sanctuary

Households' characteristics (N = 310)	Mean-Percentage (%)
% Ethnic groups	Bunong (83%) - indigenous people
% Native to the area	89%
% Religion of household head	Ancestor worship (82%)
% Male-headed households	73%
% Education level of household head	Illiterate (49%), Primary school (39%), Secondary school (9%), High school (2%) & informal education (1%)
% Main occupation of the household	Farming (79%)
% Secondary occupation *(multiple)*	NTFPs (93%); hired labour (40.30%); fishing (33.90%); logging (24.80%)
Average age of household head	37.56 years old
Average household size	6 people
Average total land owned by a household	2.77ha

Source: Author's structured interviews, 2016

is 2,225km^2 (WWF, 2016: 5–7). PPWS consists of a mosaic of deciduous dipterocarp forest (1,027km^2) and wetter semi-evergreen/mixed-deciduous forest (1,070km^2) (Gray, 2011: 312–313).

The reason for selecting this site is because PPWS is one of the largest stretches of continuous dry and semi-evergreen forest in Southeast Asia (WWF, 2016: 5–7). PPWS has been ranked as one of the most important sites for biodiversity conservation in Cambodia. PPWS' location means it can represent the current forest situation in Cambodia. PPWS is still well endowed with NTFPs offering a variety of opportunity for use and trade. This wildlife sanctuary consists of alternative livelihoods and employment opportunities, but these benefits have been critically threatened by rapid deforestation and inappropriate forest management policy. With increasing populations, the need for food and agriculture are ever rising in communities. There is an increasing pressure for PPWS to be converted to agriculture or for expanding communities through social land concessions or economic land concessions. As such, forests and their rich biodiversity are decreasing at an alarming rate because of commercial land clearance, agricultural expansion, hunting, and logging (Watkins et al., 2016: 18). However, PPWS has been recognized as a global conservation priority within the Lower Mekong Dry Forest Eco-Region (Gray, 2011), so it is a potential protected area that needs to reduce the further loss of forest biodiversity.

The majority of households are Bunong, who account for 83% of the total households, as shown in Table 1. Average household size was six persons. In general, males are the heads of households who make decisions about livelihood activities. The average age of household heads was around 38 years old. The illiteracy rate of household heads was high (49%), and only 9% of respondents entered secondary school and 2% high school. A household owned almost 3 ha of agricultural land. Each household had at least three activities to make a living. The main occupation of households was

farming (79%), while they had secondary occupations such as extraction of NTFPs, working as hired labour, fishing, and logging.

2.2. Data Collection

Fieldwork was conducted in September 2015 for secondary data collection, key informant interviews, and participatory rural appraisals (PRA). Another fieldwork session was conducted from March to April 2016 for PRA and structured questionnaire interviews. PRAs were conducted by way of focus group discussions (FGDs) at four community-protected areas (CPAs) in PPWS. Five to ten local people were invited to participate in each FGD. Testing and adjusting structured questionnaires was conducted prior to the survey. Structured questionnaire interviews were conducted with 310 households which were randomly selected. This study selected six CPAs from all eight CPAs in PPWS for the survey, including Nglaoka, Sre Y, Chi Klab, Poutong-Pouhoung, Toul, and Srae Khtong. All selected CPAs are located in different geographic zones in PPWS so they can represent the current situation of PPWS. Respondents were local people who live in these communities and were household heads or youth above 18 years old.

There are more than 900 types of NTFPs listed in the declaration of the Ministry of Agriculture, Forestry and Fishery-Cambodia (MAFF, 2005). Due to time constraints, this study decided to select only the most important NTFPs for the daily life of local people living in PPWS. Results PRAs and descriptive statistics from previous studies indicated that the most important NTFPs in PPWS were fuel wood, bamboo shoots, prich leaves (*Melientha suavis* Pierre), solid resin, bamboo poles, liquid resin, wild honey, and orchids, which have been widely consumed by local people.

2.3. Analysis Framework

This study applied a quantitative flow-based approach, which captures use and sale of NTFPs by local people living in a particular protected area. This approach allows the measurement of the economic value of NTFPs which are directly consumed by the rural population. It can evaluate household decision-making on the characteristics of use across NTFPs, such as frequency of collection, amount of subsistence use, and cash income from selling (Godoy et al., 1993: 222–223). Another strength of this approach is that empirical evidence of the economic importance of NTFPs in poverty alleviation and household vulnerability to poverty can be determined.

2.3.1. Measurement of Economic Value of NTFPs

Income from NTFPs is defined as the combined values of cash income and subsistence use value (Cavindish, 2002: 35). This study tries to estimate economic value of NTFPs from the viewpoint of households. The sampled households traded NTFPs directly to middlemen or consumers at a market, so they did not trade NTFPs with each other in the community. Therefore, the issue of double

counting the economic value of NTFPs is not the case.

Equation (1) explains income from $NTFP_j$ (j = liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood) by $household_i$ in a period of t (that is income of NTFPs in 2015). V_{ji} is income of $NTFP_j$, V_{ji}^{*} is cash income of $NTFP_j$, and V_{ji}^{**} is subsistence use value of $NTFP_j$ for $household_i$.

$$V_{ji} = V_{ji}^{*} + V_{ji}^{**} \tag{1}$$

To calculate cash income from NTFPs, this study used cash income from selling NTFPs. Tradable NTFP is the function of quantity collected by household in a period of time and price sold to market (Adam et al., 2013: 91). Therefore, V_{ji}^{*} is cash income derived from $NTFP_j$ of $household_i$. Q_{jit}^{*} is the quantity of $NTFP_j$ sold by $household_i$ in a period of t. P_{jit}^{*} is self-reported price, at which a $household_i$ sold $NTFP_j$ in a period of t (Equation 2).

$$V_{ji}^{*} = \sum_{t=1}^{N} (Q_{jit}^{*} P_{jit}^{*}) \tag{2}$$

Cavindish (2002) estimated subsistence use value through market price of the product or its substitution in the region. Therefore, based on this concept, Equation (3) explains V_{ji}^{**} of subsistence use value for $NTFP_j$ of $household_i$. P_{jit}^{**} is price of the same $NTFP_j$ as that sold by a neighbour around the community in a period of t, If $NTFP_j$ is not sold by sampled households, the price at which other households do transactions at local stores in PPWS is used. Q_{jit}^{**} is the quantity of $NTFP_j$ consumed by $household_i$ in a period of t.

$$V_{ji}^{**} = \sum_{t=1}^{N} (Q_{jit}^{**} P_{jit}^{**}) \tag{3}$$

Equation (4) can be used to evaluate the hidden economic value of NTFPs as a proportion of household income. It explains the crucial role of subsistence hidden in household consumption. It is helpful to debate with policymakers to improve decision-making on resource management based on livelihood context.

$$\%V_{gji} = (V_{ji}^{**} * 100) / V_{ji} \tag{4}$$

2.3.2. Contribution of NTFPs to Rural Poverty Alleviation

Typically, most studies have assessed only the contribution of cash income from NTFPs to household income from the viewpoint of poverty alleviation. Heubach et al. (2011: 1997–1999) measured the contribution of NTFPs to reducing poverty by explaining the share of income from NTFPs in household income. Escobal and Aldana (2003: 1878) compared different groups on the level of dependency on forest resources for household income. Despite concentrating on cash income from NTFPs, Cavindish (2002) and IIED (1995) focused on the role of subsistence use value in rural livelihoods, and they found that local people can survive without any concerns about nutrition, health, shelter, cooking fuel, fencing materials, agricultural materials, and medicine. However, those studies were descriptive case studies without any statistical analysis.

Therefore, this study has adopted four approaches to explain the role of NTFPs in rural poverty

alleviation. First, the share of income from NTFPs to household income is measured. In rural areas, households focus on different income sources to sustain their livelihoods (Ellis, 1998: 5). In the study site, household income is a sum of income from NTFPs (cash income and subsistence use value), income from farming (cash income and subsistence use value), income from forest (cash income and subsistence use value of timber, bush meat, and fish), and income from employment (cash income only).

Second, this study compared dependency on NTFPs among household income tertiles. The Ministry of Planning in Cambodia classifies households by five income quintiles (20% for each quintile). The sampled households collected NTFPs was 288. This study simply splits sampled households into three household income tertiles, including low-income tertile households (n = 96, 33.33%), medium-income tertile households (n = 96, 33.33%), and above medium-income tertile households (n = 96, 33.33%). This disaggregation simply provided equal distribution of sampled households for each income tertile.

Third, the contribution of NTFPs to reducing rural poverty is measured based on the national poverty line in rural areas. Household income with income from NTFPs is compared with that without income from NTFPs. Household income is earned by a group of household members living together. Since there are differences between males and females as well as between adults and children in terms of consumption, it is better to discuss per capita income as being equivalent to an adult rather than all household members. This study used the OECD modified scale to calculate per capita income. As of 2009, the rural poverty line of Cambodia was approximately US$0.84 per capita income per day, according to the national price index (MoP, 2013). Since prices have increased by 2.22% between 2009 to 2015 (World Bank, 2017), the poverty line in 2015 is US$0.84 * (1.22) = approximatelyUS$1.02.

Fourth, Bivariate correlation between income from NTFPs (logarithm: log) and rural poverty indicators and between subsistence use value of NTFPs (logarithm: log) and rural poverty indicators are estimated. For rural poverty indicators, three dimensions of the multidimensional poverty index (MPI) are suggested by UNDP (2014: 9). Variables to be considered for health as the first dimension are malnourishment, and being mentally or physically disability. Education as the second dimension encompasses illiteracy and not being able to enroll in the school of a school-age child. For the third dimension of living conditions, variables are as follows: no access to cooking fuel, no access to toilet or adequate sanitation, no access to clean water (drinking, cooking, bathing), no access to lighting (electricity, battery, solar, etc.), house cannot be protected from strong winds, no access to information, and no assets for mobility or assets related to livelihoods.

2.3.3. Role of NTFPs in Responding to Household Vulnerability to Poverty

Household vulnerability to poverty is defined as uncertainty which households face in the future that stems from multiple sources of risk (Ex-ante poverty prevention) (Chaudhuri, 2003: 3). Many

studies, especially Arnold and Pérez (2001: 441) and Paumgarten and Shackleton (2011: 124) claimed that NTFPs play a crucial role as a safety net to reduce vulnerability to poverty in rural areas, but they could not provide any empirical evidence of this contribution.

Ordinary least square (OLS) in the regression model is to check the hypothesis of 'In a time of crisis and shocks, rural households turn to the forest to extract more NTFPs as a safety-net for their livelihoods.' This study was designed to reduce measurement error. This study did pre-tests several times on structured questionnaires, focusing on unit and range of variables for validity and reliability of the data. This study checked the quality of data by each questionnaire collected by enumerators and the author himself. After the data entry process, the author checked the errors through descriptive statistics in SPSS. Also, this study was designed to avoid the reverse causality problem. According to the literature, when households suffered from crisis and shocks in 2015, they would go to collect more NTFPs to earn more income in 2015 for dealing with problems. Therefore, income from NTFPs could not reverse vulnerability to poverty in the same fiscal year (2015). Hence, reverse causality could not happen in this case.

Equation (5) is used to test this hypothesis. This study focuses on only the signs of significant level rather than the level of coefficient due to the limitation of data.

$$LogY_i = \beta_0 + \beta_1 X_i + \beta_2 H_i + \beta_3 C_i + \beta_4 G_i + \varepsilon_i \quad (5)$$

$\boldsymbol{Y_i}$ is income from NTFPs (logarithm: log). $\boldsymbol{X_i}$ are dummy variables representing shocks and risks, which are indicators of household vulnerability to poverty. Referring to the household vulnerability indicators of Chaudhuri (2003), those dummy variables are lack of labor force (illness, disability, and death of main income earner), low human capital (less know-how, skill), less savings, suffered from social exclusion, suffered from rising food prices, experience of natural disaster (drought, windstorm, and forest fires), and living in a community where job creation is insufficient. $\boldsymbol{H_i}$ represents household characteristics such as age of household head (years), male-headed household (dummy), schooling years of household head (years), household members (persons), occupations in a household (number), time living in the forest sanctuary (years), ability to read and write (dummy), total agricultural land owned (ha), motorcycles owned (number), and kinds of NTFPs collected (number). $\boldsymbol{C_i}$ refers to community involvement with three variables such as membership of a community protected area (CPA) (dummy), received technical training from a CPA and partners (dummy), and received market information from a CPA and partner (dummy). $\boldsymbol{G_i}$ stands for geographic status with two variables: distance from residence to forest where they collect NTFPs (km) and distance from residence to a market where they sell NTFPs (km). The explanation of independent variables and expected signs are shown in Table A.1.

3. Results

3.1. Current Uses of NTFPs by Local People in Phnom Prich Wildlife Sanctuary

Most of the sampled households in PPWS collected NTFPs for their livelihoods (93%). Selected NTFPs for this study are liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood.

The most important NTFPs for subsistence uses in PPWS were fuel wood, bamboo shoots, bamboo poles, prich leaves, wild honey, and liquid resin. Bamboo shoots and prich leaves were consumed for food during the wet season and the dry season, respectively. Bamboo shoots and prich leaves were sometimes sold when only local markets were available. Fuel wood ultimately served local communities for energy sources for cooking. Local people used bamboo poles for agricultural materials and shelter construction. In a few cases, bamboo poles were sold in the market. Wild honey was used for traditional medicine and as a food ingredient, but mostly it was sold in the market during the dry season. Liquid resin was used for shelter construction, but it was often sold in the market to earn cash income. Liquid resin is the most valuable NTFP, which local people extracted intensively year-round. Solid resin and orchids were completely sold through middlemen or to local markets in PPWS, especially during the dry season.

3.2. Economic Value of NTFPs from Subsistence Use and Sale Per Year

Monetary value of NTFPs from both cash income and subsistence use is a concern of this study. Economic value is assessed by type of NTFP, based on interviews with 288 sampled households which collected NTFPs.

As shown in Table 2, the economic value of NTFP through income varied according to the type of NTFP. Regarding cash income, liquid resin was the most valuable NTFP. Around 50% of sampled households were involved in collecting liquid resin, and per household cash income from liquid resin was around R3,120,900 (US$767). Wild honey was another valuable NTFP, which around 31% of sampled households collected. A household earned cash income of approximately R3,072,400 (US$755) from wild honey. Solid resin was a primary NTFP for trading, which around 56% of sampled households collected. On average, a household earned cash income of approximately R1, 202,200 (US$296) from solid resin. Orchids are seasonally collected and sold. Around 32% of sampled households collected them, earning about R511,900 (US$125). Bamboo poles, prich leaves, and bamboo shoots were collected by a large proportion of sampled households, but earn less cash income, approximately R189,900 (US$47), R120,800 (US$30), and R24,200 (US$6), respectively. Fuel wood was the only non-marketed NTFP in PPWS because it is free and easy to access.

Regarding subsistence use, local people in PPWS used NTFPs for food, shelter construction, cooking energy, fencing materials, agricultural materials, and medicine. Table 2 shows that fuel

Table 2 Hidden Economic Value and Economic Value of NTFPs Per Household in 2015

NTFPs	HHs involved (%)	Unit price (Riel)	Total quantity	Sale	Subsistence	Income of NTFPs (Riel)	Cash income (Riel)*	Subsistence use value (Riel)**	Subsistence value (%)
Liquid resin (n=143)	50	1,825/kg	1,711kg	1,710kg	1.13kg	3,122,900	3,120,900	2,000	0.06
Solid resin (n=162)	56	2,243/kg	536kg	536kg	0	1,202,200	1,202,200	0	0
Wild honey (n=89)	31	33,762/liter	92.42liter	91liter	1.42liter	3,120,300	3,072,400	47,900	1.54
Orchids (n=91)	32	5,625/kg	91kg	91kg	0	511,900	511,900	0	0
Bamboo poles (n=160)	56	300/meter	2,443m	633m	1,810m	732,700	189,900	542,800	74.07
Bamboo shoots (n=244)	85	1,273/kg	88kg	19kg	69kg	112,000	24,200	87,800	78.39
Prich leaves (n=239)	83	12,052/kg	33.02kg	10.02kg	23kg	398,000	120,800	277,200	69.65
Fuel wood (n=281)	98	1,000/kg	1,397kg	0	1,397kg	1,397,000	0	1,397,000	100

Note: 1) Riel is the national currency of Cambodia
2) 1US$=4068 Riel (in 2015, National Bank of Cambodia)
3) *: average price obtained from self-report of sampled households
4) **: average price obtained from neighbours who sold at their location (Except for bamboo poles and fuel wood, being collected from local store's recording)
Source: Author's structured interviews, 2016

wood was collected widely by sampled households (98%). It is because fuel wood is the primary source of cooking fuel for households in PPWS. Subsistence use value of fuel wood was R1,397,000 (US$343). Bamboo poles are primarily used for shelter construction and building fences. Bamboo poles were collected by 56% of sampled households, and subsistence use value was around R543,000 (US$133). Prich leaves are very popular wild vegetables for rural households. About 83% of sampled households collected prich leaves during the dry season, whose subsistence use value was R277,200 (US$68). Bamboo shoots are one of the most popular traditional food items for rural households in PPWS. Around 85% of sampled households collected bamboo shoots during the rainy season, and the subsistence use value was R87,800 (US$22).

Table 2 shows that annual income from liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood were R3,122,900 (US$768), R1,202,200 (US$296), R3,120,300 (US$767), R511,900 (US$126), R732,700 (US$180), R112,000 (US$28), R398,000 (US$98), R1,397,000 (US$343), respectively.

Thus, the economic value of NTFPs is promising in PPWS, though it varies according to the type of NTFP. Policymakers are likely to know economic value of NTFPs more by summing up NTFPs and multiplying by total households in PPWS (considering the proportion of households involved in

collecting NTFPs).

Estimating subsistence use value of NTFPs can be helpful to perceive the hidden economic value of NTFPs. As shown in Table 2, among eight selected NTFPs, four NTFPs' economic values were mostly hidden in subsistence use. They were fuel wood, bamboo shoots, bamboo poles, and prich leaves, with the proportion of subsistence use value being 100%, 78%, 74%, and 70% respectively. Due to nature of subsistence, these four NTFPs were widely used by 98%, 85%, 56%, and 83% of sampled households respectively.

3.3. Contribution of NTFPs to Rural Poverty Alleviation

3.3.1. Contribution of NTFPs in Cash Income and Household Income for Rural Households

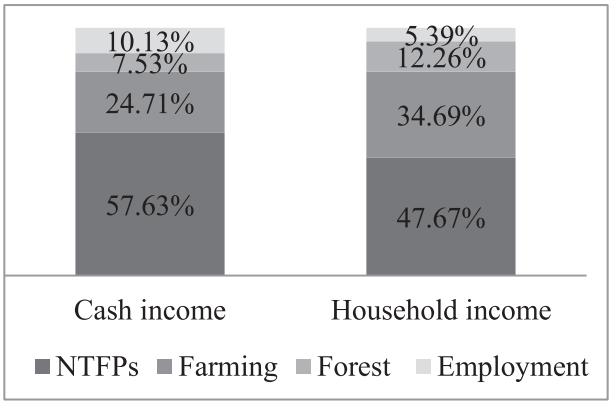
In general, rural households living in Phnom Prich Wildlife Sanctuary have diversified income sources to make a living.

Cash income from NTFPs accounted for the largest share of household cash income (58%), followed by farming (25%), employment (10%), and forest resource extraction (8%) (Figure 2). From the viewpoint of household income (subsistence use value and cash income) from all income sources, income from NTFPs was the highest share, 48% of household income, followed by farming (35%), forest resource extraction (12%), and employment (5%). It can be seen that NTFPs were the primary income source for households living in PPWS.

3.3.2. Contribution of NTFPs to Household Income: Comparing Among Household Income Tertile

The null hypothesis is that local people are living in the same protected area, so the income from NTFPs and each type of NTFP are the same. However, comparing average income from NTFP among

Figure 2 Share of NTFPs in Cash Income and Household Income of Sampled Households



Source: Author's calculation

three household income tertiles by type of NTFP, average income from liquid resin, solid resin, wild honey, orchids, and fuel wood were significantly different among three household income tertiles. For sampled households of above medium-income tertile, they got higher income from these five NTFPs than the other two income tertiles (Table 3). Average income from bamboo poles and prich leaves were not significantly different across the three tertiles. In contrast, the medium-income tertile households got higher income from bamboo shoots than the other two income tertiles, but it was not significantly different across the three tertiles.

By comparing the share of NTFP income in household income tertile, it was found that its share for the lower-income tertile (67%) was lower than those for the medium-income tertile (73%) and the above medium-income tertile (77%). Similarly, comparing share by type of NTFP, shares of liquid resin, wild honey, orchids, and bamboo poles for the above medium-income tertile were higher than those of the other two tertiles. Conversely, shares of solid resin, bamboo shoots, prich leaves, and fuel wood for lower-income tertile households were higher than those for the other two tertiles because these four NTFPs were very important for the poor.

Therefore, NTFPs were very important products for all income tertiles. It is likely that dependence on NTFPs gradually increases as household income increases. Sampled households in the medium-income and the above medium-income tertiles were notably more engaged in sale of NTFPs compared to the low-income tertile.

Table 3 NTFP Income and Its Share to Household Income by Type of NTFP and Household Income Tertile

NTFPs	Household income tertile						ANOVA (on income)	
	Low-income		Medium-income		Above medium-income		F	Sig.
	(Riel)	(%)	(Riel)	(%)	(Riel)	(%)		
Liquid resin	2,218,000	11.32	2,769,900	19.80	3,788,300	21.84	5.104	.007***
Solid resin	798,900	10.22	1,114,900	8.22	1,553,300	9.62	3.006	.052*
Wild honey	1,448,600	4.13	2,583,700	10.51	4,089,700	13.74	6.416	.003***
Orchids	348,600	1.99	513,100	2.07	609,700	2.10	2.417	.095*
Bamboo poles	453,300	5.97	682,300	6.27	925,400	7.68	1.897	.154
Bamboo shoots	107,100	2.90	109,500	1.78	101,300	1.14	.116	.891
Prich leaves	326,300	6.22	417,000	5.74	437,600	4.62	1.052	.351
Fuel wood	949,500	24.52	1,323,900	18.90	1,947,400	16.27	8.261	.000***
Overall NTFPs (N = 288)	2,702,200	67.27	5,360,100	73.29	8,569,700	77.00	78.129	.000***

Note: Household income tertiles are as follows: low-income tertile (33.33%), medium-income tertile (33.33%), and above medium-income tertile (33.33%) from 288 sampled households collected NTFPs

Source: Author's structured interviews (2016)

3.3.3. Contribution of NTFPs to Reducing Rural Poverty

To examine the contribution of income from NTFPs to reducing rural poverty, R4,100 (US$1.02) of per capita income per day, which was Cambodia's poverty line in 2015, can be used as a criterion for comparison. Though an average, per capita subsistence use value of NTFPs (= R1,600) accounted for 39% of Cambodia's rural poverty line. Nevertheless, result from ANOVA test shows that average per capita income/day, per capita income/day excluding subsistence use value of NTFPs, and per capita income/day excluding income from NTFPs were of highly significant difference between the three household income tertiles.

In Table 4, for the low-income tertile, despite including income of NTFPs, per capita income per day of R5,000 (US$1.23) was slightly higher than Cambodia's rural poverty line of R4,100 (US$1.02). Excluding subsistence use value of NTFPs, per capita income of the low-income tertile households would decrease to R3,700 (US$0.91), which was slightly lower than the poverty line. Excluding cash income of NTFPs, per capita income of low-income tertile households would further decrease to R2,500 (US$0.61). It is of interest that the difference (R1,600) between the poverty line and per capita income excluding income of NTFPs can be reduced R1,300 (35%) by subsistence use of NTFPs and R1,200 (32%) by the cash income of NTFPs, though per capita income is undoubtedly below the poverty line. Without collecting NTFPs, the low-income households would fall into poverty.

Per capita income of the medium-income tertile was R9,000 (US$2.21), higher than Cambodia's rural poverty line. Excluding subsistence use value of NTFPs, per capita income of medium-income tertile households would decrease to R7,300 (US$1.79), still higher than the poverty line. Furthermore, by excluding income of NTFPs, per capita income of medium-income tertile households would decrease to R4,300 (US$1.05), which was assumed as equal to the poverty line because the difference was only R200 or US$0.03 (Table 4). It could be seen that subsistence use of NTFPs (R1,700) enables this income tertile to get over the poverty line in practice. It is not to say that without the income from NTFPs, medium-income tertile households would likely to fall into poverty.

Per capita income of the above medium-income tertile was R15,200 (US$3.74), higher than Cambodia's rural poverty line. Excluding subsistence use value of NTFPs and income of NTFPs, per capita income of the above medium-income tertile would decrease to R13,200 (US$3.24) and R8,500 (US$2.09) respectively, still higher than the rural poverty line (Table 4). It is likely that for this income tertile, they keep NTFPs collection as a part of livelihood rather than for alleviating poverty, while still being a crucial income source for the household.

3.3.4. Correlation Between Income of NTFPs and Multidimensional Poverty Indicators

As per capita income does not always explain rural poverty in detail, here the bivariate correlation between subsistence use value of NTFPs and multidimensional poverty indicators. as well as between income from NTFPs and multidimensional poverty indicators, as suggested by United Nations

Table 4 Per Capita Income/Day by Household Income Tertile (in 2015)

Per capita income/day	Household income tertile				Significance	Cambodia poverty line (2015)
	Low-income	Medium-income	Above medium-income	Overall		
Per capita income/day	R5,000 (US$1.23)	R9,000 (US$2.21)	R15,200 (US$3.74)	R9,700 (US$2.38)	.0 00***	R4,100 (US$1.02)
Per capita income/day excluding subsistence use value of NTFPs	R3,700 (US$0.91)	R7,300 (US$1.79)	R13,200 (US$3.24)	R8,100 (US$1.99)	.000***	
Per capita income/day excluding income from NTFPs	R2,500 (US$0.61)	R4,300 (US$1.06)	R8,500 (US$2.09)	R5,100 (US$1.25)	.000***	

Note: 1) Poverty line at rural areas of Cambodia is US$0.84 in 2009 (MoP, 2013). The price increases by 2.22% between 2009 and 2015.
2) *, **, and *** denote level of significance of 0.1, 0.05, and 0.01, respectively
Source: Author's calculation

Development Programme (UNDP), is examined.

As shown in Table 5, for the health indicator, only 'at least one member is malnourished' was significantly and negatively correlated with subsistence use value of NTFPs. None of the education indicators was significantly correlated with subsistence use value of NTFPs. For indicators of living conditions, subsistence use value of NTFPs was significantly and negatively correlated with no access to cooking fuel, no access to toilet or adequate sanitation, no access to clean water, no access to lighting energy, and house cannot be protected from strong wind.

Meanwhile, income from NTFPs (= subsistence use value + cash income) was significantly and negatively correlated with health indicators such as malnourished and mental or physical disability. Since local people living in the forest sanctuary have limited alternative livelihoods, NTFPs play an important role when households lack food or a household member becomes sick, disabled, or dies. For education, only 'at least one school-aged child did not enrol in school' was significantly and negatively correlated with income from NTFPs. Most of the indicators in indicators of living conditions were negatively and significantly correlated with income from NTFPs. They were no access to toilet or adequate sanitation, no access to clean water, no access to lighting energy, house cannot be protected from strong wind, and no assets for mobility or assets related to livelihoods.

Thus, though the relationship is not strong as far as coefficients are concerned, it could be seen that income of NTFPs may influence some difficulties of rural livelihoods, but due to the limitation of analysis, this study did not have enough evidence to support the argument that NTFPs could alleviate multidimensional poverty.

Table 5 Correlation Between Income of NTFPs and Poverty

Multidimensional poverty indicators		HHs suffered (%)	Correlation with subsistence use value of NTFPs	Correlation with income of NTFPs
Health	At least one member is malnourished	35%	−.236***	−.312***
	Mental/physical disability	23%	−.096	−.291***
Education	No one in household can read and write	59%	−.058	−.047
	At least one school-aged child does not enroll in school	23%	−.075	−.134**
Living conditions	No access to cooking fuel	9%	−.281***	−.043***
	No access to toilet or adequate sanitation	45%	−.166***	−.384***
	No access to clean water (drinking, cooking, bathing)	11%	−.141**	−.157***
	No access to lighting energy (electricity, battery, solar, etc.)	20%	−.155***	−.260***
	House cannot be protected from strong wind	15%	−.106*	−.272
	No access to information	32%	−.035	−.043
	No assets for mobility or assets related to livelihoods	10%	.003	−.140**

Note: 1) *, **, and *** denote level of significance of 0.1, 0.05, and 0.01, respectively
Source: Author's analysis

3.3.5. Importance of NTFPs for Responding to Household Vulnerability to Poverty

(1) Current Situation of Household Vulnerability to Poverty in PPWS

From the viewpoint of local perception, exposure to risks and shocks can be household vulnerability to poverty. Based on structured interviews with sampled households, there were idiosyncratic and covariate crises in 2015 in Phnom Prich Wildlife Sanctuary.

In PPWS, households were exposed to four idiosyncratic shocks. Almost 80% of sampled households lack human capital, especially knowledge to earn higher incomes. Local people lacked information and connections for acquiring appropriate skills. About 78% of sampled households have low savings. Because of low savings, they were unable to invest in other profitable occupations and furthermore were unable to cope with unexpected shocks. Lack of household labor force and suffering from social exclusion were faced as a shock by 19% and 7% of sampled households, respectively.

Households in PPWS were also exposed to various types of covariate crises. Around 77% of sampled households lived in communities where there was a lack of job opportunities because of being remote. Drought, windstorms, and forest fires were natural shocks, which around 51% of sampled households experienced. These natural disasters can cause widespread livestock losses, crop failure, and house damage. Besides, around 36% of sampled households suffered from rapidly rising food prices.

(2) Importance of NTFPs for Responding to Household Vulnerability to Poverty

Households may make various choices in responding to shocks, even though the shock is the same.

It is assumed that local people could collect NTFPs to cope with problems when risks or shocks occur.

Table 6 shows results from OLS regression. Based on adjusted R^2 of 0.582, a set of predictors as variables can explain a linear relationship to some extent. Herein a hypothesis is verified, which is that in a time of crisis, households extract more NTFPs as a safety-net for livelihood.

All idiosyncratic shocks significantly influenced income from NTFPs, but signs of coefficients were different across shocks. Low human capital and low savings positively and significantly influenced

Table 6 Influence of Household Vulnerability on NTFPs Collection

(i) Dependent variables: income of NTFPs (Logarithm: log)	B	SE	Sig.
(Constant)	5.904	.094	.000***
(a) Idiosyncratic risks			
Lack of labor forces	−.144	.038	.000***
Low human capital	.211	.046	.000***
Less saving	.079	.038	.041**
Social exclusion	−.120	.055	.030**
(b) Covariate risks			
Rising food prices	.080	.029	.007***
Natural disaster	.054	.029	.066*
Living in community where being lack of job opportunities	.011	.037	.766
(c) Households' characteristics			
Age of household head	.000	.001	.914
Male-headed household	.060	.032	.060*
Schooling years of household head	.003	.006	.609
Household members	.004	.006	.511
Occupations in a household	−.019	.014	.194
Years living in current forest sanctuary	.002	.001	.170
Ability to read and write	.014	.035	.693
Agricultural land owned	−.006	.009	.508
Motorbikes owned	.052	.019	.008***
Types of NTFPs collected	.089	.011	.000***
(d) Community involvement			
Membership of Community Protected Area (CPA)	.057	.035	.101
Technical training received from CPA and partner	−.002	.035	.961
Market information from CPA and partner	−.024	.032	.466
(e) Geographic status			
Distance from residence to forest	.005	.003	.109
Distance from residence to marketplace	−.021	.006	.000***
R^2 = .614			
Adjusted R^2 = .582			
Regression mean Square = .992			

Note: *, **, and *** denote 0.1, 0.05, and 0.01 levels of significance, respectively
Source: Author's analysis

income from NTFPs. This implies that households with low human capital and low savings were likely to earn more income from NTFPs to secure their livelihoods. In contrast, lack of labour force had a negative and significant coefficient. This means that households which suffer from labour shortage cannot increase income from NTFPs because collection of NTFPs requires intensive labour. For social exclusion, with the coefficient being negative and significant, households cannot earn more income from NTFPs due to inadequate networks. Meanwhile, covariate shocks such as rising food prices and natural disaster significantly and positively influenced income from NTFPs. This implies that households were likely to collect more NTFPs for consumption and cash income in responding to these shocks.

Besides, among households' characteristics, male-headed household, motorbikes owned, and types of NTFPs collected positively and significantly influenced income from NTFPs. For geographic status, only distance from residence to marketplace significantly and negatively influenced income from NTFPs.

4. Discussions and Conclusion

Society needs accurate and comprehensive estimates of the economic value of NTFPs in order to conserve and manage forests. Due to the hiddenness of NTFPs' values, policymakers may regard forests as being of little importance. In the Cambodian context, the government has made considerable efforts to address the issue of deforestation in recent years, with approximately 24% of the country now designated as protected areas. Cambodia's Millennium Development Goal 7 (CMDG 7) has been set up to maintain forest coverage of at least 60% of total land area by 2015. The Ministry of Environment also issued the National Forestry Program 2010–2029 to provide a guideline for extraction on biological resources. Nevertheless, the commitment, actions, and sustainable environmental protection and management policies of the government have not yet been achieved. One critical issue is that the government did not include NTFPs in their main policy agenda. This study clarified the hidden value of NTFPs from the viewpoint of poverty alleviation. Valuation of NTFPs can pave the way for policy dialogues that reconcile forest management and sustainable development, particularly in the natural protected areas or forest sanctuaries.

It was clarified that part of NTFPs collected was hidden as subsistence use in households and consequently was not valued because of not being dealt through the market. Though limited to data from 2015, annual cash income per sampled household in Phnom Prich Wildlife Sanctuary derived from selling liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood was US$755, US$296, US$755, US$125, US$47, US$6, US$30, and US$0 respectively. Then, by adding subsistence use value, annual income of respective NTFPs increased to US$768, US$296, US$768, US$126, US$180, US$28, US$98, and US$343. Therefore, attaching a monetary

value to subsistence use value is crucial to achieving a complete valuation of the direct use of NTFPs.

Comparing to Adam et al. (2013), Arnold and Pérez (2001), Belcher et al. (2005), and Neumann and Hirsch (2000), which focused on only the cash value of NTFPs and concluded that NTFPs are just minor products from the forest and do not lead to rural poverty alleviation, it was verified that the hidden economic value of NTFPs in subsistence use enabled households to alleviate poverty in the low-income group and to lift households away from the poverty line among the marginal poor (part of the medium-income group). The background nature are as follows: first, though the share of subsistence use varies significantly from type to type among NTFPs, subsistence use value of NTFPs accounts for 35% of income of NTFPs and 16% of household income on a per capita basis. Second, for low-income households (33% of sampled households), NTFPs collection can prevent the poorest from falling into deeper poverty. For medium-income households (33% of sample households), without assessing subsistence value as a contribution of NTFPs, 33% of them will be close to the poor. Medium-income households will become poor if income from NTFPs is not included in assessment. Third, NTFPs are important for dealing with multidimensional poverty. Subsistence use value of NTFPs is important to deal with many livelihood problems, especially for health and living conditions.

Paumgarten and Shackleton (2011) described that an increase in subsistence use and sale of NTFPs is a strategy to respond to shocks. However, as a result of this study, it is of interest that only a few shocks such as labour force shortage and social exclusion constrain NTFPs collection, while local people could collect more NTFPs to cope with other shocks like lack of human capital, low savings, rising food prices, and natural disasters.

However, NTFPs significantly contribute to rural poverty alleviation because rural households can be lifted from poverty or prevented from slipping into poverty in the future. The decline in NTFPs leads to devastating impacts on the lives of rural families who are living in the forest sanctuary. These hidden values of NTFPs need to be recognized to ensure accurate and comprehensive assessment. The assessment of hidden value and cash value of NTFPs in an area can provide a community with a vital tool for fighting expropriation by outside interests. This study believes that this valuation approach will harmonize rural livelihoods and conserve forest biodiversity.

Notes

1. OECD Modified scale: Adult equivalent unit due to type of household member as follows: Value 1 to the household head, of 0.5 to each additional adult member, and of 0.3 to each child.
2. Definitions of NTFPs:
   a. Liquid resin: *Dipterocarpus alatus, Dipterocarps intricatus* Dyer
   b. Solid resin: *Shorea guiso, Shorea siamensis*, and some of *Genera of Dipterocarpaceae (Vatica & Hopea)*
   c. Wild honey: *Apis dorsata, Apis florae, Apis cerana*
   d. Orchids: *Vandopsis gigantea*
   e. Bamboo poles: *Bambusa sp., Bambusa bambos*

f. Bamboo shoots: *Bambusa sp., Bambusa bambos*
g. Prich leaves: *Melientha suavis* Pierre
h. Fuel wood: Diverse parts of long-lived tree species

References

Adam, Y. O., Pretzsch, J. r., & Pettenella, D. 2013. Contribution of Non-Timber Forest Products livelihood strategies to rural development in drylands of Sudan: Potentials and failures. *Agricultural Systems. 117:* 90–97. doi: http://dx.doi.org/10.1016/j.agsy.2012.12.008

Arnold, J. E. M., & Pérez, M. R. 2001. Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics. 39:* 437–447.

Belcher, B., Ruiz-Perez, M., & Achdiawan, R. 2005. Global patterns and trends in the Use and Management of Commercial NTFPs: Implications for Livelihoods and Conservation. *Wold Development. 33:* 1435–1452. doi: 10.1016/j.worlddev.2004.10.007

Cavendish, W. 2002. Quantitative methods for estimating the economic value of resource use to

rural households. In B. M. Campbell & M. K. Luckert (Eds.), *Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources:* 17–65. London, United Kingdom: Earthscan Publication Ltd.

Chaudhuri, S. 2003. *Assessing vulnerability to poverty: concepts, empirical methods and illustrative examples*. United States of America: World Bank.

Cock, A. 2016. *Governing Cambodia's Forests: The International Politics of Policy Reform*. Copenhagen: Nias Press.

De Beer, J. H., & McDermott, M. J. 1996. *The Economic Value of Non-timber Forest Products in Southeast Asia* (Second Revised Edition ed.). Amsterdam: Netherlands Committee for IUCN.

Ellis, F. 1998. Household strategies and rural livelihood diversification. *Journal of Development Studies. 35*(1): 1–38.

Escobal, J., & Aldana, U. 2003. Are Nontimber Forest Products the Antidote to Rainforest Degradation? Brazil Nut Extraction in Madre De Dios, Peru. *World Development. 31*: 1873–1887. doi: 10.1016/j.worlddev.2003.08.001

Godoy, R., Lubowski, R., & Markandya, A. 1993. A Method For the Economic Valuation of Non-Timber Tropical Forest Products. *Economic Botany. 47*(3): 220–233.

Gray, T. N. E. 2011. Habitat preferences and activity partterns of the larger mammal community in Phnom Prich Wildlife Sanctuary, Cambodia. *The Raffles Bulletin of Zoology. 59*(2): 311–318.

Heubach, K., Wittig, R. d., Nuppenau, E. -A., & Hahn, K. 2011. The economic importance of non-timber forest products (NTFPs) for livelihood maintenance of rural west African communities: A case study from northern Benin. *Ecological Economics. 70*, 1991–2001. doi: 10.1016/j.ecolecon.2011.05.015

International Institute for Environmental and Development. 1995. *Hidden Harvest: The value of wild resources in agricultural systems - A Project Summary*. London: Sustainable Agriculture Programme of the International Institute for Environmental and Development (IIED).

Mahapatraa, A. K., & Tewari, D. D. 2005. Importance of non-timber forest products in the economic valuation of dry deciduous forests of India. *Forest Policy and Economics. 7:* 455–467. doi: 10.1016/j.forpol.2004.02.002

Milne, S., & Mahanty, S. 2015. *Conservation and Development in Cambodia: Exploring frontiers of change in nature, state and society* New York: Routledge.

Ministry of Agriculture, Forestry and Fisheries-Cambodia. 2005. *PRAKAS: On Non-Timber Forest Products*. (No. 132 RBK/KSK). Phnom Penh: Ministry of Agriculture, Forestry and Fisheries-Cambodia.

Minisry of Environment of Cambodia. 2011. Cambodia Human Development Report 2011: Climate Change and Forestry. 9pages: Minisry of Environment of Cambodia, Ministry of Economy and Finance of Cambodia & United Nations Development Programme.

Ministry of Planning-Cambodia. 2013. Poverty in Cambodia - A New Approach Redefining the Poverty Line. Phnom Penh: Ministry of Planning, Royal Government of Cambodia.

Neumann, R. P., & Hirsch, E. 2000. *Commercialisation of Non-Timber Forest Products: Review and Analysis of Research*.

Indonesia: Center for International Forestry Research.

Organization for Economic Co-peration and Development. 2013. *OECD Framework for Statistics on the Distribution of Household Income, Consumption and Wealth*: OECD Publishing.

Paumgarten, F., & Shackleton, C. M. 2011. The role of non-timber forest products in household coping strategies in South Africa: the influence of household wealth and gender. *Population Environment, 33*: 108–131. doi: 10.1007/s11111–011–0137–1

Peters, C. M., Gentry, A. H., & Mendelsohn, R. O. 1989. Valuation of an Amazonian rainforest. *Nature, 339*: 655–656. doi: 10.1038/339655a0

Tola, P., Kimsay, S., Prum, S., Vanny, R., Touch, V., & Aquino, A. 2010. Economic Importance of Non-Timber Forest Products: Case studies on resin and rattan in Kampong Thom province, Cambodia. Phnom Penh, Cambodia: NTFP-EP.

United Nations Development Programme. 2014. Human Development Report 2014: Techinal notes. New York, USA: United Nations Development Programme.

Watkins, K., Sovann, C., Brander, L., Neth, B., Chou, P., Spoann, S., Hoy, S., Choeun, K., & Aing, C. 2016. Mapping and Valuing Ecosystem Services in Mondulkiri: Outcomes and Recommendations for Sustainable and Inclusive Land Use Planning in Cambodia. Phnom Penh: WWF Cambodia.

World Bank. 2017. Inflation, GDP deflator (annual%). Retrieved 05/29, 2017, from http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG?locations=KH

World Wildlife Fund. 2016. *Phnom Prich Wildlife Sanctuary*. Phnom Penh: Cambodia.

Appendix

Table A.1: Explanation of Independent Variables and Expected Sign

Dependent variables: income of NTFPs			
Explanatory variables	Assumptions	Expected sign	Sources
(a) Idiosyncratic risks			
Lack of labor forces (dummy)	When the main income earner of a household seriously suffers from an illness, disability, or death, they tend to collect more NTFPs to deal with above problems.	+	Author
Low human capital (dummy)	HH having less know-how skill are more likely to collect NTFPs because they lack alternative livelihoods.	+	Melaku et al. (2014)
Low savings (dummy)	HH having less financial saving are more likely to collect NTFPs for dealing with necessary expenses.	+	Paumgarten and Shackleton (2011)
Social exclusion (dummy)	HH suffer from social exclusion in a community are more likely collect NTFPs because they lack networking in related to livelihoods.	+	Author
(a) Covariate risks			
Rising food prices (dummy)	In a time of rising food prices, households extract more NTFPs as safety-net for livelihoods.	+	Paumgarten and Shackleton (2011)
Natural disaster (dummy)	In a time of natural disasters hit, households extract more NTFPs to supplement the livelihoods.	+	
Living in community where being lack of job opportunities (dummy)	HH living in a community, where job creation is insufficient, tend to collect more NTFPs because they lack alternative livelihoods.	+	Author
(c) Households' characteristics			
Age of household head (years)	The older of household head are more likely to collect NTFPs due to his/her experiences.	+	Melaku et al. (2014)
Male-headed household (dummy)	The female-headed households are more likely to collect NTFPs because of physical strength and time.	−	
Schooling years of household head (years)	HH having higher education are less likely to collect NTFPs because they have other alternative livelihoods.	−	Schaafsma et al. (2014)
Household members (persons)	HH having many labors are more likely to collect NTFPs to generate higher income.	+	Lopez (2011)
Occupations in a household (number)	HH having numerous occupations are less likely to collect NTFPs.	−	Melaku et al. (2014)
Years living current forest sanctuary (years)	HH living in forest longer period are more likely to collect NTFPs.	+	Melaku et al. (2014)
Ability to read and write (dummy)	HH head, who can read and write are less likely to collect NTFPs because they have more alternative jobs.	−	Schaafsma et al. (2014)

Agricultural land owned (ha)	HH owned large land are less likely to collect NTFPs for their livelihoods because they are busy with farming activity.	−	Lopez (2011)
Motors owned (number)	HH having many motorbikes are more likely to collect NTFPs because they can travel in longer distance.	+	Author
Types of NTFPs collected (number)	HH collecting numerous types of NTFPs, tend to get higher income from NTFPs.	+	Author
(d) Community involvement			
Membership of CPA (dummy)	The members of community-protected area are more likely to collect NTFPs to improve livelihoods.	+	Melaku et al. (2014)
Technical training received from CPA (dummy)	HH received technical training from CPA are more likely to collect NTFPs because they know how to collect valuable NTFPs.	+	
Market information from CPA (dummy)	HH received marketing information on NTFPs from CPA are more likely to collect NTFPs because they know the demand and price of NTFPs.	+	
(e) Geographic status			
NTFP access (km)	HH willing to travel a further distance to the forest are more likely to get higher income from NTFPs because the valuable NTFPs place in the deep forest.	+	Adam et al. (2013)
Market access (km)	HH living far from the market are less likely to get higher income from NTFPs because they difficult to sold NTFPs to consumers.	−	Author