The Hidden Value of Non-Timber Forest Products towards Poverty Alleviation and Forest Conservation: A Case of Phnom Prich Wildlife Sanctuary, Mondulkiri Province, Cambodia

by

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List of Acronyms and Abbreviations

ADB	Asian Development Bank
ANOVA	Analysis of Variance
CBD	Secretariat of the Convention on Biological Diversity
CDRI	Cambodia Development Resource Institute
CEDAC	Cambodian Center for Study and Development in Agriculture
CC	Commune Council
CDP	Commune Development Plan
CIP	Commune Investment Plan
CMDG	Cambodia's Millennium Development Goal
CPA	Community Protected Area
EPL	Eastern Plain Landscape of Cambodia
ESs	Ecosystem Services
EU	European Union
FA	Forestry Administrative, Cambodia
FAO	Food and Agriculture Organization of the United Nations
FGDs	Focus Group Discussions
ha	Hectare
HHs	Households
IIED	International Institute for Environmental and Development
INGO	International Non-Governmental Organization
InVEST	Integrated Valuation of Environmental Services and Trade-offs
IUCN	International Union for Conservation of Nature
km	Kilometer

km^2	Square Kilometers
Ksh	Kenyan Shilling (Official Currency of Kenya)
LULC	Land Use and Land Cover
MA	Millennium Ecosystem Assessment
MAFF	Ministry of Agriculture Forestry and Fishery, Cambodia
Max_dist	Maximum Distance
MFV	Mondulkiri Forest Vulture
MK	Mondulkiri Province
MoE	Ministry of Environment, Cambodia
MoP	Ministry of Planning, Cambodia
MoT	Ministry of Tourism, Cambodia
MPF	Mondulkiri Protected Forest Area
NCDD	National Committee for Sub-National Democratic Development
NGO	Non-governmental organization
NSDP	National Strategic Development Plan
NTFPs	Non-Timber Forest Products
NTFP-EP	Non-Timber Forest Products-Exchange Program
NWFPs	Non-Wood Forest Products
ODC	Open Development Cambodia
PA	Protected Area
PPWS	Phnom Prich Wildlife Sanctuary
R	Riel (Official Currency of Cambodia)
REDD	Reducing Emission from Deforestation and Forest Degradation

REDD^{+}	Reducing Emission from Deforestation and Forest Degradation in Developing Countries
RGC	Royal Government of Cambodia
RUPP	Royal University of Phnom Penh
SMART	Spatial Monitoring and Reporting Tool
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
US$	United States Dollar (Official currency of United States)
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund for Nature
WWF-Cambodia	World Wildlife Fund for Nature-Cambodia Office
WWF-EPL	World Wildlife Fund for Nature-Eastern Plain Landscape Office, Cambodia

Chapter 1: Introduction

1.1 Background of Study: General Context

Global forest areas are very much at risk. There was a net loss of 129 million ha of forest between 1990 and 2015, about the same size of South Africa (FAO, 2016). Presently, the tropical deforestation is the most critical environmental disaster threatening the livelihoods of rural people and global welfare in general. Developing countries are always confronted with an inescapable dilemma of choosing between forest conservation and national economic growth (DeBeer and McDermott, 1996). When conservation competes with conversion, conversion wins because policymakers regard forests as being less important (Pearce, 2001). This dilemma arises partly because of the economic value of forest is often assumed that forests have no value until they are logged or farmed (Arnold and Pérez, 2001; Godoy et al., 1993; Kar and Jacobson, 2012). The direct and indirect benefits of forest resources, which local people utilize for their livelihood, are often ignored solely in terms of economic value (Belcher et al., 2005b; Brander et al., 2010; DeBeer and McDermott, 1996). This way of valuing the forests leads to rapid deforestation (Godoy et al., 1993; Pearce, 2001).

At present, the role of non-timber forest products (NTFPs) in rural livelihood and forest management has gained broader attention from scholars and international non-governmental organizations (INGOs). NTFPs are the primary resources from forests in developing countries (Belcher and Schreckenberg, 2007; Kar and Jacobson, 2012). NTFPs are a vital resource that attach more value to forests. Nevertheless, the roles of NTFPs in the rural economy and environmental incentives have been long overlooked (Byron and Arnold, 1999; Cunningham, 2011; DeBeer and McDermott, 1996; Godoy et al., 1993; Peters et al., 1989). However, capturing the hidden value of NTFPs is the first crucial step to convince economists

and policymakers to consider the importance of forests beside their price.

NTFPs are defined as *"All biological materials other than timber which are extracted from forests for human use"* (DeBeer and McDermott, 1989: 6) . FAO called NTFPs another name: non-wood forest products (NWFPs), but the definition is almost the same. NWFPs are *"products [that] consist of goods of biological origin other than wood, derived from forests, other wooded land, and trees outside forests"* (FAO, 1999). People living in and around forests have widely used NTFPs for centuries (Arnold and Pérez, 1998; Khosravi et al., 2017; Shackleton, Shackleton, et al., 2011). NTFPs are collected worldwide for fuel, foods, gums, resin, oils, fruits, fodder, tannins, medicine, latexes, spices, ornamental plants, wildlife (products and live animals), fuel wood and raw materials, notably rattan, bamboo, and fibers (Belcher and Kusters, 2004a; DeBeer and McDermott, 1996; Melaku et al., 2014). However, in the beginning of the early 1980s, NTFPs were given a higher profile than timber as in an effort to link conservation and development to alarming rates of deforestation (Myers, 1988; Ruiz-Pérez et al., 2004).

There are some important roles of NTFPs as follows. First, NTFPs are important source of livelihoods for millions of people across the world (Arnold and Pérez, 1998; Melaku et al., 2014; Shackleton and Pandey, 2014). Farm products may provide higher income and staple food for home consumption, but during the off-season, NTFPs can become more important when farm products and non-farm income decline (Arnold and Pérez, 2001). Local people can survive without any concerns about nutrition, health, shelter, cooking fuel, fencing, agricultural materials, and medicine to sustain their livelihoods (Mekaku et al., 2014; Shackleton et al., 2011).

Second, NTFPs contribute to rural households' incomes and the national economy. Over 150 NTFPs are traded internationally (Sills et al., 2011). Approximately, 1.4-1.6 billion

people worldwide have been estimated to make use of at least some NTFPs (Shackleton et al., 2011: 56) . The main NTFPs for trading are gum, resin, oil, leaves, fruit, fodder, honey, mushrooms, tanning materials, bush meat, and medicine (Melaku et al., 2014: 215). Peters et al. (1989) estimated the gross annual per ha value of NTFPs (fruits and latex) by using 1ha forest plot as the case study. They found that per ha the value of NTFPs was almost US$700 annually. This value was ten times greater than that of timber logged and two times higher than that of land use conversion in the Amazonian rainforest (Peters et al., 1989: 655-656). NTFPs accounted for 39% of total household incomes of forest dwellers in rural West Africa (Heubach et al., 2011: 1991-1998). NTFPs provided an economic value of around US$42 million per year in the Eastern Arc Mountains, and income from NTFPs accounted for 20% of the household income of local people living near the forest (Schaafsma et al., 2014: 295-303).

Third, NTFPs are widely exploited and consumed by poor households that have limited land, minimal education, and low skills (Angelsen and Wunder, 2003; Cavendish, 2002). It is likely to contribute to employment opportunities. On the contrary, around 45 million people worldwide are associated with formal and informal NTFP-based enterprises, and around 350 million rural people have relied on forest resources and NTFPs for their livelihoods (Shackleton et al., 2011). Therefore, NTFPs can be closely related to creating jobs for local people, in particular for those who live in or nearby a forest.

Fourth, NTFPs help people to cope with risks, including social and natural hazards. The difficulties facing local people are crop failure, natural disasters, a shortage of wage employment, and the inability to fulfill social needs such as school fees or weddings. These are considered to be excessive expenditure (Arnold and Pérez, 1998; Saha and Sundriyal, 2012; Sills et al., 2011). Forest dwellers can extract NTFPs when they are free from farm activities and have the time to earn extra income (Ros-Tonen and Wiersum, 2005). When the

agricultural yield is low, local people go to the forest and collect NTFPs for home consumption (Arnold and Pérez, 2001: 442). The extra income from NTFPs can be used to deal with shocks difficulties resulting from death, disease, and traditional ceremonies (Paumgarten and Shackleton, 2011). NTFPs may play the significant role as a safety net to reduce the impact of some possible risks in rural areas.

The fifth advantage of NTFPs is that their exploitation is less ecologically destructive than harvesting timber (Neumann and Hirsch, 2000; Perez and Byron, 1999). NTFPs positively contribute to carbon storage, nutrient cycling, erosion control, hydrological regulation, and biodiversity stabilization (Arnold and Pérez, 2001; Chou, 2017). Traditionally, local communities only collect NTFPs such as fruit, seeds, short-lived leaves, and deadwood. NTFPs are therefore generally regarded as having a low impact on plant or tree live; the only species that are collected for home consumption and trading are those which are widespread, with a large population and are fast growing. Their collection does not negatively impact forest ecosystems (Ticktin and Shackleton, 2011). When the forest structure is not adversely changed, the regeneration of those species and ecosystem services can be maintained (Ros-Tonen and Wiersum, 2005).

The sixth benefit of NTFPs is that they are crucial for cultural and recreational purposes (Cocksedge, 2006: 13). Indigenous people in North America were entirely dependent on natural resources to feed and clothe their families. These subsistence activities have maintained their culture, language, ceremonies, beliefs, and practices (Tippeconnic, 1995). Many ethnic groups in Indonesia were passed knowledge orally from one generation to the next, and the pattern of utilizing traditional medicines and foods became a part of their culture (Hadi, 1995).

Last, NTFPs are likely to maintain community attitudes to control the resources in

order to be cost-effective (Sunderland et al., 2011). Local communities allocate their time and labor to regularize the extraction amount (Infield and Namara, 2001; Saha and Sundriyal, 2012). Besides, when local people utilize NTFPs from the forest, they more actively protect the forest that they depend upon (Gibson et al., 2005; Sunderland et al., 2011). Extraction of NTFPs may give local communities an incentive to conserve forests.

In contrast, there are critics who question the economic value and ecological contribution of NTFPs. Even though NTFPs have been promoted as a pathway for poverty reduction and forest conservation, the recognition of their value is inadequate. There is a claim that NTFPs play little role in the economy or household incomes. Some research suggests that the average income per year from selling NTFPs at local and international levels is often small (Arnold and Pérez, 2001; Belcher et al., 2005; Godoy et al., 1993). NTFPs are said to be just a minor by-product that contributes little to livelihoods. While farm activities and non-farm activities provide a higher return to households, NTFPs are less likely to be an important source of income. In the majority of cases, NTFPs only contribute a small proportion to household income (Belcher et al., 2005a). NTFPs are widely exploited and consumed by poor households that have limited land, minimal education, and low skills (Cavendish, 2002; Ghate et al., 2009; Wunder, 2001). Critics claim that NTFP extraction is a seasonal activity that cannot create formal employment for regional and national economic growth (Angelsen and Wunder, 2003; Arnold and Pérez, 2001; Belcher et al., 2005). Other opponents say that the increasing number of individuals using forests and NTFPs, combined with a diminishing resource base, is resulting over the sharing of benefits between local people and intruders (Cocksedge, 2006).

1.2 Background of Study: Cambodia Context

Cambodia is one of the largest remaining pristine tropical forests in mainland

Southeast Asia, but its widespread destruction in recent decades has been seen very obvious (Cock, 2016: 1-7). Forest resources of Cambodia play the significant role in rural livelihood and country's economic development (MoE, 2011). Forest resources are used for trading including logging concessionaries or holders of other concessions or coupe rights (FA, 2009). More than 30% of the Cambodian population live within 5km of forest, and they highly depend on forest resources, accounting for 10% to 20% of household consumption (MoE, 2011: 1).

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). Cambodia's forests are under severe pressure from unlawful logging, illegal land procession, and illegal claims of state land (MoE, 2011). Wildlife hunting, habitat destruction, and human disturbance are also main threats to forest resources in Cambodia (Clements et al., 2010). In 2010, forest cover was 57.07% of Cambodia's land area, which is below the target of maintaining forest cover at 60%, and most of the forestation has happened in the northwest and northeast provinces of Cambodia (MoE, 2012). To lessen the deforestation rate, Royal Government of Cambodia (RGC) has implemented the forest protection and management through improving farming techniques, reducing dependency on fuel wood, engaging in forest rehabilitation and reforestation, and commercial plantations (FA, 2009). RGC issued the national forest programme 2010-2029 to achieve sustainable forest management (FA, 2010b). International aids from international non-governmental organizations (INGOs) spent million dollars for forest management projects in Cambodia (Cock, 2016).

However, contribution of the forestry sector to Cambodia's GDP is likely to be small (FA, 2009). To get higher benefits from forest management, RGC has decided to extract

benefits from forests through forest product trade (forest logged, charcoal, poles, and NTFP, etc.) and forest revenue (fine, auction, reforestation fees, royalty from forest concession, royalty from other forests, etc.) (FA, 2010a). In addition, the government has granted economic land concessions (ELCs) as long-term leases for developing large-scale plantations, raising animals, and building factories to process agricultural products, according to sub-decree N_0.46 on economic land concession in Cambodia (RGC, 2005). However, according to a government report[1], a total 1,934,894 ha of ELCs were granted to the total 230 companies, of which 122 companies received licenses from MAFF while others 133 received licenses from MoE (ODC, 2015). Most of the deforestation is attributed to the conversion of forests to agricultural use through ELCs (Milne and Mahanty, 2015: 3).

The government has tried to manage the forest systematically, but the trend of deforestation is even worse (Lopez, 2005). In the forest landscape of Cambodia, millions of local people collect NTFPs under the customary law for food, medicine, construction, agricultural tools, and cash income (Vantomme et al., 2002). Most importantly, NTFPs are still invisible to most of land use management and rural livelihood development policies, strategies, and projects. Currently, NTFPs are threatened by the continued deforestation (Watkins et al., 2016: 41-45).

There are more than 900 types of NTFPs listed in the declaration of the MAFF (MAFF, 2005). They classified NTFPs into 14 groups, such as (1) Lower class wood, poles, and other non-timber used in traditional construction; (2) fuel wood; (3) Bamboo, palm tree, rattan, liana; (4) Medicinal plant/wood; (5) Aromatic plant/wood; (6) Resin/gum; (7) Wax; (8) Material producing dye or chemical substance; (9) Edible plants; (10) Ornamental plants; (11)

[1] Government report has combined the figures for Ministry of Agriculture, Forestry and Fisheries (MAFF) and Ministry of Environment (MoE) for the first time since September 2015.

Wood for carving; (12) Non-Timber Forest Products for craft; (13) Wildlife products; and (14) Forest services. NTFPs have been believed that they have been widely used since at least the 11th century during the reign of His Majesty King Suryavarman II (Suntra, 1995). NTFPs had started to trade domestically and internationally during French colonial (Suntra, 1995). Resins were traded during the 1930s or even earlier (Evans et al., 2003). After Cambodia declared independence from France, this country demanded more raw materials from the forest, particularly NTFPs for industry (Suntra, 1995). The last 30 years of civil war have seriously depleted not only forest resources but also the documentation of NTFPs. Most of NTFPs have been traded informally or illegally, so the formal statistical records cannot show the reality of current NTFPs production and trade value.

1.3 Problem Statements

In the 1960s, Cambodia was believed to have 73% of its area under forests (FA, 2010a). The forest cover had declined from 61% in 2002 to 59% in 2006 (FA, 2010a: 8-11). The rate of forest loss was about 93,000 ha per year, due to expansion of agriculture and other commercial plantations (MoP, 2011: 26-30). The forest cover in 2010 decreased to about 58% (MoP, 2011), and it continued to decline to 54% in 2015 (FAO, 2015). Thus, Cambodia forest cover fell slightly below the CMDG 7 target of 60%. Cambodia has made considerable efforts to address the issue of deforestation in recent years. There are many forest management policies and interventions in Cambodia, such as national policy and strategic plan for green growth 2013-2030, Forestry Law 2002 (amended in 2006 and re-amended in 2010), National Forest Program 2010-2029, Protected Area Law (2008), National Biodiversity Strategy and Action Plan (2002), and Law on Environmental Protection and Natural Resources (2001). There are questions about why the goals of Cambodia forestry reforms are not yet achieved,

and despite its high level, why aids from INGOs have failed in reducing deforestation and improving rural livelihood.

Deforestation in Cambodia has resulted in the destruction of the local population's livelihood, social injustice, cultural identity loss, and conflicts (Milne and Mahanty, 2015). Forest-dependent people who are mostly ethnic groups living in remote forest areas are the most vulnerable. Forest-dependent communities are suffering from land use changes as a result of forest degradation, forest conversion into mass agro-industry, settlements, and infrastructure development. This situation reflects a lack of coherence in rural land management policies, weak capacities of national committee for sub-national democratic development (NCDD)[2], poor service delivery mechanisms, and limited involvement of rural land and resource users in formalized natural resource management procedures (FA, 2010a).

This study suspects that policymakers value the forest in the insufficient way. Valuation of Cambodia's forest for forest management and development plans has been traditionally based on a financial appraisal of its timber stock or/and forest conversion to plantation (Cock, 2016: 1-7; Milne and Mahanty, 2015: 2-5). This kind of valuation has resulted in the degradation of Cambodia's forest and other economic forms (Cock, 2016: 1-7; Milne and Mahanty, 2015). The rapid deforestation in Cambodia negatively affects about 84% of rural people who are heavily dependent on forest resources, especially NTFPs for domestic consumption and complementary cash income (FA, 2009; Milne and Mahanty, 2015; MoE, 2011).

[2] NCDD is the inter-ministerial mechanism for promoting democratic development through decentralization and deconcentration reforms throughout Cambodia. NCDD is accountable to the royal government of Cambodia for implementation of the law on administrative management of the capital, province, municipalities, districts, and communes.

At present, the role of NTFPs in Cambodia's economy has mostly been overlooked by country's ruling elites and forest management planners. NTFPs' values are less appreciated. The current economic value of NTFPs represents only one aspect of the manifold economic benefits. As long as based on conventional methods, part of the value of NTFPs could be missed, which results that the government would regard forests as being less important.

In general, with the political economy of forest resources changing around the world, the hidden value of NTFPs has been debated in the valuation of tropical forests (FAO, 2015; Mahapatraa and Tewari, 2005). To date, two main propositions of NTFPs' value, which have been long overlooked by policymakers and scholars are: (1) the subsistence use value of NTFPs and their role in poverty alleviation, (2) the role of NTFPs in creating incentives for forest conservation.

Hence, assessing the hidden value of NTFPs lets policymakers recognize how much they should compensate if NTFPs are substituted by other intensive production systems. Capturing the hidden value of NTFPs from rural poverty alleviation and forest conservation perspectives can raise policy awareness and convince policymakers, INGOs, and other institutions to include them in national or even international policies and strategies to combat deforestation and poverty.

1.4 Objective of the Study

The overall objective of this study is to assess the hidden value of NTFPs from perspectives of poverty alleviation and forest conservation in order to integrate it into development agendas of official institutions.

1) To explore the current utilization and management of NTFPs in Phnom Prich Wildlife Sanctuary, Cambodia
2) To classify NTFPs in household livelihood strategies and its determinants

3) To clarify how economically important NTFPs are to rural poverty alleviation and household vulnerability to poverty

4) To examine the value of NTFPs' incentives for forest conservation

1.5 The Significance of the Study

The study outcomes will contribute to a new perspective on the value of NTFPs. The empirical results of this study will help inform policymakers and international agency alliances about a better decision for forest resources management and rural livelihood development. This research is applicable to either Cambodia or other tropical forest countries. The specific significance of this study is as follows:

1) NTFPs in household livelihood strategies were classified subjectively on a macro scale without any distinct profile of NTFP profiles (Adam et al., 2013; Belcher et al., 2005). This study re-classifies NTFPs in household livelihood strategies at the household level. It seeks the best option for NTFPs extraction in order to improve rural livelihoods and help sustainably manage forests.

2) To date, a complete valuation regarding the direct use of NTFPs, which takes into account both marketed and subsistence benefits, has not been well documented. This study therefore contributes to a valuation approach on how to use the price of substitute goods[3] to assess subsistence use value. Moreover, most of the literature descriptively analyzes the role of NTFPs in rural poverty alleviation. However, this study applies different analytical approaches in order to reinforce the importance of NTFPs in poverty alleviation and reducing household vulnerability to poverty.

[3] Price of substitute goods is the price of those goods which can be used in place of one another for satisfaction of a particularly want.

3) It is claimed that NTFPs are essential for forest conservation (Arnold and Pérez, 2001; Belcher et al., 2005a; Shaanker et al., 2004; Sunderland et al., 2011), but empirical evidence of this role remains limited. More importantly, a measurement NTFPs' value as incentives for forest conservation is crucial for developing policies that combat deforestation. Furthermore, most previous studies used cost-based approaches in environmental valuations to measure damage costs, avoided costs, or replacement costs. Economists are always quick to attack this overestimation. Estimating the value of NTFPs as incentives for forest conservation can be an alternative approach for calculating the overall value of NTFPs. This approach is the most direct physical expenditure to reflect the actual amount paid for forest conservation activities. It is the first step in convincing economists and policymakers to recognize the value of NTFPs, beyond their market value.

1.6 Dissertation Structure

This dissertation is organized into eight chapters. Chapter 1 introduces the background of the study, Cambodia context, problem statements, research objectives, and significance of the study.

Chapter 2 introduces the concepts and theoretical framework according to the logic of the study's objectives. The justification for this study is that it reveals the hidden value of NTFPs from perspectives of poverty alleviation and incentives for forest conservation. Evidence from other empirical studies is used to identify the key questions of the study. Methodologies and approaches from different scholars are also reviewed.

Chapter 3 explains the overall methods and data collection procedures related to this study. The reasons for selecting Phnom Prich Wildlife Sanctuary (PPWS) to carry out this study are also described. Furthermore, the procedures for selecting sample households are

described. Interview quality control and enumerator management are similarly explained. Likewise, the approaches to analysis are illustrated according to the study's objectives.

Chapter 4 explores the current utilization and institutional management of NTFPs in PPWS. This chapter clarifies the characteristics of households in PPWS. The overall understanding of how local people make use of NTFPs for their livelihoods is described. In addition, the kinds of institutional management for different types of NTFPs are examined.

Chapter 5 shows how the extraction of NTFPs is classified in household livelihood strategies. The overall objective of this chapter is to suggest a promising policy and management option for improving rural livelihood and sustainable forest management through extraction of NTFPs. In this way, chapter 5 identifies factors influencing household decisions regarding the extraction of NTFPs as household livelihood strategies.

Chapter 6 aims to economically evaluate the hidden value of NTFPs in rural poverty alleviation. Moreover, it analyzes the role of NTFPs in reducing household vulnerability to poverty. This chapter discusses the contribution of NTFPs to rural poverty alleviation through four approaches. These include: the share of NTFPs income in household income; dependency on NTFPs as income among household income tertiles; the contribution of NTFPs income in reducing rural poverty based on the national poverty line in rural areas; and a Bivariate correlation between NTFPs income and rural poverty indicators. Finally, this chapter discusses the role of NTFPs in reducing household vulnerability to poverty in rural areas using the following hypothesis: 'In a time of crisis and shock, rural households turn to the forest to extract more NTFPs as a safety-net for their livelihood.'

Chapter 7 discusses the value of NTFP's incentives for forest conservation in PPWS. This chapter explores the current forest conservation activities in PPWS. The role of NTFPs

in creating incentives for forest conservation is statistically analyzed. Furthermore, the value of NTFPs as incentives for forest conservation is estimated.

Lastly, Chapter 8 provides concluding remarks with policy recommendations for effective interventions for sustainable natural resources management and rural poverty alleviation. This chapter conveys the limitations and prospects for future studies.

Chapter 2: Literature Review

2.1 Utilization and Institutional Management of NTFPs

2.1.1 Evolving Perspective on NTFPs

Historically, many NTFPs have been used and traded for centuries in Asia and Europe (Shackleton and Pandey, 2014: 23-31). In the nineteenth and early twentieth century a growing volume of NTFPs was exported to Europe, but after World War II the export value of NTFPs dropped dramatically (DeBeer and McDermott, 1996: 23). Since that time, NTFPs become almost invisible in forest statistics, management and policy (Shackleton and Pandey, 2014: 23-31). Recently, the role of NTFPs that enhance the quality of life of forest users has brought back in the international spotlight. Because there remained insufficient data on NTFPs to meet the standard of evidence-based, NTFPs are rarely drawn upon in design of poverty alleviation or land use policies (Chou, 2018b; DeBeer and McDermott, 1996; Shackleton and Pandey, 2014). Indeed, it is crucial for current research to study the role of NTFPs to alleviate poverty and incentivize forest conservation should be a central consideration in policy recommendation.

2.1.2 NTFPs Utilization of Local People

In a generic sense, analysis on current utilization and institutional management of NTFPs is crucial to understand the reality of relationship between local people and NTFPs in a forest (Moran and Ostrom, 2005).

NTFPs have been utilized by the local community in various forms for different purposes according to resources available, rights to access, market accessibility, and alternatives of forest resources (Belcher et al., 2005a; Mulcahy and Boissière, 2014). However, existing literature and evidence are not sufficient for understanding how do local people use NTFPs for their livelihoods (Byron and Arnold, 1999). The utilization of NTFPs

can be described by a function of the number of people involved in their use and the frequency of their subsistence use and commercialization because it contains variation in the utilization and exploitation practices for different types of NTFPs (Berg et al., 2007).

2.1.3 Types of NTFPs Management

Management of NTFPs implies social arrangements for protection, maintenance, and exploitation (Berg et al., 2007). Some studies measure technical management practices regarding extensive management or intensive management, which influence the natural regeneration of species (Nepstad and Schwartzman, 1992). Other studies consider management of NTFPs from extraction methods including wild gathering, managed system, and cultivated system (Belcher et al., 2005a). Nygren (2005) found that resource management at the local level is good for forests and the people who depend on them because the local population can make the decision to utilize those resources by proper rules and regulations. Furthermore, NTFPs could play a greater role in supporting their livelihoods if their extraction and sale were sufficiently managed by relevant institutions (B. Belcher et al., 2005a). Therefore, without an understanding of the institutional management of NTFPs, it could not be identified who should regulate the use of NTFPs and what kind of management should be devised and implemented to serve people's needs. Management of NTFPs can be assessed by examining the role and dynamics of all relevant institutions implicated in this task (Mutenje et al., 2011; Uphoff, 1992).

2.2 NTFPs in Household Livelihood Strategies

2.2.1 Classification of NTFPs in Household Livelihood Strategies

Scoones (1998; 2009) hypothesizes that rural sustainable livelihood can be applied in the range of household livelihood strategies which likely affect the livelihood outcomes. DFID (1999) denotes 'livelihood strategies' as the range and combination of activities and

choices that people make or undertake in order to achieve their livelihood goals. Local people who live in the forest tend to be marginalized, so they use a diverse portfolio of activities to meet their basic needs based on a traditional livelihood (Belcher et al., 2015). Promising management options to improve livelihoods and to reduce the impact of biodiversity can be gained from a study of household preferences for certain livelihood strategies (Tesfaye et al., 2011).

Typically, NTFPs were classified by phylogenetic grouping (Example: bamboos, rattans, palms) or by functional categories (Example: medicinal and aromatic plants; bush-meat and woodcarving). It is inappropriate to consider the implications of development and conservation through people's use and management (Belcher et al., 2005b). Following this, several authors have attempted to classify NTFPs based on their trade and investment. To estimate the Mopane worm in Africa by applying livelihood strategy approach, Stack et al. (2003) used the terms: (1)'Hanging on' to describe the survival activity at a subsistence level only; (2) 'Linking in' to describe the subsistence activity and small trading activity for the accumulation of social benefits; (3) 'Stepping up' to describe the accumulation of productive resources to expand current livelihood activity and incomes; (4) 'Stepping out' to describe the increase of income flow and accumulation of capital assets. In addition, Ruiz-Pérez et al. (2004) included a management system in the analysis of NTFPs in household livelihood strategies. As a subsistence strategy, households collect NTFPs from unmanaged wild resources. NTFPs are mainly used for subsistence purposes only. In the diversified strategy, households tend to extensively manage[1] NTFPs so as to earn additional cash income. In the specialized strategy, households tend to focus on specific high-valued NTFPs, and enjoy the

[1] Extensively managed is the management activity producing rapid and substantial returns. Extensively managed is mostly done by conventional practices especially from indigenous knowledge.

trade value with stability in the market. Belcher et al. (2005) conducted a comparative study on NTFPs at the country level from 61 cases by grouping NTFPs in household livelihood strategies: (1) subsistence strategy; (2) supplementary strategy; (3) integrated strategy; (4) specialized natural strategy; (5) specialized cultivated strategy. They adopted the keywords from Ruiz-Peréz et al. (2004), but they broke down the 'diversified-strategy' into a supplementary and integrated strategy and the 'specialized-strategy' into a specialized-natural strategy and specialized-cultivated strategy. Adam et al. (2013) modified the typology of strategies from Ruiz-Peréz et al. (2004) by classifying NTFPs into three strategies such as the subsistence strategy, supplementary strategy, and specialized strategy using similar identification procedures.

Belcher et al. (2005a) proposed a method to classify NTFPs through household livelihood strategies, but the definition of each household livelihood strategy has been still debated. Previous studies by other researchers focused only on commercial NTFPs, so they did not reflect the reality of roles, diversity, and trends associated with the use and management of NTFPs. Henceforth, a more useful and straightforward typology is needed to classify NTFPs.

2.2.2 Factors Influenced NTFPs in Household Livelihood Strategies

Classifying NTFPs in household livelihood strategies alone is not sufficient, as it does not take into account interrelated factors that determine household choices for a livelihood strategy (Hegde et al., 1996; Melaku et al., 2014; Schaafsma et al., 2014). An understanding of factors that influence household choices for a livelihood strategy is crucial to reinforce policy recommendations that have promising management options. It is a process to improve the livelihood outcomes to be more responsive to peoples' needs (DFID, 1999).

In theories of allocation, people make all livelihood decisions sensibly for what they

want, and what they want is revealed by the choices they make (Gowdy and Erickson, 2005). A household can gain economic opportunities by improving the quantity, quality, or timing of collection through more intensive management (Belcher et al., 2005). Related studies have indicated that a household production model explains the choice of the livelihood strategy for natural resources extraction, including capital, labor, and land (Belcher et al., 2005a; Lopez, 2011; López-Feldman and Taylor, 2006; Schaafsma et al., 2014). Some studies found that household characteristics determine the decision on how much NTFPs should be collected; they illustrate 'native to the area' and 'age of household head' were key factors that influence the extraction of NTFPs (Kar and Jacobson, 2012; Melaku et al., 2014). A household head with good education is likely to decrease the extraction of NTFPs because they have alternative livelihood activities (Schhaafsma et al., 2014). Another study identified that community participation strongly influences management and trading options of NTFPs. A community member often received technical training from the government and development agencies, so they were more likely to collect further NTFPs to improve their income (Melaku et al., 2014). From a comparative study at a macro level, livelihood strategy choices may also be influenced by market accessibility. Belcher et al. (2015) found that where forest resources are available, people use them to meet subsistence needs, and where market conditions permit, they will trade to generate cash income.

2.3 Hidden Value of NTFPs: Rural Poverty Alleviation Perspective

With the political economy of forest resources changing around the world, uncovering the hidden value of NTFPs has been debated in the valuing of tropical forests (Mahapatraa and Tewari, 2005). Firstly, Peters et al. (1989) 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. DeBeer and McDermott (1996) concluded that the economic value of NTFPs in

Southeast Asia was critical to both local and national economies. However, some studies criticized these findings, as Neumann and Hirsch (2000); Sheil and Wunder (2002); Belcher et al. (2005) assumed that NTFPs are just minor forest products that contribute less to household income and national economy. Other studies found optimistic results about NTFPs' values (Godoy et al., 2000; Heubach et al., 2011; Schaafsma et al., 2014). As long as assessing by conventional methods[2], part of the value of NTFPs could be missed, with the result that policymakers would regard forests as being less important (Campbell and Luckert, 2002).

Not a few NTFPs are mostly hidden in subsistence use because local people consume them in different patterns without passing through a market (Cavindish, 2002; DeBeer and McDermott, 1996). Even so, subsistence use has a value as an opportunity cost of household consumption (Heubach et al., 2011). IIED (1995) and Cavindish (2002) indicated that monetary equivalent to subsistence use value can be measured from the price of substitution or costs of time spent on collection and processing.

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; Shackleton et al., 2011), but empirical evidence from these studies remains vague because they did not provide a clear indicator of vulnerability to poverty and analysis approach. The role of NTFPs must be assessed by more comprehensive manner in livelihood context to improve decision-making basis for policymakers and land-use planners (Cavendish, 2002; CBD, 2013; IIED, 1995; Watkins et al., 2016).

[2] Conventional method of assessing value of NTFPs refers to the studies taken into account only marketed benefits (cash) only, as it was done by Belcher et al. (2005); Hegde et al. (1996); Neumann and Hirsh (2000).

2.4 Hidden Value of NTFPs: Incentives for Forest Conservation

Forest conservation is subject to a wide variety of definitions. Elliott (1996) reviewed on paradigms of forest conservation and concluded that 'forest conservation' can mean anything from intensive timber production to total preservation, but forest should not be permanently converted to another use, such as agriculture. Due to a broad range definition of 'forest conservation', some studies define forest conservation as 'forest maintenance' activities through sustainable extraction behavior (Infield and Namara, 2001; Ticktin and Shackleton, 2011). Many researchers regard 'forest conservation' as forest protection activities including forest patrolling and financial supporting to rangers (Balmford and Whitten, 2003; Gibson et al., 2005). McNeely (1988: 38-41) adds that 'reforestation' is a significant activity for forest conservation. Therefore, this study regards 'forest conservation' as activities of forest maintenance, forest protection, and reforestation.

Two levels of forest conservation are found, according to Figure 2-1. First, at the national level or protected area level, the government and INGOs conserve forest by two ways. The government and INGOs assert restriction placed on forest use to protect forest and biodiversity (Elliott, 1996; Mbaria and Ogada, 2016; Scherr et al., 2003). Second, at the local level, a community often exercise power over the use of resources, and they always protect forest biodiversity at their own costs (Berkes, 2004). Nevertheless, local people seldom have sufficient financial capital to invest in biological resources, so they sometimes accept collaboration with the government or INGOs to conserve the forest (McNeely, 1988).

Further, some researchers claim that economic benefit from NTFPs is likely to change local community attitude to maintain forest biodiversity (Gibson et al., 2005). Household's labor and time will be allocated more intensive to secure regularized yields together with maintaining forest biodiversity (Saha and Sundriyal, 2012). Therefore, there is an entry

question about whether or not NTFPs extraction can represent a sustainable form of tropical forest management, for which traditional forest management systems provide benefits for forest-dweller, and creating the incentives to combating deforestation. Even there is a claim that NTFPs may induce incentives for forest conservation, but empirical evidence has not statistically confirmed. More importantly, even NTFPs are important for forest conservation, and they tend to be undervalued by most of policymakers

There are many possible valuation tools to measure the value of incentives for forest conservation as follows. First, possibility approach is damage cost avoided or replacement cost. Local people protect the forest to ensure ecological functions, so they are protected by some of ecosystem services to avoid any loss or damage, especially from windstorm, erosion, flash flood, etc. This value equals to the cost of willingness to pay to avoid damages or costs of replacement (costs of constructing dam and water reservoir to protect flash flood or erosion).

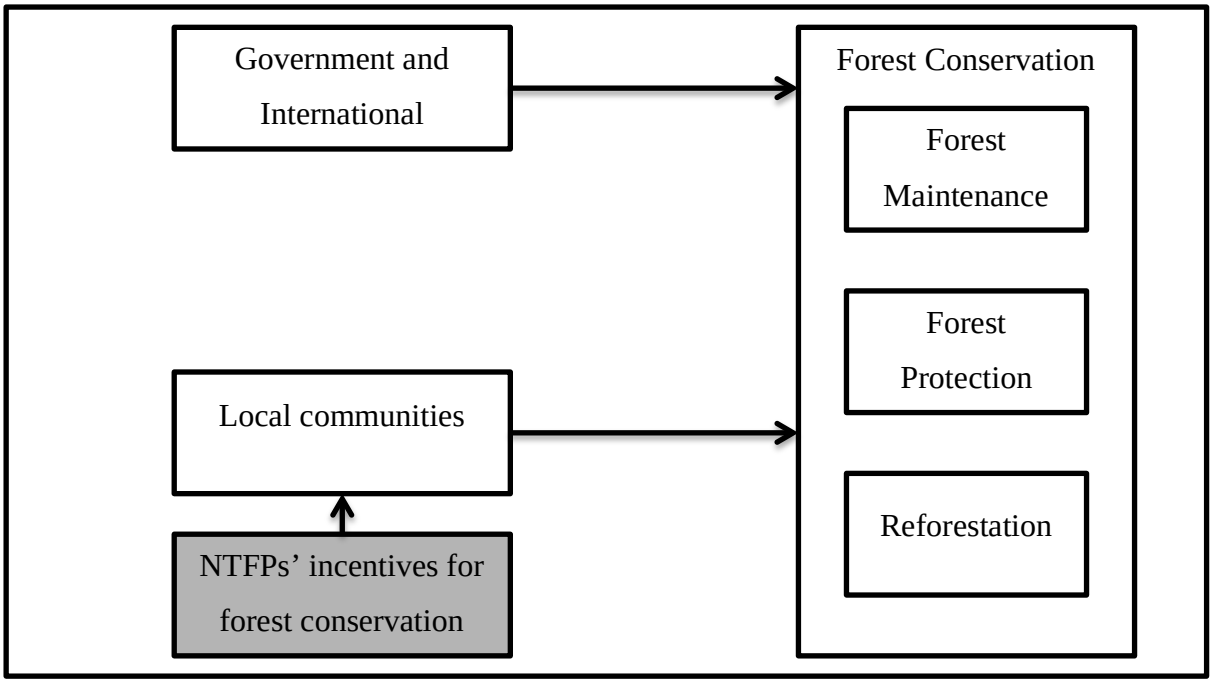


Figure 2-1 Forest Conservation Practices
Source: Author, 2016

Second, traveling costs method (TCM) can be applied. Local people conserve forest for ecotourism purpose so that they can get income from entrance fees or payment from the tourists. This value equals to the number of visitors from different zones multiplying the average travel cost to each zone from a tourism destination. Third, contingency valuation method (CVM) can be used. When local people conserve a forest, they enable to get payment from beneficiaries on value of ecosystem services, especially water, air, and wildlife habitat (Kremen et al., 2000). These ecosystem services equal to households' willingness to pay for something they value. Fourth, cost of forest conservation activities is the most appropriate approach. When local people participate in forest conservation, the government and INGO save a tremendous amount of conservation costs in the particularly area (McNeely, 1998: 30). In addition, this value can be estimated from direct costs of forest conservation activities (cost of cash compensation for not offending wildlife or damaging keystone species, cost of daily wages and food, fines from illegal activities, and cost of training (McNeely, 1998).

2.5 Overall Conceptual Framework

NTFPs are primary resources from forests, but the value of NTFPs has gone long unrecognized. Currently, the study of utilization and institutional management of NTFPs is still very complicated. Also, classifying NTFPs in household livelihood strategies is critical in understanding the background of the role and potential of NTFPs in livelihoods and conservation.

The hidden value of NTFPs has long been overlooked. Two perspectives regarding the background study of NTFPs in a specific protected area must therefore be assessed, as be shown in Figure 2-2.

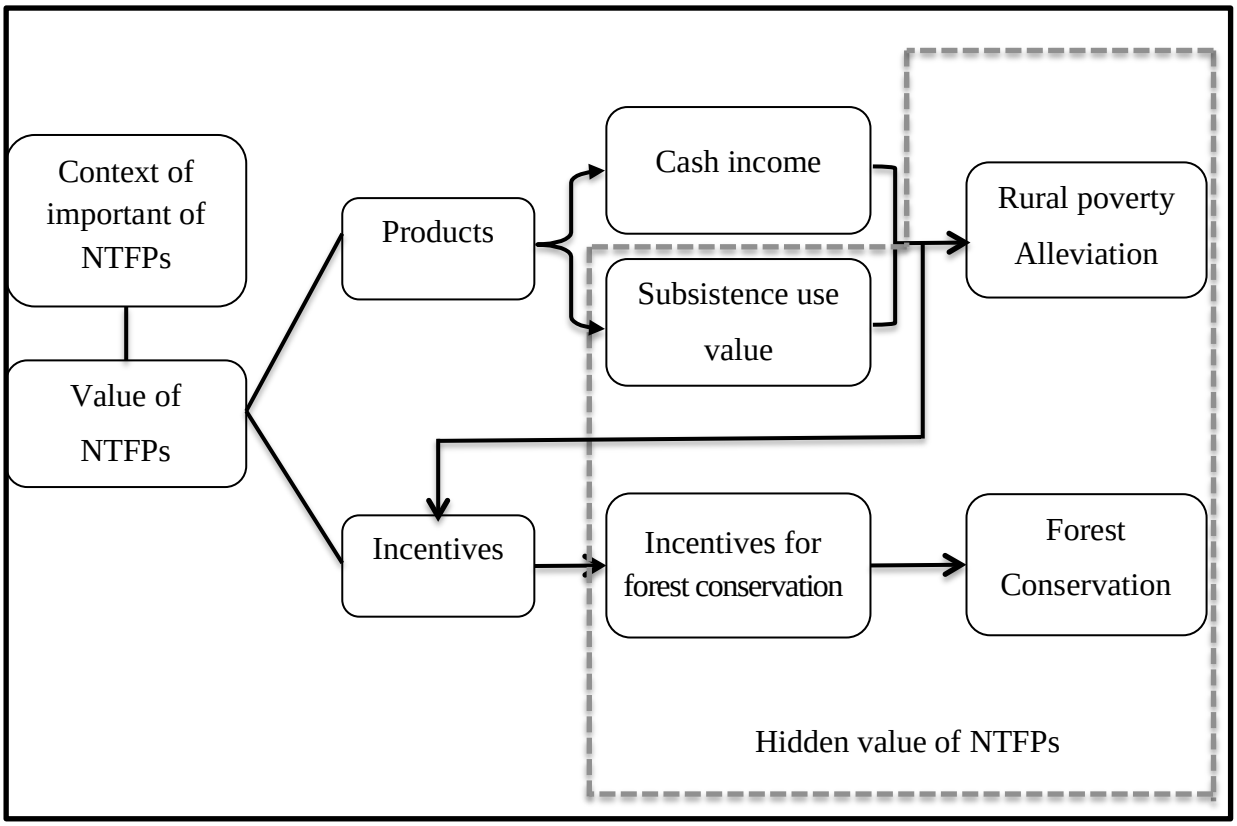


Figure 2-2 Conceptual Framework for Analyzing the Hidden Value of NTFPs
Source: Author, 2016

First, NTFPs provide products for consumption and commercialization. The economic value of NTFPs is mostly unrecognized from the perspective of rural poverty alleviation. The economic value of NTFPs consists of a combined value of cash income and the subsistence use value of NTFPs (Cavindish, 2002).

In the meantime, the economic value of NTFPs is mostly hidden in subsistence use because local people consume them according to different patterns (Cavindish, 2002: 18; DeBeer and McDermott, 1996: 22). In addition, it is claimed that NTFPs are important, not only for combating poverty, but also for reducing vulnerability to poverty (Paumgarten and Shackleton, 2011; Shackleton, Shackleton, et al., 2011). Hence, this study theorizes that the income from NTFPs plays a vital role in lifting rural households from poverty and prevents them from slipping into poverty in the future.

Second, NTFPs' incentives are generally acknowledged as being positively associated with forest conservation (Sunderland et al., 2011). Since the 1980s, the concept of incentives for forest conservation has gained a broader attention (McNeely, 1988). Jones et al. (2016) define incentives for forest conservation as the voluntary agreements that landowners make to conserve forests, and they will thus receive direct incentives as a result. NTFPs extraction can represent a sustainable form of tropical forest management. Theoretically, local people have little incentive to conserve the forest unless they gain something from it (Badola, 1998). Therefore, this study hypothesizes that NTFPs' extraction can create an incentive for local people to participate in forest conservation activities.

Chapter 3: Research Methodology[1]

3.1 Study Sites

In the distance around 277km from Phnom Penh, Capital city of Cambodia, Mondulkiri province is located in Eastern Cambodia. "Mondul" in Khmer language means "Group" and "Kiri" means "Mountain", so the meaning of this province's name is "Group of mountains." In ancient time, it was only a district of Kratie province, named “Chhlong Leu”. This region was separated to become a new province in 1960 by the former king Norodom Sihanouk. The coordination of this province is 12°27´N 107°14´E. This province may get warm in the daytime, and it turns chilly at the nighttime. The average temperature is 20 degrees Celsius with the average rainfall of about 1,800 mm/year. The landscape of Mondulkiri is mostly mountainous and hilly area with the average elevation of about 800 m above the sea level (MoT, 2015). The total area of this province is 14,288 km^2, which is divided into 5 districts (Sen Monorom, Kèv Seima, Koh Nhèk, O Reang, and Péch Chenda), 21 communes, and 91 villages (MoP, 2013b). The total population of Mondulkiri in 2013 was 72,680 persons. This province was the second lowest population in the country. The total households in 2013 were 15,206 households. The household size was almost 5 persons in a household (MoP, 2013b). This province is dominant by ethnic minorities, which account for around 80% of the total population while Khmer ethnic is about 20%. This province is the largest area of the country for ethnic minorities (NCDD, 2010).

[1] The section of Chapter 3 has been published in a technical report: Watkins, K., Sovann, C., Brander, L., Neth, B., **Chou, P**., Hoy, S., Spoann, V., and 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.

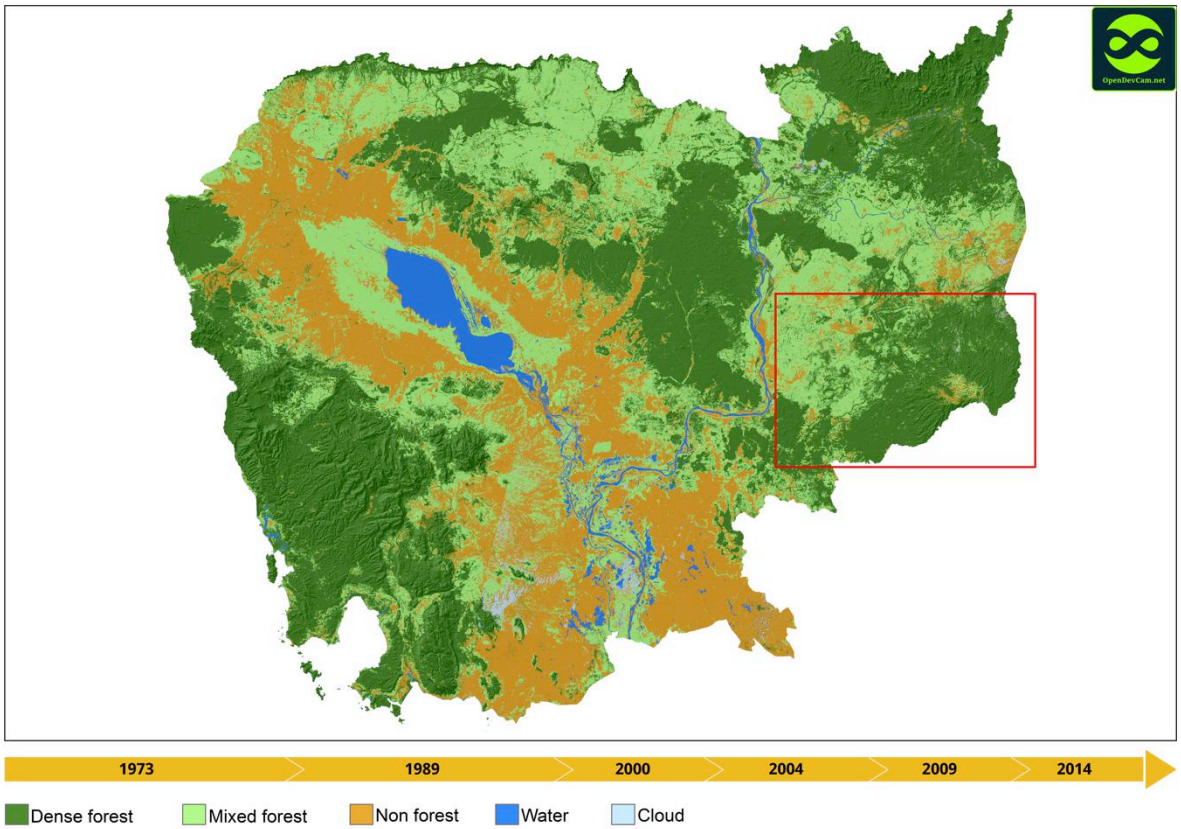


Figure 3-1 Cambodia Forest Cover 2014

Source: Open Development Cambodia, 2015

The main livelihood activities of people are rice cultivation, fruit trees plantation, livestock production, NTFPs extraction, eco-tourism, and working as hired labor to the rubber company plantation (NCDD, 2010). The poverty rate is still high, which is around 37% of the total population (Somoline, 2010). Forest had logged under forest concession about 73,199 ha in 2002 (Dane et al., 2015: 7). Up to 2002, the government had provided ELC to 21 companies, covering the land of 148,410ha to develop rubber plantation, and 21 mining corporation had held mining licenses to explore almost 6,144 km^2 (Dane et al., 2015).

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 seen in Figure 3-1. The whole area of PPWS is 2,225km^2. It covers more than 15% of the total area of

Mondulkiri province. PPWS was originally designated as a reserve forest by King Sihanouk in 1962 as a refuge for kouprey (*Bos sauveli*), and PPWS was later declared a Wildlife Sanctuary in 1993 by the Royal Decree (WWF-Cambodia, 2012). The climate is highly seasonal with a cooler rainy-season (July-November) and a hot dry-season (December-June). PPWS has rich forest habitats, which consists of a mosaic of deciduous dipterocarp forest (1,027km^2) and wetter semi-evergreen/mixed-deciduous forest (1,070km^2) (Gray, 2011). The mosaic of forest types in PPWS support more than 18 endangered and critically endangered mammals, birds, and reptiles (WWF, 2016). The reason for selecting this site for this research is because PPWS is one of the largest stretches of continuous dry and semi-evergreen forest in Southeast Asia (WWF, 2016). PPWS has been ranked as one of the most important sites for biodiversity conservation in Cambodia. PPWS is the wealth of ecosystems and is also of great importance to communities. Local people harness natural resources in the forest for supporting their livelihoods. Local communities celebrate diverse society with different believes and ethnic groups.

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 population, the need for food and agriculture is ever rising in Cambodia 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).

Table 3-1 Administrative Districts, Communes, Villages, and CPAs Located in PPWS

	CPAs	District	Commune	Village
1	Chi Klab	Koah Nheak	Sok Sant	Chi Klab
2	Srae Thum			Srae Thum
3	Srae Khtong	Kaev Seima	Srae Chhuk	Khtong
4	Poutong-Pouhoung		Chong Phlah	Poutong
				Pouhoung
5	Toul (Phnom Kduk)		Memang	Toul
6	Ronus-Khnheng		Chong Phlah	Khnheng
7	Sre Y	Saen Monorom	Romnea	Sre Y
8	Nglaoka		Sokh Dom	Lauka

Source: WWF-Cambodia, 2015

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. PPWS's location means that 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. Local people extract NTFPs primarily for subsistence use, especially for food, construction, cooking fuel, and medicine. The extraction of NTFPs is the traditional strategy of local people to cope with shocks including natural disasters or rising food prices. Giving the importance of NTFPs in livelihood and well-being, the NTFPs has been critically threatened by rapid deforestation and inappropriate forest management policy. If forests and their rich NTFPs are continuously decreasing, local livelihood and biodiversity will be severely suffered.

This wildlife sanctuary is the largest protected area in Mondulkiri province. It covers some parts of 7 communes in 4 districts among total 5 of the province.

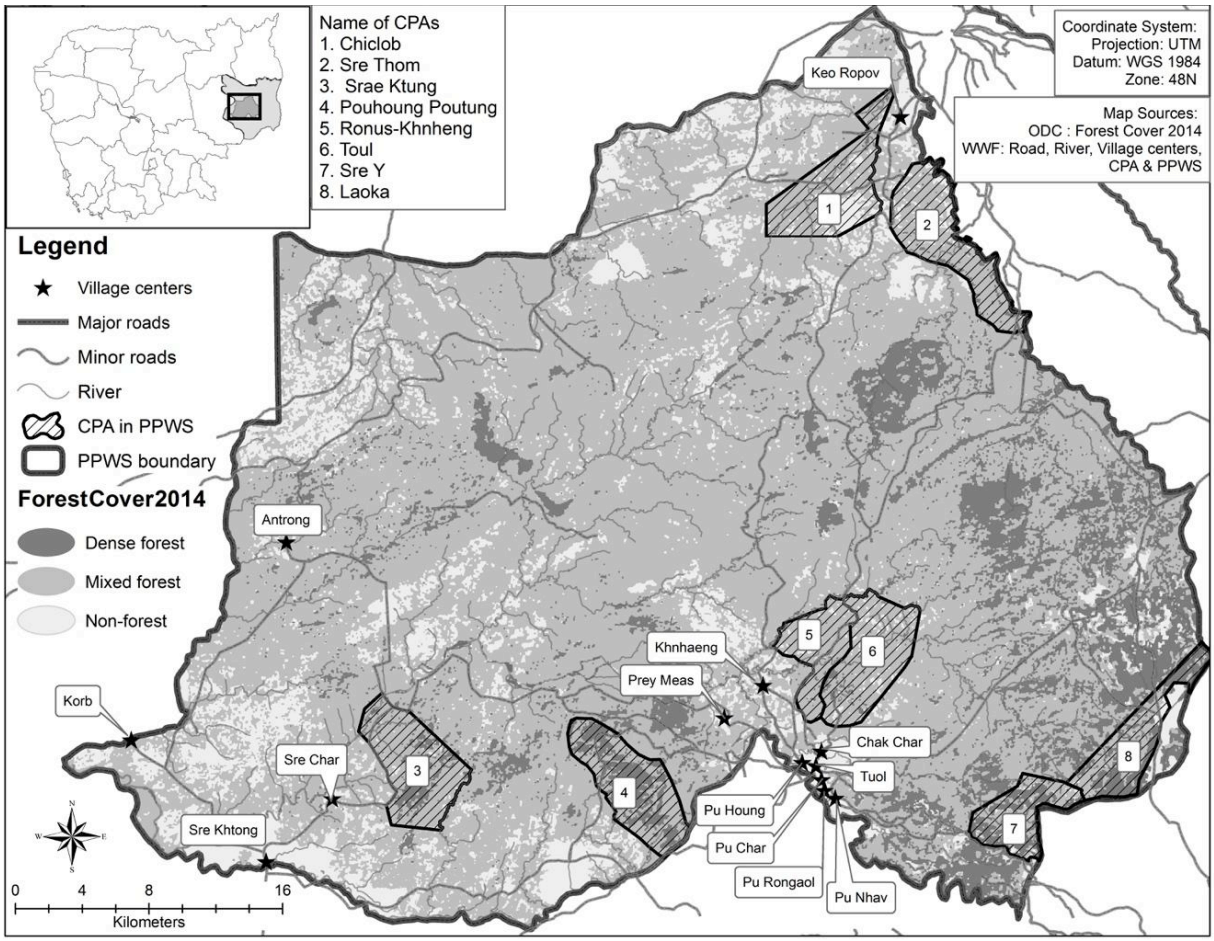


Figure 3-2 Phnom Prich Wildlife Sanctuary

Source: Author, 2016

Table 3-1 shows all CPAs and its location. Local people have diverse livelihood activities including agriculture, NTFPs collection, working as hired laborer, and other seasonal activities. Currently, 8 CPAs have been organized under supported by WWF-EPL together with PPWS protected officers and Ministry of Environment (See Figure 3-2). All CPAs have been thriving to join livelihood enhancement program through NTFP extraction and other conservation activities.

3.2 Data Collection

Multi-disciplinary approaches were used for collecting various data. Secondary data, participatory rural appraisals, structural questionnaire interviews, and literature reviews were

used to collect the data.

3.2.1 Secondary Data Collection

Secondary data were collected from official reports of the Ministry of Environment (MoE), the Ministry of Agriculture, Forestry and Fishery (MAFF), and World Wildlife Fund (WWF) as follows: the dataset of forest cover 2010, census data 2014, center of population 2008, road locations and size 1998, current livelihood conditions of local people in PPWS, forest management policies, forest conservation practices by government and INGOs, and NTFPs market price.

3.2.2 Primary Data Collection

Fieldwork was conducted in September 2015 for secondary data collection, key informant interviews, and participatory rural appraisal (PRA). The second fieldwork was conducted from March to April 2016 for structured questionnaire interviews. Another fieldwork was conducted in March 2017 for key informant interviews, especially for collecting data on conservation costs in PPWS. Structured questionnaire testing and adjusting was conducted prior to the survey.

A. Participatory Rural Appraisal (PRA): PRAs were conducted by way of focus group discussions (FGDs) at four community-protected areas (CPAs) in PPWS. Those CPAs were Nglaoka, Sre Y, Chi Klab, and Poutong-Pouhoung. Five to ten local people were invited to participate in each FGDs. The differences in gender, educational level, and ages were considered to select participants.

Five primary tools were applied during the focus group discussion. First, ‘Seasonal calendar’ tool was applied to know the current livelihood activities of local people in PPWS. Second, this study applied a ‘Ranking’ tool to identify the most important of NTFPs in the daily life of rural people in PPWS. Third, ‘Institutional framework’ was applied to know the

stakeholders and institutions involving in managing NTFPs. The role and level of management were discussed among participants at FGD. Fourth, 'NTFPs stock' was applied by identifying each NTFP stock to each type of land cover in current land-use and land-cover (LULC) in PPWS. Each NTFP was given value from 0 to 1 on the available stock in each LULC, where 0 is not available and 1 is the highest available stock. The definition of forest type was agreed with local meaning before participants was allowed to score the availability. To avoid confusion, value was classified into three main classes (low stock=0 to 0.3; medium stock=0.4 to 0.7; and high stock 0.8 to 1). When people selected low, medium, or high, exact value was asked to put according to their reason. If participants could not put the exact value, the mean value of those level were assumed. Fifth, 'forest conservation' was done in a way of drawing a figure. The roles of national government, provincial government, INGOs/NGOs, and local communities regarding the direct action, joint forest conservation, and policy/legal assistance were asked to identify.

B. Key Informant Interviews

Key informant interviews were conducted with village heads, chiefs of commune councils, heads of CPAs, MoE officers, WWF staffs, Wildlife Conservation Society (WCS) staff, Mondulkiri Forest Vulture (MFV) staff, rangers of MoE, and representative of the Bamboosa company to understand the current situation of PPWS, utilization of NTFPs, management of NTFPs, forest conservation, and conservation costs.

C. Structured Questionnaire Interviews

Criteria for Site Selection and Targeted Respondents: Presently, 8 CPAs have been established under recognition by the Ministry of Environment (MoE). This study selected only the CPAs supported by WWF-Cambodia and MoE because those CPAs are the centers of population. Only CPAs managing NTFPs for sustainable extraction and diverse livelihood

activities were considered. Selected CPAs must be located in different geographic zones in PPWS. Therefore, this study selected 6 CPAs among the 8 CPAs, including Nglao Ka, Sre Y, Chi Klab, Toul, Poutong-Pouhoung, and Srae Khtong. Figure 3-2 shows that all selected CPAs are located in different geographic zones in PPWS so that they can generally represent the current situation of PPWS.

Sampling Procedures: The population size in Mondulkiri province is small. Structured questionnaire interviews were conducted with 310 households, which were randomly selected from the above-mentioned 6 CPAs. The number of samples was considered with the checklist proposed by Godoy et al. (1993).

Table 3-2 shows the sample households from each CPA in PPWS. To get the best samples, this study considered the respondents as follows. The respondents were the local people who live in these communities and included the household head or youth above 18 years of age.

Table 3-2 Total Sample Households from Each Selected CPA in PPWS

	CPA	District	Commune	Village	Samples (HHs)
1	Nglao Ka	Saen Monorom	Sokh Dom	Laoka	42
2	Sre Y	Saen Monorom	Romnea	Sre Y	40
3	Chi Klob	Koh Nhaek	Sok Sant	Chi Klob	45
4	Poutong-Pouhoung	Keo Seima	Chong Phlah	Puhung	57
				Putung	38
5	Sre Khtong	Keo Seima	Sre Chhuk	Sre Khtong	44
6	Tuorl	Keo Seima	Memong	Tuorl	44
			Total		310

Source: Author, 2016

Various ethnic groups including Bunong, Khmer, Kuoy, and Cham were considered. All respondents were randomly selected by using 'Radom Function' from the name list of all people in the community, which include both members[2] and non-members[3] of CPAs. This study was designed to reduce measurement error. This study did pre-tests several times on the structured questionnaires for validity and reliability of the collected data. The quality of the data collected through each questionnaire was checked by enumerators and the author himself. After the data entry process, the author estimated the errors through descriptive statistics in SPSS.

3.3 Analytical Methods

To respond to the main objectives of this study, the key analytical methods to each objective were applied. Each analytical method has its own advantages. However, this study uses the most appropriate approaches to get the best empirical results for discussion. The procedure of analysis was designed based on the data accessibility, time availability, and budget constraints.

3.3.1 Utilization and Institutional Management of NTFPs

This objective describes the current utilization of NTFPs in Cambodia. However, this objective addresses the following research questions: (1) What are the current households' characteristics in PPWS? (2) How do local people utilize NTFPs for livelihoods, (3) What kinds of institutional management exist for the different types of NTFPs?

To respond to the first research question, descriptive statistics were used to describe

[2] Members of CPAs are the local people who register in the member list of the CPA, and they participate in managing NTFPs and join forest conservation.

[3] Non-members of CPAs are the local people living in the same village, but they do not engage in forest conservation activities.

household characteristics of local people in PPWS. Then the people-forest relationships by the seasonal calendar and people's dependence on the forestry resources were indicated. The simulation of "Open Access" model in Arc-GIS was run to get the map of NTFPs accessibility stock over the landscape of PPWS. Crosstabs in SPSS were used to analyze the dependence on the NTFPs, which varies with different households' characteristics.

To respond to the second research question, this study follows the definition of Berge et al. (2007). The utilization of a NTFP is a function of a number of people involved in their use and the frequency of their use and commercialization. Descriptive statistics were used to figure the frequency of people being involved with a NTFP and frequency of subsistence use or commercialization of a NTFP in the past year (2015).

Management of NTFPs implies social arrangements for protection, maintenance, and exploitation of NTFPs (Berg et al., 2007). This study focuses only the role of institutions in managing NTFPs in a forest-protected area. The enforcement of institutional arrangement allows policymaker to govern the use of the protected forests' resource (Mutenje et al., 2011). According to the information from government documents, focus group discussions, key informant interviews, and field observation, the institutional management of NTFPs was indicated by policy contribution, direct intervention, and financial or technical assistant.

3.3.2 Classification of NTFPs in Household Livelihood Strategies and Its' Determinants

This objective aims to classify NTFPs according to their contribution to household cash income[4] and household income, and management of NTFPs. Classification of NTFPs in household livelihood strategies allows policymakers to consider the roles of NTFPs used for improving rural livelihood. Furthermore, this study suspect that in the same protected area,

[4] The definitions of household cash income and household income are shown in Appendix, Table A-1 Glossary.

some local people devote their available NTFPs tor subsistence while others have the opportunity to increase household income through trading NTFPs. Adam et al. (2013) claimed that NTFPs in household livelihood strategies are influenced by many factors.

Further, local people make different decisions on integration NTFPs into cash income. The determinants of household livelihood strategies were analyzed using binary logistic regression and multinomial logistic regression. Household' production factors, household characteristics, community involvement, geographic status are the independent variables. The list of explanatory variables shows in Appendix, Table A-2.

3.3.3 The Hidden Value of NTFPs from the Viewpoint of Poverty Alleviation and Household Vulnerability to Poverty

The objective is to clarify how economically important NTFPs are to rural poverty alleviation and household vulnerability to poverty. Three research questions were addressed to response the objective: (1) How much economic value of NTFPs is hidden?; (2) Does NTFPs contribute to rural poverty alleviation?; (3) How important are NTFPs to cope with household vulnerability to poverty?

To respond to the first research question, this study applied quantitative flow-based approach, which captures use and sale of NTFPs by local communities living in a protected area. Campbell and Luckert (2002: 1-7) defined economic value as the sum of income from commercial goods and non-commercial goods. Therefore, this study estimated the economic value of NTFPs per household per year, limiting selected NTFPs from the viewpoint of combined values of cash income of NTFPs[5] and subsistence use value of NTFPs[6].

[5] The definition of cash income of NTFPs is shown in Appendix, Table A-1 Glossary.

[6] The definition of subsistence use value of NTFPs is shown in Appendix, Table A-1 Glossary.

To respond to the second research question, this study adopted 4 approaches to explain the role of NTFPs in rural poverty alleviation. First, share of income from NTFPs to household income was measured. In this study, household income is the sum of income from NTFPs, income from farming, income from forest, and income from employment. Second, this study compared dependency on NTFPs among household income tertiles. Third, this study measured the contribution of NTFPs to reducing rural poverty based on national poverty line in rural areas. This study used per capita income with and without income from NTFPs to compare with the rural poverty line of Cambodia. Fourth, this study checked the correlation between income from NTFPs and rural poverty indicators. 'Bivariate correlation' was applied in this case. As rural poverty indicators, three dimensions of multidimensional poverty index (MPI) suggested by UNDP (2014: 9) were used.

To respond to the third research question, this study applied the new approach to finding out how income from NTFPs is used for household vulnerability to poverty. This study used ordinary least square (OLS) in the regression model to test the hypothesis of 'In a time of crises and shocks, rural households turn to forests to extract more NTFPs as a safety-net for the livelihood'. This study used cross-section data based on the literature that when households suffered from crisis and shocks, local people would go to collect more NTFPs in the same year to earn more income for dealing with problems. Therefore, the signs of significant level can confirm this claim due to data available.

3.3.4 The Hidden Value of NTFPs through the Incentive for Forest Conservation

It aims to examine the value of NTFPs from the viewpoint of incentives for forest conservation. Three research questions were addressed to response the objective: (1) What are current forest conservation activities in PPWS?; (2) Can NTFPs create incentives for forest conservation?; (3) How much is the value of NTFPs from its' incentives for forest

conservation in PPWS?

For the first research question, this study used the qualitative information to explore current forest conservation activities, which has been done by the government, INGOs/NGOs, and local people. This study incorporates conservation activities from three categories, forest maintenance, forest protection, and reforestation.

For the second research question, this study applied binary logistic regression to test the hypothesis of 'Income derived from extraction of NTFPs will be an incentive for local people's participation in forest conservation'. Dependent variables are 7 indicators of forest conservation activities such as (1) not collect a critical part of the plant that affects growth/reproduction, (2) not collect only species that have low population size, (3) not collect species that have slow growth rate or reproduction rate, (4) joint community forest patrol, (5) inform or report the illegal collection activities, (6) contribute finance or administration to support forest protection, and (7) participate in forest reforestation. The independent variables are income from NTFPs and other related variables (See Appendix, Table A-5).

For the third research question, this study measured the value of NTFPs' incentives for forest conservation through costs of forest conservation activities.

Chapter 4: The Current Utilization and Institutional Management of Non-Timber Forest Products in Phnom Prich Wildlife Sanctuary[1]

4.1 Introduction

In the first place, economic growth is essential for the Cambodia to develop. However, economic growth at the expense of natural resources is unsustainable which increase the vulnerability among poor communities, especially those extraction NTFPs for livelihood (Watkins et al., 2016). In the forest landscape of Cambodia, about 84% of rural people collect NTFPs under the customary law for food, medicine, construction, agricultural tools, and cash income (Kim et al., 2008; Milne and Mahanty, 2015; MoE, 2011; Vantomme et al., 2002). NTFPs are an intrinsic part of culture and tradition of forest-based and indigenous communities of Cambodia (Vantomme et al., 2002). Different actors extract NTFPs with various purposes under different regulatory systems. Therefore, current utilization and management of NTFPs in Cambodia are still much complicated (Mulcahy and Boissière, 2014; Tola and McKenney, 2003; Vantomme et al., 2002). Lack of proper regulations may result in an inefficient use of resources to support the local economy (Milne & Mahanty, 2015).

Many NTFPs are unmarketed, generating the assumption that because their price is

[1] This Chapter 4 has been published in articles:

1) **Chou, P.** (2017). The Importance of Non-Timber Forest Products for Rural Livelihoods and Ecosystem Services at Phnom Prich Wildlife Sanctuary. *International Journal of Environmental and Sustainable Development, 8*, 7-13.

2) **Chou, P**. (2018). The Utilization and Institutional Management of Non-Timber Forest Products in Phnom Prich Wildlife Sanctuary, Cambodia. *Environment, Development and Sustainability*. doi: 10.1007/s10668-018-0113-3.

zero or low, so is their economic value. It is intriguing why the Cambodia government has not included NTFPs in the development agenda because it does not know the importance of NTFPs contribution to livelihood and well-being of local people. At present, the empirical evidence on the importance of NTFPs is not well documented in Cambodia. The role of the government and stakeholders in management of NTFPs is unknown.

The objective of this chapter is to understand how local people make use of and manage NTFPs for their livelihoods. This chapter addresses the following questions: (1) What is the current situation of Phnom Prich Wildlife Sanctuary (PPWS)? (2) Where are the most accessible sites of NTFPs over the landscape of PPWS? (3) How do local people utilize NTFPs for their livelihoods? and (4) What kinds of institutional management exist for different types of NTFPs?

4.2 Methodology

This study describes characteristics of households in PPWS and forest dependent[2] in order to understand the resource use in PPWS. The livelihood of local people, who are living in PPWS, was indicated by distribution of seasonally varying economic activities through the figure of seasonal calendar.

This study produces a map, which shows where there are the most accessible sites of NTFPs over the landscape of PPWS. 'Open Access' model in Arc-GIS software (version 10.1) was applied to get the map of NTFPs resources endowment. The data for processing were current land use and land cover 2010, NTFP products stocks (unique value 0, 0.3, 0.5, 0.7, 1), maximum travel distance to the product, population center, road size, and legal accessibility

[2] Forest dependent describes human populations who are most dependent on forests for livelihood including wood products, bushmeat, non-timber forest products, and environmental services (Newton et al., 2016).

for harvesting. The map is interpreted by whether NTFP resources are abundant in the area or not and how local people make use of those resources for daily life.

Descriptive statistics were used to analyze the number of sample households involved with each NTFP in the past year (2015). The percentage of sample households being involved with each NTFP was indicated as follows: a minus sign '-' for not or little involvement, corresponding 0-24% of sample households; a plus/minus sign '+/-' for moderate involvement, corresponding to 25-75% of sample households; a plus sign '+' for a strong involvement, corresponding to >75% of sample households. Also, the percentage of subsistence use or sale of NTFPs was indicated as follows: a minus sign, '-' for no or little subsistence use/sale; a plus/minus sign, '+/-' for occasional subsistence use/sale (seasonal); a plus sign, '+' for a continuing subsistence use/sale (high amount, all year round). Each classification was established through the structured questionnaire interviews. The sample households indicated the level of subsistence use/sale of specific NTFPs.

In addition, this section used crosstabs in SPSS to identify who are the NTFPs-dependent people. It shows different categories of households collecting NTFPs for livelihoods.

This study did not measure the technical management practices regarding extensive management or intensive management, which influence the natural regeneration of the species. This study focuses only the role of institutions in managing NTFPs in a forest-protected area. According to the information from government documents, FGDs, key informant interviews, and field observations, the institutional management of NTFPs was assessed by policy contribution, direct intervention, and financial or technical assistant. The role of institutions in the management of NTFPs was indicated as follows: a minus sign '-' represents weak enforcement if three indicators mentioned above (policy contribution, direct

intervention, and financial or technical assistant) were not implemented by an institution; a plus/minus sign '+/-' represents 'moderate enforcement' if an institution enforced at least one type of the indicated management activities; a plus sign '+' represents 'strongly enforcement' if an institution enforced at least two types of the indicated management activities.

4.3 Results

4.3.1 Characteristics of Households in Phnom Prich Wildlife Sanctuary

A. Households' Characteristics

The majority of local people are Bunong (Phnong), who account for 83% of the total sample households, as shown in Table 4-1. The Bunong is an aboriginal Cambodian minority ethnic group who believes in their ancestors that are represented by the spirits. Bunong people also believe that all things have spirits including animals, plants, hills, stones, jars, and building, so they traditionally have a strong link with forest ecosystems to ensure their spiritual beliefs.

Most of sample households are the native people[3] who have been living in PPWS for centuries. The second most common ethnic group is Khmer, and they are Buddhist. There are a few Cham who believe in Islam.

Table 4-1 shows that the average household size was six persons. In general, males are heads of households who make decisions about livelihood activities. Average age of household heads was around 38 years old. Illiteracy rate of household heads was high (49%), and only 9% and 2% of household heads entered secondary school and high school, respectively. A household owned almost 3 ha of farmland. Sample household had 3 livelihood activities to make a living on average. Main occupation of households was farming (79%) while they had secondary occupations such as extraction of NTFPs, working as hired labour, fishing, and logging.

[3] Native people are known as the indigenous people or first people who are the original inhabitants.

Table 4-1 Households' Characteristics in PPWS

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 (90.30%); hired labour (40.30%); fishing (33.90%); logging (24.80%)
Average age of household head	37.56 years old
Average household size	6 persons
Average years of living in the area	29.27 years
Average total land owned by a household	2.77ha
Number of occupations per household	3 occupations/household

Source: Structured Questionnaire Interviews, 2016

B. Rural Livelihood Activities of Local People in PPWS

Figure 4-1 shows the current livelihood activities of local people in PPWS. They were still doing traditional livelihood activities.

Regarding farming activities, rainfed rice, cash crop, and vegetables were cultivated in rainy season. Livestock production, fishing, and small business were carried out by rural people in all year round. Some people, who are landless or own small farmland worked for other farmers especially in farming practices such as sowing and harvesting in rice cultivation. Also, local people collect NTFPs in both dry and rainy seasons depending on the type of NTFPs. For illustration, bamboo shoots can be collected only in rainy season, but wild honey and prich leaves (*Melientha suavis* Pierre*)* are available only in dry season.

Household Activities	Dry Season (November-April)				Rainy Season (May-October)						Dry Season	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rainfed Rice												
Chamkar[4]												
Vegetables												
Livestock												
Fishing												
Small Business												
Hired labor												
NTFPs												

Figure 4-1 Seasonal Livelihood in PPWS

Note: Blank, light grey highlight, and patterns highlight represent no activity, occasional activity, and more frequent activity, respectively

Source: Focus Group Discussions, 2016

Liquid resin, solid resin, bamboo poles, orchids, and fuel woods can be collected in all year round. Indeed, local people more frequently collect commercial NTFPs such as liquid resin, solid resin, wild honey, and orchids in dry season, when they are free from farming.

C. Forest-Dependent Households in PPWS

Forest resources in developing countries fundamentally provide benefits to forest dwellers who live in or nearby the forest (Cavendish, 2002; Sheil and Wunder, 2002).

Figure 4-2 shows that a large proportion of the sample households in PPWS used forest resources for their livelihoods as follows.

[4] Chamkar is a Khmer word that literally refers to field or cultivation on fruit trees (Mango, Banana, Avocado, Pine-apple, etc.) or cash crop (Cashew, Cassava, or Rubber trees).

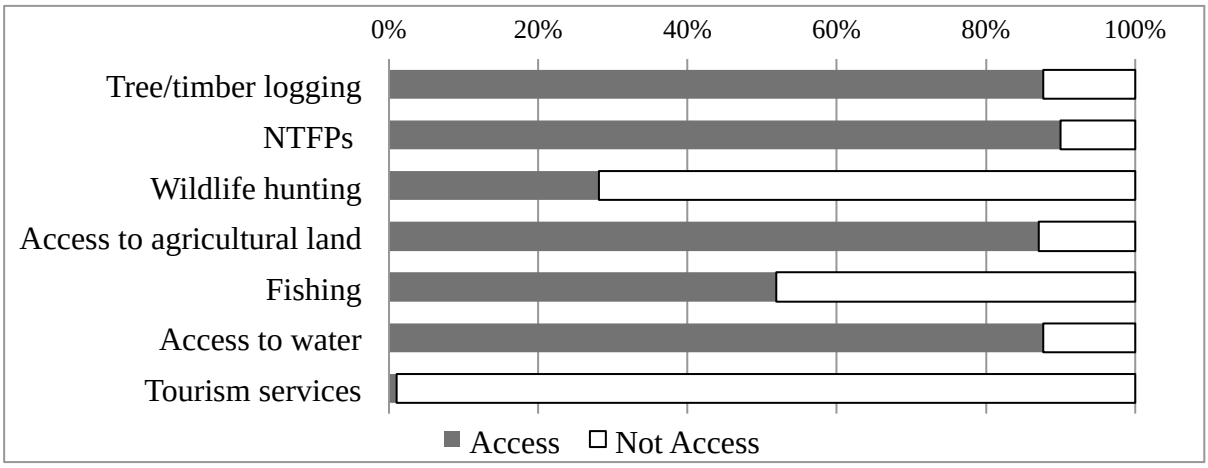


Figure 4-2 Forest-Dependent Households in PPWS

Source: Structured Questionnaire Interviews, 2016

Around 93% of the sample households collected NTFPs for subsistence use and cash income. Approximately 61% of NTFPs collectors sold at least one NTFP to the market for earning cash income. Eighty eight percentage of sample households logged timber, and 15% of them sold the timber for cash income, while other households used timber for household's construction and farming equipment. Eighty eight percentage of sample households used water from forest streams and river for subsistence use, including drinking, cooking, bathing, and washing. Eighty seven percentage of sample households owned farmland, and only 17% of them sold farm products to the market. Fifty two percentage of sample households caught fish for household consumption, and only 7% of them sold fish for cash income. Twenty eight percentage of sample households hunt wildlife for food, and around 18% of them sold bush meat to the market. There was only 1% of sample households that provided tourist service to earn cash income.

4.3.2 NTFPs Resources Endowment in PPWS

Figure 4-3 is the result of 'Open access' model simulation.

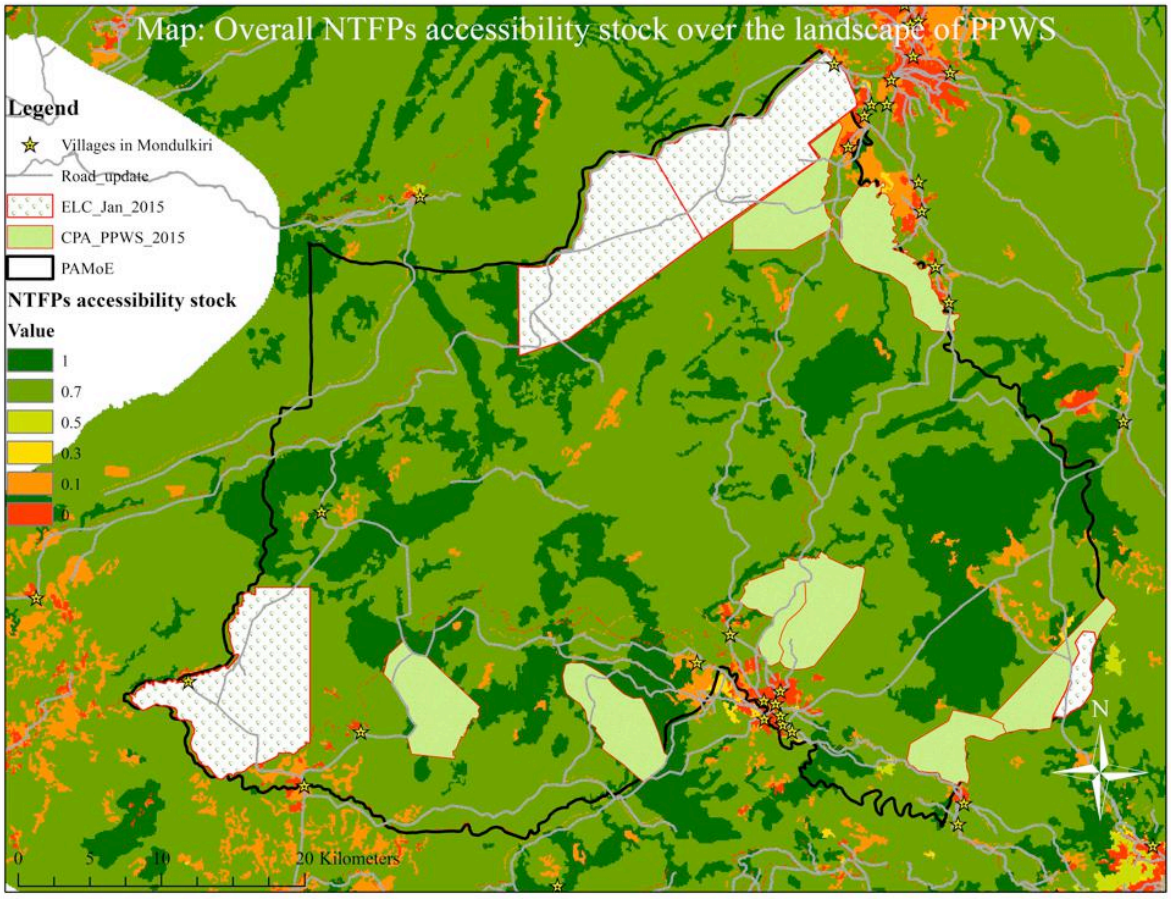


Figure 4-3 Map of Accessible NTFPs in PPWS

Source: Author, 2016

Through the NTFPs accessibility map, it is clearly seen that NTFPs are abundant over the landscape, according to the identified value of high accessibility - light green (0.7) and dark green (1.0). The value of resources accessibility is likely to be less in the areas nearby roads, village, and city, as indicated by red, orange, and yellow colors. Each NTFP has different characteristics of habitats and stock. Bamboo, fuel wood, prich leaves (*Melientha suavis* Pierre*)* are very abundant, so local people easily access. Commercial products including liquid resin, solid resin, wild honey, and orchids are located in further distance, mostly in evergreen and semi-evergreen forests, of which the distance ranges from 9km to 14km from their villages.

4.3.3 NTFPs Utilization by the Local People

A. The Most Important NTFPs for Livelihood of Local People in PPWS

There are more than 900 types of NTFPs listed in the declaration of the Ministry of Agriculture, Forestry, and Fishery of Cambodia (MAFF, 2005). Because of time constraints, this study decided to select only the most essential NTFPs for livelihood of local people living in PPWS. According to FGDs and key informant interviews, 14 NTFPs were initially selected.

Around 93% of sample households collected NTFPs (N=288). Based on structured questionnaire interviews with 288 sample households, who collected NTFPs, 6 NTFPs were firstly selected as important NTFPs to rural livelihood because more than 50% of sample households collected them for either home consumption or cash income. Figure 4-4 shows the percentage of sample households that were involved with each NTFP were 98%, 85%, 83%, 56%, 56%, and 50% for fuel wood, bamboo shoots, prich leaves (*Melientha suavis* Pierre), solid resin, bamboo poles, and liquid resin, respectively. Additionally, wild honey (31%) and orchids (32%) were considered as essential NTFPs because they constitute sources of cash income.

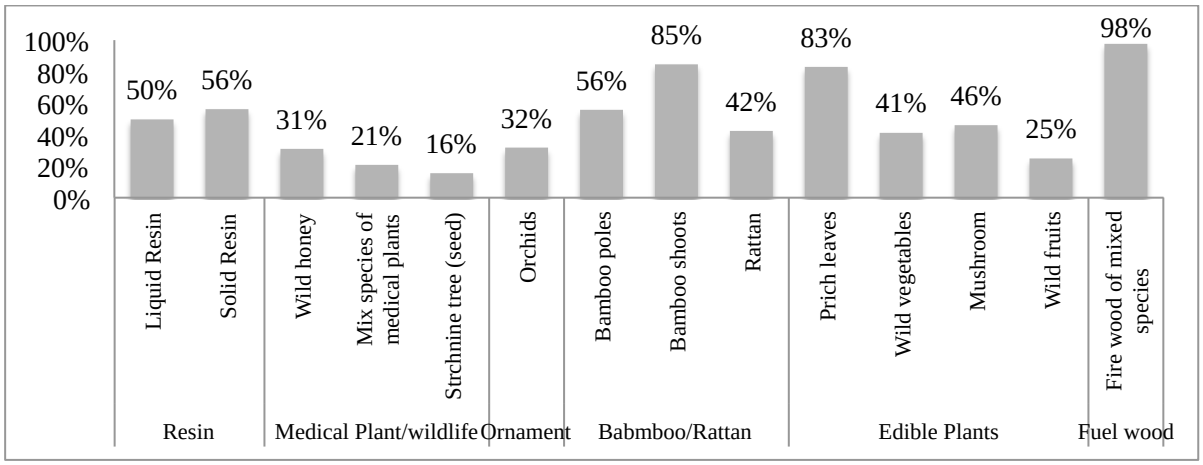


Figure 4-4 Percentage of Sample Households Involved in Each NTFP

Source: Structured Questionnaire Interviews, 2016

B. NTFPs Utilization by Local People

Table 4-2 shows diversity of NTFPs utilization in PPWS.

Table 4-2 Utilization of NTFPs

NTFPs	Key species	Sample households involved	Home consumption	Cash income
Liquid resin	1. *Dipterocarpus alatus* 2. *Dipterocarps intricatus* Dyer	+/-	+/-	+
Solid resin	1. *Shorea guiso* 2. *Shorea siamensis* 3. *Genera of Dipterocarpaceae (Vatica & Hopea*)	+/-	-	+
Bamboo-shoots	1. *Bambusa sp.* 2. *Bambusa bambos*	+	+	+/-
Bamboo-poles	1. *Bambusa sp.* 2. *Bambusa bambos*	+/-	+	-
Fuel wood	Diverse tree species	+	+	-
Wild honey	1. *Apis dorsata* 2. *Apis florae* 3. *Apis cerana*	+/-	+/-	+
Orchids	*Vandopsis gigantea*	+/-	-	+
Prich leaves	*Melientha suavis* Pierre	+	+	-

Notes: 1) Percentage of sample households involved: - not or little (0-24% of sample households); +/- moderate (25-75% of sample households); + strong (>75% of sample households).

2) Percentage of subsistence use/sale: - not or little subsistence use/sale; +/- sometimes subsistence use/sale (moderate amount/seasonally); + often subsistence use/sale (moderate or large amount of all year round).

Source: Structured Questionnaire Interviews, 2016

The most important NTFPs for subsistence uses in PPWS were fuel wood, bamboo shoots, bamboo poles, prich leaves, wild honey, and liquid resin. All sample households collected fuel wood for subsistence use and regularly in year round. Fuel wood ultimately served local communities as the source of energy, especially for cooking. Prich leaves were the second most important NTFP for subsistence use, especially for food consumption. Around 93% of sample households laboriously collected prich leaves during the dry season for their livelihood. The third important NTFP for subsistence use was bamboo shoots because 91% of sample households collected it for food consumption in moderate amount. Bamboo shoots were essential vegetable for local people during the rainy season. Around 82% of sample households extracted bamboo poles occasionally in small amount when they needed raw materials for construction, fencing, and furniture, but about 18% collected it regularly in a moderate amount to fulfill their demand. In a few cases, wild honey was used for traditional medicine and as a food ingredient. Liquid resin was used for shelter construction.

Table 4-2 shows that liquid resin, solid resin, wild honey, and orchids were often sold to the market at PPWS. Around 62% of sample households extracted liquid resin intensively in all year round for sale, while 39% of sample households extracted it seasonally, especially during the dry season. Wild honey, orchids, and solid resin were seasonally collected for sale, as seen in Table 4-2. All these commercial NTFPs were commonly sold to local middlemen without any further processing. Bamboo shoots were sold when only local markets were available. In a few cases, bamboo poles and prich leaves were sold to the market. In fact, market-oriented harvesting of bamboo poles occurs only in Chi Klab and Sre Thom because Mondulkiri Forest Venture (MFV) and Bamboosa Global Ventures initiated bamboo poles market in both communities.

C. NTFPs-Dependent People in PPWS

Households' characteristics make a crucial distinction among people who rely on NTFPs as the main source of livelihood.

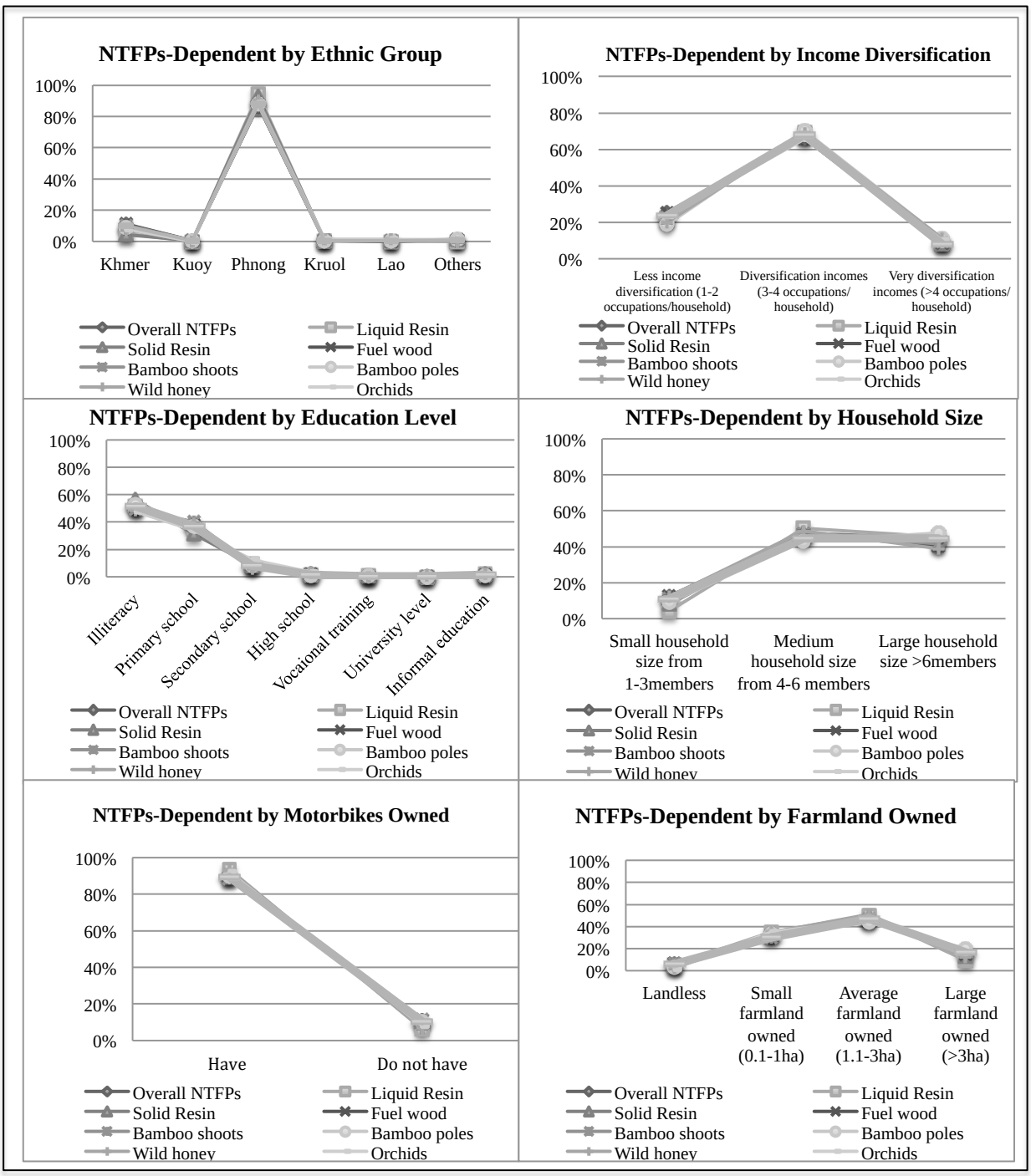


Figure 4-5 NTFPs Dependency by Households' Characteristics

Source: Structured Questionnaire Interviews, 2016

Figure 4-5 shows that Bunong tend to depend on NTFPs because extraction of NTFP is the traditional activity to sustain their livelihoods. Sample households, who had moderate income-diversification (3 to 4 occupations per household), seem to collect more NTFPs. Likewise, sample households, who are illiterate, are more likely to depend on NTFPs. Regarding households' production factors, sample households with more household members collect NTFPs more than sample households with few household members, as shown in Figure 4-5. This indicates that NTFPs collection is labor intensive. Anyway, sample households, who has motorbike for mobility, are able to travel further to collect more NTFPs. Also, sample households, who own an average size of farmland, are likely to collect more NTFPs than landless households or households with large farmland.

4.3.4 Institutional Management of NTFPs

This study suggests management strategies of NTFPs that imply an active role of the institution. Institutions involved in NTFPs management can be classified into external institutions and local institutions. Table 4-3 shows the institutional management for selected NTFPs.

External institutions play an indirect role in managing NTFPs. First, government institutions have been engaged mostly in providing a legal framework. For example, the Ministry of Agriculture, Forestry, and Fisheries issued the Sub-decree No. 79 dated December 2003 on Community Forestry Law entitling local communities the right to use local resources. The Ministry of Environment issued the National Forestry Program 2010-2029 to provide technical management practices and financial supports to the relevant ministries. Second, provincial and district government authorities are responsible for executing the government policies and laws. Provincial and district governments cooperate with INGOs and local communities to prevent illegal logging. Third, PPWS Authority, which is under the

Ministry of Environment, has cooperated with local communities to patrol the forest in their region. Fourth, international donors such as USAID and European Union and INGOs including World Wildlife Fund-Cambodia (WWF-Cambodia), Wildlife Conservative Society-Cambodia (WCS-Cambodia), Winrock International, Non-Timber Forest Products Exchange Programme (NTFP-EP), and others play a significant role in providing fund and technical assistance. They delivered services to the community for capacity-building, organizing forestry communities, marketing, and research.

Table 4-3 Institutions for Managing Forest and NTFPs in PPWS

Institutions	Main Responsibilities
External institutions	
Central government	Legal framework from MAFF, Cambodia (Community Forestry Law, Sub-decree No.79 Dec 2003); National forestry program 2010-2029 to support technical and financial to in-line ministries.
International donors (EU, USAID) & INGOs (WWF, WCS, NTFP-EP, Winrock)	Financial and technical assistance to the government and directly delivery services to community (capacity building, CPAs facilitating, marketing and research).
Provincial & district government authorities	Executing the policies and plans, tasks delivery, and cooperation with INGOs & NGO for services delivery.
PPWS authority	Executing the policy of conservation.
Local NGOs & Company	Operate development project and closely facilitate with CPAs; Marketing (CEDAC, MFV, Bamboosa co., ltd., AMK, ACLEDA)
Local institutions	
Commune councils (CC)	Administrative services and development CDP and CIP under the commune council funds
CPAs	Enforce rule & regulation for forest protection and utilization; collaboration with village, commune councils and NGOs

Source: Focus Group Discussions, 2016

Local institutions include commune council (CC) and community protected areas (CPAs), as shown in Table 4-3. Commune council is composed of 5 to 10 members depending on demography and geography, elected through a proportional system. Each commune consists of a number of villages. Community protected areas and community forests share the same definition. It is a village level, which intimately involves local people in forest management and land use decision. At present, commune councils contribute to solving administration problems. On the other hand, CPAs play a role in controlling natural forest areas under the common property right of its members within its geographic boundary. CPAs actively protect liquid resin trees and forests.

Regarding the role of institutions in managing NTFPs, external institutions manage a few NTFPs.

Table 4-4 Management Level of NTFPs

NTFP Products	External institutions					Local institutions	
	Central Government	INGOs	Government at provincial and district	PPWS Authority	Local NGOs & Company	Commune council (CC)	Community protect areas (CPAs)
Liquid resin	+/-	+/-	+/-	+/-	+	+	+
Solid resin	-	-	-	-	-	-	+/-
Bamboo shoots	-	-	-	-	-	-	-
Bamboo poles	-	+/-	-	-	+/-	-	+/-
Fuel wood	-	-	-	-	-	-	-
Wild honey	-	+/-	-	-	+/-	+/-	+/-
Orchids	-	-	-	-	-	-	+/-
Prich leaves	-	-	-	-	-	-	-

Note: Management level of NTFPs: - weak enforcement; +/- moderate enforcement; + strongly enforcement

Source: Field Observation, 2016

Table 4-4 shows that only liquid resin was moderate managed by the government, provincial and district authorities, and PPWS authority through their engagement by law and policy enforcement. INGOs played a role in supporting CPAs. Also, local NGOs strongly managed liquid resin trees, as identified by the sign '+' in Table 4-4. Local NGOs not only cooperated with local communities to patrol trees but also supported them with fund. In addition, INGOs and local NGOs cooperated and supported each other to manage bamboo poles and wild honey in the same ways as liquid resin. Other NTFPs have not received any attention or intervention from external institutions.

Local institutions manage many NTFPs. Most of NTFPs collected by households were not legitimized and were constrained by commune councils and other regulatory frameworks. Table 4-4 shows that liquid resin and wild honey received sign '+' or '+/-,' respectively. This finding clearly shows that only liquid resin and wild honey were receiving some protection and cooperation from commune councils in PPWS. On the other hand, members of CPAs have been patrolling the forest to protect liquid resin trees regularly, at least two times per week. CPAs monitored tapping techniques of resource users, forest fire, and illegal logging. CPAs cooperated with middlemen and NGOs (Mondulkiri Forest Venture and WWF-EPL) for trading liquid resin in the community. Besides liquid resin, CPAs have engaged and supported local people in collecting solid resin, bamboo pole, wild honey, and orchids with proper techniques, as indicated by sign '+/-' in Table 4-4. They have worked closely with commune councils and village chiefs to settle internal disputes. Nevertheless, CPAs are still lack of financial supports to prevent illegal logging and poaching.

4.4 Summary

Rural households living in a forest sanctuary of PPWS highly depend on forest resources for their livelihoods.

Indeed, many NTFPs provide vital benefits to local livelihood, especially during the off-season when local people are free from farming.

Even there are more than 900 types of NTFPs listed in the declaration of the MAFF, this study identified fuel wood, bamboo shoots, prich leaves (*Melientha suavis* Pierre*)*, solid resin, bamboo poles, liquid resin, wild honey, and orchids as the most important NTFPs in PPWS for local livelihood. Many NTFPs were self-sufficiently collected and consumed by sample households. NTFPs are crucial for household consumption, especially for food, construction, fencing, cooking fuel, and farm equipment. Also, NTFPs provide cash savings to many households. People sell NTFPs only when the markets and local traders are available at their locations. Cash income from selling NTFPs can be saved for use in times of misfortune or livelihood needs, such as school fees, agricultural purchases. Indeed, NTFPs are the primary resources for most of local people even though they have different households' characteristics.

Regarding the institutional management of NTFPs, the local institutions play the greatest role to achieve the management of more NTFPs, since the external institutions are interested only a few NTFPs. Nevertheless, NTFPs for household consumption, such as bamboo shoots, prich leaves, and fuel wood did not receive any attention from the stakeholders. Thus, utilization of NTFPs is not sufficiently considered when developing policies or management plans. Considering the importance of NTFPs in the livelihood and well-being of local people, it is a serious mistake that NTFPs have not yet received attention from the government and from international donors for their national policies and development agendas.

Chapter 5: Non-Timber Forest Products in Household Livelihood Strategies

5.1 Introduction

To lessen the deforestation rate, the Cambodian government has implemented forest protection and management through various policies, but the integration of NTFPs development agendas have not well-considered (FA, 2009). These methods of forestry reform not only failed in implementing sustainable forest management schemes, but also actively lead to worsened deforestation (Cock, 2016). Therefore, without understanding the basis of NTFPs' use and households' choice for pursuing a particular household livelihood strategy, the goals of forestry reforms can never be achieved.

The influential study of DeBeer and McDermott (1996) suggested that even though NTFPs are important for rural livelihoods and forest conservation, policy makers often tended to forget the role of NTFPs because they lack strong evidence that they contribute significantly to the national economy and livelihoods of local people. The body of literature regarding the potential contribution of NTFPs remains limited and open to doubt (Adam et al., 2013; Arnold and Pérez, 2001; Belcher et al., 2005a). Nevertheless, studying the processes of current utilization and management of NTFPs has presented contrasting perspectives (Ruiz-Pérez et al., 2004). Some researchers consider the extraction of NTFPs from the wild as serving subsistence needs, thus enhancing livelihoods in is the long-term (Angelsen and Wunder, 2003; Belcher and Kusters, 2004b; Ticktin, 2004). Belcher and Schreckenberg (2007) concluded that commercialization of NTFPs is likely to be successful primarily as a means to improve livelihoods for local people. Other studies suggest that the increasing extraction of NTFPs often results in overexploitation. The process of intensified management can therefore maintain or increase the supply to the markets (Belcher et al.,

2005a; Ruiz-Pérez et al., 2004). In general, NTFPs extraction can be classified as diversified livelihood strategies that improve their standard of living, yet an empirical basis for these discussions is weak. Consequently, an attempt to classify NTFPs in household livelihood strategies is crucial for institutions to gain insight into more effective ways of forest management.

This study modifies the analysis procedure of Belcher et al. (2005) and Ruiz-Pérez et al. (2004). This study attempts to classify NTFPs according to their contribution to household cash income and household income, alongside the management of NTFPs. This study seeks to define an appropriate term applicable to household livelihood strategies, which exposes the different current roles of NTFPs. This study also questions why some local people devote their available NTFPs to subsistence while others have the opportunity to increase household income through trading NTFPs, despite all being located in the same forest landscape. Thus, this study aims to classify NTFPs in household livelihood strategies and illustrate their determinant factors in the context of Phnom Prich Wildlife Sanctuary, Cambodia.

This chapter discusses the contribution of NTFPs to household cash income and household income in different groups of household livelihood strategies. Furthermore, it compares the ecological impact from different alternatives for the management of NTFPs, ranging from low-managed (collecting from the wild) to strong-managed (intensive management). Another objective is to analyze the factors determining households' decision on livelihood strategies.

5.2 Methodology

5.2.1 Classification of NTFPs in Household Livelihood Strategies

Previous studies by other researchers focus only on commercial NTFPs, so they do not accurately reflect the reality of their role, diversity, and trends. This chapter uses data from

structured questionnaire interviews, gathered from 288 sample households who collected NTFPs. This study thus reflects the current contribution of NTFPs to local livelihoods in Cambodia.

The main objective of this chapter is to explain the classification of NTFPs in terms of household livelihood strategies. The share of cash income from NTFPs in household cash income and the share of income from NTFPs in total household income are therefore used to classify the role of NTFPs into four groups. Sample households can appear in several livelihood strategies, so they are not divided into mutually exclusive groups. Table 5-1 illustrates four distinct groups: (1) low contribution to household cash income and low contribution to household income; (2) low contribution to household cash income but high contribution to household income; (3) high contribution to household cash income but low contribution to household income; and (4) high contribution to household cash income and high contribution to household income. However, there is no economical reason, and there were not any cases found in group (2) above. Therefore, only three groups presented, including (1), (3), and (4).

The group of 'high integration into the cash but low contribution to household income' cannot be distinguished, so this study established an alternative criteria – the management of NTFPs. Management of NTFPs is a key strategic decision for local people who collect NTFPs to support their livelihoods. The intensity of management has disrupted ecosystem services through disturbance to genes, species, and communities (Shaanker et al., 2004). Intense management of NTFPs ranges from wild collection to intensive cultivation (Anderson, 1992; Belcher et al., 2005), but there were no discovered instances of NTFPs being cultivated in PPWS. However, this study defines three levels of management, such as low, moderate, and strong.

Table 5-1 Characteristics of NTFPs in Household Livelihood Strategies

Contribution to household cash income		Contribution to household income		Management of NTFPs			Household livelihood strategy
<50%	>50%	<50%	>50%	Low	Moderate	Strong	
Sell <50% of amount of collected a NTFP		Share <50% of HH income		Low managed (collect from the wild)			(S1) Subsistence strategy
Sell >50% of amount of collected a NTFP		Share <50% of HH income		Low managed			(S2) Supplementary strategy
Sell >50% of amount of collected a NTFP		Share <50% of HH income		Moderate or Strong managed			(S3) Diversified strategy
Sell >50% of amount of collected a NTFP		Share >50% of HH income		Strong managed			(S4) Specialized strategy

Source: Modified from Belcher et al. (2005)

Low management of NTFPs represents wild collection activity without any transformation to the forest structure, due to extraction of NTFPs (Belcher et al., 2005). Moderate management refers to conventional practice, where local people use their indigenous knowledge to meet economic needs through efficient labor and regeneration control. This had an overall positive impact on biodiversity (Anderson, 1992). Strong management in this study refers to intermediate management (between wild collection and intensive cultivation) that local people utilize in order to increase production through natural treatments, such as weeding or crown opening. Forests are partially transformed, but natural succession still operates (Belcher et al., 2005).

Table 5-1 illustrates four groups of NTFPs in livelihood strategies. The subsistence strategy (S1) represents sample households who collect NTFPs from the wild in low managed or unmanaged ways. Those NTFPs tend to contribute little to household cash income and household income. They primarily serve subsistence use. The supplementary strategy (S2) refers to sample households who are more oriented towards cash income. NTFPs are collected

from the wild to provide a supplementary cash income, yet the share of income from NTFPs in household income is relatively small. The diversified strategy (S3) stands for sample households who managed NTFPs through conventional practice (moderate managing) or intermediate management (strong managing) as a source of additional income. The specialized strategy (S4) refers to sample households who tend to manage NTFPs as the main source of their household income. NTFPs are managed strongly in the manner of intermediate-intensive management for natural regeneration.

5.2.2 Analysis of Factors Influenced Decisions on NTFPs in Household Livelihood Strategies

This study hypothesizes that the ability to pursue different livelihood strategies depends upon the possession of household production factors; community involvement; households' characteristics; and geographic status. Identifying the factors influencing the decisions of local people regarding the collecting of NTFPs thus helps policymakers to enforce better management of NTFPs. This can provide benefits to local livelihoods and forest conservation.

The determinants used in the selection of household livelihood strategies are analyzed using binary logistic regression and multinomial logistic regression. The binary logit model is applied to assess the determinant between two household livelihood strategies. In practice, the sample households had two choices of livelihood strategies regarding five NTFPs, such as: liquid resin, solid resin, bamboo poles, bamboo shoots, and prich leaves. The equation (5.1) describes the empirical model of the binary logistic model. Since wild honey was the only NTFP which sample households had three choices in household livelihood strategies, Multinomial logistic regression is used in this case. The reason for using this model is it can predict more than two outcomes from response variables, as shown in equation (5.2).

Anyway, sample households had only one choice for a household livelihood strategy using fuel wood and orchids. Neither aforementioned NTFPs were included in this analysis.

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \tag{5.1}$$

Where $\boldsymbol{y}$=(1,0), it is outcome of binary choice of household livelihood strategies

Matrix $\boldsymbol{X}$ = [$\boldsymbol{I\ S\ H\ G}$]

$$\boldsymbol{z} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \tag{5.2}$$

Where z = (1,2, or 3), it is outcome of multi-choices of household livelihood strategies

Matrix $\boldsymbol{X}$=[$\boldsymbol{I\ S\ H\ G}$]

Explanatory Variables:

I: Household's production factors (Household's labor, land owned, and capital)

S: Community involvement (membership of a CPA, received market information, and received technical training)

H: Household's characteristics

G: Geographic status

$\boldsymbol{\varepsilon}$: error term

$\boldsymbol{\beta}$: function of coefficient

The reliability prediction analysis and diagnostic procedures were done sufficiently as follows: First, Chi-square test and One-Way ANOVA test are used taking all concerned explanatory variables into consideration (Appendix, Table A-2). Only significant variables from this analysis are included in the final model (Appendix, Table A-3). Second, a multicollinearity test is used to avoid the problem of high correlation among predictors. The results from tolerance & VIF (variance inflation factor) are calculated to check multicollinearity problems. Third, Omnibus tests of model coefficients are checked to assess

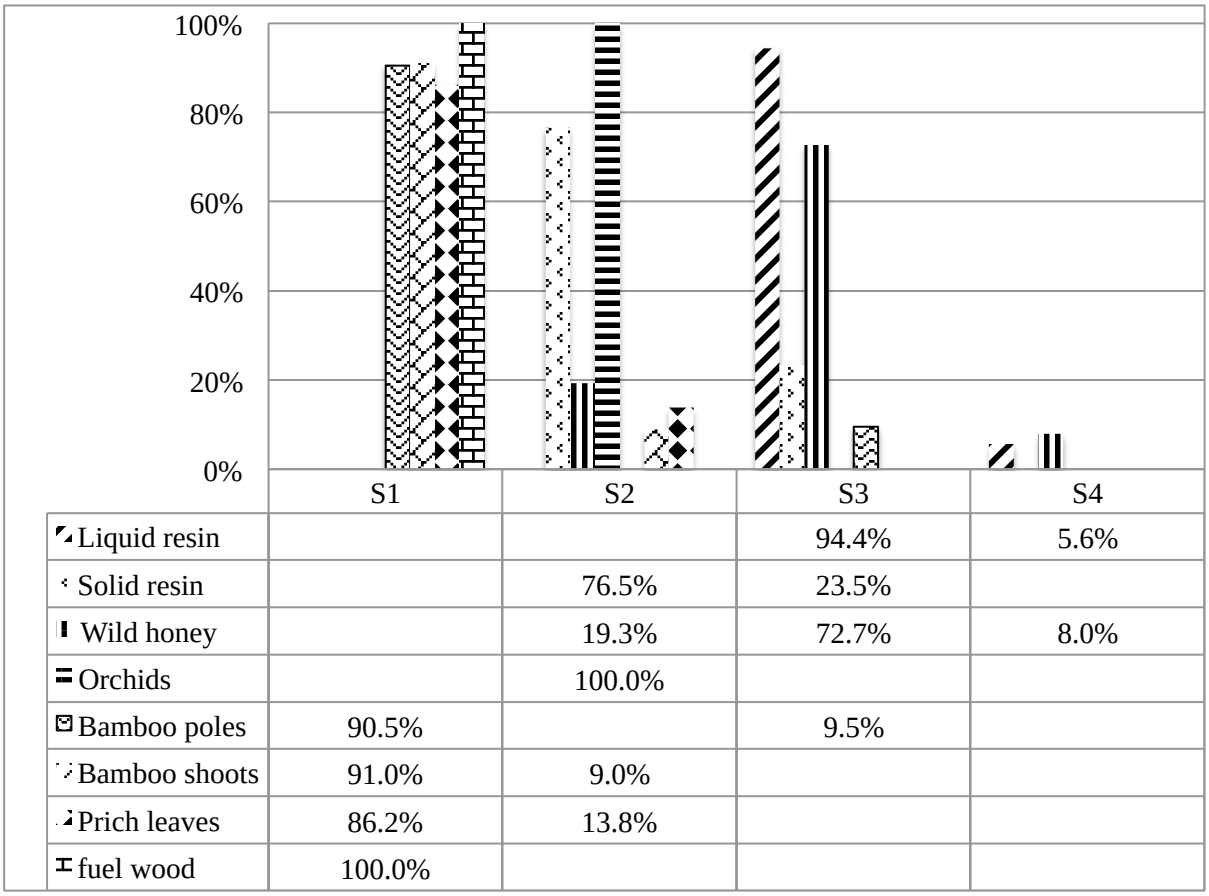
whether the predicted variables are fit well or not. They test whether the explained variance in a set of data is significantly greater than the unexplained variance. Fourth, Hosmer-Lemeshow test is used to check how well the model predicts an outcome. Finally, a classification table is referred to in order to see how useful the model is in predicting actual outcomes. The correct percentage value must be greater than the null hypothesis.

For reliable prediction analysis in Multinomial logistic regression, the final model is checked to see whether P-value is significant or not. The Goodness of fit in both Pearson and Deviance are tested. The Psedo R-Square value, which explains the proportion value of total variance is estimated. The likelihood ratio tests are checked by using the Chi-Square.

5.3 Results

5.3.1 NTFPs in Household Livelihood Strategies

It is generally understood that many NTFPs are just minor products contributing less to the economy or household income. There has been some expectations that commercial NTFPs play a crucial role as the primary income sources for rural households. The results of this study indicate that the contribution of cash income from NTFPs to household cash income varies across NTFPs. Solid resin, orchids, liquid resin, and wild honey represent the highest share of commercialization: 100%, 100%, 99%, and 98% respectively. Sample households predominantly collected these NTFPs for selling to local markets and middlemen. Beside this, prich leaves, bamboo shoots, and bamboo poles were sold to market in small amounts as supplementary sources of cash income. Furthermore, fuel wood was the only NTFP which was not sold in PPWS. Regarding the contribution of NTFPs to household income, liquid resin, wild honey, fuel wood, solid resin, bamboo poles, orchids, prich leaves, and bamboo shoots share are about: 26%, 24%, 15%, 11%, 7%, 5%, 4%, and 2% respectively.



	S1	S2	S3	S4
Liquid resin			94.4%	5.6%
Solid resin		76.5%	23.5%	
Wild honey		19.3%	72.7%	8.0%
Orchids		100.0%		
Bamboo poles	90.5%		9.5%	
Bamboo shoots	91.0%	9.0%		
Prich leaves	86.2%	13.8%		
fuel wood	100.0%			

Figure 5-1 NTFPs in Household Livelihood Strategies in PPWS, Cambodia

Note: S1=Subsistence strategy; S2=Supplementary strategy; S3=Diversified strategy; S4=Specialized strategy

Source: Author's Calculation, 2017

Regarding the management of NTFPs, their extraction causes direct and indirect impacts upon forest ecosystems. The management level is associated with ecological cost because it represents the level of human disturbance to specific species, as well as forest biodiversity. This study found three levels of management methods for NTFPs such as collecting from the wild, conventional practices, and intermediate management. In most cases, fuel wood, prich leaves, orchids, bamboo shoots, bamboo poles, and solid resin were gathered extensively with little management, or no management altogether. Collecting wild honey remains a predominantly opportunistic activity, while the management of wild honey varies from wild collection to intermediate management. At the extreme, liquid resin in

PPWS was regularly collected using intermediate management. Local people who own liquid resin trees collected their products regularly; they tapped the tree in order to acquire resin every three to four days. Local people used a combination of techniques, drawing from their indigenous knowledge and new methods introduced by INGOs (WWF).

Considering the contribution of cash income from NTFPs to household cash income, share of income from NTFPs to household income, and management of NTFPs: four household livelihood strategies can be identified as follows. Sample households used fuel wood, bamboo shoots, bamboo poles, and prich leaves for a 'subsistence strategy', as shown in Figure 5-1. All sample households used fuel wood as a subsistence strategy, serving as cooking fuel. Ninety one percent and 86% of sample households consumed bamboo shoots and prich leaves as a subsistence strategy, respectively. Local people collected bamboo shoots and prich leaves for food consumption. Nevertheless, the remaining 9% and 14% of sample households sold bamboo shoots and prich leaves respectively as a supplementary strategy. Ninety percent of sample households collected bamboo poles as a subsistence strategy, but the remaining 10% can be classified as a diversified strategy. Bamboo poles were mostly used for construction, but a few households sold to local markets for a cash income.

Orchids and solid resin were largely used as a 'supplementary strategy', resulting in additional financial security. Orchids and solid resin were overwhelmingly sold to middlemen and local markets for earning cash income. Both of these NTFPs were extracted as a supplementary strategy, but their contributions to household income were still low. NTFPs in this supplementary strategy were collected from the wild without any management. Figure 5-1 shows that all sample households sold orchids as a supplementary strategy. Notably, 76.5% of sample households sold solid resin as a supplementary strategy, but the remaining 23.5% as a diversified strategy. Since communities received some technical training on collection

techniques of solid resin, some sample households have started to manage solid resin for better production. They do this to receive a better price at market.

Liquid resin and wild honey were commonly traded and managed as a diversified strategy. The diversified strategy and supplementary strategy are distinguished by whether or not the NTFPs are moderate managed or collected from the wild. Figure 5-1 shows that 94% and 73% of sample households sold and managed liquid resin and wild honey respectively as a diversified strategy, but 5.6% and 8% respectively as a specialized strategy. Few households tend to rely on both aforementioned NTFPs as the main sources of cash income. The NTFPs' collectors use their labor and time more intensively to harvest liquid resin and wild honey regularly to get higher productivity yields, with an improved quality. The management of both NTFPs was strong, yet they were not moved to cultivation or monoculture. Local people are still relying upon their indigenous knowledge and the management techniques acquired from NGOs (WWF, MFV, CEDAC, and WCS). Even though the specialized strategy accumulates a high share in household income, there are some constraints in risks of overexploitation.

5.3.2 Factors Influenced Households' Decision on NTFPs in Household Livelihood Strategies

Some sample households collected NTFPs for subsistence use only, while others collected them so as to increase cash income through selling. Some sample households managed NTFPs using intermediate management in order to increase production to meet market demands. Thus, this study questions why NTFPs are used differently in individual livelihood strategies, despite all of them being located in the same forest vicinity.

Table 5-2 Factors Influenced Household Choices of Household Livelihood Strategies: Cases of Liquid Resin, Solid Resin, Bamboo Poles, Bamboo Shoots, and Prich Leaves

Variables		Liquid resin (S3-S4)[1]	Solid resin (S2-S3)[2]	Bamboo Poles (S1-S3)[3]	Bamboo shoots (S1-S2)[4]	Prich (S1-S2)[5]
		β	*β*	*β*	*β*	*β*
Household's production factors	HH labor					0.005
	HH land owned	-0.420		0.243		
	HH capital (motorbike owned)					
Community involvement	Member of CPA	0.626	-0.370	-0.914		
	NTFPs market information received			-0.2160		
	Technical training received	0.639		1.266		
Household's characteristics	Living period in current location			-0.069		
	Age of household head			0.046		-0.039*
	Occupations/ hh					-0.570**
	Ability to read					
	Number of NTFPs collected/hh	-0.962**	0.636***			
Geographic status	Distance to NTFPs (km)	0.120*	0.024			
	Distance to market (km)	-0.236	-0.225***	-1.288***	-0.111***	-0.532***

Notes: 1) Omnibus tests of model coefficient=0.007***; Hosmer and Lemeshow test=0.228; Correctly predicted percent=95.1%

2) Omnibus tests of model coefficient=0.000***; Hoesmer and Lemeshow test=0.878; Correctly predicted percent=77.8%

3) Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=1.000; Correctly predicted percent=96.2%

4) Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=0.310; Correctly predicted percent=93.0%

5) Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=0.538; Correctly predicted percent=90.4%

Source: Author's Analysis, 2017

Of all expected explanatory variables, some of them were excluded from the final model because the Chi-square test and One-Way ANOVA showed no significant link between groups, as seen in Appendix, Table A-3.

Table 5-2 indicates that liquid resin was extracted as a diversified strategy (S3), but a few sample households decided to use a specialized strategy (S4) in order to earn a higher income. Six explanatory variables were included in the final model, such as land owned; member of a CPA; technical training received, numbers of NTFPs collected per household; distance to forest for collecting NTFPs; and the distance to market. The fitted model correctly predicted 95.1% of the observed values. There was no multicollinearity problem in the predicted variables. The Omnibus test was fitted (see in note 1). Table 5-2 shows that numbers of NTFPs collected per household significantly and negatively influence the choice of S4 rather than S3. Distance to collected NTFPs significantly and positively influences the choice of S4, relative to S3.

Some sample households decided to collect solid resin as a diversified strategy (S3) while many sample households continue to use a supplementary strategy (S2). Four explanatory variables were included in the final model, such as member of a CPA; numbers of NTFPs collected per household; distance to collect NTFPs; and distance to market. The fitted model correctly predicted 77.8% of observed values. No multicollinearity problem occurred in the predicted variables. The Omnibus test and Hosmer and Lemeshow test were fitted, (see in note 2). Table 5-2 shows that the distance to market significantly and negatively influences the choice of S3 rather than S2. Numbers of NTFPs collected per household significantly and positively influence the choice of S3 rather than S2.

Bamboo poles were mostly harvested as a subsistence strategy (S1), but few sample households decided to collect this product for a diversified strategy (S3). After the Chi-square test and One-Way ANOVA test, seven variables were included in the final model, such as land owned; members of a CPA; NTFPs market information received; technical training received; living period in the current location; age of household head; and distance to market.

The fitted model correctly predicted 96.2% of observed values. No multicollinearity problem occurred. The Omnibus test was significant in the coefficient-fit of predicted variables (see in note 3). Table 5-2 shows that the distance to market significantly and negatively influences the collection of bamboo poles as a S3 rather than S1.

Table 5-2 indicates that sample households extracted bamboo shoots as part of two household livelihood strategies for a subsistence strategy (S1) and supplementary strategy (S2). The fitted model correctly predicted 93% of observed values. There was no multicollinearity problem. The Omnibus test and Hosmer and Lemeshow test were also fitted (see in note 4). Table 5-2 shows that the distance to market significantly and negatively influences the decision to extract bamboo shoots as a S2 rather than S1.

Prich leaves were collected for two household livelihood strategies such as a subsistence strategy (S1) and supplementary strategy (S2). Of 13 explanatory variables, household labor; age of household head; number of occupations per household; and distance to market show significant differences between the S1 and S2 groups. The fitted model correctly predicted 90.4% of observed values. There was no multicollinearity problem. The Omnibus test was fitted (sees in the note 5). Table 5-2 shows that age of household head; number of occupations per household; and distance to market significantly and negatively influence the decision to collect prich leaves as S2 rather than S1.

Wild honey was extracted for three choices of household livelihood strategies, as seen in Table 5-3. Almost 20% of sample households collected wild honey as a supplementary strategy (S2). Many sample households collected wild honey as a diversified strategy (S3), but few sample households decided to manage NTFPs as a specialized strategy (S4). Two explanatory variables were included in the final model such as household capital (motorbikes owned) and the ability to read.

Table 5-3 Factors Influenced Household Choices for Collecting Wild Honey in Household Livelihood Strategies

Wild honey in hh livelihood strategy		β	Std. Error	Wald	P-value	Exp(β)
Supplementary strategy	Intercept	-3.004	1.375	4.776	0.029	
	HH capital (motor)	1.382**	0.632	4.772	0.029	3.981
	[Cannot read =0]	3.257**	1.274	6.531	0.011	25.967
	[Can read =1]	0	.	.	.	.
Diversified strategy	Intercept	1.308	0.920	2.020	0.155	
	HH capital (motor)	0.132	0.549	0.058	0.810	1.141
	[Cannot read =0]	2.126*	1.112	3.652	0.056	8.381
	[Can read =1]	0	.	.	.	.

a. The reference category is: Specialized strategy

Note: Number of Observation (N=88)
Final model (P=0.001)
Goodness of fit: Pearson (P=0.942), Deviance (P=0.893)
Psedo R-Square = 0.259

Source: Author's Analysis, 2017

The P-value was significant in the final model, so this model is fitting. The goodness of fit was good enough to predict the Pearson and Deviance test. The Psedo R-Square was 0.259, so 25.9% of variance is explained. Table 5-3 illustrates that households that owned motorbikes as capital are more likely to extract NTFPs as S2 rather than S4. Also, household heads that cannot read are more likely to choose S2 rather than S4. Those who cannot read generally prefer to choose S3 rather than S4.

5.4 Discussions

5.4.1 Roles of NTFPs by Household Livelihood Strategies

Looking at four household livelihood strategies allows policymakers to understand four advantages of NTFPs in rural livelihood through their contribution to household cash income and household income. The first important use of NTFPs is for survival. Figure 5-2 shows that most sample households used fuel wood, prich leaves, bamboo shoots, and bamboo poles as a subsistence strategy. Those NTFPs contributed less than 50% to overall

household cash income, and their contribution to household income was minimal. Therefore, this finding agrees with other studies such as Angelsen and Wunder (2003); Arnold and Pérez (2001) that the collection of many NTFPs from the wild serve local people's basic needs, especially as food, energy, and construction materials.

The second important use of NTFPs is to provide supplementary cash income. Figure 5-2 shows that solid resin and orchids were traded as a supplementary strategy. Likewise, a small proportion of sample households collected wild honey, bamboo shoots, and prich leaves as a supplementary strategy to earn extra cash income (Figure 5-2). Sample households in this strategy are oriented towards cash income, and they gathered NTFPs from the wild. Even though these NTFPs contributed to cash income more than 50% in household cash income, a large share of household income was derived from farm and non-farm activities rather than NTFPs. Cash income from NTFPs is vital for local people's expenses on necessary needs. As Shackleton et al. (2011) have mentioned, NTFPs reduce livelihood risks because cash income from NTFPs can complement a range of other livelihood activities.

Third, NTFPs are important for income diversification. Figure 5-2 shows that sample households used and managed liquid resin and wild honey as a diversified strategy. Some sample households collected bamboo poles as a diversified strategy rather than as a subsistence strategy (Figure 5-2). Local people who collect NTFPs as a diversified strategy tend to use household labor and conventional techniques to extract NTFPs in order to earn the bulk of cash income. For instance, households' laborers are intensively used for farm activities during the rainy season, and they actively extract liquid resin, wild honey, and bamboo poles for selling during the dry season. Income diversification through extraction of NTFPs is a good way to accumulate savings for emergencies spending, especially during difficult times (Adam et al., 2013; Ruiz-Pérez et al., 2004; Stack et al., 2003).

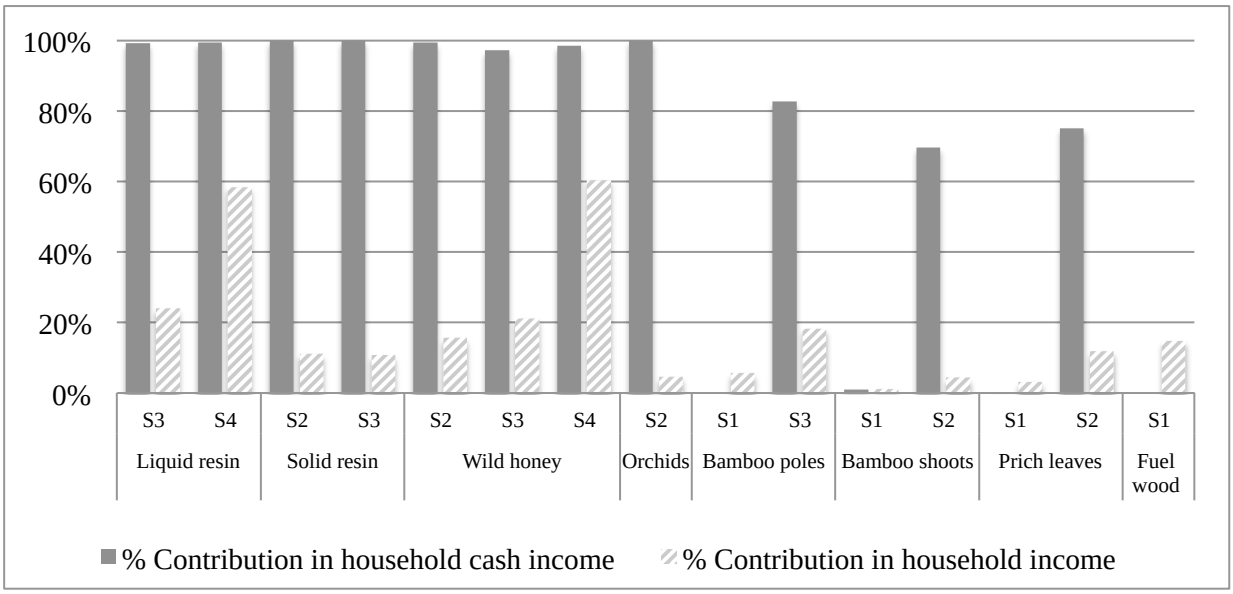


Figure 5-2 Roles of NTFPs by Household Livelihood Strategies

Note: S1=Subsistence strategy; S2=Supplementary strategy; S3=Diversified strategy; S4=Specialized strategy

Source: Author's Calculation, 2017

Lastly, few NTFPs are the primary source of household income. Figure 5-2 shows that few sample households decided to manage NTFPs as a specialized strategy. Only liquid resin and wild honey were collected as a specialized strategy. The sample households sold liquid resin and wild honey as their primary source of household income, resulting in high level of specialization. The sample households used their labor and time more intensively to collect specific liquid resin and wild honey. Since the market for liquid resin and wild honey are stable, households' incomes can be secured all year-round.

5.4.2 Ecological Impact from Management of NTFPs

Even though the collection of NTFPs has often been considered to be less damaging to biodiversity than timber extraction or agriculture, the impact depends upon management activities (Belcher et al., 2005). Collecting NTFPs from the wild is the traditional extraction method for areas with a low population, poor access to markets, credits, and other facilities

(Anderson, 1992). This is regarded as the non-intensive system (this study defines it as as 'low managed'[1]). Low managed NTFPs have a low impact on forests on a local and landscape scale (Belcher et al., 2005). The second management method is extensively managed (this study represents it as 'moderate managed'[2]). Extensive management can produce rapid and substantial returns. This method consists of selective thinning to promote regeneration and growth of selected species. The third management type examined in this study is intermediate intensively managed (this study called it 'strong managed'[3]). This study did not find any cases where NTFPs are deliberately planted as seeds or seedlings, but rather local people invest their labors intensively using conventional practices such as weeding or crown opening. Therefore, this study used the term suggested by Belcher et al. (2005) – 'intermediate intensively managed'. However, this study examines ecological costs from the choices of three management levels for NTFPs.

NTFPs, which are thought to be subsistence and supplementary strategies are gathered from the wild with little management or none whatsoever. Figure 5-3 shows that most sample households did not manage fuel wood, prich leaves, orchids, bamboo shoots, bamboo poles, and solid resin. According to field observation, local people collected those NTFPs from the wild. Collecting from the wilderness is a traditional forest extraction method used by Bunong people living in PPWS. Likewise, NTFPs collected from the wild were in the areas with a low population and poor access to markets. Local people used their minimal labor or financial

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[1] Low managed: Collect from forests without any transformation of the forest structure

[2] Moderate managed: Collect using indigenous knowledge and customary rules which makes little transformation of the forest structure

[3] Strong managed: Collect using indigenous knowledge and new techniques introduced by NGOs which partially transform the forest structure

inputs so as to collect these NTFPs. These NTFPs have therefore not declined. However, this study agrees with other studies that NTFPs gathered from the wild result in little or no transformation to the forest structure, so the regeneration of those species and forest structures can still be maintained (Neumann and Hirsch, 2000; Ros-Tonen and Wiersum, 2005).

Extensive or moderate management methods were practiced by sample households with bamboo poles, wild honey, solid resin, and liquid resin. Figure 5-3 shows that these NTFPs were collected in forest with little alteration to the forest structure. The local people used indigenous knowledge together with customary rules to manage solid resin, wild honey, bamboo poles, and liquid resin, according to key informants interviewed. The collection methods are mostly focused on regeneration, allowing for multiple uses of the forest resources whilst maintaining the biodiversity. To illustrate, Mondulkiri Forest Vulture (MFV), WWF-Cambodia, and WCS-Cambodia provided training to all CPAs in PPWS in techniques for collection of liquid resin, wild honey, and bamboo poles. This was to achieve improved production and quality. After having received training and support, some local people decided to manage NTFPs in order to earn a higher cash income. In addition, wild honey is a high-value product, and the intensity of its collection and management varies from low to strong. The impact to forest structure was low. Wild honey was reported to have been declining slightly, according to key informants interviewed. Thus, this study supports Belcher et al. (2005a) and Shaanker et al. (2004) in their assertion that the forest structure is only slightly impacted by extensive management; the target NTFPs can still be regenerated naturally together with relatively high levels of biodiversity.

Intermediate intensive management is the most intense method currently practiced in PPWS. Figure 5-3 shows that liquid resin and wild honey were strongly managed. Local people who own liquid resin trees collected their products regularly.

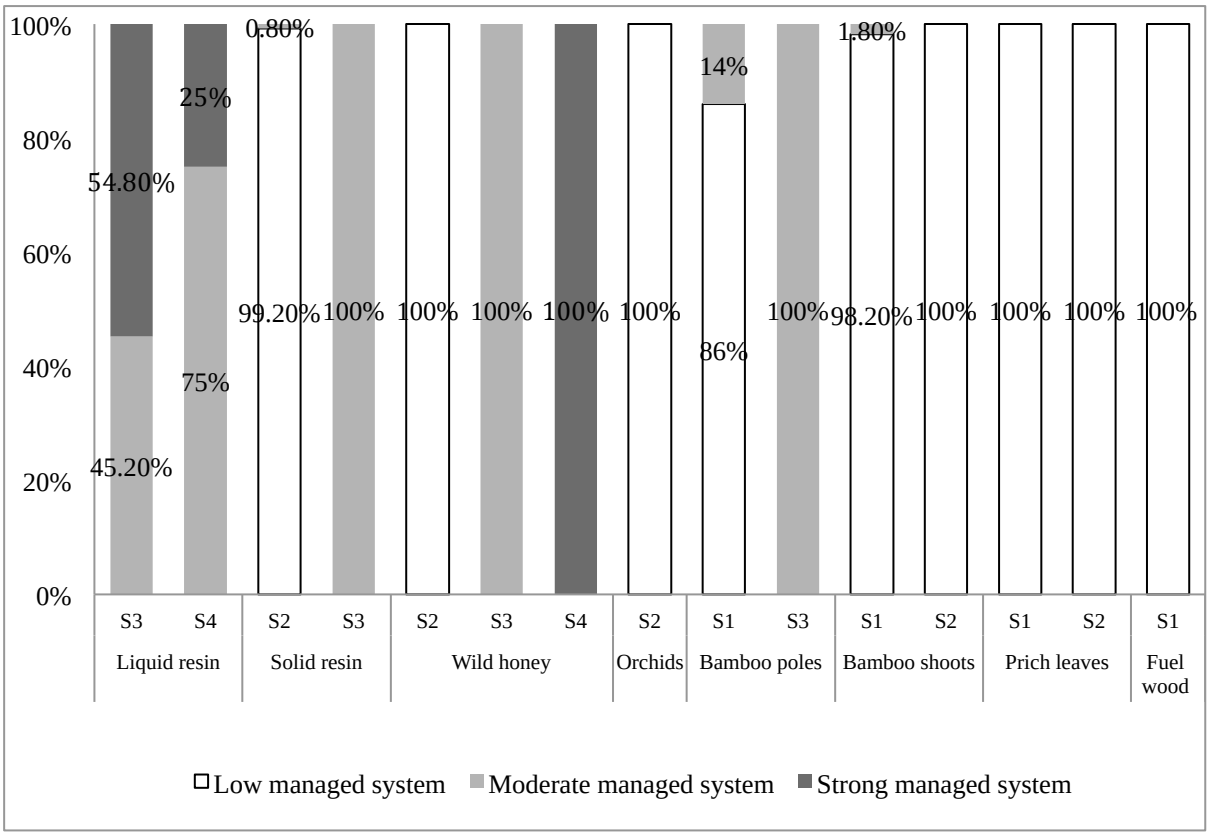

Figure 5-3 Ecological Impact from Management Systems of NTFPs

Source: Author's Calculation, 2017

They tapped the tree to get resin every three to four days. They used a combination of techniques drawing upon their indigenous knowledge and new methodology introduced to them by INGOs. The CPAs and commune councils controlled resin tapping techniques to prevent forest fires and illegal logging. In addition, owners of liquid resin trees performed various treatments such as weeding to encourage the production of preferred species and to control forest fires. Such treatments were found to partially transform the forest structure. This management practice did not impact to biodiversity at the landscape level, according to WWF staff. However, intermediate intensive management of liquid resin and wild honey leads to higher production and returns. Overall this management activity did not aversely impact the whole forest structure, as seen in Figure 5-3. Belcher et al. (2005a) which found

that even though NTFPs are managed in an intermediate intensive way, there is still the prospect of them being highly rewarding. On the contrary, if intermediate intensive management continues to be practiced by more people, it may lead to the erosion of biodiversity as forest structures are transformed (Anderson, 1992; Shaanker et al., 2004).

5.4.3 Factors Influenced Households' Decision on NTFPs in Household Livelihood Strategies

Theoretically, all NTFPs could be collected and sold to increase household cash income, but this is not true in practice. In reality local people apply different livelihood strategies due to determining factors, in spite of using the same NTFPs.

Geographic status from the viewpoint of distance from residence to market place strongly influenced households' decision to use NTFPs for a greater cash income. An analytical result shows that the distance from residence to the market strongly and negatively affects the household livelihood strategies for bamboo shoots, bamboo poles, prich leaves, and solid resin. Sample households living far distance away from the market are less likely to extract NTFPs for cash income. For instance, sample households are likely to collect bamboo shoots and prich leaves for use as a subsistence strategy, rather than as a supplementary strategy when their houses are located at a further distance from market. Similarly, sample households living a great distance away from the market are likely to manage bamboo poles and solid resin as a subsistence strategy and supplementary strategy respectively. This evidence reveals that where the market is available nearby their house, NTFPs will be sufficiently more valuable, and people are likely to manage NTFPs in order to increase cash income (Belcher et al., 2005b). Most of sample households are located in remote areas, so they are not willing to take risk in order to transport their goods to the markets. Therefore, it can be argued that local people are still heavily relying on NTFPs for subsistence, unless they can access markets at low costs and with few risks. The improvement of information about

potential markets and marketing channels may provide an incentive to local people to boost incomes through increased selling of NTFPs.

Household capital significantly and positively influenced the choice of extraction and the sale of wild honey as a supplementary strategy rather than as a specialized strategy. This finding goes against the theory of random utility maximization (Lopez, 2011; López-Feldman & Taylor, 2006). According to this theory, in order to maximize the yield, household production factors including capital, labor, and land must be used intensively. This theory is recognized as the most appropriate model, especially in the agricultural sector and for many cases of NTFPs' management (Tesfaye et al., 2011). The application of the aforementioned model can now be considered as strange, since this study discovered that sample households who owned motorbike as capital were less likely to manage wild honey as a specialized strategy. This is due to the fact that most wild honey collectors preferred conventional practices, even if they owned a motorbike to travel further into the forest. Likewise, household capital is still believed to be a primary investment input for intensified management styles.

The number of NTFPs collected per household significantly and positively determined the preference of households for solid resin as a diversified strategy rather than a supplementary strategy. It implies that local people cannot increase the quantity of solid resin, so they need to collect other NTFPs to meet their livelihood needs. On the contrary, Belcher et al. (2005) found that rural households will not collect many types of NTFPs if they already manage a few highly valued NTFPs. For instance, the number of NTFPs collected per household is significantly and negatively associated with the choice of managing liquid resin as a specialized strategy rather than as a diversified one.

The ability to read significantly and positively influenced the decision to manage wild

honey as a specialized strategy rather than as a supplementary or diversified strategy. The evidence reveals that local people who can read tend to invest more in intermediate intensive management for wild honey in order to scale up their productions and income. Locals were able to read marketing information and techniques of wild honey collection and processing. As Escobal and Aldana (2003) claim, education enhances the intensive management for sustainable income-generating activities, including NTFPs extraction. However, policy implementations to help increase school years attended by rural households are costly and timely.

The age of the household head negatively and significantly determined the preference for using prich leaves as a supplementary strategy rather than as a subsistence strategy. The elderly suffer from an inability to climb taller trees; this renders them unable to pick the leaves. Melaku et al. (2014) claimed that younger people are more likely to participate in NTFPs production because their physical health is strong enough to collect them.

The average number of occupations per household significantly and negatively influenced to the choice of prich leaves as a supplementary strategy rather than as a subsistence strategy. The sample households who have more occupations per household were likely to collect prich leaves as a subsistence strategy rather than as a supplementary strategy. As Lopez (2011) has claimed, people will concentrate on collecting NTFPs when they lack alternative livelihood options. NTFPs' use as a subsistence strategy is not difficult to replace with other livelihood activities if local people are given a different choice.

5.5 Summary

Analyzing to various levels of contribution made by NTFPs to household cash income, household income, and NTFPs' management, four household livelihood strategies become apparent: the subsistence strategy, supplementary strategy, diversified strategy, and

specialized strategy. Results revealed that sample households use fuel wood as a subsistence strategy. Many sample households collect prich leaves and bamboo shoots as a subsistence strategy and as a supplementary strategy for others. Bamboo poles were used as a subsistence strategy for many sample households, and as a diversified strategy for a few other households. Orchid flowers were only used as a diversified strategy. Solid resin was used as a supplementary strategy for many sample households and as a diversified strategy for some households. Liquid resin was used as a diversified strategy for many sample households and as a specialized strategy for a few other households. Wild honey was used as a diversified strategy for many sample households and as a supplementary strategy and specialized strategy for a few other households. Overall, geographic status, household capital, and households' characteristics were found to be the most important factors when determining NTFP's use and management style for a household livelihood strategy.

Chapter 6: Uncovering the Hidden Value of Non-Timber Forest Products from a Poverty Alleviation Perspective[1]

6.1 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). 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 never achieved, and despite its high level, why foreign aid from international agencies has failed in reducing deforestation and improving rural livelihoods. This study suspects that policymakers value the forest in the insufficient 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

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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). Firstly, Peters et al. (1989) 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' values (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), 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?

6.2 Methodology

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 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 on economic importance of NTFPs in poverty alleviation and household vulnerability to poverty can be determined.

6.2.1 Measurement of Economic Value of NTFPs

Income from NTFPs is defined as the combined values of cash income and subsistence use value of NTFPs (Cavindish, 2002: 35). This study tries to estimate economic value of NTFPs from the viewpoint of households. The sample 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 on the economic value of NTFPs is not the case.

Equation (6.1) 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.

$$v_{ji}=v_{ji}^{*}+v_{ji}^{**} \tag{6.1}$$

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; Belcher et al., 2005; Schaafsma et al., 2014). Therefore, v_{ji}^{*} is cash income derived from NTFP$_j$ of household i. q_{jit}^{*} is quantity of NTFP $_j$ collected 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, as seen in equation (6.2).

$$v_{ji}^{*} = \sum_{t=1}^{N} \left(q_{jit}^{*} p_{jit}^{*} \right) \tag{6.2}$$

Cavindish (2002) estimated subsistence use value through market price of product or its substitution in region. Therefore, based on this concept, Equation (6.3) 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 community in a period of *t*, If NTFP $_j$ is not sold by sample households, the price at which other households do transactions at local stores in PPWS is used. q_{jit}^{**} is quantity of NTFP $_j$ consumed by household *i* in a period of *t*.

$$v_{ji}^{**} = \sum_{t=1}^{N} \left(q_{jit}^{**} p_{jit}^{**} \right) \tag{6.3}$$

Equation (6.4) can be used to evaluate hidden economic value of NTFPs as a proportion to household income. *g* is a proportion of subsistence use value of NTFP $_j$ consumed by household *i* to household income. It explains the crucial role of subsistence hidden in household consumption. It is helpful to debate with policy makers to improve decision-making on resource management based on livelihood context.

$$v_{gji} = \left(v_{ji}^{**} * 100 \right) \Big/ v_{ji} \tag{6.4}$$

6.2.2 Contribution of NTFPs to Rural Poverty Alleviation

Role of NTFPs must be assessed in more comprehensive manner of rural livelihood to improve decision-making basis for policymakers and land use planners (Cavindish, 2002; IIED, 1995; Watkins et al., 2016).

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) measured contribution of NTFPs to reducing poverty by explaining the share of income from NTFPs in household income. Escobal and Aldana (2003) compared different groups (Non-

poor, moderate poor, and extremely poor) 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 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 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). 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, bushmeat, 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 sample households collected NTFPs was 288. This study simply splits sample households into three household income tertiles, including low-income tertile households (N=96, 33.3%), medium-income tertile households (N=96, 33.3%), and above medium-income tertile households (N=96, 33.3%). This disaggregation simply provided equal distribution of sample 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 adult equivalent 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 22.2% between 2009 to 2015 (World Bank, 2017), the poverty line of 2015 is US$0.84 ∗ (1.22)=approximately US$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 energy (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.

6.2.3 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). Many studies, especially Arnold and Pérez (2001) and Paumgarten and Shackleton (2011) 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 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 (6.5) 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.

$$y = X\beta_1 + H\beta_2 + S\beta_3 + G\beta_4 + \varepsilon \qquad (6.5)$$

$\boldsymbol{y}$ is income from NTFPs (in natural logarithm). $\boldsymbol{X}$ 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. $\boldsymbol{H}$ represents households' 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), motorbikes owned (number), and kinds of NTFPs collected (number). $\boldsymbol{S}$

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). ***G*** stands for geographic status with two variables: distance from residence to forest where they collect NTFPs (km) and distance from residence to market where they sell NTFPs (km). The explanation of independent variables and expected signs are shown in Appendix Table A-3.

6.3 Results

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

Most of sample 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.

Table 6-1 Summary of NTFPs Utilization of Rural Households in PPWS

NTFPs	Type of use						Season of use
	Food	Agricultural materials	Medicine	Construction inputs	Cooking fuel	Sell	
Liquid resin				○		✓	Year-round
Solid resin						✓	Dry season
Wild honey	○		○			✓	Dry season
Orchid flower						✓	Year-round
Bamboo poles		○		✓		○	Year-round
Bamboo shoot	✓					○	Rainy season
Prich leaves	✓					○	Dry season
Fuelwood					✓		Year-round

Note: ✓= Major role; ○= Minor role; Blank = no role.

Source: Focus Group Discussions, 2016

Table 6-1 shows that 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 cooking fuel. 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.

6.3.2 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 sample households which collected NTFPs.

As shown in Table 6-2, 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 sample households were involved in collecting liquid resin, and per household cash income from liquid resin was around R3,120,900 (US$767)[2]. Wild honey was another valuable NTFP, which around 31% of sample 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 sample households collected. On average, a household earned cash income of approximately R1, 202,200 (US$296) from solid resin.

[2] R is Riel, which is the national currency of Cambodia.

Table 6-2 Economic Value of NTFPs per Household in 2015

NTFPs	HHs involved (%)	Unit price (R)	Total quantity	Sale	Subsistence use	Income of NTFPs (R)	Cash income (R)*	Subsistence use value (R)**	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

Notes: 1) R= 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 sample 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: Structured Questionnaire Interviews, 2016

Orchids are seasonally collected and sold. Around 32% of sample households collected them, earning about R511,900 (US$125). Bamboo poles, prich leaves, and bamboo shoots were collected by a large proportion of sample 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 fuel, fencing materials, agricultural materials, and medicine. Table 6-2 shows that fuel wood was collected widely by sample 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 sample households, and subsistence use value was around R543,000 (US$133). Prich leaves are very

popular wild vegetables for rural households. About 83% of sample 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 sample households collected bamboo shoots during the rainy season, and the subsistence use value was R87,800 (US$22).

Table 6-2 shows that annual income from liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuelwood 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 6-2, 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 sample households respectively.

6.3.3 Contribution of NTFPs to Rural Poverty Alleviation

6.3.3.1 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.

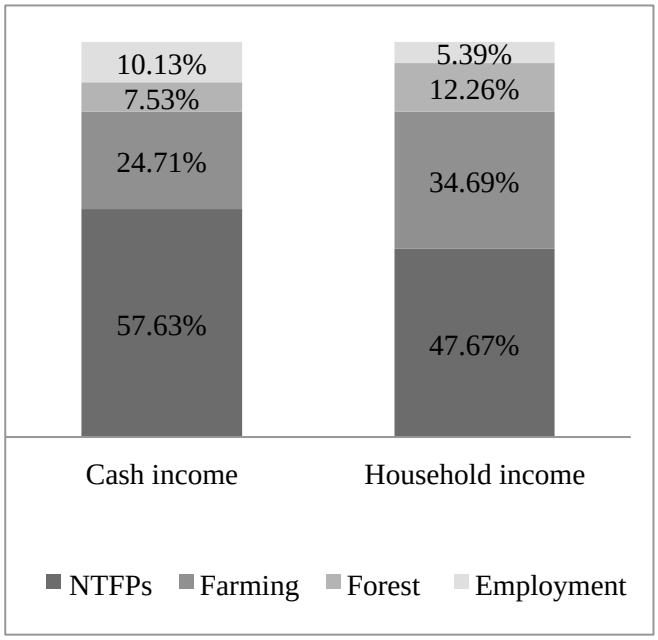

Figure 6-1 Share of NTFPs in Cash Income and Household Income of Sample Households
Source: Author's Calculation, 2017

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 6-1). From the viewpoint of household income (subsistence use value and cash income) from all income sources, income from NTFPs (subsistence use value and cash income) 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.

6.3.3.2 Contribution of NTFPs to Household Income: Comparing Among Household Income Tertiles

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 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 sample households of above medium-income tertile, they got higher income from these five NTFPs than the other two income tertiles (Table 6-3). 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.

Table 6-3 Income from NTFPs and Its Share to Household Income by Type of NTFPs and Household Income Tertiles

NTFPs	Household income tertile						ANOVA (on income)	
	Low-income		Medium-income		Above medium-income		F	P-value
	(R)	(%)	(R)	(%)	(R)	(%)		
Liquid resin	2,218,000	11.32	2,769,900	19.80	3,788,300	21.84	5.104***	0.007
Solid resin	798,900	10.22	1,114,900	8.22	1,553,300	9.62	3.006*	0.052
Wild honey	1,448,600	4.13	2,583,700	10.51	4,089,700	13.74	6.416***	0.003
Orchids	348,600	1.99	513,100	2.07	609,700	2.10	2.417*	0.095
Bamboo poles	453,300	5.97	682,300	6.27	925,400	7.68	1.897	0.154
Bamboo shoots	107,100	2.90	109,500	1.78	101,300	1.14	0.116	0.891
Prich leaves	326,300	6.22	417,000	5.74	437,600	4.62	1.052	0.351
Fuel wood	949,500	24.52	1,323,900	18.90	1,947,400	16.27	8.261***	0.000
Overall NTFPs (N=288)	2,702,200	67.27	5,360,100	73.29	8,569,700	77.00	78.129***	0.000

Notes: 1) Household income tertiles are as follows: low-income tertile (33.3%), medium-income tertile (33.3%), and above medium-income tertile (33.3%) from 288 sample households collected NTFPs.

2) *, **, and *** denote levels of significance of 0.1, 0.05, and 0.01, respectively.

Source: Author's Calculation, 2017

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. Sample households in the medium-income and the above medium-income tertiles were notably more engaged in sales of NTFPs compared to the low-income tertile.

6.3.3.3 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 6-4, 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 6-4). 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.

Table 6-4 Per Capita Income/Day by Household Income Tertiles (2015)

Per capita income /day	Household income tertiles				P-value	Cambodia poverty line (2005)
	Low-income	Medium-income	Above medium-income	Overall		
Per capita income /day	R5,000 ($1.23)	R9,000 ($2.21)	R15,200 ($3.74)	R9,700 ($2.38)	0.000***	R4,100 ($1.02)
Per capita income/day excluding subsistence use value of NTFPs	R3,700 ($0.91)	R7,300 ($1.79)	R13,200 ($3.24)	R8,100 ($1.99)	0.000***	
Per capita income/day excluding income from NTFPs	R2,500 ($0.61)	R4,300 ($1.06)	R8,500 ($2.09)	R5,100 ($1.25)	0.000***	

Notes: 1) Poverty line at rural areas of Cambodia is US$0.84 in 2009 (MoP, 2013). The price increases by 22.2% between 2009 and 2015.

2) *, **, and *** denote levels of significance of 0.1, 0.05, and 0.01, respectively.

Source: Author's Calculation, 2017

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 6-4). 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.

6.3.3.4 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 UNDP, is examined.

As shown in Table 6-5, 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 winds.

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.

Table 6-5 Correlation between Income from NTFPs and Multidimensional 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%	-0.236***	-0.312***
	Mental/physical disability	23%	-0.096	-0.291***
Education	No one in household can read and write	59%	-0.058	-0.047
	At least one school-aged child does not enroll in school	23%	-0.075	-0.134**
Living conditions	No access to cooking fuel	9%	-0.281***	-0.043
	No access to toilet or adequate sanitation	45%	-0.166***	-0.384***
	No access to clean water (drinking, cooking, bathing)	11%	-0.141**	-0.157***
	No access to lighting energy (electricity, battery, solar, etc.)	20%	-0.155***	-0.260***
	House cannot be protected from strong winds	15%	-0.106*	-0.272***
	No access to information	32%	-0.035	-0.043
	No assets for mobility or assets related to livelihoods	10%	0.003	-0.140**

Note: *, **, and *** denote levels of significance of 0.1, 0.05, and 0.01, respectively.
Source: Author's Analysis, 2017

Thus, though the relationship is not strong as far as coefficients are concerned, it could be seen that income from 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.

6.3.3.5 Importance of NTFPs for Responding to Household Vulnerability to Poverty

(A) 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 sample 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 sample households lack human capital, especially knowledge to earn higher incomes. Local people lacked information and connections for acquiring appropriate skills. About 78% of sample households have low savings.

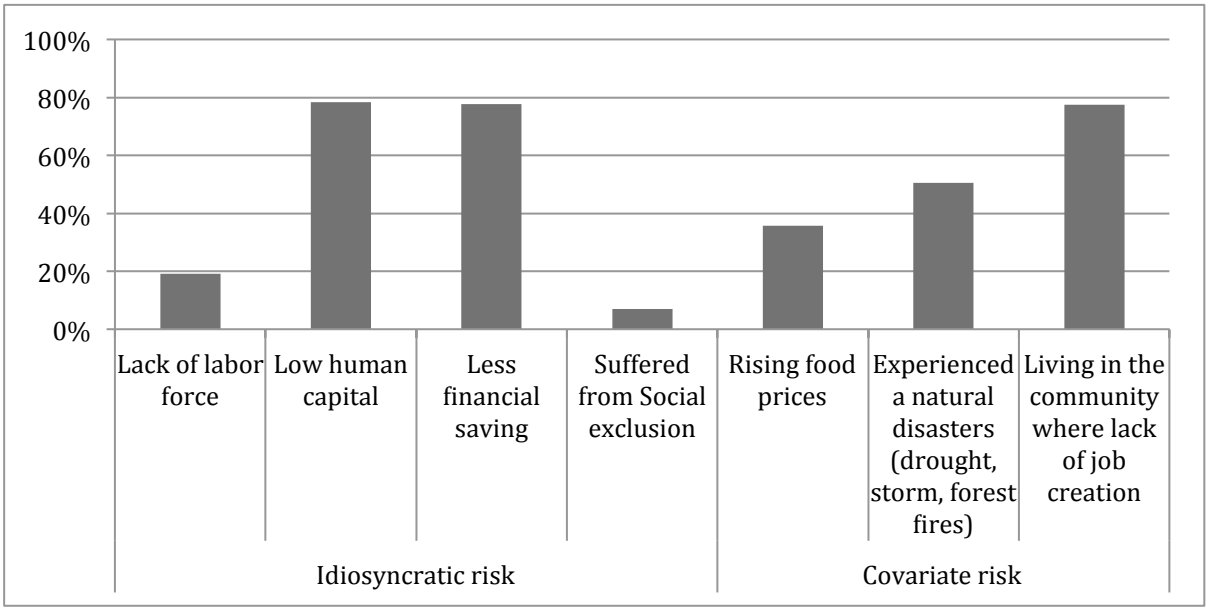

Figure 6-2 Household Vulnerability to Poverty in PPWS

Source: Structured Questionnaire Interviews, 2016

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 sample households, respectively.

Households in PPWS were also exposed to various types of covariate crises. Around 77% of sample households lived in the 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 sample households experienced. These natural disasters can cause widespread livestock losses, crop failure, and house damage. Besides, around 36% of sample households suffered from rapidly rising food prices.

(B) 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 6-6 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 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.

Table 6-6 Influence of Household Vulnerability to Poverty on Extraction of NTFPs

(i) Dependent variables: income of NTFPs (Logarithm: log)	β	SE	P-value
(Constant)	5.904***	0.094	0.000
(a) Idiosyncratic risks			
Lack of labor forces	-0.144***	0.038	0.000
Low human capital	0.211***	0.046	0.000
Less saving	0.079**	0.038	0.041
Social exclusion	-0.120**	0.055	0.030
(b) Covariate risks			
Rising food prices	0.080***	0.029	0.007
Natural disaster	0.054*	0.029	0.066
Living in community where being lack of job opportunities	0.011	0.037	0.766
(c) Households' characteristics			
Age of household head	0.000	0.001	0.914
Male-headed household	0.060*	0.032	0.060
Schooling years of household head	0.003	0.006	0.609
Household members	0.004	0.006	0.511
Occupations in a household	-0.019	0.014	0.194.
Years living in current forest sanctuary	0.002	0.001	0.170
Ability to read and write	0.014	0.035	0.693
Agricultural land owned	-0.006	0.009	0.508
Motorbikes owned	0.052***	0.019	0.008
Types of NTFPs collected	0.089***	0.011	0.000
(d) Community involvement			
Membership of Community Protected Area (CPA)	0.057	0.035	0.101
Technical training received from CPA and partner	-0.002	0.035	0.961
Market information from CPA and partner	-0.024	0.032	0.466
(e) Geographic status			
Distance from residence to forest	0.005	0.003	0.109
Distance from residence to marketplace	-0.021***	0.006	0.000
R^2 = 0.614			
Adjusted R^2 = 0.582			
Regression mean Square = 0.992			

Note: *, **, and *** denote 0.1, 0.05, and 0.01 levels of significance, respectively.

Source: Author's Analysis, 2017

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.

6.4 Discussions

This study clarifies that part of NTFPs collection is hidden as subsistence use in households and consequently has not valued because of not being dealt through the market. Though limited to data from 2015, annual cash income per sample 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 sample 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.

6.5 Summary

As long as assessing 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. This study found that the combined value of subsistence use and cash income of NTFPs were US$768, US$296, US$768, 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 66% of sample households, who collected NTFPs from falling into poverty. NTFPs also play vital role of responding to the potential future vulnerability to poverty of some households.

Chapter 7: The Hidden Value of Non-Timber Forest Products: Incentives for Forest Conservation[1]

7.1 Introduction

Extraction of non-timber forest products for both subsistence and trade remains common and widespread today because it is highly significant to the rural and national economies in provision of food, material, construction, energy, cash income, employment, and other benefits (Chou, 2018b; Shackleton et al., 2011). Tens of thousands of non-timber forest products around the world is supporting local livelihoods and economies (Shackleton et al., 2015). At present, over 150 non-timber forest products have been traded internationally (Sills et al., 2011). With some 1.4-1.6 billion people Worldwide were estimated to make use at least some non-timber forest products (Shackleton et al., 2011). NTFPs are also acknowledged as being positively associated with forest conservation (Chanthayod et al., 2017; Sunderland et al., 2011). Some scholars claimed that economic benefit from non-timber forest products is likely to change local community attitude to maintain forest biodiversity (Chanthayod et al., 2017; Gibson et al., 2005). Indeed, extraction of non-timber forest products is less ecologically destructive because it does not critically impact to forest functions and regeneration of species (Harbia et al., 2018; Ros-Tonen and Wiersum, 2005; Ticktin and Shackleton, 2011).

In forest landscape of Cambodia, non-timber forest products, which benefits to livelihood of millions of people are under threats due to current deforestation (Watkins et al.,

[1] This Chapter 7 has been published in article: **Chou, P.** (2018). The Role of Non-Timber Forest Products in Creating Incentives for Forest Conservation: A Case Study of Phnom Prich Wildlife Sanctuary, Cambodia. *Resources, 7(3)*, 1-16.

2016). The absence of NTFPs would critically impact to the livelihood and well-being of people living in and near the forest (Chou, 2018a). NTFPs collection can prevent the poorest from falling into deeper poverty, and medium-income households will be close to the poor (Chou, 2018b). Extraction of NTFPs is a conventional strategy to respond to shocks such as lack of human capital, low savings, rising food prices, and natural disasters (Chou, 2018b). Cambodia has the largest area of pristine tropical forests in mainland Southeast Asia which is most suitable for non-timber forest products, but its' forests are alarmingly under tremendous pressure (FAO, 2015; Watkins et al., 2016). Under Cambodia's Millennium Development Goal 7 (CMDG 7), the country aims to achieve forest cover of at least 60% of total land area by 2015 (RGC, 2003). In the 1960s, Cambodia was believed to have 73.04% of its area under forests (FA, 2010a). Forest cover declined from 61.15% in 2002 to 59.09% in 2006 (FA, 2010a). The rate of forest loss was about 93,000 ha per year due to the expansion of agriculture and other commercial plantations (MoP, 2011). Forest cover in 2010 decreased to about 58% (FA, 2010a), and it continued to decline to 53.60% in 2015 (FAO, 2015). After the civil war, Cambodia made considerable efforts to address the issue of deforestation approximately 41% of the country, which is around 7.5 million hectare, was designated as protected areas by 2017, according to Ministry of Environment, Cambodia. Nevertheless, the efforts of government have not yet achieved their goals because deforestation is still occurring rapidly (Cock, 2016). Rapid deforestation in Cambodia has been caused by large-scale infrastructure projects, timber production, illegal logging, and other developing activities. This deforestation trend is weakening the provisioning services and increasing vulnerability among poor communities, especially those extracting non-timber forest products for livelihoods (Watkins et al., 2016).

Failure of government policies on forest conservation arises because they seldom have

sufficient capital or labor to manage their nation's biological resources in an optimum way (Neumann, 1996). Another reason is that investment in forest conservation can be very costly (Green et al., 2018; McNeely, 1988). The most common problem of government policies on forest conservation is that they often assert restriction zones on forest use in order to protect forests, but restriction policies limit local efforts and community rights to protect resources in their forests from outsiders and illegal forest dwellers (Scherr et al., 2003). Another constraint in setting restriction zones is a prohibition of local use of forest resources, which often disrupts local livelihoods (Dewees and Scherr, 1996; Ruiz-Pérez et al., 2005). However, do we have the initiative to enhance forest conservation and to increase income of local people at the same time?

This study proposes that extraction of NTFPs can provide benefits for forest-dwelling peoples, and incurred incentives for forest conservation[2]. There are a claim that NTFPs are essential for forest conservation (Arnold and Pérez, 2001; Shaanker et al., 2004; Sunderland et al., 2011; Ticktin, 2015), but empirical evidence of this role remains inadequate, especially in Cambodia and other developing countries. More importantly, even though NTFPs are important for forest conservation, they tend to be undervalued by most policymakers. This is because they often fall outside the market system and have no market price (Chou, 2018b). The measurement of value of NTFPs from incentives for forest conservation[3] is crucial for integrating NTFPs into development agendas of official institutions (Chou, 2018b; DeBeer and McDermott, 1996; Shackleton et al., 2015). Likewise, realizing the value of NTFPs from

[2] Incentives for forest conservation is the voluntary agreements that landowners or local people make to conserve forest in exchange for their livelihood benefits (Jones et al., 2016; McNeely, 1988).

[3] NTFPs' incentives for forest conservation is defined by this study as the motivation to encourage local people to participate in forest conservation when they get income from NTFPs.

its' incentives for forest conservation is vital for providing the best means of transforming an exploiter into a conservationist through promoting management of NTFPs. This study addresses the following research questions: (1) What are the current forest conservation practices in Phnom Prich Wildlife Sanctuary?; (2) Does extraction of NTFPs incur incentives for forest conservation activities?; and (3) How much is the value of NTFPs from its' incentives for forest conservation activities derived from their extraction in Phnom Prich Wildlife Sanctuary?

7.2 Methods

7.2.1 Current Forest Conservation Practices in PPWS

Many authors have not well defined the term forest conservation[4]. As a result, it is difficult to distinguish whether government and International non-governmental organizations (INGOs) play a direct or indirect role in forest conservation. Forest conservation practices can be assessed by examining the role of all relevant institutions. To understand the role of multi-stakeholders in forest conservation, this study incorporates forest conservation activities from three categories, forest maintenance, forest protection, and reforestation. Descriptions of multi-stakeholders who were involved in forest conservation reflect on opportunities and

[4] Forest conservation can mean anything from intensive production to total preservation, but forests would not be permanently converted to another use such as agriculture (Elliott, 1996; Kaczan et al., 2016). Some studies define forest conservation as 'forest maintenance' activities through sustainable extraction behavior (Infield and Namara, 2001; Ruiz-Pérez et al., 2005; Ticktin and Shackleton, 2011). Many studies regard forest conservation as 'forest protection' including forest patrolling and financial supporting to rangers (Balmford and Whitten, 2003; Gibson et al., 2005). Another studies add that 'reforestation' is a significant activity for forest conservation (McNeely, 1988). Therefore, this study regards forest conservation as activities of forest maintenance, forest protection, and reforestation.

challenges of forest conservation in Phnom Prich Wildlife Sanctuary. This study applied institutional framework to identify the role of institutions in forest conservation activities in PPWS. According to the information from government documents, INGO reports, focus group discussions, key informant interviews, and field observations, the role of institutions in forest conservation activities can be explored by their direct enforcement, joint forest conservation (Government, INGOs, and CPAs), and indirect enforcement (policy and legal framework). Local people's participation in forest conservation was analyzed by descriptive statistics.

7.2.2 NTFPs' Incentives for Local People's Participation in Forest Conservation

Theoretically, local people have little incentive to conserve the forest unless they gain something from it (Badola, 1998; Harbia et al., 2018; Rode et al., 2015). Binary Logistic in the regression model was used to check the hypothesis of 'To increase income of local people derived from extraction of NTFPs will be an incentive for local people's participation in forest conservation activities.' This study focused only on the sign of significant level rather than the levels of coefficient due to the limitation of data. The goal of a binary logistic regression is to understand a binary on the basis of one or more predictors. The dependent variable (z_i) is binary, so it must be input as 1 or 0. One (1) indicates a yes, participated in a forest conservation activity; zero (0) a no, not participated. Equation (7.1) expresses the binary logistic regression that involves fitting an equation of the following form.

$$z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_i x_{ni} + \varepsilon \qquad (7.1)$$

Where β_0 is the intercept of the model, the β_i (i=0, 1, 2, …, n) is the slope coefficient of the logistic regression model, and x_i (i=1, 2, …, n) are the independent variables. The linear model formed is a logistic regression of participated or not participated in forest conservation (present condition) on the independent variables (last year).

Equation (7.2) describes the empirical models for testing the hypothesis. z_i is a dummy variable representing forest conservation activity participated by local people. Dummy variables to be considered in forest maintenance are as follows: (1) not collect the critical part of the plant that affects the growth or reproduction, (2) not collect species that have low population size, and (3) not collect species that have low growth rate or reproduction rate (Ticktin and Shackleton, 2011). Regarding forest protection, dummy variables are as follows: (4) join community forest patrol, (5) inform or report illegal resources extraction or extraction of resources, and (6) contribute either financial assistance or administrative assistance to community forest patrol team (Balmford et al., 2003; Gibson et al., 2005). Regarding reforestation, a dummy variable is (7) contribute household labor to reforestation (McNeely, 1988). Hence, this study tests seven models for different dependent variables (z_i).

$$(z_i=1/0)=\alpha+\beta_1 ntfp+\beta_2 farm+\beta_3 forest+\beta_4 ethnic+\beta_5 edu+\beta_6 hsize+\beta_7 ylive$$
$$+\beta_8 agri+\beta_9 dist+\beta_{10} mem+\beta_{11} tec+\varepsilon \qquad (7.2)$$

Theoretically, local people's participation in forest conservation is often determined by many factors. The explanatory variables are following. '*ntfp*' is income from NTFPs (logarithm: log), and it is the observed variable. '*farm*' is income from farming activities (logarithm: log). The influence of income from farming can be positive or negative. Income from farming positively influences forest conservation activities (Dolisca et al., 2006), while (Willis et al., 1988) claimed that income from farming had a negative impact to forest conservation because it involved economic trade-offs. '*forest*' is income from forest[5] (logarithm: log). The income from forest positively influences people's motivation to participate in forest conservation because local people get benefits over a longer period of

[5] Income from forest is the cash income and subsistence use value of timber, bush meat, and fish.

time (Balmford et al., 2003).

Local people's participation in forest conservation activities in a protected area may vary according to household characteristics. For instance, indigenous people are more likely to participate in forest conservation through their indigenous knowledge for preserving the biodiversity (Brown, 2003). This study uses '*ethnic'* for representing Bunong people, who are indigenous people of Cambodia. Education (*edu*) has been reported that it positively influences local people's participation in forest management and conservation (Stone et al., 2008). A household with more members (*hsize*) is more willing to participate in forest conservation activities because they have enough labor and high demand for forest resources (Stone et al., 2008). Local people, who have lived longer in a protected area (*ylive*) are more likely to participate in forest conservation activities because they have greater experience in resources utilization and management (Newmark et al., 1993). The influence of agricultural land owned (*agri*) can be positive or negative. Households with large agricultural land are more likely to participate in forest conservation activities (Dolisca et al., 2006), but Kauneckis and York (2009) reported that households having large agricultural land are less likely to participate in forest conservation activities because they are busy with farming. Additionally, distance from residence to the forest (*dist*) influences farmer's motivation to participate in forest conservation activities due to the cost of traveling, according to the author's observation.

Community involvement determines local people's participation in forest conservation activity. Member of CPA is more likely to participate in forest conservation activities (*mem*) (Brännlund et al., 2009). When the member of CPA received technical training regarding sustainable resources extraction and forest protection, they are more likely to engage more in forest conservation activities (*tec*).

For reliability analysis, diagnostic procedures are done sufficiently as follows. First, multicollinearity test is used to avoid the problem of high correlation among the predicted variables. Tolerance & VIF (variance inflation factor) are calculated to check multicollinearity problems. Second, Omnibus tests of model coefficients are checked whether the predicted variables are fit or not. They test whether the explained variance in a set of data is significantly greater than the unexplained variance. Third, Hosmer-Lemeshow test is checked on how well the model predicts the outcomes.

7.2.3 Measurement of Value of NTFPs' Incentives for Forest Conservation

This study uses 'conservation costs' approach in revealed preference methods to estimate the value of NTFPs' incentives for forest conservation activities.

It is the most direct and relevant method at this moment because other approaches such as REDD^{+}, ecotourism, and payment for ecosystem services have not existed in PPWS at this moment. Forest conservation activities are not cost-free, so this 'conservation costs' is the most applicable approach to measure costs incurred to conserve the forest on a scale of the specific protected area (Emerton, 1998; Rode et al., 2015).

This value can be estimated from the costs of compensation for not offending wildlife or costs of damaging keystone species, daily wages and food, and fines from illegal activities and costs of training costs or consultative workshops from government and INGOs provided to the community to encourage local people to participate in forest conservation activities (McNeely, 1988; Rode et al., 2015). Incentive for forest conservation occurs when local people receive forest products benefiting their livelihoods, and the incentive's value should be relatively equal to the management costs/conservation costs in a similar context (Emerton, 1998; Jones et al., 2016).

Table 7-1 Value of NTFPs' Incentives for Forest Conservation

Forest Conservation	Proxy Value of NTFPs' Incentives	Measurement
(a) Forest maintenance		
FM1: Do not collect the critical part of plant that affect the growth or reproduction	Training costs provided by government/INGOs	=Multiply (considering between percentage of trainees received training and percentage of sample households participated in FM1)
FM2: Do not collect species that have small population size	Consultative workshop/group discussions provided by government/INGOs	=Multiply (considering between percentage of participants in the workshop and percentage of sample households participated in FM2)
FM3: Do not collect species that have low growth rate or reproduction rate	Consultative workshop/group discussions provided by government/INGOs	=Multiply (considering between percentage of participants in the workshop and percentage of sample households participated in FM3)
(b) Forest protection		
FP4: Join community forest patrol team	Costs of forest patrolling done by rangers in PPWS	=Number of patrolling days and distance or areas of patrolling between rangers and community forest patrol team
FP5: Inform or report illegal resources extraction	Consultative workshop/group discussions provided by government/INGOs	=Multiply (considering between percentage of participants in the workshop and percentage of sample households participated in FP5)
FP6: Contribute either finance assistance or administrative assistance for forest protection	Direct payments given by local people	=Direct payments given by local people
(c) Reforestation		
FR7: Contribute household labour in reforestation program with either government or INGOs	Payments given by GO/INGOs for forest planting	=Multiply (considering between percentage of local people received payment from GO/INGOs and percentage of sample households participated in FR7)

Source: Author, 2016

This study used data of the direct conservation costs of 2016. This study assumes that if extraction of NTFPs creates incentives for forest conservation activities, then these

incentives should be worth at least amount of costs paying by government and INGOs for conservation activities in the particular area because government and INGOs implement projects to motivate local people to participate in similar forest conservation activities. This value of NTFPs' incentives refers that the government and INGOs can save a certain amount of conservation costs if local people can increase income derived from collection of NTFPs. To estimate conservation costs, this study obtained data on costs of conservation per unit area from key informant interviews with local experts (WWF staffs, rangers, and head of CPAs).

Table 7-1 shows the procedure of estimating the value of NTFPs' incentives for forest conservation activities. Each forest conservation activity must be confirmed whether or not it is influenced by income from NTFPs. When the results show significantly influenced, this study estimates the value of NTFPs' incentives according to various conservation costs as seen in Table 7-1.

7.3 Results

7.3.1 Current Forest Conservation Practices in Phnom Prich Wildlife Sanctuary

PPWS is officially under the administration of Ministry of Environment (MoE). However, there are many forest conservation activities have been done by government, INGOs, NGOs, and local communities as follows.

Forest maintenance is about the control of growth and reproductive capacity, and it is mostly related to extraction behaviour of forest dwellers. Forest maintenance has been done in following ways, as seen in Figure 7-1. First, it can be done by direct enforcement, and it is mostly done by CPAs. The CPAs acted the direct role to control extraction techniques. They monitored local people and intruders to ensure continuous regenerating population of the resource, especially on NTFPs, timber, and wildlife. CPAs controlled extractive reserves that could help to avoid the critical damage to forest functions. Second, forest maintenance

activities are done by indirect enforcement, and it is mostly done by government institutions. In fact, the General Department of Administration for Nature, Conservation and Protection (GDANCP) of MoE is the core government institution that responsible for issuing the legal framework of controlling forest extraction. MoE issued the National Forestry Program 2010-2029 to provide guidelines on the extraction of biological resources. MoE also offered official recognition to local communities as the community-protected areas (CPAs). The recognition of these CPAs by MoE is crucial to ensure traditional use rights, successful conservation, and sustainable livelihoods of local communities (USAID-Cambodia, 2016).

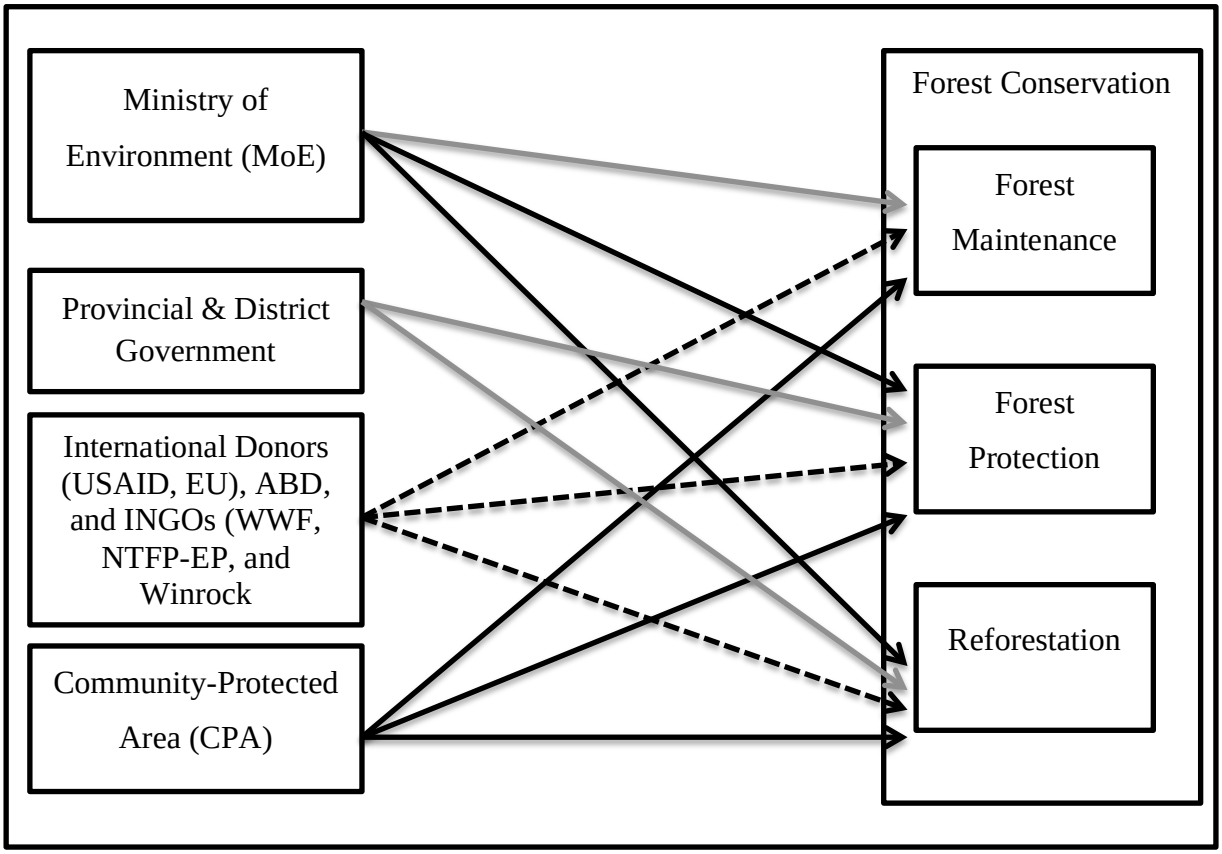

Figure 7-1 Forest Conservation Practices by Institutions in PPWS

Note: → Direct intervention; ⇢Joint forest conservation (Government, INGOs, and CPA);

→ Indirect intervention (policy and legal framework)

Sources: Focus Group Discussions, 2016

Third, joint cooperation on forest maintenance activities is also done in PPWS. For illustration, INGOs, especially WWF-Cambodia provided support and cooperation for local communities for forest conservation in various ways. WWF-Cambodia coordinated local people to establish the CPAs so that these CPAs can be protected by law. Further, WWF-Cambodia cooperated with Winrock International under financial support from USAID-Cambodia on Supporting Forests and Biodiversity Project (SFB) to provide two to three technical trainings every year to all CPAs in PPWS regarding sustainable extraction of NTFPs, especially on liquid resin, wild honey, and bamboo poles.

Forest protection refers to activities that address the threats of illegal logging, wildlife poaching, and improper extraction of NTFPs. It is costly requiring labor, transportation, food, equipment, and wages. Figure 7-1 shows that there are two primary groups playing the vital role in forest protection, rangers and community forest patrol teams. The rangers of MoE patrolled the forest in the core zones of PPWS. There are six outposts of rangers in PPWS, Khtong-Antrong, Antrong, Keo Ropov, Sre Khtong, Laoka, and Memong and two sub-outposts, O Krak and Dei Ey. The outpost is where rangers permanently stay and work. Sub-outpost is where for rangers relax during field patrolling. Each outpost is responsible for patrolling the identified geography boundary ordered by MoE. The costs of salary, weapon, motorbikes, utility (water and battery), and office construction are paid by MoE. To date, there are only 31 rangers in PPWS, including one director of PPWS, three deputy directors, and 27 rangers. The number of rangers is too few considering the area of PPWS, which is 2,225km^2 or 222,500 ha. The CPA is another institution enforcing direct role in forest protection activities. The members of CPA participate in forest patrolling within the boundary of community forestry. Forest patrolling is done weekly within a group of five to ten members. Members of CPA pay most of expenses for forest patrolling. Likewise, INGOs do

not enforce direct role in forest patrolling, as be seen in Figure 7-1. INGOs provide vital cooperation and support to rangers and community forest patrol teams. In PPWS, WWF-Cambodia provides an allowance to rangers of MoE for forest patrolling. WWF-Cambodia also provides technical training for monitoring and data management to control the illegal activities, especially on SMART. Besides the rangers, WWF-Cambodia provides gasoline to cover the transportation cost of community forest patrol team.

Reforestation is a long-term endeavor that requires thoughtful planning, implementation, and monitoring. The purpose of reforestation is to restore forest cover to ensure the production of specific forest products and ecosystem services. The reforestation program in PPWS is carried out on abandoned agricultural and deforested land. The Forestry Administration of Ministry of Agriculture, Forestry and Fishery (FA-MAFF) introduces the native trees or seeds, but the reforestation program is implemented by MoE and Mondulkiri Provincial Department of Environment. Asian Development Bank (ADB) has supported the finance for this program since 2015. To date, the reforestation program is carried out in four CPAs in PPWS, Sre Y, Poutong-Pouhoung, Sre Thom, and Khnheng. Around 30 to 50 members from each CPA participate in planting trees and controlling weeds. The reforestation is going to expand in other CPAs in coming years.

7.3.2 NTFPs' Incentives for Forest Conservation

A. Local People's Participation in Forest Conservation

Based on structured interviews with sample households, seven activities had been done by local people towards forest conservation in PPWS as follows.

In PPWS, many households participated in three forest maintenance activities. Figure 7-2 shows that more than 80% of sample households do not collect the critical part of the plant (NTFPs) that affect growth and reproductive capacity of plants. About 78% of sample

households do not collect plants that have small population size, especially endangered and critically endangered species. Around, 70% of sample households do not collect plants that have low growth rate or reproduction rate, especially high-value species.

Figure 7-2 shows around 53% of sample households participated in joint community forest patrolling for forest protection. Even though CPAs lack financial resources to cover the expenses, community forest patrol teams commit to participating in forest protection to combat the illegal logging and hunting. Most community forest patrol team members are ex-hunters or traders, so they know the geography of the forest very well. On average each community forest patrol team spent 11 days and five nights per month on patrolling in the forest. Besides, around 51% of sample households actively reported any illegal resources extraction or illegal timber logging to CPA, rangers, and WWF-Cambodia when they saw or knew someone committed any illegal resource extraction.

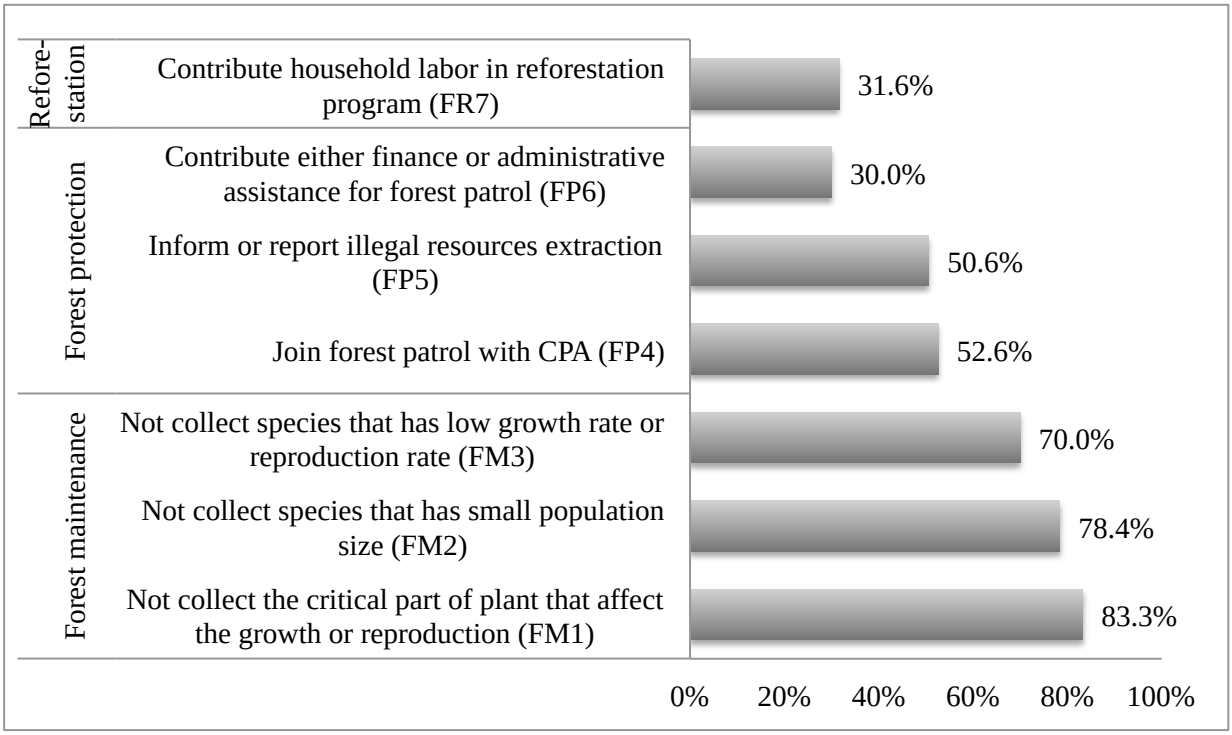

Figure 7-2 Local People's Participation in Forest Conservation

Source: Structured Questionnaire Interviews, 2016

Communication was oral or via phone call. Only 30% of sample households contributed food, money, and administrative works for community forest patrol teams. For example, some school teachers at the primary school in Srae Khtong CPA and most of the village heads in other CPAs in PPWS helped the community to process administrative documents and financial reports for forest patrol activities.

Figure 7-2 shows that around 32% of sample households participated in reforestation programs, which were paid by MoE, while others voluntarily participated in tree planting and weed. This program received financial support from Asian Development Bank (ADB). Some of the local people participated in reforestation program by getting paid, while others voluntarily participated in tree planting and weeds removing for natural growth without getting paid because they understand that those trees are essential for food and shelter.

B. NTFPs' Incentives for Local People's Participation in Forest Conservation

This study examines whether income from NTFPs is an incentive to motivate local people's participation in forest conservation.

Table 7-2 shows results from Binary Logistic Regression analyses. Based Omnibus tests of the model coefficient and Hosmer-Lemeshow goodness of fit test of all seven models, a set of predictors can explain a binary relationship to some extent except FM3 of which the model was not fit enough in Omnibus test; however, it is acceptable in Hosmer-Lemeshow goodness of fit test, as seen in Table 7-2.

However, Table 7-2 shows that income from NTFPs positively and significantly influences four forest conservation activities. Income from NTFPs positively and significantly influences forest maintenance activity of 'not collect the critical part of the plant that affects the growth rate or reproduction rate'.

Table 7-2 Influence of Income from NTFPs to People's Participation towards Forest Conservation

Variables	FM1	FM2	FM3	FP4	FP5	FP6	FR7
	β	*β*	*β*	*β*	*β*	*β*	*β*
(a) Household income							
Income from NTFPs	4.204***	0.138	-0.026	1.762***	0.179	1.260**	0.982**
Income from farming	-0.005	0.092	-0.013	0.007	-0.049	0.104	0.095
Income from forest	0.013	-0.097	-0.027	-0.027	0.021	0.018	0.010
(b) Households' characteristics							
Bunong Ethnic	-0.136	0.622	0.413	-0.399	-0.257	-0.102	-0.140
Schooling years of household head	-0.032	0.049	0.024	0.017	0.073	0.062	-0.007
Household members	-0.085	0.017	-0.014	0.021	0.032	0.052	0.032
Years living in current forest sanctuary	-0.008	0.029*	0.011	0.003	-0.010	-0.025*	-0.006
Agricultural land owned	0.126	-0.071	-0.159*	0.003	-0.005	0.036	-0.022
Distance from residence to forest	-0.096**	-0.087**	0.021	-0.038	0.010	-0.022	0.021
(c) Community involvement							
Membership of a CPA	-0.803*	0.819	0.565	-0.003	-0.719**	-21.54	-0.656**
Technical training received from CPA and partner	0.891*	-0.231	-0.172	-0.036	-0.614**	0.429	0.141

Model Diagnosis:

FM1: Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=0.680; Correctly predicted percent=84.4%
FM2: Omnibus tests of model coefficient=0.044**; Hosmer & Lemeshow test=0.016; Correctly predicted percent=83.7%
FM3: Omnibus tests of model coefficient=0.494; Hosmer &Lemeshow test=0.098; Correctly predicted percent=75.7%
FP4: Omnibus tests of model coefficient=0.003***; Hosmer & Lemeshow test=0.339; Correctly predicted percent=64.6%
FP5: Omnibus tests of model coefficient=0.002***; Hosmer & Lemeshow test=0.710; Correctly predicted percent=65.3%
FP6: Omnibus tests of model coefficient=0.000***; Hosmer & Lemeshow test=0.039; Correctly predicted percent=78.5%
FR7: Omnibus tests of model coefficient=0.024**; Hosmer & Lemeshow test=0.690; Correctly predicted percent=67.4%

Notes: 1) FM1: Do not collect the critical part of the plant that affects the growth or reproduction
2) FM2: Do not collect species that have small population size
3) FM3: Do not collect species that have low growth rate or reproduction rate
4) FP4: Join community patrol team
5) FP5: Inform or reported illegal resources extraction
6) FP6: Contribute either finance or administrative assistant for forest patrol
7) FR7: Contribute household labor in reforestation program either with government or INGO
8) *, **, and *** denote 0.1, 0.05, and 0.01 levels of significance, respectively.

Source: Author's Analysis, 2017

Among three activities of forest protection, 'join community patrol team for forest protection' and 'contribute either finance or administrative assistant for forest patrol' were positively and significantly influenced by income from NTFPs. Income from NTFPs influenced positively to reforestation activity as seen in Table 7-2.

7.3.3 Value of NTFPs' Incentives for Forest Conservation Activities

This study confirmed that income from NTFPs positively and significantly influences four forest conservation activities (See Table 7-2). Here in, the value of NTFPs' incentives can be estimated by forest conservation costs paying by government and INGOs in similar activities.

Table 7-3 shows that training costs provided by WWF-Cambodia and NTFP-EP to all CPAs in PPWS to encourage local people to extract the natural resources sustainably can be reached to 44% of sample households, and this actual cost was around R49,468,800. However, around 83% of sample households participated in FM1, so the value of NTFPs' incentive to 'not collect the critical part of plant that affects the growth or reproduction' is worthy equal to around R98,937,600 (two times higher than actual costs).

The forest patrolling days are done regularly according to the agreement among members of CPA in PPWS. The value of NTFPs' incentives for local people to join community forest patrol team for forest protection can be similar to the cost of forest patrolling activities by rangers in PPWS for two reasons. First, the patrol days and nights of rangers were about the same (16 days and 10 nights) as that of community forest patrol team. The distance and areas of patrolling were almost the same. The rangers patrol in the core zone of PPWS and outside boundary of the CPAs, while the community forest patrol team patrol within the CPAs areas. Therefore, the value of NTFP's incentive to 'joint community patrol team' was approximately R505,888,800.

Table 7-3 shows that community members voluntarily paid to support the forest protection activities every month. Each of them contributed from R500 to R1,000 per month. On average, a CPA got contribution money around R300,000 per month.

Table 7-3 Estimated Value of NTFPs' Incentives for Forest Conservation

Forest conservation	Confirmation of influence from NTFPs	Actual conservation costs	Proxy value of NTFPs' incentives for forest conservation (Riel/year)
(a) Forest maintenance Do not collect the critical part of plant that affect the growth or reproduction	Yes	Training costs for 44% of sample households provided by INGOs = R49,468,800	83% of sample households participated in FM1 (2 times higher than actual training costs) = **R98,937,600**
Do not collect species that have small population size	NO	-	-
Do not collect species that have low growth rate or reproduction rate	No	-	-
(b) Forest protection Joint community patrol for forest protection	Yes	Costs of forest patrolling done by rangers in PPWS (wages and transportation) = R505,888,800	• Number of patrolling days are almost the same • Distance of patrolling/areas of patrolling is similar • Value can be assumed to equal to actual forest patrolling costs = **R505,888,800**
Inform or report illegal resources extraction	No	-	-
Contribute either finance assistance or administrative assistance for forest protection	Yes	Direct payments given by local people	Direct payment given voluntarily by local people (8CPAs): 300,000 multiply 8 CPAs multiply12 months= **R28,800,000**
(c) Reforestation Contribute household labour in reforestation program either with government or INGO	Yes	Payments given by GO&ADB for forest planting 1. Trees planting = R99,000,000 2. Controlling weeds for native plants growing = R16,800,000 Sub total = R115,800,000	• % of local people received payment and % sample households join (volunteer) was about the same • Actual costs from reforestation were measured from 4 CPAs while value of NTFP's incentives measured from 8 CPAs • Value of NTFP's incentives to FR7 (2 times higher than actual reforestation costs)= **R231,600,000**
Total areas of PPWS is 222,500ha Conservation costs per unit area ≈ **3,900 (US$0.95/ha)**			Direct conservation costs in PPWS ≈ **865,226,400 (US$212,690)**

Notes: 1) R= Riel is the national currency of Cambodia

2) 1US$=4068 Riel (in 2015, National Bank of Cambodia)

Source: Author's Interviews, 2017

Thus, this contribution from all eight CPAs per year was around R28,800,000. Therefore, the value of NTFP's incentive to 'contribution money for forest protection' was approximately R28,800,000. Even though MoE and ADB paid local people for trees planting or controlling weeds for native plants growing individually, but local people spent on traveling costs and food expenditure. In some cases, MoE paid a daily wage for one member, but he or she brought other members from their family to plant trees without getting any fees. According to the calculation of reforestation cost in PPWS, which were received fund supports from MoE and ADB in 2016, was about R115,800,000. The actual cost of reforestation was measured from four CPAs while the value of NTFPs' would be calculated from eight CPAs in PPWS. Therefore, the value of NTFPs' incentive to 'contribute household labour in reforestation' is worthy equal to around R231,600,000 (two times higher than actual costs).

Thus, at the minimum, NTFPs created incentives for forest conservation activities with the value being around R865,226,400 (US$212,690) in PPWS in 2016. Though, being on average, per unit area of value of NTFP's incentive for forest conservation activities in PPWS was around R3,900 (US$0.95) per ha per year.

7.4 Discussions

It has been increasingly debated that extraction of NTFPs is generally seen as a factor that motivates local people to participate in forest conservation activities (McNeely, 1988; Shaanker et al., 2004; Ticktin, 2015). However, those studies did not provide any empirical evidence. This study found that among seven forest conservation activities, extraction of NTFPs creates incentives to at least four of them as follows. This study found that extraction of NTFPs motivates local people not collect the critical part of the plants that affect the growth or reproduction. When local people do not collect the critical part of species, the extractive reserves could ensure that the NTFPs deletion is not occurred (Shackleton et al.,

2015; Ticktin and Shackleton, 2011). Also, incentives from extraction of NTFPs motivate local people to join in forest protection and to contribute money for forest patrol. This study agrees to Balmford and Whitten (2003);Gibson et al. (2005) that local people's participation in forest protection has led to more effective forest conservation because local people know exactly on the consequences of deforestation, wildlife poaching, and improper resources extraction. In addition, income from NTFPs encourages local people to participate voluntarily in tree planting and weeds removing from natural growth without getting paid because they understand that those trees are essential for foods and shelter (Balmford and Whitten, 2003; deJong, 2010; McNeely, 1988). However, this study found that income from NTFPs creates the incentives for local people's participation towards forest conservation in various ways. Incentives from NTFPs are the proper inducement mechanism that is intended to incite or motivate local people to conserve the forest. The incentives from NTFPs was also occurred in other countries such as in Tanzania (Schaafsma et al., 2014), in Thailand (Delang, 2006), in Vietnam (Quang and Anh, 2006), in India (Shahabuddin and Prasad, 2004), in Nepal (Spiteri and Nepal, 2005), in Czech Republic (Sisak et al., 2016), in Ethiopia , in Africa (Ndangalasia et al., 2007). Those countries are mostly less wealthy, and their rural regions base on natural resources for livelihoods.

Meanwhile, without the contribution of NTFPs to rural livelihoods, government and INGOs would pay higher costs to encourage local people to participate in forest conservation. Hence, this study found that the annual value of NTFPs' incentives for forest conservation activities was around US$0.95/ha (US$95/km^2). Comparing to Emerton, 1998, who found direct costs of conserving two of Kenya's wetland National Parks were some Kenyan Shilling (Ksh) 20 million per year (US$ 333,333, the exchange rate in 1998). Comparing to Bamford et al. 2003, who found that the annual costs of conservation vary enormously from less than

US$0.1 to greater than US$1,000,000 per km^2. Another study estimated the implementation costs incurred by municipal and state governments on forest conservation, and they found that the costs range from US$385 to US$1,153/ha in Brazil (Cunha et al., 2016). Therefore, it was verified that value of NTFPs' incentives for forest conservation activities was not seeing much in Cambodia.

7.5 Summary

The fundamental issue in this study is to confirm whether or not the extraction of NTFPs will encourage additional pro-conservation behavior from local people. Though this study confirmed that extraction of NTFPs is generally seen as the most positive influenced factors for local people's participation towards forest conservation. Additionally, this study found that annual value of NTFPs as incentives for forest conservation was around US$0.95/ha or US$95/km^2 in Phnom Prich Wildlife Sanctuary, Cambodia. Without the encouragement of local livelihood improvement through extraction of NTFPs, government and INGOs are going to pay higher costs to conserve standing forests. Therefore, an appropriate incentive policy for promoting NTFPs extraction is a considerable ecological economic framework to turn a poacher to become a ranger with fewer conservation costs but greater conservation achievements.

Chapter 8: Conclusions and Recommendations

8.1 Conclusions

The proposition that the extraction of NTFPs from forests can simultaneously achieve both rural poverty alleviation and forest conservation has fostered a vigorous debate among policymakers, politicians, conservationists, and researchers. To agree consistently with this idea, the method of assessment upon the value of NTFPs must be utilized beyond other conventional approaches. Most valuation studies concentrate solely on cash income generated from NTFPs. This conventional valuation provides a rough assessment of the value of NTFPs, and may also be misleading. As long as the cash economy indicates the fate of NTFPs in the forest, a part of NTFPs value is ignored. These results in policymakers regarding forests with less importance, compared to alternative economic activities. This study contributes to an assessment of NTFPs hidden value, considering the perspectives for both rural poverty alleviation perspective and incentives for forest conservation. These two new forms of analysis ensure that NTFPs can be integrated into proper environmental assessing, planning, and policy decision-making related to sustainable forests and rural livelihoods.

The current use of NTFPs in Cambodia has not been well documented. Different users extract NTFPs for various purposes, so current use and management of NTFPs is still complicated. This study first explores current issues for local people living in the forest sanctuary using NTFPs for their livelihoods. It also considers what kinds of institutional management styles exist for administrating NTFPs. From the case study of Phnom Prich Wildife Sancutary (PPWS) Cambodia, forests are the primary resource for rural household living in the forest vicinity. The tropical forests of PPWS have an abundance of NTFPs. Intensive extraction depends greatly on the high value of NTFPs (liquid resin, solid resin, wild honey, and orchids), as well as market demand. Around 93% of the sample households

extracted NTFPs; this study therefore argues that NTFPs play a vital role in supporting local livelihoods and general well-being. Local people collect commercial NTFPs in the dry season when they are free from farm work. There are more than 900 types of NTFPs identified by the Ministry of Agriculture, Forestry and Fishery, Cambodia. Among these NTFPs, this study found that the most important 8 NTFPs for daily life of local people in PPWS are as follows: liquid resin, solid resin, wild honey, orchids, bamboo poles, bamboo shoots, prich leaves, and fuel wood. This clearly shows that local people in PPWS do not collect numerous types of NTFPs. In addition, the uses of these 8 NTFPs varied according to the type of product and household characteristics. Based on 8 NTFPs, many NTFPs are crucial for households' subsistence use as: food, construction, fencing, furniture, traditional medicine, food ingredients, and cooking fuel. Commercial NTFPs such as liquid resin, solid resin, wild honey, orchids, and bamboo poles were commonly sold to local middlemen without any further processing. Local people traded NTFPs only when local markets and local traders were available at their locations. This study found that NTFPs play a greater role in subsistence use rather than for selling; only a fraction of NTFPs high value can be traded locally. Therefore, the real value of NTFPs cannot be substantively defined in monetary terms, so a range of values must be taken into consideration in any valuation (Cavendish, 2002; Godoy et al., 1993; Pyhälä et al., 2006). Regarding NTFPs management, local institutions, especially CPAs, play a significant role to in managing more NTFPs, since the external institutions (central government, provincal & district government authorities, and INGOs) are interested in only in a few NTFPs. These include: such as liquid resin, bamboo poles, and wild honey. The reason why external institutions show little effort for NTFPs is appraent from the value of minor forest products, which contribute little to the national economy. In fact, local people recognize NTFPs as the most essential resource for their livelihood because they use NTFPs to support

their well-being.

Before assessing the hidden value of NTFPs, an understanding of how local people use them based on household livelihood strategies must first be explored. 4 household livelihood strategies for NTFPs' use can be considered as sustaining livelihoods. NTFPs are used by local people firstly to survive, then get a safety-net, and finally earn a high income in cash from them. In this regard, this study was able to reveal the contribution of NTFPs to cash income and the management of NTFPs to improve livelihoods, with a reduced ecological impact. This study discovered that fuel wood, bamboo shoots, bamboo poles, and prich leaves were mostly used as a subsistence strategy. Some households collected NTFPs as a supplementary strategy to earn extra cash income. For example, orchids and solid resin are mostly sold to supplement cash income. For NTFPs with larger markets, a diversified strategy and a specialized strategy are both good options to earn higher cash incomes. For instance, wild honey and liquid resin have a high potential to generate money for cash income-oriented strategies. There are niche opportunities to get higher economic returns when rural households manage NTFPs to get higher prices. Since they can be extensively managed and intensively managed on an intermediate bassic, NTFPs like wild honey and liquid resin NTFPs do not impact negatively on forest ecology.

Society needs accurate and comprehensive estimates of the economic value of NTFPs in order to conserve and manage forests better. Due to the hiddenness of NTFPs' values, policymakers may regard forests as being of little importance. This study firstly clarifies the unknown value of NTFPs from the viewpoint of poverty alleviation. This is based on the fact that part of NTFPs value are hidden as contributions to household subsistence because they are not being traded through the market. This study concludes that NTFPs significantly contribute to rural poverty alleviation because rural households can be lifted from poverty,

based on 4 aspects of empirical findings. The cash income generated from NTFPs accounted for 58% of the household cash income and 48% of the total household income; this clearly shows that NTFPs are the primary income source for local people living in PPWS. The low-income household stratum (33% of sample households) and medium-income household stratum (33% of sample households) would fall into poverty if they were unable to collect NTFPs. Income from NTFPs may also alleviate multi-dimensional poverty. This includes malnourishment; mental/physical disability; no enrolment in school (at least one school-aged child); no access to toilet or adequate sanitation; no access to clean water; no access to lighting; no shelter from strong winds; no assets for mobility; or no assets to sustain livelihoods. In addition, NTFPs can be used to prevent rural households from slipping into poverty in the future. Referring from the empirical finding from this study, local people could collect more NTFPs to cope with other difficulties like a lack of human capital, low savings, rising food prices, and natural disasters. The decline in NTFPs leads to devastating impacts on the lives of rural households living in or nearby a forest.

Secondly, NTFP's incentive for forest conservation activities has not yet been widely discussed by many scholars, governments, or international organizations. This study explains that NTFPs' uses have a hidden value as incentives for forest conservation. Thus far regarding PPWS, the Cambodia government and INGOs have directly protected forests through patrolling activities. They also supported CPAs for forest conservation activities. In fact, the MoE provided payments through ADB funds to local people for reforestation. WWF cooperated with NTFP-EP and Winrock International to support the committee of CPAs in PPWS through technical trainings regarding forest maintenance and sustainable extraction of NTFPs. Therefore, forest conservation in protected areas may be doomed unless local communities become an integral part of conservation efforts - this is because local people can

exercise the real power for forest conservation activities. Among 7 forest conservation activities, income from NTFPs influenced 4 of them. Without the contribution of NTFP as incentives for forest conservation, the government and INGOs will have to pay higher costs in order to encourage more local participation in conservation activities. Indeed this study found that NTFPs, as incentives, contributed an annual value of US$0.95/ha (US$95/km^2) to conservation efforts. Therefore, an appropriate policy for promoting NTFPs extraction would be a considerable incentive mechanism to turn a poacher into a ranger. This could be achieved with lower conservation costs, yet greater conservation achievements. Local people with a direct interest in NTFPs extraction would then be better positioned to protect their forests, upon which they depend.

8.2 Policy Recommendations

For economic, social, and political reasons, extraction of NTFPs must be intensified. The carrying capacity of the resources must be closely monitored however; this is so that domestication or substitution problems can be avoided. This study argues that if households wish to achieve a better quality of life, then NTFPs' extraction must face many constraints in order to reduce the overall ecological impacts. Therefore, more efforts on policy development and interventions should be considered as follows.

- NTFPs must have a clear position on the policy development agenda.

Refering to results from this study, NTFPs have a considerable economic value in poverty alleviation, when taking cash income and the subsistence use value of NTFPs into account. NTFPs provide a livelihood benefit, which prevents local people from falling into poverty. Futhermore, NTFPs play the role of a safety-net when local people are affected by the idiosyncratic and covariate shocks. Meanwhile, NTFPs create incentives for local people to engage with forest conservation. This reality is rarely referred to in debates and designs for

poverty alleviation solutions; forest management policies, strategies, or projects, except at local levels. Evaluation and management for NTFPs' roles in rural poverty alleviation and forest conservation must be reconsidered. Therefore, relevant government departments should address the following tasks urgently: first, the Ministry of Agriculture, Foresty, and Fisheries (MAFF-Cambodia) must keep a record inventory about key species and production quantities of NTFPs. MAFF-Cambodia can begin to record statistics of NTFPs, especially the most important NTFPs, particularly: liquid resin, solid resin, wild honey, bamboo poles, bamboo shoots, and orchids, etc. Statistics of NTFPs are important for developing sectoral policies, management plans, and investment opportunities. Second, the Ministry of Environment, Cambodia should develop and implement policies and laws related to NTFPs in the natural resource management on a national level. To date, there many key policies and strategies related to land and natural resource management. These include: the National Strategic Development Plan (NSDP) 2014-2018 to better manage protected areas; National Policy and Strategic Plan on Green Growth 2013-2030 (2013); Forestry Law (2002, amended in 2006 and then again 2010); National Forest Program 2010-2029 (2010); Protected Area Law (2008); National Biodiversity Strategy and Action Plan (2002); and Law on Environmental Projection and Natural Resources (2001). However, the position of NTFPs in those policy development agendas are minor or absent. NTFPs must be included in those policy development agenda because it will enable Cambodia to be more resilient and ensure that Cambodia's forests continue to provide benefits to local people, private sectors, the national economy, and the global environment.

- The Ministry of Environment should reform the regulation and guidebook on the enviromental impact assessment.

Investors related to economic land concessions and natural resource exploitation are required

to conduct a full impact assessment to analyze environmental damage and the economic gains of a development project. Environmental impact studies done by independent consulting firms and the review process conducted by Department of Monitoring and Environmental Impact Assessment, MoE rarely include the hidden value of NTFPs in subsistence use value, rural poverty alleviation, and as incentives for forest conservation. This leads to controversy regarding benefits-sharing between investors and local people living in the forest. Therefore, NTFPs must be considered according to the guideline of environmental impact assessment, especially in the section of the environmental impacts mitigation measurement.

- Relevant ministries and INGOs must promote the extraction of NTFPs with intense management, being intermediate.

Rural poverty can be alleviated without a negative impact to forests. However, promoting NTFPs through intensive, intermediate management can be done as follows. According to the result from Chapter 5, geographic status limits opportunities to increase NTFPs income through trading. Households living far from the market can find it difficult to access the market; this is because travelling costs and unstable market demands are so high. Therefore, local people continue to extract NTFPs for subsistence use, unless they can access the market with low costs and few risks. This constraint can be solved through a market agent, who can initiate the communication between NTFPs' collectors and traders. The market agents should be INGOs and academic institutions because they can facilitate or lobby on behalf of local people who lack the particular knowledge or skills. Also, effective NTFPs commercialization requires the improvement of access to market information pertaining to the demand and price of NTFPs. Likewise, supporting the birth and growth of NTFP enterprises is a further way of supporting the local economy. This support can help to incentivize forest conservation, ensuring that the forests continue to sustain NTFPs for local livelihoods. Second, referring to

the findings of Chapter 5: the ability to read significantly and positively influences access to the larger market through intensified management of NTFPs, especially on wild honey and liquid resin. It surmises that local people who can read tend to invest more in NTFPs' management to scale up their production and returns; this is because they can access information regarding commercial NTFPs. Nonetheless, interventions to increase school years attended by rural households are costly and timely. Therefore, improving the ability to read enables local people to develop their knowledge and to communicate well with government officers, INGOs, and NTFPs traders. Third, community involvement must be enhanced through providing incentive programs, which reflect the voluntary agreements that local people make to conserve forests. As a result, they will receive direct/indirect rewards from the government or INGOs. In Cambodia, budget allocations for managing and trading NTFPs are limited at the national level. To date, only NGOs provide incentives to local people for organizing the community-protected area (CPA); providing technical trainings about the extraction of NTFPs; and facilitating market information at a local level. Therefore, relevant ministries (the Ministry of Environment, the Ministry of Agriculture, Forestry, and Fisheries, and the Ministry of Commerce) and international organizations should consider providing more incentives as detailed: the government and INGOs should provide the incentive of fiscal measures, such as price support for NTFPs, which are collected from the wild with less disturbance to ecosystem services: wild honey, liquid resin, bamboo poles; commodities agreements between NTFPs collectors and buyers. Technical assistance should be provided to local people to enhance the capacity of intensive management in producing commercial NTFPs, and encourage new species of them too.

8.3 Limitations and Future Studies

Despite numerous significant findings, this study is not free from limitations. The

limitations are mostly related to the number of NTFPs selected, the analysis approach and data. Further research is therefore required in the flowing areas:

- This study applies a bottom-up approach, enabling access to the value of NTFPs as perceived by local people based on sample households. This assessment captures aspects of individual decision-making, factors affecting how much to collect, the impact on rural poverty alleviation, and incentives for forest conservation. However, when estimating the value of NTFPs, it would be better to apply the production to consumption approach, innovated by Belcher (1998). Since the value of NTFPs may frequently change and go through various processes before reaching the final consumer or export market, the added-value of processing and innovative marketing should include an entire set of actors in order to capture the accurate value of NTFPs.

- This study uses cross-section data for only one fiscal year (2015) so as to evaluate whether income from NTFPs contributed to rural poverty alleviation and reduced household vulnerability to poverty. Some researchers argue that this approach may contain measurement errors because respondents might have experienced less poverty or vulnerability to poverty from year-to-year. Even this study's carefully designed questionnaire has been tested several times to reinforce the quality of the data, so it would be much better to fix the time period of impacts or perceptions in a future study. For example, to test the hypothesis of 'Income from NTFPs plays a crucial role in alleviating multidimensional poverty', a structured questionnaire should have been conducted for interviews in 2016. This would have helped gain reliable data of incomes from NTFPs in 2015. Another survey in 2017 with the same respondents regarding the state of multidimensional poverty in 2016 should also have been conducted. As another example that tests the hypothesis of 'In a time of shock, rural households extract more NTFPs to prevent them from falling into poverty in the future',

another structured questionnaire for interviews in 2015 should also have been run in order to gather information regarding the risks and shocks that households experienced in 2014. A later survey again in 2016 to collect data of incomes from NTFPs in 2015 would also have been useful.

- To analyze the role of NTFPs accurately, the following starting points are most favorably suggested: the correlation between income from NTFPs and multidimensional poverty. The simple OLS regression could be used to estimate how much rural households extract NTFPs to prevent household vulnerability to poverty. However, a future study can enhance models to be more precise for estimation through the 'Quintile regression model'. This method allows the examination of impacts of independent variables at different levels of income from NTFPs. This is done by categorizing sample households into quintiles (can be low income, moderate-income, above medium-income, and high income).

- Another limitation of this study is not knowing the extent of the forest loss in PPWS. If the statistics about the forest loss in PPWS are readily available in the future, it would provide more discussion upon how NTFPs create incentives for forest conservation, and whether they help to reduce deforestation or not.

- This study applied only the 'Logit Model' to examine whether the income of NTFPs creates an incentive for local people's participation in forest conservation or not. To improve the quality of analysis regarding incentives for forest conservation, 4 factors of incentives for forest conservation should be considered for inclusion in a model. The first factor is financial incentives provided by the government or international organizations (McNeely, 1988; Pearce, 2001). The second factor is an indirect incentive form, such as capacity building and natural resource policies from either the government and international organizations (McNeely, 1988). The third factor is incentives arising from ecological

functions (Pearce, 2001). This latter factor is complex and varied according to study sites. A potential researcher needs to focus on one or several ecosystem services, whatever is the most appropriate for estimating the value of those ecosystem services, for example: the value of carbon dioxide (CO_2) reduction; the value of economic damage from the loss of biodiversity; loss of water quality; increased watershed disruption; and risks to human health. The last factor is positively confirmed by this study, that is, incentives for the extraction of NTFPs. Thus, these four factors could support the wider argument for using effective economic instruments to promote the conservation of the remaining forests.

- Lastly, individual households might have various incentives for forest conservation. For example, after collecting NTFPs, some households make considerable efforts to participate in forest conservation, while other households contribute little to such efforts. At this moment, this study measures only the overall value of NTFPs' incentives for forest conservation activities in PPWS as a case study. The main objective of this study is to identify who can save conservation costs through NTFPs' incentives for forest conservation - it is the crucial step for integrating NTFPs into development policies. This study did not measure the incentive value for different types of individuals, so it is much better to deal with the value obtained by individual households. An alternative approach could be to measure the direct payments made to conserve forests, paid by sample households who joined forest conservation activities after receiving incentives from the extraction of NTFPs.

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Appendix

Table A-1 Glossary

	Terms	Descriptions
1	Non-Timber forest products (NTFPs)	De Beer and McDermott (1989) define "*NTFP is all biological materials other than timber which are extracted from forests for human use*". FAO (1999) calls NTFPs as NWFPs. FAO defines that *"NWFP consist of goods of biological origin other than wood, derived from forests, other wooded land, and trees outside forests"*. However, the definitions are almost the same, but NTFPs have been called commonly from scholars and practitioners.
2	Economic Value	The sum of all benefits, monetary or other, obtained from a resource: use value (direct and indirect) + option value + non-use value (bequest + altruistic + existence value) (CBD, 2013).
3	Value	The contribution of an action or object to user specified goals, objectives or conditions (MEA, 2003). According to the Oxford English Dictionary, the term "value" is described in three ways such as exchange value (=market price), utility (very different from the market price according to the actual use of goods and services), and importance (=appreciation or emotional value).
4	Hidden value/Unrecognized value	International Institute for Environment and Development (1995: 14) defined hidden values as wild resources, which are collected and consumed directly without passing through markets, or/and they have generally been ignored by government decision-makers and international development agencies.
5	Economic value/Consumptive value	Values of commercial goods (monetary exchanges) and non-commercial goods (subsistence use) (Campbell & Luckert, 2002: 1-7).
6	Subsistence use	It refers to non-market value of resources, which are consumed

	value	directly by local households without crossing through a market. Subsistence use values often are not captured in the national economic statistic (Cavendish, 2002: 35).
7	Cash income from NTFPs	It is the quantity of NTFPs sold by household in a period of time and price sold to market (Adam et al., 2013: 91).
8	Income from NTFPs	It is a combined value of cash income and subsistence use value of NTFPs (Cavindish, 2002: 35; Kar and Jacobson, 2012: 136).
9	Household cash income	It is a sum of cash income generated from various economic activities (cash income from NTFPs, cash income from farming, cash income from forest, and cash income from employment).
10	Household income	It is consists of all receipts, whether monetary or in-kind (goods and services), that are received by the household or by individual members of the household at annual or more frequent intervals (OECD, 2013). Cavindish (2002: 35) defines household income that it is a sum of cash income generated from various economic activities and monetary equivalent of subsistence use of products of various activities In this study, household income is a sum of income from NTFPs (cash income from NTFPs and subsistence use value of NTFPs), income from farming (cash income from farming and subsistence use of farming), income from forest (cash income from forest and subsistence use of forest), and income from employment (cash only).
11	Per capita income/day	It is the average income earned per person per day in a given area in a specific year.
12	Purchasing Power Parity (PPP)	PPP is an economic theory that compares different countries' currencies through a market "basket of goods" approach.
13	Poverty	United Nations Development Programme measured poverty by human development index (HDI) since 1980 until now, using multidimensional poverty index from three dimensions such as

		health, education, and livelihood; and the absolute value of US$1.25 PPP/day (UNDP, 2014). World Bank measured poverty by three dimensions including opportunity, security, and empowerment; and the absolute value of US$1.25 PPP/day.
14	Household vulnerability to poverty	Uncertainty, which households face in the future, stems from multiple sources of risk (Ex-ante poverty prevention) (Chaudhuri, 2003: 3).
15	Forest conservation	The activities of forest maintenance, forest protection, and reforestation

Source: Author's Compilation, 2016

Table A-2 Explanatory Variables of NTFPs in Household Livelihood Strategies (for Chapter 5)

Explanatory variables	Assumptions	Expected sign	Sources
Households' production factors			
HH labor	Household has more labors are more likely to belong to collect more NTFPs for cash income and household income	+	Lopez (2011); Schaafsma et al. (2014)
HH land owned	Household who has large land are less likely to collect more NTFPs for their livelihoods	-	
HH capital	Household that have more capital are more likely to collect more NTFPs to improve the livelihoods (Motorbike as proxy)	+	Lopez (2011)
Community involvement			
Member of CPA	A member of community protected area are more likely to collect more NTFPs to improve livelihoods	+	
Received NTFPs market information	Household received marketing information on NTFPs from CPA are more likely to collect more NTFPs	+	Melaku et al. (2014)
Received technical training	Household received technical training from CPA are more likely to collect more NTFPs	+	
Households' characteristics			
Time living in the current area	HH have living in longer period are more likely to collect more NTFPs	+	Kar and Jacobson (2012)
Gender of household head	Male household head are more likely to choose more intensive livelihood strategy	+	
Age of household head	The older of household head are more likely to collect more NTFPs due to his/her experiences	+	
Number of Occupations	HH have more occupations are less likely to collect more NTFPs	-	Added by author
Education level	HH have higher education are less likely to collect more NTFPs because they have another alternative livelihoods	-	Schaafsma et al. (2014); Escobal and Aldana (2003)
Ability to read	HH can read are more likely to increase production and returns from NTFPs	+	
Number of NTFPs collected/hh	HH collected numerous NTFPs are less likely to invest more on the specific NTFP for increasing income	-	Added by author
Geographic status			
NTFP access (km)	HH willing to travel furthest distance to the forest are more likely to collect more NTFPs	+	Adam et al. (2013)
Market access (km)	HH located in shorter distance from resident to the market are more likely to integrate NTFP into cash income	-	Added by author

Source: Author's Compilation, 2016

Table A-3 Significant Differences between Independent Variables (for Chapter 5)

Variables		Liquid resin (S3-S4)	Solid resin (S2-S3)	Wild honey (S2-S3-S4)	Bamboo poles (S1-S3)	Bamboo shoot (S1-S2)	Prich Leaves (S1-S2)
		P-value	P-value	P-value	P-value	P-value	P-value
Households' production factors	HH labor	0.365	0.244	0.166	0.190	0.529	0.877
	HH land owned	0.069*	0.749	0.759	0.001***	0.992	0.890
	HH capital (motorbikes owned)	0.611	0.271	0.003***	0.159	0.827	0.664
Community involvement	Member of CPA	0.059*	0.045**	0.543	0.035**	0.961	0.447
	Received NTFPs market information	0.101	0.190	0.236	0.001***	0.389	0.902
	Received technical training	0.063*	0.576	0.513	0.057*	0.806	0.286
Household's characteristics	Time living in the current location	0.861	0.776	0.360	0.035**	0.508	0.742
	Gender	0.635	0.582	0.852	0.148	0.500	0.498
	Age of household head	0.820	0.991	0.327	0.089*	0.192	0.025**
	Number of occupations/hh	0.292	0.956	0.772	0.784	0.442	0.007***
	Education level	0.669	0.451	0.109	0.887	0.314	0.304
	Ability to read	0.467	0.655	0.039**	0.369	0.303	0.783
	Number of NTFPs collected/hh	0.005***	0.000***	0.437	0.935	0.134	0.536
Geographic status	Distance to collect NTFPs (km)	0.056*	0.097*	0.914	0.312	0.447	0.560
	Distance to the market place (km)	0.443	0.002***	0.273	0.000***	0.000***	0.000***

Source: Author's Analysis, 2017

Table A-4 Explanatory Variables and Expected Sign (for Chapter 6)

Dependent variable: income of NTFPs			
Explanatory variables	Assumptions	Expected sign	Sources
(a) Idiosyncratic risks			
Lack of labor forces (dummy)	When a household seriously suffers from an illness, disability, or death of main income earner, they collect more NTFPs to support their livelihoods.	+	Author
Low human capital (dummy)	HH having less know-how skill collect more NTFPs because they lack alternative livelihoods.	+	Author
Less saving (dummy)	HH having less financial saving tend to collect more NTFPs for dealing with necessary expenses.	+	Paumgarten and Shackleton (2011)
Social exclusion (dummy)	HH having less networking in a community tend to collect more NTFPs because they lack alternative 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 is more likely to collect more NTFPs due to his/her experiences.	+	Melaku et al. (2014)
Male-headed household (dummy)	Female-headed household collect more NTFPs.	-	
Schooling years of household head (years)	HH having higher education are less likely to collect more NTFPs because they have other alternative livelihoods.	-	Schaafsma et al. (2014)
Household members (persons)	HH having many labors is likely to collect more NTFPs to generate higher income.	+	Lopez (2011)
Occupations in a household (number)	HH having numerous occupations is less likely to collect more NTFPs.	-	Melaku et al. (2014)
Time living in the forest sanctuary (years)	HH living in forest longer period are more likely to collect more NTFPs.	+	Melaku et al. (2014)
Ability to read and write (dummy)	HH head, who can read and write is less likely to collect more NTFPs.	-	Schaafsma et al. (2014)
Agricultural land owned (ha)	HH owned large land are less likely to collect more NTFPs for their livelihoods because they are busy with farming activity.	-	Lopez (2011)
Motorbikes owned (number)	HH having many motorbikes is more likely to collect more 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)	A member of community-protected area is more likely to collect more NTFPs to improve livelihoods.	+	
Technical training received from CPA (dummy)	HH received technical training from CPA are more likely to collect more NTFPs because they know how to collect valuable NTFPs.	+	Melaku et al. (2014)
Market information from CPA (dummy)	HH received marketing information on NTFPs from CPA is more likely to collect more 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 is 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 located at a shorter distance from resident to the market is more likely to get higher income from NTFPs because they easily sold it to consumers.	-	Author

Source: Author's Compilation, 2016

Table A-5 Rational of Independent Variables Influenced Local People's Participation in Forest Conservation (for Chapter 7)

Dependent variables:
1. Not collect the critical part of plants that effect the growth/reproduction (FM1)
2. Collected only species that has large population size (FM2)
3. Collected only species that have quick growth rate or reproduction rate (FM3)
4. Joint patrolling team to protect the forests (FP4)
5. Informed or report on the illegal collection or inappropriate extraction techniques (FP5)
6. Contributed in finance or administration for forest protection (FP6)
7. Participated in reforestation (FR7)

Explanatory variables	Assumptions	Expected sign	Sources
(a) Household income			
Income from NTFPs (log)	Local people benefits from extraction of NTFPs have incentives for participating in forest conservation.	+	Author
Income from farming (log)	Local people get high revenue from farming are more likely or less likely to participate in forest conservation.	-/+	Dolisca et al. (2006); Willis et al. (1988)
Income from forest (log)	Local people benefits from forest resources act as powerful incentives to conserve the forest.	+	Balmford et al. (2003)
(b) Households' characteristics			
Bunong ethnic (indigenous people)	Indigenous people are more likely to participate in forest conservation through their indigenous knowledge.	+	(Brown, 2003)
Schooling years of household head (years)	Education has been reported to influence positively to participation in forest conservation.	+	Stone et al. (2008)
Household members (persons)	Large household size is more willing to participate in forest conservation because they have enough labor and high demand from forest.	+	Stone et al. (2008)
Time living in the forest sanctuary (years)	Households who have lived longer in adjacent to a protected area are more likely to participate in forest conservation because they experienced greater in resources utilization.	+	Newmark et al. (1993)
Agricultural land owned (ha)	Households with large agricultural land are more/less likely to participate in forest conservation.	-/+	Dolisca et al. (2006); Kauneckis and York (2009)
Distance to forest (km)	Household living far distance from the forests is less likely to participate in forest conservation due to the high traveling costs.	-	Author
(c) Community involvement			
Membership of CPA (dummy)	A member of community-protected area is more likely to participate in forest conservation.	+	
Technical training received from CPA (dummy)	HH received technical training from CPA are more likely to engage more in forest conservation.	+	Brännlund et al. (2009)

Source: Author's Compilation, 2017

Table A-6 Content of Conservation Program in PPWS (for Chapter 7)

Local people people's participation in forest conservation	Conservation practices	Practitioners	Type of physical expenditure
(a) Forest maintenance			
Not collected critical part of plants (FM1)	Technical training: Extraction and harvesting techniques (wild honey, liquid resin, and bamboo poles)	WWF and NTFP-EP	Training costs for local people in PPWS/year
Collected only species that have large population size (FM2)	Consultative group discussions at the field regarding the list of NTFPs having large population size (Bamboo shoots, bamboo poles, deadwood for fuelwood, price leaves, etc.)	WWF	Costs of organizing focus group discussions/year
Collected only species that have quick growth rate or reproduction rate (FM3)	Consultative group discussions at the field regarding the keystone species that has low growth rate or reproduction rate	WWF	Costs of organizing focus group discussions/year
(b) Forest Protection			
Joint forest patrolling (FP4)	Forest patrolling in PPWS	Rangers of MoE	Costs of forest patrolling (wages, foods, transportation, etc.) in PPWS/year
Informed or reported illegal resource extraction (FP5)	Consultative group discussions for controlling outsiders from resource extraction or from illegal logging	WWF	Costs of organizing focus group discussions/year
Contributed finance or administration assistance for forest protection (FP6)	Contribution fees by community members to support community patrolling team	Community members	Contribution fees by community members in PPWS/year
(c) Reforestation			
Joint reforestation program (FR7)	Reforestation program	ADB & MoE	Paying fees for local people joint in forest planting activities

Source: Author's Compilation, 2017

Liquid Resin
Source: Author, 2016

Liquid Resin Tree
Source: Author, 2016

Bamboo Shoots
Source: Author, 2016

Solid Resin
Source: Author, 2016

Prich leaves: *Melientha suavis* Pierre
Source: Author, 2016

Bamboo Poles
Source: Author, 2016

Fuel wood
Source: Author, 2016

Wild honey
Source: Author, 2016

Orchids: *Vandopsis gigantean*
Source: http://www.pbase.com/schnitz/image/30639938/original
(Retrieved 2017/10/16)

Figure A-1 Photos of Selected NTFPs for the Study

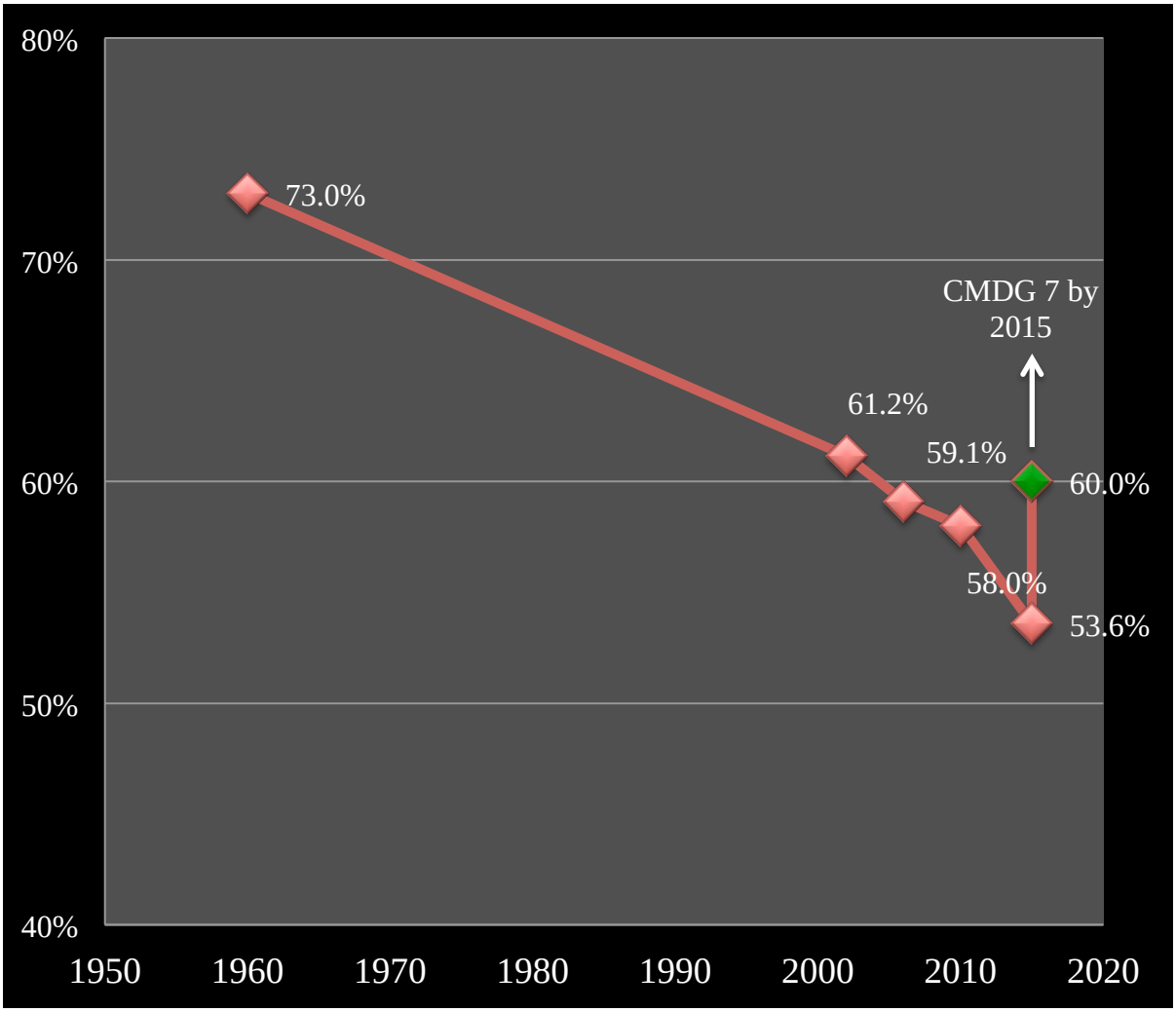

Figure A-2 Forest Cover Changes in Cambodia (%)

Source: Author's Analysis, 2017