

Article

# The Role of Non-Timber Forest Products in Creating Incentives for Forest Conservation: A Case Study of Phnom Prich Wildlife Sanctuary, Cambodia

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**Abstract:** The fundamental issue in this study is to confirm whether or not the extraction of non-timber forest products (NTFPs) will encourage additional pro-conservation behavior from local people. This study clarifies three research questions as follows: what is the current activity of forest conservation in Phnom Prich Wildlife Sanctuary?; does the extraction of NTFPs create incentives for forest conservation?; and how much value do NTFPs have for incentives for forest conservation activities? Fieldworks were conducted in September 2015, March and April 2016, March 2017 in Phnom Prich Wildlife Sanctuary: participatory rural appraisals, key informant interviews, and structured questionnaire interviews with 288 households were randomly selected. 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 the annual value of NTFPs as incentives for forest conservation was around US\$0.95/ha or US\$95/km<sup>2</sup> in Phnom Prich Wildlife Sanctuary, Cambodia.

**Keywords:** NTFPs; incentives; forest conservation; Phnom Prich Wildlife Sanctuary; Cambodia

## 1. Introduction

Non-timber forest products (NTFPs) are the primary resources from forests in developing countries [1–3]. 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 [4–6]. Tens of thousands of non-timber forest products around the world support local livelihoods and economies [7]. At present, over 150 non-timber forest products have been traded internationally [8]. With some 1.4–1.6 billion people worldwide having been estimated to make use at least some non-timber forest products [6]. A study found that the value of NTFPs was 10 times greater than that of timber logged and two times higher than that of land use conversion in the Amazonian rainforest [9]. Non-timber forest products accounted for 39% of total household incomes of forest dwellers in rural West Africa [10]. Likewise, NTFPs provided the economic value of around US\$42 million per year in the Eastern Arc Mountains [11]. NTFPs are also acknowledged as being positively associated with forest conservation [12,13]. Some scholars claimed that economic benefit from non-timber forest products is likely to change local community attitude to maintain forest biodiversity [12,14]. Indeed, extraction of non-timber forest products is less ecologically destructive because it does not critically impact forest functions and regeneration of species [2,15,16].

In forest landscape of Cambodia, non-timber forest products, which benefits the livelihoods of millions of people are under threats due to current deforestation [17]. The absence of NTFPs would

critically impact to the livelihood and well-being of people living in and near the forest [18]. NTFP collection can prevent the poorest from falling into deeper poverty, and medium-income households from becoming poor [4]. 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 [4]. 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 [17,19]. 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 [20]. In the 1960s, Cambodia was believed to have 73.04% of its area under forests [21]. Forest cover declined from 61.15% in 2002 to 59.09% in 2006 [21]. The rate of forest loss was about 93,000 ha per year due to the expansion of agriculture and other commercial plantations [22]. Forest cover in 2010 decreased to about 58% [21], and it continued to decline to 53.60% in 2015 [19]. After the civil war, Cambodia made considerable efforts to address the issue of deforestation, when approximately 41% of the country (which is around 7.5 million hectares) 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 [23]. 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 [4,17].

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 optimal way [24]. Another reason is that investment in forest conservation can be very costly [25,26]. 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 [27]. Another constraint in setting restriction zones is a prohibition of local use of forest resources, which often disrupts local livelihoods [25,28,29]. 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 non-timber forest products can provide benefits for forest-dwelling peoples and present incentives for forest conservation. There are a claims that non-timber forest products are essential for forest conservation [13,30–33], but empirical evidence of this role remains inadequate, especially in Cambodia and other developing countries. More importantly, even though non-timber forest products 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 [4]. The measurement of value of non-timber forest products from incentives for forest conservation is crucial for integrating non-timber forest products into development agendas of official institutions [4,7,34]. Likewise, realizing the value of non-timber forest products from its incentives for forest conservation is vital for providing the best means of transforming an exploiter into a conservationist through promoting management of non-timber forest products. This study addresses the following research questions: (1) What are the current forest conservation practices in Phnom Prich Wildlife Sanctuary? (2) Does extraction of non-timber forest products incur incentives for forest conservation activities? (3) How much is the value of non-timber forest products from its' incentives for forest conservation activities derived from their extraction in Phnom Prich Wildlife Sanctuary?

## 2. Methods

### 2.1. Definition of Key Terms

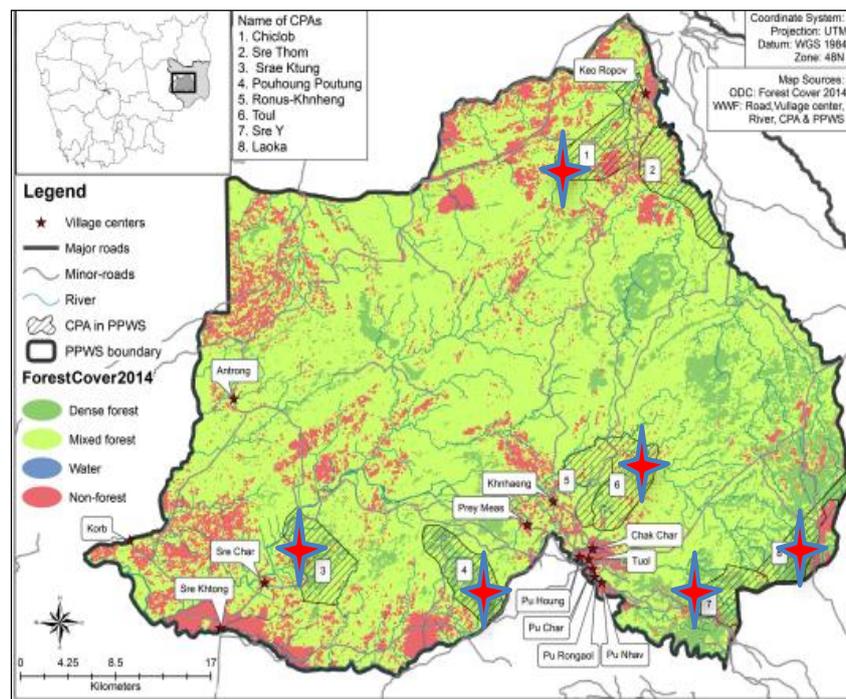
To remain consistent through the paper, key definition of terms were given as follows:

- Income from non-timber forest products: the combined value of cash income and subsistence use value of non-timber forest products [35].

- Forest conservation: it can mean anything from intensive timber production to total preservation, but forests would not be permanently converted to another use such as agriculture [36,37]. Some studies define forest conservation as ‘forest maintenance’ activities through sustainable extraction behavior [16,29,38]. Many authors regard ‘forest conservation’ as forest protection activities, including forest patrolling and financial supporting to rangers [14,39]. Another author adds that ‘reforestation’ is a significant activity for forest conservation [26]. Therefore, this study regards ‘forest conservation’ as activities of forest maintenance, forest protection, and reforestation.
- Incentives for forest conservation: references [26,40,41] define incentives for forest conservation as the voluntary agreements that landowners or local people make to conserve forest in exchange for their livelihood benefits.
- Non-timber forest products’ incentives: this study defines this term as the motivation strategies to encourage local people to participate in forest conservation activities when they get income from non-timber forest products (NTFPs).

## 2.2. Study Site

This study selected Phnom Prich Wildlife Sanctuary (PPWS) for the case study. PPWS is located in the Eastern Plains Landscape of Cambodia, which is one of the largest remaining, relatively undisturbed landscapes in mainland Southeast Asia, as shown in Figure 1. PPWS covers 2225 km<sup>2</sup> [42]. PPWS has been ranked as one of the most critical sites for biodiversity conservation in Cambodia. The mosaic of forests in PPWS support more than 18 endangered and critically endangered mammals, birds, and reptiles [42].



**Figure 1.** Map of Phnom Prich wildlife sanctuary, Cambodia.

PPWS is also of great importance in social, economic, and cultural. Local people use natural resources in the forest to support their livelihoods. Local communities are diverse with different beliefs and ethnic groups. The majority of households are Bunong (Phnong), who account for 83% of total households. Bunong people believe in their ancestors or spirits. The second most common ethnic group is Khmer, and they practice Buddhism. There are a few Cham people who practice Islam. Each household has at least three activities to make a living. The main occupation of households

is farming (79%), with secondary occupations such as extraction of NTFPs, working as hired labor, fishing, and logging.

There is increasing pressure for PPWS to be converted to agriculture or to expand communities through social land concessions or economic land concessions [42]. As such, the forests and their rich biodiversity are decreasing at an alarming rate because of commercial land clearance, agricultural expansion, hunting, and logging [17,42]. However, PPWS has been recognized as a global conservation priority within the Lower Mekong Dry Forest Ecoregion [43], so this potential protected area needs to reduce further loss of forest biodiversity. PPWS is well endowed with NTFPs that offer a variety of opportunities for subsistence use and trade. Local people extract NTFPs primarily for subsistence use, especially for food, construction, energy, and medicine [18].

### 2.3. Data Collection

Fieldwork was conducted in September 2015 for secondary data collection, key informant interviews, and participatory rural appraisals (PRA). Another fieldwork session was conducted from March to April 2016 for PRA and structured questionnaire interviews. The last fieldwork was conducted in March 2017 for key informant interviews, including collecting data on conservation costs in PPWS. Secondary data were gathered from official reports of the Ministry of Environment (MoE) and World Wildlife Fund (WWF) to assess current conservation activities in PPWS. The key informant interviews were conducted with MoE officers, WWF staffs, Wildlife Conservation Society (WCS) staff, village heads, and heads of the community protected areas (CPAs) to understand joint forest management, community-based conservation, and forest conservation practices. PRAs were conducted through focus group discussions (FGDs) at four CPAs in PPWS. Groups ranged in size with 5 to 10 local people being invited to participate in each FGD. In addition, structured questionnaire interviews were conducted with 288 sampled households, which were randomly selected from six CPAs among the eight CPAs, including Nglao Ka, Sre Y, Chi Klab, Toul, Poutong-Pouhoung, and Srae Khtong. Figure 1 shows that all selected CPAs are located in different geographic zones in PPWS so they can generally represent the PPWS. The respondents were local people and included the household heads or adult above 18 years of age. Regarding structured questionnaire interviews, the key questions/indicators included in survey are as follows:

- Forest maintenance: do not collect the critical part of plant that effect the growth or reproduction (dummy), do not collect species that have small population size (dummy), and do not collect species that have low growth rate or reproduction rate (dummy)
- Forest protection: join community forest patrol team (dummy), inform or report illegal resources extraction (dummy), and contribute financial assistance or administrative assistance for forest protection (dummy)
- Reforestation: contribute household labor in reforestation activity (dummy)
- Income from NTFPs: absolute value of cash income and subsistence use value of NTFPs
- Income from forest: absolute value of cash income and subsistence use value of forest
- Income from farming activities: absolute value of cash income and subsistence use value of crops and livestock production
- Ethnic of household head: ethnicity (categorical data)
- Education level of household head: school years (number of years)
- Household size: total members in a household (number of members)
- Period of living in current forest (number of years)
- Distance from residence to the forest (kilometers)
- Membership of a community-protected area (dummy)
- Received technical training from a community-protected area (dummy)

## 2.4. Data Analysis

### 2.4.1. Current Forest Conservation Practices

Many authors have not defined the term ‘forest conservation’ well. 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 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.

### 2.4.2. 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 [2,33,41,44]. Binary logistic in the regression model was used to check the hypothesis of ‘increasing the 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 (1) expresses the binary logistic regression that involves fitting an equation of the following form

$$z = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n \quad (1)$$

where  $b_0$  is the intercept of the model, the  $b_i$  ( $i = 0, 1, 2, \dots, n$ ) is the slope coefficient of the logistic regression model, and the  $x_i$  ( $i = 1, 2, \dots, n$ ) 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 (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) do not collect the critical part of the plant that affects the growth or reproduction, (2) do not collect species that have low population size, and (3) do not collect species that have low growth rate or reproduction rate [16]. Regarding forest protection, dummy variables are as follows: (4) joint 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 [14,39]. Regarding reforestation, a dummy variable is (7) contributing household labor to reforestation [26]. Hence, this study tests seven models for different dependent variables ( $z_i$ ).

$$\begin{aligned} (z_i = 1/0) = \alpha &+ \beta_1\text{NTFP} + \beta_2\text{FARM} + \beta_3\text{FOREST} + \beta_4\text{ETHNIC} + \beta_5\text{EDU} \\ &+ \beta_6\text{HSIZE} + \beta_7\text{YEARS LIVE} + \beta_8\text{AGRILAND} + \beta_9\text{DISTANCE} \\ &+ \beta_{10}\text{MEMBER} + \beta_{11}\text{TECHTRAINING} + \varepsilon_i \end{aligned} \quad (2)$$

Theoretically, local people’s participation in forest conservation activities 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 in [45], while [46] claimed that income from farming had a negative impact to forest conservation because it involved economic trade-offs. 'FOREST' is income from forest (income from forest is the cash income and subsistence use value of timber, bush meat, and fish) (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 time [39].

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 [47]. This study uses ETHNIC for representing Bunong people, who are indigenous people of Cambodia. Education (EDU) has been reported to positively influence local people's participation in forest management and conservation [48]. 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 [48]. Local people, who have lived longer in a protected area (YEARS LIVE) are more likely to participate in forest conservation activities because they have greater experience in resource utilization and management [49]. The influence of agricultural land owned (AGRILAND) can be positive or negative. Households with large agricultural land are more likely to participate in forest conservation activities [45], but [50] 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 (DISTANCE) 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. A member of CPA is more likely to participate in forest conservation activities (MEMBER) [51]. 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 (TECHTRAINING).

For reliability analysis, diagnostic procedures are done sufficiently as follows. First, a 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.

#### 2.4.3. Measurement of Value of NTFPs' Incentives for Forest Conservation Activities

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 [41,52].

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 [26,41]. 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 [40,52].

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 at least equal to costs paid 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 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 1.

**Table 1.** Measurement value for NTFPs' incentives for forest conservation.

Forest Conservation Activities	Proxy Value of NTFPs' Incentives	Units of 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 % trainees received training and % sampled 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 % participants in the workshop and % sampled 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 % participants in the workshop and % sampled 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 % participants in the workshop and % sampled 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 labor in reforestation program with either government or INGOs	Payments given by GO/INGOs for forest planting	=Multiply (considering between % local people received payment from GO/INGOs and % sampled households participated in FR7)

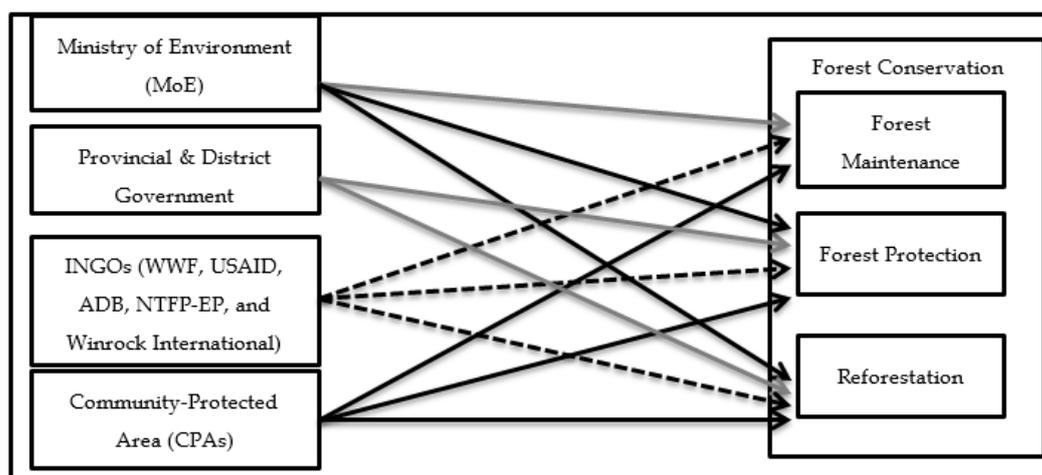
### 3. Results

#### 3.1. Current Forest Conservation Practices in Phnom Prich Wildlife Sanctuary, Cambodia

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 behavior of forest dwellers. Forest maintenance has been done in following

ways, as seen in Figure 2. First, it can be done by direct enforcement, and it is mostly done by CPAs. The CPAs undertook the direct role of controlling 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 the MoE is the core government institution that responsible for issuing the legal framework of controlling forest extraction. The MoE issued the National Forestry Program 2010–2029 to provide guidelines on the extraction of biological resources. The 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 [53]. 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 training courses every year to all CPAs in PPWS regarding sustainable extraction of NTFPs, especially on liquid resin, wild honey, and bamboo poles.



**Figure 2.** Forest conservation practices by institutions in PPWS. Note: → Direct intervention; → Joint forest conservation (Government, INGOs, and CPA); → Indirect intervention (Policy and legal framework).

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 2 shows that there are two primary groups playing the vital role in forest protection, rangers and community forest patrol teams. The rangers of the 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. The sub-outpost is where for rangers relax during field patrolling. Each outpost is responsible for patrolling the identified geography boundary ordered by the 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 1 director of PPWS, 3 deputy directors, and 27 rangers. The number of rangers is too few considering the area of the PPWS, which is 2225 km<sup>2</sup> 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 5 to 10 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 2. 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 costs of community forest patrol teams.

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 Monduliri Provincial Department of Environment. Asian Development Bank (ADB) has supported the finance for this program since 2015. To date, the reforestation program has been 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 to other CPAs in coming years.

### 3.2. NTFPs' Incentives for Forest Conservation Activities

#### 3.2.1. Local People's Participation in Forest Conservation Activities

Based on structured interviews with sampled 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 3 shows that more than 80% of sampled households do not collect the critical part of the plant (NTFPs) that affect growth and reproductive capacity of plants. About 78% of sampled households do not collect plants that have small population size, especially endangered and critically endangered species. Around, 70% of sampled households do not collect plants that have a low growth rate or reproduction rate, especially high-value species.

Figure 3 shows around 53% of sampled 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 5 nights per month on patrolling in the forest. Besides, around 51% of sampled 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. Communication was oral or via phone call. Only 30% of sampled 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 3 shows that around 32% of sampled households participated in reforestation programs, which were paid by the MoE, while others voluntarily participated in tree planting and weeding.

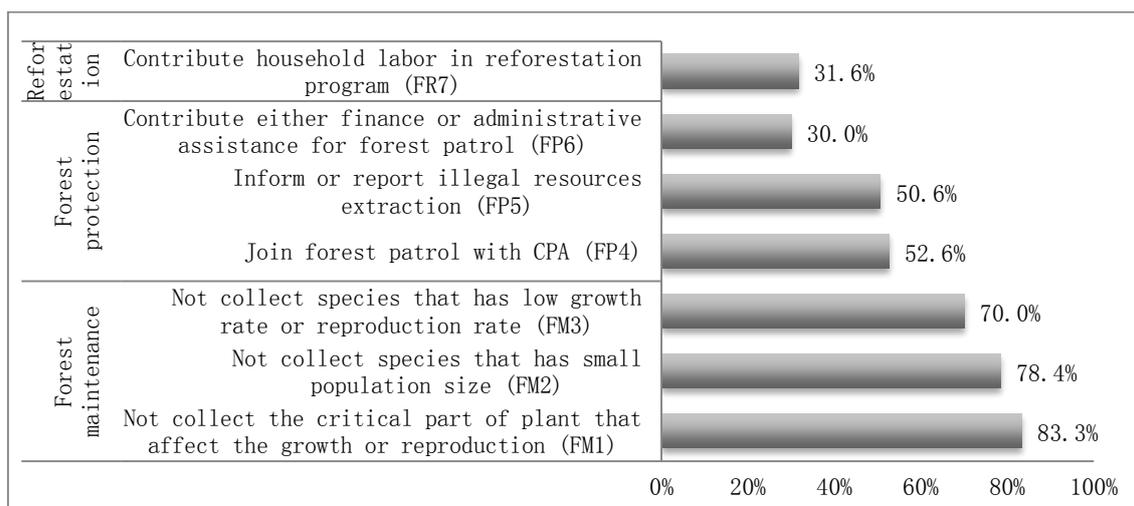


Figure 3. Local people’s participation in forest conservation activities.

### 3.2.2. NTFPs’ Incentives for Local People’s Participation in Forest Conservation Activities

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

Table 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 the Omnibus test; however, it is acceptable in the Hosmer–Lemeshow goodness of fit test, see Table 2.

Table 2. Influence of income from NTFPs to local people’s participation in forest conservation activities.

Variables	FM1	FM2	FM3	FP4	FP5	FP6	FR7
	B	B	B	B	B	B	B
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
Bunong ethnicity	−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
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%

Note: (1) FM1: Not collect the critical part of the plant that affects the growth or reproduction; (2) FM2: Not collect species that have small population sizes; (3) FM3: Not collect species that have low growth rate or reproduction rate; (4) FP4: Join community patrol team; (5) FP5: Inform or report 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 INGOs.

However, Table 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’. 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 positively influenced reforestation activity as seen in Table 2.

### 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 2). Here, the value of NTFPs’ incentives can be estimated by forest conservation costs paying by government and INGOs in similar activities.

Table 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 sampled households, and this actual cost was around R49,468,800. However, around 83% of sampled 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).

**Table 3.** Value of NTFPs’ incentives for forest conservation.

Local People’s Participation in Forest Conservation Activities	Confirmation of Influence from NTFPs	Actual Conservation Costs	Proxy Value of NTFPs’ Incentives for Forest Conservation (Riel/Year)
<b>(a) Forest maintenance</b>			
Not collect the critical part of plant that affect the growth or reproduction	Yes	Training costs for 44% of sampled households provided by INGOs = R49,468,800	83% of sampled households participated in FM1 (2 times higher than actual training costs) = R98,937,600
Not collect species that have small population	No	-	-
Not collect species that have low growth rate or reproduction rate	No	-	-
<b>(b) Forest protection</b>			
Join 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 × 8 CPAs × 12 months = R28,800,000
<b>(c) Reforestation</b>			
Contribute household labor 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 % sampled households join (volunteer) was about the same Actual costs from reforestation were measured from 4 CPAs while value of NTFPs’ incentives measured from 8 CPAs Value of NTFPs’ incentives to FR7 (2 times higher than actual reforestation costs) = R231,600,000
Total areas of PPWS is 222,500 ha Conservation costs per unit area ≈ 3900 (US\$0.95/ha)			Direct conservation costs in PPWS ≈ R865,226,400 (US\$212,690)

Note: (1) R = Riel is the national currency of Cambodia; (2) 1 US\$ = 4068 Riel (in 2015, National Bank of Cambodia).

Forest patrols are conducted regularly according to an agreement among members of CPAs 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 CPA areas. Therefore, the value of NTFPs' incentive to 'joint community patrol team' was approximately R505,888,800.

Table 3 shows that community members voluntarily paid to support the forest protection activities every month. Each of them contributed from R500 to R1000 per month. On average, a CPA got contribution money of around R300,000 per month. Thus, this contribution from all eight CPAs per year was around R28,800,000. Therefore, the value of NTFPs' 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, the 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 the 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 labor 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 NTFPs' incentive for forest conservation activities in PPWS was around R3900 (US\$0.95) per ha per year.

#### 4. Discussions and Conclusions

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 [2,26,32,33]. 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 discourages local people from collecting the critical parts of the plants that affect their growth or reproduction. When local people do not collect the critical part of species, the extractive reserves could ensure that NTFP exhaustion does not occur [7,16]. 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 [2,14,39] that local people's participation in forest protection has led to more effective forest conservation, because local people know exactly the consequences of deforestation, wildlife poaching, and improper resource extraction. In addition, income from NTFPs encourages local people to participate voluntarily in tree planting and weed removing from natural growth without getting paid because they understand that those trees are essential for food and shelter [26,54]. 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 [11], Thailand [55], Vietnam [56], India [57], Nepal [58], Czech Republic [59], Ethiopia [60], and Africa [61]. Those countries are mostly less wealthy, and their rural regions rely on natural resources for livelihoods.

Meanwhile, without the contribution of NTFPs to rural livelihoods, governments 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<sup>2</sup>). Comparing to [3], who found direct costs of conserving two of Kenya's wetland National Parks were some Ksh 20 million per year (US\$333,333, the exchange rate in 1998). Comparing to [32], 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<sup>2</sup>. 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\$1153/ha in Brazil [62]. Therefore, it was verified that value of NTFPs' incentives for forest conservation activities was not seeing much in Cambodia.

Most importantly, this study's findings underline the contribution of NTFPs to forest conservation. This study clearly illustrates to what ways livelihoods based on NTFPs can be significant enough for reducing ecological destruction and deforestation. Without the encouragement of local livelihood improvement through extraction of NTFPs, governments and INGOs are going to pay higher costs to conserve standing forests. Therefore, an appropriate incentive policy for promoting NTFP extraction is a considerable ecological economic framework to convert poachers into rangers with fewer conservation costs but greater conservation achievements.

Despite its numerous significant findings, there are still many future studies should be done for future researches. This study did not assess how serious is the forest loss in the PPWS. If the statistics of the forest loss is available, a study on how much deforestation is decreased by receiving incentives from the extraction of NTFPs should be done. Also, this study measures the overall value of NTFPs' incentives for forest conservation in PPWS as a case study. An individual household may have different incentives for forest conservation. Hence, it would better for future studies to focus on direct costs of sampled households who joined forest conservation activities after they received incentives from the extraction of NTFPs.

#### Notes:

1. Community Protected Area (CPA): It shares the same definition with community forests. They function at the village level, intimately involving the local people in forestry management and land use decisions.
2. SMART: Spatial monitoring and reporting tool (SMART) represents a major step forward for improved site-based environmental conservation efforts. SMART is a GPS-GIS software driven tool that extends and simplifies existing technologies for monitoring efforts to tackle poaching and other illegal activities. Data collected provides timely and accurate information on where, how, and by whom poaching, illegal logging, and other direct threats to biodiversity are occurring. It allows for the collection of up to date field and intelligence data, and enables rapid feedback and communication between protected area managers and frontline law enforcement staff. The process quantifies the impact of law enforcement efforts and improves evaluation and strategic planning of enforcement operations.
3. Per Diem: is a daily costs to cover food, accommodation, and local traveling
4. REDD<sup>+</sup> (or REDD-Plus): refers to reducing emissions from deforestation and forest degradation in developing countries.

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