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The implications of remittances for agricultural land use and fuelwood collection: Evidence from the remaining forested landscapes in the Philippines

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3 **The implications of remittances for agricultural land use and fuelwood collection:**
4 **Evidence from the remaining forested landscapes in the Philippines**
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Abstract

Despite the projected sharpest decline in remittances in history due to the global economic crisis induced by the Covid-19 pandemic, remittances are expected to remain an important source of external financing for many developing countries. The Philippines is among the top five recipients of remittances worldwide, while outmigration is an important livelihood strategy for rural communities in the country due to rapid population growth, poor employment opportunities, and scarce agricultural land. Migration and remittances can influence smallholder land use with potential implications on forest resource use through an impact on household income and household decisions on local activities. However, little attention has been paid in previous research to how remittances relate to changes in rural households' land use and their implications for forests. The goal of this study is to investigate the linkages between the inflow of both international and internal remittances and rural households' land use in forested landscapes in the Philippines. In order to do that, we use the data from 1,024 household surveys and an instrumental variable approach to investigate the impact of remittances on fuelwood use and on the area cultivated by perennials and cereals. The findings of this study show that remittances positively influence the size of land planted by perennials and reduce households' reliance on fuelwood use. Our findings provide an improved understanding of the links between migration - remittances - natural resource management, which will become especially relevant as countries struggle to deal with the economic fallout associated with Covid-19. We argue that demographic policy measures should play a bigger role in Land Use, Land-use Change, and Forestry (LULUCF) negotiations than before. Moreover, global sustainability agendas such as the Sustainable Development Goals (SDGs) should recognize the impacts of migration on natural resources to help bridge the gap between developmental and environmental goals.

Keywords: remittances, land use, fuelwood collection, smallholder farming, forested landscapes, Philippines

1. Introduction

Global remittances – financial or in-kind transfers of migrants to their families or communities of origin – have increased over fivefold from US\$ 126 billion in 2000 to US\$ 689 billion in 2018, surpassing official development assistance (ODA) levels since the mid-1990-s (IOM 2019). The Covid-19 pandemic is expected to cause a sharp decline in remittances by 7.2%, to US\$ 508 billion in 2020, and a further decline by 7.5% in 2021 (Ratha et al. 2020). Nevertheless, their importance as a source of external financing in low- and middle income countries is projected to increase as other sources, such as Foreign Direct Investment and private portfolio flows, are expected to fall more steeply than the remittances (Ratha et al. 2020).

Initially adopted as a temporary strategy to address high unemployment, government-supported international migration has been part of Filipino culture since the 1970-s (OECD 2017). In 2020, personal remittances from Overseas Filipino Workers (OFW) sent to the Philippines comprised almost US\$ 35 billion, or 9.6% of the national Gross Domestic Product (GDP) (World Bank 2021). According to the latest World Migration Report, the Philippines is among the top five remittance-receiving countries in the world alongside India, China, Mexico, and Egypt (IOM 2019). Although much smaller in terms of the amount, internal remittances received from the domestic migrants are also an important source of income for Filipino households, but their numbers are poorly documented (Gregorio and Opiniano 2011).

Both internal (migration of labour within the same country) and international labour migration can be an important livelihood-diversification strategy for rural households in many developing countries (Wouterse and Taylor 2008). Remittances, as an outcome of outmigration, can have substantial impacts in rural households' local activities in the communities of origin, including their land use decisions, as they are likely to influence both households' consumption and agricultural production decisions. Migration out of rural areas implies changes in rural households, their livelihoods, and surrounding landscapes (Ospina et al. 2019). Previous studies have focused on the impact of remittances on farm production and rural income (Jokisch 2002, Gray 2009, Atamanov and Van den Berg 2012, Rozelle et al. 1999, Zhunusova and Herrmann 2018). However, the migration-forest linkages are still poorly understood (Robson and Klooster 2019) and have received little attention in the literature on migration as well as in the research on forest-based livelihoods (Hecht et al. 2015). Most national policy measures addressing forest-related issues consider the communities in forested landscapes as static, while forests and natural resource management issues are missing from development policy agendas (Hecht et al. 2015). Yet understanding household mobility and behaviour and the relationship with the forest frontier is crucial for guiding conservation and development policies (Caviglia-Harris et al. 2013).

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3 More evidence is needed on the implications of migration and remittances for forests and forest-based
4 rural livelihoods which remain largely unexplored in the empirical literature (Hecht et al. 2015). A few
5 exceptions include Angelsen et al. (2020) and Lopez-Feldman and Chavez (2017). Based on household
6 data from Guatemala and Mexico, Angelsen et al. (2020) show that migration is not linked to expansion
7 of agricultural land and only partially correlated with the use of chemical inputs, whereas the impact
8 of remittances was not tested. Lopez-Feldman and Chavez (2017) further demonstrate that
9 remittances can lead to reduced likelihood of natural resource extraction and to a decreased reliance
10 on environmental income for the case of Mexico.
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17 The goal of this study is to investigate the linkages between the inflow of both international and
18 internal remittances and the decisions of rural households on land use in the Philippines' remaining
19 forested landscapes. Our study areas are located in the upland and frontier areas in the five provinces
20 of Cagayan, Quirino, Nueva Vizcaya, Leyte, and Southern Leyte, where agriculture and forests continue
21 to play an important role in rural livelihoods both in terms of production and in provisioning of
22 important ecosystem services such drinking water, irrigation, and flood protection. Using the data from
23 a survey of 1024 households, we analyse the impact of remittances on households' land allocation to
24 perennials (abaca, coconut, and banana), grains (maize and rice), as well as on the amount of fuelwood
25 collected by the household. Perennials reported in our study sites are often part of mixed agroforestry
26 systems, which have been promoted by the government of the Philippines to address environmental
27 degradation in the upland areas caused by slash-and-burn cropping practices (Bugayong and
28 Carandang 2003). Agroforestry systems, on the other hand, can help improve land productivity and
29 vegetative cover and serve as an alternative to the destructive slash-and-burn practices (Bugayong
30 2003). Cultivation of perennials, grains and fuelwood collection constitute the main land uses in the
31 study landscapes. Our econometric analysis addresses the endogeneity issue related to remittances,
32 which occurs when an independent variable is correlated with the error term (Wooldridge 2002). This
33 is why we use an instrumental variable approach and employ the Two-Stage-Least-Squares estimator
34 (2SLS).
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48 This study provides evidence of the links between migration and natural resource management and
49 can inform both environmental and developmental policy goals which are often disconnected. In
50 particular, our findings can support the planning of future reforestation or forest conservation policies
51 by expanding our understanding around land use decision choices and the implications of migration in
52 future scenarios of land use change.
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56 57 **2. Implications of remittances on land use by smallholders: Theoretical notes**

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According to Stark and Bloom (1985), outmigration can affect the farm output of migrant-sending households in two major ways. Firstly, the migrants that leave the household cannot participate in local production. In settings with limited labour markets, the labour “lost” due to migration cannot be easily replaced, thus migration of labour can lead to reduced output from local activities. This is the “lost labour” effect (Taylor et al. 2003). Secondly, remittances can compensate for the “lost labour” effect if they are invested in activities that were previously not possible due to investment constraints. This hypothesis, often referred to as the New Economics of Labour Migration (NELM) hypothesis, is illustrated in Figure 1.

Suppose a household can decide between two productive activities – a high return activity with output Q_1 and a low return activity with output Q_0 . Given the relative prices $-p_1/p_0$, a household specializes in the production of Q_1 that yields the highest return, Q^* . However, if a household faces certain production constraints, e.g. lack of financial resources, represented by line $c(\cdot)$, it will only produce outputs Q_1^c and Q_0^c . Due to the “lost labour effect” or the inflow of remittances, the constraints can be either further exacerbated due to shortage of labour induced by migration or lifted with the help of remittances invested in productive activities (Taylor et al. 2003, Atamanov and Van den Berg 2012, Rozelle et al. 1999, Zhunusova and Herrmann 2018).

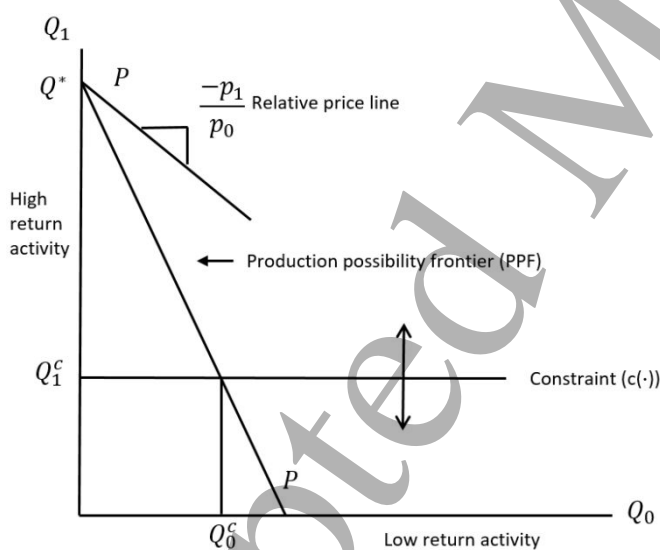


Figure 1. Potential impacts of migration and remittances on production possibilities. Source: Taylor et al. (2003).

Given the labour abundance reflected by high population density, high underemployment and the small size of landholdings (the average farm size in the Philippines comprises 1.3 ha (Philippines Statistics Authority 2015)) in rural areas in the Philippines, we assume that the lost labour effect of migration on agricultural production will be negligible. Underemployment rate is defined by Philippine

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3 Statistics Authority (PSA) as the “share of working population who work less than 40 hours per week
4 and who express the wish to have additional hours of work in their current job or to have a new job
5 with longer working hours” (Philippines Statistics Authority 2020). In 2019, 32% of underemployed in
6 the Philippines were working in the agricultural sector, while underemployment rates for the Cagayan
7 Valley and Eastern Visayas regions (i.e. location of study landscapes) were high and comprised 18.3%
8 and 18.6% respectively compared to the national rate of 13.4% (Philippines Statistics Authority 2020).
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11 Our focus is thus to find out whether remittances can have a significant impact on households
12 agricultural land use decisions. Households’ socio-demographic characteristics, such as household size,
13 gender of the household head and education level can also influence local production decisions (Taylor
14 et al. 2003), especially when production and consumption decisions are non-separable (De Brauw
15 2010). Households in the forested landscapes of Philippines cultivate a high variety of different crops,
16 which we group into grains and perennial crops for the purposes of this analysis based on the survey
17 responses. Another important land use activity is fuelwood collection which is mainly used for
18 household consumption and to a small extent for selling purposes. The majority of households are
19 involved in these three activities (grains, perennials, and fuelwood) with potentially different
20 implications for sustainable land use in the study landscapes. Cultivation of vegetables was not
21 included in this analysis due to the small number of households involved in this land use activity in our
22 study sites.
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26 Major perennial crops in our study areas include coconut, banana, and abaca, which are all cash crops.
27 Grains include rice and maize. The production of perennials often requires additional investments and
28 the growth period until harvestable products such as fruits (coconut, banana) or fibre (abaca) become
29 available can cause cash constraints for an individual household. Hence we hypothesize that
30 remittances can positively influence perennials production as they could help lift these constraints.
31 Fuelwood harvesting, especially in densely populated countries such as the Philippines, with limited
32 remaining forestlands, can be a major source of forest degradation and its impact on forest ecosystems
33 cannot be ignored (Specht et al. 2015). Based on prior research (Lopez-Feldman and Chavez 2017), we
34 further hypothesize that the inflow of remittances leads to a lesser likelihood to participate in
35 fuelwood collection and thus can have a positive effect on forest ecosystems integrity. This impact
36 could be explained by the fact that remittances are also a positive shock to households’ budget
37 constraint and as such can influence the combination of goods consumed, in this case fuelwood versus
38 other cooking sources, such as gas stoves. Hence we hypothesize that fuelwood is an inferior good, the
39 consumption of which decreases when the household budget increases.
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59 The impact of remittances on land use is likely to depend on the specific context of communities of
60 origin, their market connectivity and infrastructure situation, and the general economic and policy

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3 environment that influence the decision of households to invest or consume remittances. The quality
4 of input and output markets for agricultural products, e.g. reflected through access to markets,
5 transport costs, or price volatility, will also influence the response of household in terms of land use
6 decisions (Hettig et al. 2016). The small size of landholdings can lead to the constraints of rural
7 households in terms of available land, labour and capital, when making agricultural production
8 decisions that are not assumed under perfectly functioning markets (De Janvry et al. 1991). In sum,
9 households' land use decisions can be driven by a variety of factors rather than only profit-
10 maximization.
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16 17 **3. Materials and methods**

18 19 **3.1. The study area and data collection**

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21 With the aim to gather information about the livelihoods and land use of rural households in forested
22 landscapes, ten landscapes were selected for this study. The landscapes were located in the five
23 provinces of Cagayan, Quirino, and Nueva Vizcaya, Leyte, and Southern Leyte (Figure 2). The study sites
24 represent various forest contexts or forest frontier zones as classified by Angelsen and Rudel (2013).
25 The study landscapes in the municipalities of Santa Ana and Gonzaga have high forest cover, low
26 population density and lower tree cover loss and can be referred to as "core forest areas" in the case
27 of the Philippines (Table 1). The study landscapes in the municipalities of Quezon, Penablanca, Diffun
28 and Diadi are characterized by much lower forest cover, very high population density and can be
29 referred to as "forest-agriculture mosaics". The study landscapes in the municipalities of Lal-lo,
30 Abuyog, and Sogod could be categorized as frontier zones, with fast agriculture expansion, yet with a
31 relatively higher share of forest cover compared to the landscapes categorized as forest-agriculture
32 mosaics.
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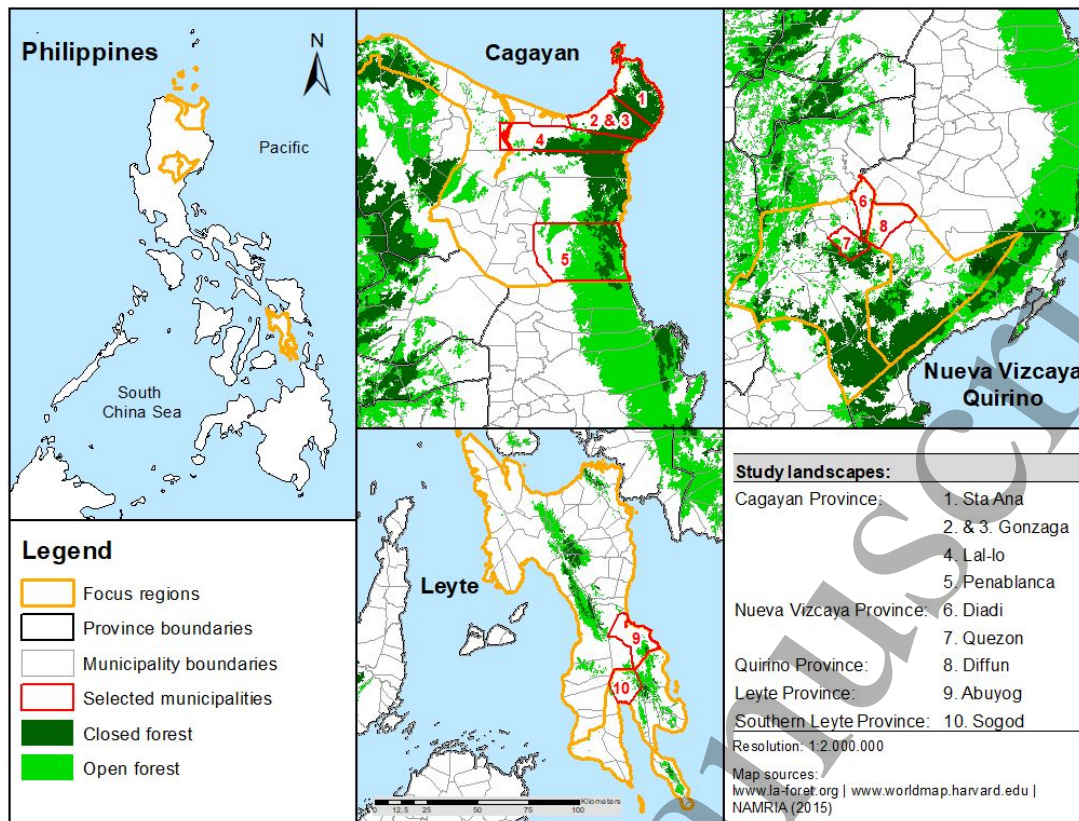


Figure 2. The location of the selected study sites. Source: Authors' design.

In each landscape, approximately 100 household interviews were conducted totalling to 1,024 for all sites. The total number of households included in the analysis is reduced to 997 after removing surveys that were incomplete. The households in each barangay, the smallest administrative division in the Philippines, were selected randomly using the population census provided by barangay officials. Due to the varying size of the village or barangay population, the number of barangays included in the study varied from 1 to 10 per municipality.

The household interviews were conducted between August 2016 and April 2018 following free prior informed consent (FPIC) using structured household questionnaires that covered information on household socio-demographic characteristics, use of forest products, land use and agricultural production, as well as other livelihood sources, including remittances. Questionnaire and survey design were adapted from the Poverty and Environment Network (PEN) technical guidelines v.4 described in Angelsen et al. (2011). The interviews were conducted face-to-face by local enumerators, while the questionnaire was translated into the local languages *Cebuano*, *Tagalog*, and *Ilocano* (for further details see Appendix E). The household head was typically targeted for interviews, replaced by a spouse or another adult when the household head was absent during the time of the interview.

Table 1. Biophysical and demographic characteristics of study landscapes.

Landscape	Province	Total area (ha)	Forest Cover %	Other Vegetation on Agriculture cover %	FC 2000 (Area share with TC over 30%) %	Average Annual Loss 2000-2019 (Area share with TC over 30%) %/yr	Pop density 2000 (pers./km ²)	Pop density 2019 (pers./km ²)	Elevation mean (m)	Slope mean (degrees)	Road density (km/km ²)
Gonzaga I	Cagayan	16,849	89.2%	9.4%	94.2%	-0.09%	11.70	14.35	391.0	15.5	0.13
Santa Ana	Cagayan	14,994	85.8%	12.5%	94.1%	-0.16%	4.67	15.24	144.3	10.9	0.21
Gonzaga II	Cagayan	8,412	68.5%	30.1%	83.4%	-0.20%	25.75	29.94	445.8	14.6	0.51
Abuyog	Leyte	6,090	59.2%	40.3%	93%	-0.20%	38.42	48.86	321.5	12.2	0.17
Lal-lo	Cagayan	14,644	43.1%	55.7%	73.7%	-0.56%	22.98	32.90	138.5	6.6	0.37
Quezon	Nueva Vizcaya	9,095	38.5%	57.8%	73.9%	-0.32%	68.22	136.02	575.6	13.6	0.48
Sogod	Southern Leyte	5,736	28.3%	70.2%	94.0%	-0.23%	45.34	60.74	405.1	15	0.42
Penablanca	Cagayan	11,798	9.9%	85.7%	42.9%	-0.52%	73.07	116.11	184.9	7.1	0.52
Diffun	Quirino	11,751	5%	93.5%	36.4%	-0.95%	52.19	115.15	343.4	11.2	0.69
Diadi	Nueva Vizcaya	10,148	4.1%	92.2%	28.1%	-0.31%	80.80	118.49	309.2	8.3	0.50

Note: TC=tree cover, FC=forest cover, Pop density = population density. Source: Own compilation based on data from NAMRIA Land Cover 2015 available on <http://www.namria.gov.ph/> on forest cover, % and other vegetation on agriculture cover, %; from Hansen et al. (2013) on area share with TC over 30% and average annual loss 2000-2010 of area share with TC over 30%, from Worldpop on population density in 2000 and 2019, from Jarvis et al. (2008) on elevation and slope, and Openstreet maps downloaded from geofabrik.de on road density.

3.2 The econometric model and variables

Equations for the value of fuelwood collected, and the areas cultivated by perennials and grains are estimated as a function of remittances and other control variables:

$$Y_i = \gamma_0 + \gamma_1 R_i + \gamma_2 X_i + \varepsilon_i \quad (1)$$

where Y stands for value of fuelwood collected/area cultivated by grains/area cultivated by perennials by household i ; R stands for remittances; and X denotes control variables that include households' socio-demographic characteristics, farm characteristics, shocks to agricultural income, and infrastructure; ε refers to the error term.

Remittances, R , are an endogenous variable for two reasons: self-selection into outmigration and a reverse causality between remittances and output from local activities (Rozelle et al. 1999, Taylor et al. 2003, Atamanov and van den Berg 2012, Manning and Taylor 2014). Whether a household receives remittances can be correlated with households' characteristics that determined their decision to send out a migrant and led to receiving remittances. This implies that households that have a migrant (and receive remittances) could be systematically different than the households that do not have a migrant (Taylor et al. 2003, Gibson et al. 2009). Moreover, the inflow of remittances as such can be a response of the migrant household member to the situation of household members in the communities of origin. If the production from some of the activities increases, remittances inflow is expected to decrease in return (Yang and Choi 2007) indicating a reverse causality. This means that estimating the model in equation (1) through Ordinary Least Squares (OLS) will be biased because one of the independent variables (remittances) is correlated with the error term. In order to address this issue, the Two-Stage-Least-Squares approach (2SLS) is used. It involves a use of an instrumental variable to estimate a first stage equation for remittances:

$$R_i = \alpha_0 + \alpha_1 X_i + \alpha_2 Z_i + \mu_i \quad (2)$$

As an instrumental variable, Z , we use the village norm to remit. The village-level norm to remit is calculated for every household i as an average amount of remittances received by all households in a given barangay excluding the household for which the village norm to remit is being calculated (Taylor et al. 2003, Manning and Taylor 2014). It is assumed that the village norm to remit has an impact on the amount of remittances received by the household (Taylor et al. 2003), but has no independent effect on the areas planted by perennials and grains, nor on the value of fuelwood collected, i.e., the instrumental variable is correctly excluded from the estimated equation (1).

The selection of control variables included in equations (1) and (2) is based on a literature review of household-level drivers of land use change. The first group of variables refers to household

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3 characteristics which play an important role in explaining the micro-level land use change (Hettig et al.
4 2016). In the case of imperfect markets, household variables that affect both consumption and
5 production should enter the empirical model (De Brauw 2010). Variables on household characteristics
6 included in the model are the size of the household, age of the household head, gender of the
7 household head, and the education level of the household head. Education level of the household head
8 allows us to control for human capital differences between the households (Taylor et al. 2003). The
9 size of crop land is included as an explanatory variable too, because it is likely to affect households'
10 decisions on how much land to allocate to different crops. Off-farm income is included, because its
11 availability could potentially affect households' investments in other income activities. "Off-farm
12 income" refers to income earned from working off their farm, but on the farms of other households in
13 the same or other villages. We use income quartiles to check whether a household being in a specific
14 wealth group has an impact on the dependent variables. Infrastructure indicators are common control
15 variables in land-use models. They can define to which extent households react to market signals in
16 terms of supply of agricultural products that lead to land use change. Variables related to infrastructure
17 in this study include access to paved road (yes/no) and the distance from homestead to the village
18 centre.
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31 The variable "remittances" is calculated as the total sum of internal and international remittances
32 received by the respondent households over the past 12 months in Philippines pesos (PhP). In total,
33 260 households reported receiving any remittances, out of which 133 received remittances from
34 abroad (on average 48,937 PhP per year), and 135 households received remittances from domestic
35 migrants (on average 19,432 PhP per year). Only 18 out of 260 households reported in-kind
36 remittances, e.g. clothes and groceries received from migrants. In this case, an estimated monetary
37 value of in-kind remittances was added to the amount of total remittances in PhP.
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44 Households reported cultivation of 29 different crops in up to 10 different patches of land per
45 household, which presented a challenge when calculating areas cultivated by different crops. The
46 number of crops reported for the same patch with the average size of one hectare varied from 1 up to
47 10 crops, where disaggregating the area for all of these crops at the time of data collection was not
48 considered due to high time costs. Areas for maize and rice, which constitute the variable "grains
49 cultivation area, ha" were easier to calculate because most of the times these crops were cultivated in
50 monoculture systems. For "perennials cultivation area, ha", we focused on the areas for three main
51 perennial crops in the study sites - coconut, abaca, and banana. In order to disentangle the areas for
52 these three crops, we had to make an assumption that in the patches where these crops were
53 reported, each crop took up an equal share of the patch area.
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3 An aggregation of the total amount of fuelwood collected by the household was done using the
4 monetary values in PhP based on the forest product prices reported in the survey. Descriptive statistics
5 of the variables used in this study are given in Appendices A and B. Appendix C contains information
6 on main land uses reported by surveyed households.
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10 **4. Results of econometric estimations**

11 Table 2 presents the results of 2SLS estimations. First stage estimates are reported in Appendix D. The
12 F-statistics from the 1st stage estimates higher than 10 show that the instrumental variable, a village
13 norm to remit, is a valid instrument to replace remittances (an endogenous variable). Both village norm
14 to remit and the amount of remittances have been log-transformed to curtail the impact of outliers.
15 We estimated three further models where remittances were separated into internal and international
16 remittances and where remittances and the village norm to remit were not log-transformed. However,
17 because the F-statistics from the 1st stage estimates for these models were lower than 10 (mostly likely
18 linked to a reduced number of observations when internal and international remittances are
19 considered separately and because log-transformation helps with the outliers often present in
20 monetary variables (Wooldridge 2020)), we decided against reporting these results.
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30 Among the households' socio-demographic characteristics, age and gender did not have any influence
31 on the three dependent variables in our models: monetary value of fuelwood collected, perennials
32 cultivation area, or grains cultivation area. Yet the household size had a significant positive impact on
33 the monetary value of fuelwood collected by the household, while an increase in the education level
34 of the household head was negatively associated with fuelwood collection. The coefficient for the
35 distance from the homestead to land use patches was significant only in the model for perennials
36 cultivation area: an increase in the distance had a positive significant impact on the perennials
37 cultivation area, though the magnitude of the impact was very small. The size of crop land positively
38 influenced both the perennials cultivation area and the grains cultivation area. Furthermore, an
39 increase in off-farm income had a positive significant impact on the grains cultivation area.
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48 Income quartiles show an overall varying influence of the total household income on the dependent
49 variables. For fuelwood collection, the results show that households in upper income quartiles are
50 likely to have larger value of fuelwood collected compared to the households in the lowest income
51 quartile. For perennials cultivation, the results indicate that total household income can foster
52 perennials cultivation up to a certain limit only: the coefficient for the 3rd income quartile is positive
53 significant and the coefficient for the 4th income quartile is negative significant, i.e., households in the
54 highest income quartile are less likely to increase perennials cultivation area. Finally, for grains
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3 cultivation, the results did not show any significant association between the income quartiles and the
4 area cultivated with grains.
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7 Significant coefficients for province dummies in all three models show that there are regional
8 differences in the magnitude of fuelwood collected, as well as areas cultivated by perennials and
9 grains. For instance, households in Leyte, Southern Leyte, and Quirino, were more likely to collect
10 larger amounts of fuelwood per household compared to the households in the Cagayan province. At
11 the same time, households in Leyte and Southern Leyte were more likely to have larger areas under
12 perennials compared to the households in other provinces. Households in the Cagayan province were
13 more likely to have larger areas under grains compared to households in the other four provinces.
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20 Finally, the coefficient estimates show a positive significant effect of remittances on the area under
21 perennials, and a negative significant effect of remittances on the monetary value of fuelwood
22 collected. Keeping all other factors constant, a 10% increase in remittances is associated with a 6.2%
23 decrease in the monetary value of fuelwood collected. On the other hand, a 10% increase in
24 remittances leads to 0.6 ha increase in the area under perennials (Table 2). The impact of remittances
25 on the grains cultivation area is negative but is not statistically significant at the 90% confidence level.
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Table 2: Results from Two Stage Least Squares (2SLS) estimations

	Fuelwood collected, monetary value, log		Perennials cultivation area, ha		Grains cultivation area, ha	
	Coefficient	Robust std. error	Coefficient	Robust std. error	Coefficient	Robust std. error
Amount of remittances, log	-0.62**	0.20	0.06*	0.03	-0.13	0.11
Household size	0.22**	0.08	-0.02	0.02	0.03	0.09
Age of the household head	0.00	0.01	0.01	0.00	0.00	0.01
Male household head (1=Yes)	0.49	0.48	0.08	0.07	0.19	0.16
Education level (1="none" to 9="university degree")	-0.24**	0.09	0.00	0.01	-0.02	0.04
Access to paved road (1=Yes)	-0.04	0.32	-0.09	0.15	0.43	0.31
Average distance from patches to homestead, km	-0.02	0.02	5 X 10 ^{-3**}	0.00	-0.02	0.02
Size of crop land, ha	-0.01	0.11	0.17***	0.04	0.43***	0.08
Total number of shocks	-0.02	0.23	-0.05	0.04	0.41	0.38
Off-farm income, PhP	0.00	0.00	0.00	0.00	6.3 X 10 ^{-6*}	0.00
Household head has no primary occupation (1=Yes)	0.38	0.57	-0.12	0.12	-0.09	0.20
Income quartiles (1st quartile is a reference category)						
2nd quartile	1.20***	0.35	-0.04	0.06	0.20	0.33
3rd quartile	0.99**	0.38	0.19*	0.11	0.67	0.68
4th quartile	0.96*	0.51	-0.11*	0.07	0.36	0.22
Province (Cagayan = reference category)						
Leyte	2.13***	0.67	0.46***	0.14	-0.92**	0.30
Nueva Vizcaya	-0.37	0.41	0.04	0.04	-0.66**	0.25
Quirino	1.02**	0.45	0.00	0.07	-0.56**	0.28
Southern Leyte	1.61**	0.57	1.29***	0.32	-1.15***	0.21
Constant	5.74***	1.00	-0.41*	0.24	0.36	0.38
Number of observations	997.00		997.00		997.00	
Wald chi2 (18)	157.31***		140.95***		165.56***	
F statistics from the 1 st stage regression	10.21***		10.21***		10.21***	

Source: Own estimations based on the household survey. Standard errors are in parenthesis. *, **, *** indicate p-values at 0.1, 0.05, and 0.001 confidence levels respectively. The instrumental variable used for remittances is the village-norm to remit calculated as the average remittances amount per barangay excluding the observed household.

5. Discussion

Our findings show that when migrants send remittances to their communities of origin, this does not only affect their household income, but the land use activities undertaken by the remaining household members could change too. Our data show that remittance-receiving households own larger amount of land, but have a smaller household size (Appendix B), possibly because migrant family members were not reported by households. Both the size of the landholdings and household size can be important in explaining land use decisions. Moreover, remittance-receiving households collect less fuelwood, but earn more from crop production (Appendix B).

Regression results demonstrate that remittances may foster the expansion of perennials. Cultivation of perennials, which include coconut, banana, and abaca in our study areas may require additional investments, as well as sufficient cash inflow until harvest. This could explain why an inflow of remittances increases the area under perennials positively. This finding is in line with the NELM hypothesis that remittances can lift cash constraints of smallholder farmers. Similarly, remittances invested in productive activities allowed rural households in Laos to diversify their incomes to other livelihood sources (Manivong et al. 2014). A study from Ifugao province, Philippines, also shows how remittances have helped to overcome credit constraints and were associated with investments in commercial bean gardens to improve agricultural income (McKay 2005). However, the coefficients for income quartiles show that an income increase might influence perennials area up to a certain level only, suggesting an inverse U relationship between household income and the area under perennials. This could be related to imperfect land markets suggesting that even though household income increases, the possibility to extend areas under crops is limited due to land scarcity in the studied landscapes. Moreover, once a certain financial threshold is met, households might be more likely to invest in alternative livelihood activities that are financially more attractive compared to farming, e.g. open a non-agricultural business, such as a small grocery or convenience store.

Our results further show that remittances are associated with less fuelwood collected per household. This implies that due to income change, remittances lead to a potential substitution of more labour-intensive fuelwood collection by a more expensive alternative, e.g. a gas cooker. Previous findings from Mexico show that the inflow of remittances can significantly reduce households' reliance on fuelwood use and increase the purchase of gas cookers and stoves (Manning and Taylor 2014). Fuelwood consumption often depends on the household size (Knight and Rosa 2012), and since remittance-receiving households in our study areas had smaller household sizes, this could be an additional reason why these households collect less fuelwood. Similar to Angelsen et al. (2014), our results show that

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3 financially better-off households are likely to extract a larger amount of fuelwood compared to the
4 households in the lowest income quartile.
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7 Not every land use activity is significantly affected by remittances in our study landscapes. For grains,
8 the coefficient for remittances is negative but not statistically significant at the 90% confidence level.
9 One possible reason could be that grains are more likely to be cultivated for subsistence purposes and
10 the areas are less sensitive to the impact of remittances. The overall negative direction of the impact
11 may also indicate at a potential substitution between perennials and grains. Moreover, investing in
12 grains might be financially less attractive compared to other activities. Previous evidence suggests that
13 smallholder agriculture is not always significantly affected by outmigration and the inflow of
14 remittances (Gray and Bilsborrow 2014, Gray 2009, Jokisch 2002, Zhunusova and Herrmann 2018).
15 Remittances may not influence crop income if remittances are invested in non-agricultural activities
16 (Zhunusova and Herrmann 2018). This implies that remittances are not likely to be invested in
17 agriculture if the policy environment is not conducive in terms of providing appropriate technologies
18 and support (Deshingkar 2012). Remittances can also be closely correlated with income shocks in
19 communities of origin: the inflow of remittances increases when the local household income decreases
20 (Yang and Choi 2007). If households turn to remittances in times of shocks instead of increasing their
21 use of forest products either legally or illegally, this can have further implications for forests. This
22 presents an interesting area for future research, in particular for the post-Covid19 recovery period.
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34 35 **6. Conclusions**

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37 The Philippines have already been implementing different reforestation initiatives since the early
38 1990-s to stop further deforestation and to restore degraded forest landscapes (Veridiano et al. 2020).
39 Future restoration policies that involve participation of smallholders and introduce household-level
40 restoration practices in forested landscapes might benefit from our finding that remittance-receiving
41 households are more likely to participate in the cultivation of perennials. Perennials reported in our
42 study sites are often part of mixed agroforestry systems. Due to its multifunctional properties,
43 agroforestry has been promoted by the Philippines' government in degraded upland areas to address
44 slash-and-burn cropping practices (Bugayong and Carandang 2003). If properly adopted and managed,
45 agroforestry systems can benefit biodiversity conservation and contribute to climate change
46 adaptation and mitigation (FAO 2020), and remittances can become a boosting factor.
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55 Even though the role of forests in mitigation and adaptation to climate change is well recognized in
56 the literature, studies on reducing emissions from deforestation and forest degradation (REDD+) rarely
57 feature migration as a positive factor (Hecht et al. 2015). There is often the over simplistic
58 generalisation that migration leads to negative implications on forest (i.e. forest clearance or forest
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3 degradation), whereas the evidence from the current study suggests - against this common rhetoric -
4 that migrants along with remittances could lead to positive forest impacts. With the growing
5 importance of both internal and international remittances globally and the increasing number of rural
6 households receiving remittances, the cumulative impact of remittances on land use and
7 environmental change can be substantial. This should be explored for designing future land use,
8 climate or conservation policies and incorporated when developing future land use change scenarios
9 (e.g. reflected in shared socioeconomic pathways (SSP)). This is of particular importance since climate
10 change driven migration is likely to increase in the future (Adger et al. 2015).

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13 Furthermore, our results imply that rural communities require more direct policy support from the
14 state that facilitate the use of remittances for farm or non-farm activities (Sunam et al. 2021).
15 Development policies can emphasise harnessing remittances, both internal and international, to invest
16 in development (Yang et al. 2019). Moreover, global sustainability agendas such as the Sustainable
17 Development Goals (SDGs) should recognize the impacts of migration on natural resources (Oldekop
18 et al. 2018) to help bridge the gap between developmental and environmental goals. Future
19 environmental sustainability efforts could complement development initiatives by linking
20 opportunities between remittance investment strategies and sustainable resource management.

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23 Investments funded via remittances can be nuanced and may not always lead to 'positive' forest
24 outcomes, e.g. if increased productivity due to remittances drives further cropland expansion into
25 forests. Demographic policy measures would have to play a bigger role in Land Use, Land-use Change,
26 and Forestry (LULUCF) negotiations than before. An improved understanding of the links between
27 migration - remittances - natural resource management will become especially relevant as countries
28 struggle to deal with the economic fallout associated with Covid-19, as the pandemic is already having
29 major consequences on migration and remittances' flows worldwide.

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41 42 43 **Ethical statement**

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46 All interviews were conducted face to face by local enumerators and administered in local languages
47 based on a free-informed prior consent and according to local statutory requirements.

48 49 50 **Data availability statement**

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53 The data that support the findings of this study are available upon reasonable request from the
54 authors.

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Appendix A: Descriptive statistics**Table A1: Summary statistics for continuous variables**

Continuous variable	Mean	Std. Dev.	Min	Max
Fuelwood collected, monetary value	4393.50	7604.38	0	130000
Household size	4.54	1.90	1	14
Age of the household head	48.69	14.41	19	90
Average distance from homestead to patches, km	5.83	8.29	0	50
Size of crop land, ha	0.97	1.58	0	15
Total number of shocks	0.44	0.61	0	3
Off-farm income, PhP	13877.26	27542.89	0	300000
International remittances, PhP	6521.74	28691.54	0	360000
Internal remittances, PhP	2628.65	13999.77	0	240000
Amount of remittances, PhP (internal and international)	9150.39	31516.82	0	360000
Total household income, PhP	104006.40	147103.90	0	1497740

Source: Authors' estimations based on the household survey of 997 households.

Table A2: Summary statistics for categorical variables

Categorical variables	Proportion	Std. Err.
Male household head (1= Yes)		
0	0.121	0.010
1	0.879	0.010
Education level (1="none" to 9="university degree")		
1	0.016	0.004
2	0.008	0.003
3	0.348	0.015
4	0.185	0.012
5	0.141	0.011
6	0.172	0.012
7	0.031	0.005
8	0.048	0.007
9	0.050	0.007
Access to paved road (1= Yes)		
0	0.197	0.013
1	0.803	0.013
Household head has no primary occupation (1=Yes)		
0	0.900	0.010
1	0.100	0.010

Source: Authors' estimations based on the household survey of 997 households.

Appendix B: Comparison of recipients and non-recipients of remittances

Table A3 shows the differences between the households that receive and the households that do not receive remittances. Significant differences can be observed for several household characteristics. Households that receive remittances have a smaller household size but an older household head. They also operate on a slightly larger area of land compared to households that do not receive remittances. The mean value of fuelwood collected and off-farm income are smaller for the group that receives remittances, while the total crop production value and the value of grains produced is significantly higher, which is partially attributed to larger amount of land owned by recipients of remittances. The households that receive remittances also have a significantly higher total household income compared to the households that did not receive remittances. Moreover, recipients of remittances live further away from their patches and have a smaller proportion of male household heads. Finally, a larger proportion of household heads in the group of recipients of remittances reported having no primary occupation compared to the group that did not receive remittances (Table A3).

Table A3: Test of mean differences/proportions between recipients and non-recipients of remittances

	Remittances received = No (1)	Remittances received = Yes (2)	Mean difference (1)-(2)
Household size	4.59 (0.07)	4.36 (0.12)	0.24 (0.13)**
Age of household head	46.93 (0.49)	53.64 (0.97)	-6.70 (1.02)***
Education level (1="none" to 9="university degree")	3.58 (0.07)	3.68 (0.11)	-0.09 (0.13)
Crop land, ha	0.92 (0.05)	1.11 (0.12)	-0.19 (0.11)**
Total number of shocks	0.44 (0.02)	0.45 (0.04)	-0.01 (0.04)
Total value of fuelwood collected, PhP	4719.6 (291.9)	3472.8 (404.6)	1246.8 (546.6)**
Off-farm income, PhP	15272.9 (1074.8)	9936.2 (1353.3)	5336.7 (1977.7)**
Total household income, PhP	91879.5 (4789.2)	138249.6 (11335.1)	-46370 (10499)***
Production value of perennials, PhP	3345.0 (692.3)	5149.0 (1430.9)	-1803.9 (1465.2)
Production value of grains, PhP	45852.7 (3058.5)	55883.5 (9026.2)	-10030.8 (7431.8)*
Production value of vegetables, PhP	751.5 (204.5)	863.9 (455.7)	-112.4 (443.4)
Total crop production value, PhP	49949.2 (3091.2)	61896.5 (8981.1)	-11947.3 (7456.2)*
Distance from homestead to the village center, km	5.67 (1.52)	3.89 (1.62)	1.78 (2.72)
Average distance from homestead to patches, km	6.07 (0.33)	5.17 (0.39)	0.91 (0.59)*
Male household head (1= Yes)	0.89 (0.01)	0.83 (0.02)	0.06 (0.03)**
Access to paved road (1= Yes)	0.79 (0.01)	0.83 (0.02)	-0.03 (0.03)

Household head has no primary occupation (1=Yes)	0.07 (0.01)	0.17 (0.02)	-0.10 (0.03)***
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Source: Own estimations. Results of two-sample t test with equal variances. H0: no difference of means. *, **, *** indicate p-values for the t test at 0.1, 0.05, and 0.001 confidence levels. Standard errors in parentheses. Test of proportions is calculated for dummy variables.

Appendix C: Main land uses by rural Filipino households in forested landscapes

Overall there are 341 households that did not have any crop land. These households are distributed across all 10 study sites, i.e., their presence was not concentrated in a specific study site. We found that a larger share of the households without crop land received remittances (32% or 110 of 341 households), compared to those with crop land (23.2% or 151 of 652 households). We further found that households without crop land collected on average less fuelwood (with the mean value of 3844 PhP) compared to households that have crop land (mean value of 4724 PhP).

In total, 78% (521 households) of households that were involved in crop production cultivated grains that included rice and maize. Fewer households at 24% (161 households) were found to be cultivating perennials. Survey responses identified perennials such as: abaca, banana, coconut, avocado, citrus fruits, rambutan, pineapple, Philippine fig, mango, and soursop. Most commonly planted perennials included coconut, cultivated by 12.4% of households, abaca (6.3%), and banana (4.9%), while the rest of the perennials were cultivated by 1.8% of households.

Households reported a large variety of vegetables grown, including: tomatoes, squash, okra, cucumber, eggplants, string beans, white beans, chili, ginger, sweet potatoes, turmeric, cassava, and taro. Only 6.3% (42 households) of crop producers were involved in vegetable growing, which is why participation in vegetables production, the production value of vegetables and the area cultivated by vegetables were not used as dependent variables in the econometric models.

Out of 997 households included in this study, 74.6% reported collection of fuelwood, all of which was used only for subsistence purposes, while 9.4% of households reported extracting timber. Out of non-wood forest products, households collected edible plants (18.2%), medicinal plants (1.4%) and rattan (0.5%).

Appendix D: First stage results

Table A4. Results of the 1st stage from the 2SLS estimations reported in Table 2.

	Amount of remittances, log	
	Coefficient	Robust std. error
Household size	-0.03	0.07
Age of the household head	0.04***	0.01
Male household head (1=Yes)	-0.61	0.48
Education level (1="none" to 9="university degree")	0.14*	0.07
Access to paved road (1=Yes)	0.41	0.28
Average distance from patches to homestead, km	-0.02	0.01
Size of crop land, ha	0.09	0.09
Total number of shocks	0.20	0.23
Off-farm income, PhP	0.00***	0.00
Household head has no primary occupation (1=Yes)	1.05**	0.53
Province (Cagayan = reference category)		
Leyte	2.22***	0.49
Nueva Vizcaya	0.46	0.36
Quirino	0.43	0.46
Southern Leyte	1.46**	0.48
Income quartiles (1st quartile is a reference category)		
2nd quartile	-0.18	0.33
3rd quartile	0.56	0.35
4th quartile	1.49***	0.41
Village norm to remit, log	0.25***	0.04
Constant	-2.79**	0.89
Number of observations	997	
F statistics	10.21***	

Source: Own estimations based on the household survey. Standard errors are in parenthesis. *, **, *** indicate p-values at 0.1, 0.05, and 0.001 confidence levels respectively. The instrumental variable used for remittances is the village-norm to remit calculated as the average remittances amount per barangay.

Appendix E: Questionnaire Development and Execution of the Household Survey

The data used in the present study have been collected within the frame of a larger research project, LaForeT – Landscape Forestry in the Tropics – that was conducted in close cooperation with local partner organizations in three different countries in the tropics (Philippines, Ecuador and Zambia). The overall goal of the project was to understand deforestation and reforestation processes as well as land use dynamics. The project aimed at providing scientific evidence for the development of policy instruments that effectively protect forests and concomitantly benefit the livelihoods of the local people (<http://la-foret.org/>).

The objective of the household survey was to collect information about land use and the role that forests play for the livelihoods of the local communities in the study regions. A structured questionnaire was developed for field assessments within the LaForeT project that included the following sections:

1. Instructions to the enumerator, introduction of the project, and statements of free prior informed consent for the participating household;
2. General information, household demographic information;
3. Land use and assets;
4. Economic and productive activities;
5. Policy instruments;
6. Forest issues;
7. Crises and unexpected expenditures;
8. Household assets;
9. Assessment of the household by the enumerator.

The questionnaire was completed with the information provided by the household head. If the household head was not present, another adult was asked to complete the questionnaire. In total, ten research sites were selected for data collection. For each site, the targeted number of household interviews was 100, and the overall number of interviews conducted was 1024. However, 27 interviews in total were not completed during the interview process and were excluded from the household analysis.

For the execution of the questionnaire, a technical manual was developed to guide the enumerators on how to conduct the household surveys. It contained the definitions used in the questionnaire, explanations on different types of questions, a detailed guide to the use of the questionnaire and for conducting the interview following free prior informed consent (FPIC), and the tasks to be completed after the interview, including data entry. Two training workshops for the field teams were organized in August 2016 and April 2017 at the Visayas State University (VSU) and Isabella State University (ISU), during which the field teams were trained on how to use the questionnaire, practiced interviews, data entry, GPS use, and had a field practice. The household questionnaire was then pre-tested with 20 households in two barangays in close proximity to VSU in September 2016 and the formulation of questions in local dialect, questionnaire structure and sequence of questions were adjusted based on the results of pre-testing. In case of ISU, a pretesting was not conducted given the start of the survey in Southern Leyte and Leyte provinces already, but field practices were conducted with enumerators to ensure questionnaire comprehension and understanding.

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3 Respondents were selected randomly using a lottery from official household lists obtained from
4 barangay officials with a 20% reserve to replace the households that were unavailable. Meetings with
5 the barangay captains (and other leaders) were essential to gain informed consent prior the start of
6 the survey, and to further gather a contextual overview on the community's livelihoods and
7 landscapes. In dispersed barangays, that had settlements with significant distances from the village
8 center, a good representation of remote parts of the community was targeted.
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