# Contribution of Forest Restoration to Rural Livelihoods and Household Income in Indonesia

**Nayu Nuringdati Widianingsih [1,2,*], Ida Theilade [2] and Mariève Pouliot [2]**

1   Burung Indonesia (BirdLife Affiliate), Jl. Dadali 32, PO. Box 310/Boo, Bogor 16161, West Java, Indonesia
2   Department of Food and Resource Economics, Faculty of Science, University of Copenhagen, Rolighedsvej 25, Frederiksberg C 1958, Denmark; idat@ifro.ku.dk (I.T.); mapo@ifro.ku.dk (M.P.)
*   Correspondence: nn.widianingsih@gmail.com or nayu@ifro.ku.dk; Tel.: +45-50-18-50-81

**Abstract:** Forest resources remain vital to the survival of many rural communities, though the level of forest reliance varies across a range of sites and socio-economic settings. This article investigates variation in forest utilization across households in three ethnic groups living near a forest restoration area in Sumatra, Indonesia. Survey data were collected on 268 households, with a four-month recall period and three repeat visits to each selected household within a year. Random sampling was applied to select households in five villages and five Batin Sembilan (indigenous) semi-nomadic groups. Sampled households belonged to three ethnic groups: 15% were Batin Sembilan, 40% Local Malayan, and 45% Immigrant households. Indigenous households displayed the highest reliance on forests: 36% of their annual total income came from this source, as compared with 10% and 8% for Local and Immigrant households, respectively. Our findings showed that the livelihoods of indigenous groups were still intricately linked with forest resources, despite a rapid landscape-wide transition from natural forest to oil palm and timber plantations.

## 1. Introduction

Rural communities in the Global South have diversified livelihood strategies; one source of income that has gained a lot of attention in recent years is forest income [1,2]. Its importance to many households remains, despite concern over continuing deforestation and forest degradation. Income derived from natural forests contributed 22% to the total household income of 8000 households spread over 24 developing countries [2]. Different household socio-economic characteristics—total household income, in particular—were found to be important determinants of the level of household reliance on forest resources [3]. Reliance on forest income was more important (as a share of total annual household income) to the poorest households, even though better-off households generated higher forest income (in absolute values) [2]. Forest and environmental resources have been shown to perform three major roles in the livelihoods of vulnerable households: supporting local consumption needs; providing safety nets through consumption and/or commercialization; and acting as a pathway out of poverty [4–11]. Deforestation and forest degradation, however, pose a significant threat to the ecosystems and well-being of forest-dependent communities, and forest dependence tends to be highest in areas with high forest cover and pervasive poverty [12].

Analysis of 1582 peer-reviewed papers focusing on ecological restoration and published between 2000 and 2008 showed that socio-economic aspects are inadequately quantified and largely ignored in restoration research [13]. Accurate assessment of patterns, drivers, and consequences of local livelihood systems, and particularly of synergies and trade-offs between agriculture and forest use, are essential to the efficiency of initiatives directed at indigenous and smallholder communities [14,15]. Differences

in reliance on a forest-related livelihood can cause varying conservation attitudes [16]. Ethnicity can play an important role [17]. In particular, ethnic-specific perceptions of the environment may create a significant impact on land and resource management [18–20]; an approach that considers these may thus provide a richer analysis of forest reliance determinants than one focused solely on poverty. For example, Lairds et al. [21] found that indigenous households are often much more dependent on a diverse range of habitats and species than non-indigenous households. Until recently, most research on the economic value of forests has been conducted in dry southern and eastern Africa, Latin America, and Asia [22]. In 2008, Sunderlin et al. [12] showed that there were approximately 20 million Indonesians residing in and around forest areas, of whom around six million depend on forest resources. However, data on forests and poverty in Indonesia are scant [23], and no previous study has focused on the benefits of forest restoration to household income.

Forest cover loss in Indonesia reached 16 million ha during the period 2000–2012 [24]. Sumatra has experienced intensive forest conversion and had lost 70% of its forested area by 2010 [25]. The dominant drivers of forest loss in Sumatra are related to expanding global markets for pulp, timber and oil palm [26–30]. In a response to widespread deforestation, the Indonesian government amended the forest law so that logging concessions could be converted into forest restoration concessions. In 2007, the first forest restoration concession, Hutan Harapan, was granted; it covered 100,000 ha of Sumatran rainforest previously subject to logging. The aim of the restoration concession is ecosystem restoration, conservation of biodiversity, and sustainable use of non-timber forest products (NTFPs). This article investigates the following questions: (i) What is the forest economic contribution in and around a forest restoration concession? (ii) How do household socio-economic characteristics (including ethnicity) determine forest use within the forest restoration concession?

## 2. Study Area

The forest restoration license issued by the Indonesian government allows the concession holder, a company called PT. REKI set up by the NGO Burung Indonesia, to manage and earn revenue from the Hutan Harapan through the sustainable harvesting of NTFPs, ecosystem services, eco-tourism and other non-exploitative resources. The concession holder has a responsibility to support the livelihoods of the indigenous people (Batin Sembilan) living in the concession area.

Hutan Harapan ("the forest of hope") is a secondary lowland dipterocarp forest located in the Jambi and South Sumatra provinces of Indonesia. It is a home for the critically endangered Sumatran Tiger (*Panthera tigris sumatrae*) and Asian Elephant (*Elephas maximus*), as well as four critically endangered tree species—*Hopea mengerawan* Miq, *Hopea sangal* Korth, *Shorea cuminata* Dyer, and *Syzygium ampliforum* (Koord. and Valet) Amshoff). Hutan Harapan is surrounded by three oil palm plantations on its northeastern perimeter and five timber production forests along its remaining borders.

Since its establishment, Hutan Harapan has struggled to minimize forest encroachment by immigrants. During the last seven years, more than 17,000 ha of the concession have been converted illegally into rubber, oil palm and paddy field. However, NTFP utilization is still an integral part of local community livelihoods in and around the restoration area. High population growth rates, boosted by immigration from other parts of the Indonesian archipelago—mainly from Java (Javanese) and North Sumatra (Batak)—has led to a socio-economic transition with diversified income sources, including wage labor and smallholder rubber plantations.

Batin Sembilan formerly followed a nomadic hunter-gatherer way of life. They are named for the nine brothers (Sembilan = nine) who ruled along nine rivers in the border region between Jambi and South Sumatra [31], as well as along the banks and tributaries of the main rivers Musi and Batang Hari [32] in Hutan Harapan. Traditionally, Batin Sembilan considered land as communal property, although ownership could be claimed over particular fruit trees (*Durio zibetinus*) and bee trees (*Koompassia excelsa*) [32].Their historically high reliance on forests for a livelihood made the Batin Sembilan particularly vulnerable to large-scale land transformation [19]. After intensive logging in

the 1980s followed by the transmigration scheme, most Batin Sembilan now live on state land (hutan negara) within or in the vicinity of a forest restoration concession. The forest restoration concessionaire, PT. REKI, has negotiated conservation agreements with the Batin Sembilan groups, permitting them to utilize a designated area within the Hutan Harapan and to collect NTFPs [33].

Local Malayan and Immigrant groups live in the villages under research. Local Malayans constitute most households in Pagar Desa, Lamban Sigatal, and Sepintun, while Immigrants are the major ethnic groups in Tanjung Lebar and Bungku. The five villages have a mixture of new and long-settled households, and a variety of land uses: small-scale rubber and agroforestry; smallholder oil palm plantations; and other agricultural land. Rubber (*Hevea brasiliensis*) was introduced into Jambi and South Sumatra in the second half of the 19th century. At the beginning of the 20th century, small-scale rubber monoculture and agroforests rapidly replaced other land production systems and became the dominant mode of land use in lowland Jambi as well as South Sumatra [34].

During the 1970s, timber concessions accounted for the entire forested area in Jambi [35]. In the 1980s, regional policy shifted towards the development of plantations, with the implementation of transmigration schemes. Bungku village, perched on the edge of land occupied by the state-owned oil palm company, developed oil palm cultivation together with smallholdings for Javanese transmigrants [35,36]. Land distribution followed along the new road and recently attracted outsiders, creating further pressure on the remaining forest occupied by the Batin Sembilan. With population growth, the two hectares of land allocated by government to each transmigrant household are no longer sufficient to sustain livelihoods. Meanwhile, however, stories from successful transmigrants have attracted other families to migrate into the area, fueling further conversion of forest. Land use transformation in Jambi province is closely linked to immigration—migrants provide expanding agro-businesses with a workforce, or else hope to be set up on land and begin production by themselves [37].

## 3. Method

### 3.1. Data Collection

Quantitative data were collected using a simplified-PEN (Poverty and Environmental Network) questionnaire developed by CIFOR (Center for International Forestry Research). It aims at the systematic collection of high-quality and comparable data from a variety of tropical and subtropical forest settings using similar definitions and methodologies [38]. Meanwhile, qualitative data were collected through Group Discussions (GD), key informants interviews (KII), and direct field observations as well as informal random checking and visits to interviewed households judged to be cases of possible over- or under-reporting. "A household is defined as a group of people (normally family members) living under the same roof, and pooling resources (labor and income)" ([38], p. 21).

Qualitative information on harvesting periods of NTFPs and agricultural products, daily wages, and prices on raw and processed forest products were used to support the quantitative data. Qualitative information on harvest periods of seasonal products was also used to ensure there was no double counting. The PEN household questionnaires were conducted three times with four-month recall periods so that a whole year's income could be recorded. This is also a way to cover different seasons; dry and rainy seasons influence the peak and slack harvesting periods of most harvested forest and non-forest products as well as agricultural products. Rubber was the most commonly harvested product from planted forest. Rubber trees yield less during the rainy season (December–February) and peak in April–May. Income from dryland fields was highest in January–February. The repetitive visits to the same households are chosen to obtain in-depth data, to enhance accuracy and reliability, and thereby to improve the quality of the data [39]. Each round of data collection, including all types of questionnaires, took two months to conduct. The more detailed execution of data collection and recall period are illustrated in Table 1.

**Table 1.** Execution of data collection.

| Time Frame | Month | Type of Questionnaire |
|---|---|---|
| t − 4 | November 2013 (limit of recall period for the 1st data collection) | |
| t | March 2014 (1st data collection was started—limit of recall period for the 2nd data collection) | A1 (1st Annual Household Survey), V1 (1st Village Survey), H1 (1st Household Survey) |
| t + 4 | July 2014 (2nd data collection was started—limit of recall period for the 3rd data collection) | H2 (2nd Household Survey) |
| t + 8 | November 2014 (3rd data collection was started) | A2 (2nd Annual Household Survey), V2 (2nd Village Survey), H3 (3rd Household Survey) |

The village surveys (V1 and V2) were implemented to collect data that were common to all households within a village. There were two different village surveys, one (V1) applied at the beginning of data collection (March–May 2014) to get background information on the villages, and a second (V2) was at the end of the data collection period (November 2014–January 2015) to get information for the 12-month period covered by the surveys. Two different household surveys were employed: the first one was used to collect income information three times in a year (H1, H2, and H3) and the second one to collect general household information (A1 and A2). These two types of household questionnaires were conducted with household heads and/or in their absence, another adult household member. The first annual household survey (A1) aimed to provide basic household information (household composition, land and assets ownership, and forest resource base information) and was completed at the beginning of the survey period. The second annual household survey (A2) was used to gather information for the 12-month period covered by the surveys (crisis and unexpected expenditures, welfare perceptions, and social capital). Wage, business, forest-related, and non-forest environmental sources were based on a one-month recall period, as they often display high seasonal variation in harvested volumes. However, data from agriculture, livestock, and other income sources less affected by seasonal variation were based on four-month recall periods. Subsistence products were assigned cash-equivalent values based on each household's own-reported values, which were independently and randomly checked by comparing with the price obtained from GD and KII at the same village.

A total number of 228 Batin Sembilan households living in 10 groups (illustrated by square boxes) and five groups (indicated by stars) were sampled (Figure 1). Five villages located next to the restoration concession, namely Tanjung Lebar, Lamban Sigatal, Sepintun, Bungku, and Pagar Desa were sampled to represent Local Malayan and Immigrant communities (Figure 1).

Five out of ten indigenous groups were randomly selected as sample groups, with consideration of accessibility and household presence when the data collection took place. The total number of indigenous households presented in Table 2 below represents households in which both husband and wife were born from indigenous Batin Sembilan parents. The 39 households selected were chosen carefully to avoid households that were established through strategic mixed-ethnicity marriage, which became a popular adaptive strategy to cope with recent rapid land use change in this study area. The inclusion of strategic marriage households in the indigenous households' sample could introduce different adopted livelihood strategies from their semi-nomadic lifestyle to the more modern way of life.
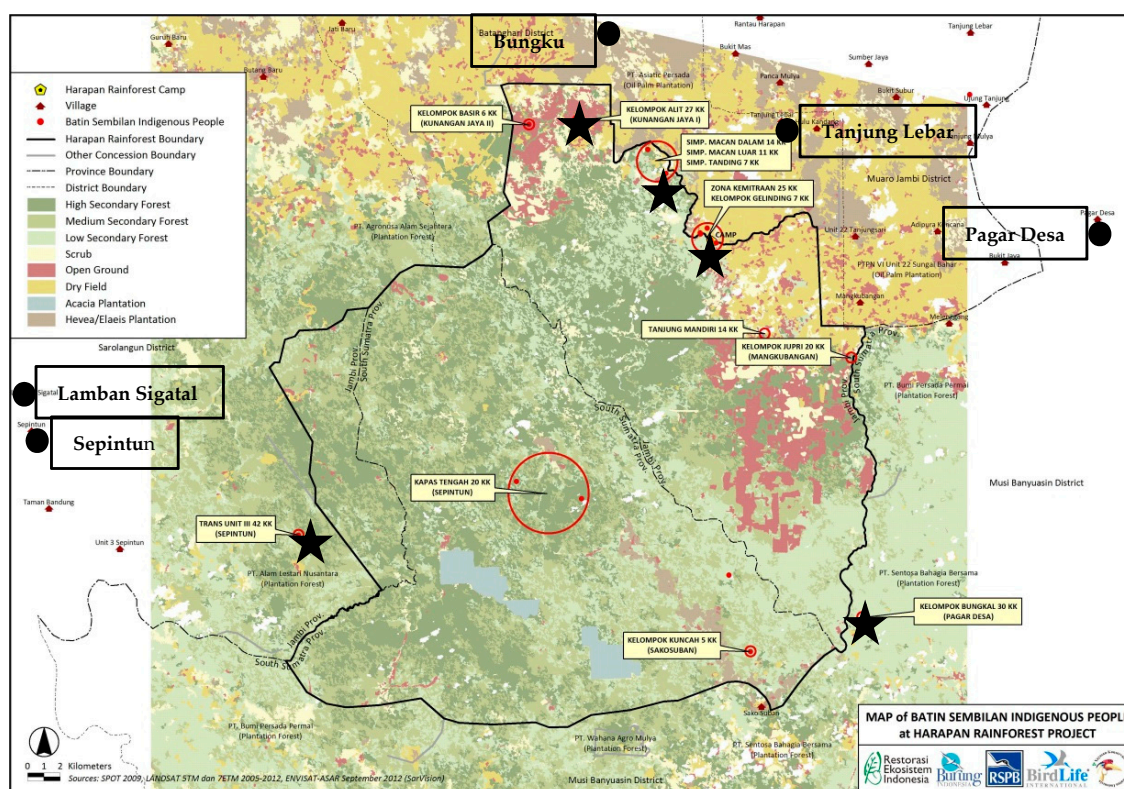
**Figure 1.** Location of study area. Black stars show location of sampled indigenous groups (Batin Sembilan) and black circles the location of sampled villages (Local Malayan and Immigrant households).

**Table 2.** List of indigenous people groups residing in and around Hutan Harapan.

| Group | Names of Groups | Total Number of Households in the Groups | Number of Sampled Households |
|---|---|---|---|
| 1 | Kel Basir (Kunangan Jaya II) | 6 | 0 |
| 2 | Kel Alit (Kunangan Jaya I) | 27 | 5 |
| 3 | Simp. Macan Dalam, Luar, Tanding | 32 | 7 |
| 4 | Zona Kemitraan + Kel Gelinding | 32 | 7 |
| 5 | Tanjung Mandiri | 14 | 0 |
| 6 | Kel Jupri (Mangkubangan) | 20 | 0 |
| 7 | Kapas Tengah (Sepintun) | 20 | 0 |
| 8 | Trans Unit III (Sepintun) | 42 | 9 |
| 9 | Kelompok Kuncah (Sako Suban) | 5 | 0 |
| 10 | Kelompok Bungkal (Pagar Desa) | 30 | 11 |
| Total | | 228 | 39 |

Random sampling using a "random walk" method was applied for collecting the data, as there was no sufficient and recent list of the sample frame prior to the data collection period. Sampling started with random selection of a center point at which the first selected household was interviewed (around the center of the village area at all 5 selected villages) and proceeded via a random step length in each village. The random number was used to choose the following *n*-th households to be interviewed. The target population was 5 villages located adjacent to the restoration area, as listed in Table 3 below. In Tanjung Lebar and Bungku, where the highest influx and outflux of migrants occurred—as shown by the many houses left empty by the owners—a household check was run prior to data collection to adjust the number of total households to the most recent conditions.

**Table 3.** List of sampled villages adjacent to Hutan Harapan.

| No. | Village | Province | Total Households | Sampled Households |
|-----|---------|----------|------------------|--------------------|
| 1 | Tanjung Lebar | Jambi | 545 | 57 |
| 2 | Bungku | Jambi | 979 | 59 |
| 3 | Pagar Desa | South Sumatra | 121 | 35 |
| 4 | Lamban Sigatal | Jambi | 124 | 38 |
| 5 | Sepintun | Jambi | 409 | 40 |
| | Total | | 2178 | 229 |

*3.2. Definitions of Variables and Income Calculation*

The concept of income used in this article was defined as the total of both cash and subsistence incomes. Table 4 presents the definition of income and socio-economic variables collected in the household surveys. The definition of income is adopted from what is outlined in the PEN technical guidelines ([38], p. 17), and is defined as "the return to the labor and capital that a household owns, used in own production and income-generating activities (self-employment or business) or sold in a market (e.g., wage labor)". Remittance income, gift/support from friends and/or relatives, pensions, and subsidies from government (including those in the form of cash, livestock, and staple food) are also included in the income definitions. The definition of natural forest used in this study is also adopted from the PEN technical guidelines ([38], p. 11): "forest consists of indigenous (native) tree species and managed only to a very limited degree". This includes restoration management. Meanwhile, rubber plantation is categorized under planted forest as defined by FAO ([40], p. 8) as "forest predominantly composed of trees established through planting and/or deliberate seeding". The valuation method implemented for forest, agriculture, and non-environmental products reported in this study was based on local-level prices. All local prices were gathered at household level during the interview, and then matched with the information recorded from FG and KII. This valuation method has the advantage of capturing real price as revealed by a real transaction found in the field [39].

**Table 4.** Definition of incomes and socio-economic variables collected in the household survey.

| No. | Type of Income Variables | Description | Utilization Type | |
|-----|--------------------------|-------------|------------------|--|
| | | | **Cash Income** | **Subsistence** |
| **Natural Forest Income Sources** | | | | |
| 1 | Natural forest | Income from self-employment of household members in the harvesting of raw forest products, used or sold in unprocessed form. | Sale of rattan, fruits of Dragon Blood, timber, honey, birds, wildlife for meats (Pangolin, Deer, Wild Boar, Wild Chicken, Soft-shell turtle, Dumeril's Monitor), forest fruits (*Areca catechu*, *Durio zibethinus* L., Parkia pod), Gadung, Damar resin, reed, firewood and bamboo. | Some households collected wild animals for protein intake and fruits for daily consumption. |
| 2 | Forest-derived income (FDI) | Income from self-employment of household members in processing (value added) forest products. | FDI covers resins of Dragon Blood, furniture from wood, coal from stumps or dead trees, crafts (plaited mats/bags, baskets, roof). | Only 1–2 units of mats and/or baskets were reported by each household for subsistence. |
| 3 | Forest wage | Income from wage labor or fixed salary generated from the related forest activities. | Cash income generated by households as employee or daily laborers at the restoration concession. | |
| 4 | Forest business | Income from businesses owned and managed by household members. | Businesses selling wooden and rattan furniture, rattan wholesaler, tree nursery, and Dragon Blood (in fruits and resins) wholesaler. | |

**Table 4.** *Cont.*

| | **Non-Natural Forest Income Sources** | | | |
|---|---|---|---|---|
| 1 | Planted forest (rubber) | Income from self-employment of household members in the harvesting of resin. | Cash income generated from rubber plantation concession or small-scale rubber plantation owned by households. For partial income received in kind (i.e., staple food), the amount of food obtained was converted into monetary values (USD/aeu). | |
| 2 | Agricultural income | All income generated from cropping of agricultural land (including yards/gardens) and oil palm plantation (fruit bunches). | Cash income was mainly from fruit bunches and vegetables and spices harvested from agroforestry land. | Agricultural products used for subsistence were vegetables and spices harvested from gardens/yards as well as rice. |
| 3 | Non-forest wage income | Income from non-forest-related wage labor or fixed-salary employment. | Cash income generated by households as teachers, civil servants, local government staff/village administrators, daily laborers at oil palm plantations, employees at oil palm plantations, daily laborers in agricultural fields, drivers, and mechanics. | |
| 4 | Non-forest business income | Income from businesses owned and managed by the household. | | |
| 5 | Non-forest environmental income | The sum of values (of goods) resulting from the extraction of raw material from non-forest and non-cultivated areas for both subsistence and sale as source of income. | Cash income was only reported for 2 households. | Subsistence of 89 small-scale fish collectors. |
| 6 | Livestock income | Income from the products (including the sale of live animals) of farm animals. | Cash income was only generated from the sale of big animals (cattle, buffalo, and goats). Small animals like chicken, duck, and geese were not counted under income tabulation, as most of the households could not remember the exact number of small animals slaughtered or sold. | |
| 8 | Other income | Income from remittances (received from family members living and working overseas or in other provinces), gifts/support from friend and relatives, income from pensions or government support, and any other income not categorized under the above groups. | | |

**Table 4.** *Cont.*

| No. | Type of Socio-Economic Variables | Description |
|---|---|---|
| | **Socio-Economic Variables** | |
| 1 | Age of household head | Years, numerical variable. |
| 2 | Ethnicity | Nominal variable: 0 = indigenous people (Batin Sembilan), 1 = Local, Malay-speaking people (Melayu tribe), 2 = migrants, Java (Java ethnic and only few households from Sundanese and Balinese) and North Sumatra (Batak ethnic). At the stage of data analysis, dummies were generated for ethnic variables. |
| 3 | Family size | The present number of household members who are living in the same household. It includes spouse, children, children-in-law, grandchildren, parents, parents-in-law, brothers/sisters, brothers/sisters-in-law, nephews/nieces. |
| 4 | Household head education | Number of years of formal education completed by the head of household. Interval variable. |
| 5 | Total land area owned | Total area of land owned by the household, measured in hectares (ha/aeu), including land rented out (and excluding land rented by the household). Includes agroforestry, monoculture, yard/garden, paddy field, residential area, oil palm plantation and bare land. The minimum land area to be counted as agroforestry and monoculture is an area which consists of 0.25 ha minimum-mapping unit as defined by Ministry of Forestry of Indonesia. Otherwise, it is designated the category yard/garden. |
| 6 | Total assets | The total value of all implements owned by the household: cars/trucks, motorcycles, canoes, televisions, mobile phones, generator sets, water pumps, and other tools valued at more than 10 USD, as well as livestock assets. |

All income variables and total assets are presented in USD/aeu (adult equivalent unit).

### *3.3. Statistical and Econometric Analyses*

This study employs a categorization of income unlike that used in similar PEN studies. While making the distinction between forest income and environmental income, this study identifies natural forest income and non-natural forest income as follows:

(a) Natural forest income = Natural forest + Forest-derived product + Forest wage + Forest business
(b) Non-natural forest income = Rubber plantation + Agriculture + Non-forest wage + Non-forest business + Non-forest environmental + Livestock + Others

The rationale was based on an ecological perspective aimed at obtaining a complete estimate of income (in cash or kind) generated from the restoration area which represents natural forest. However, the definition of all income sources other than from natural forest investigated in this study remained the same, so that potentially the results will be compatible with global comparative studies.

Overall, 268 out of the 285 sampled households completed all three household survey rounds. Income data from all sources and socio-economic variables were keyed into Microsoft Excel © (Microsoft, Redmond, WA, USA) sheets and analyzed using STATA MP13. All income data gathered in this research were recorded in Indonesian currency (IDR) and converted into USD prior to the analysis to assist in comparative presentations. The currency converter used was 1 USD = 12,086 IDR, which represented the average of the highest and the lowest values of the chosen currency during the period of data collection. OECD adult equivalence scales were applied to present the generated income and assets owned by households in a proportional way. This assigns a value of 1 to the head of household, 0.7 to each additional adult and 0.5 to each child (<14 years old at the time of data collection). This scale was proposed for possible use in Indonesia as one of the countries that has not yet established its own equivalence scale [41].

## 4. Results

### 4.1. Description of Socio-Economics Characteristics

Key observed household characteristics for the total sample as well as for the three ethnic groups are presented in Table 5.

**Table 5.** Socio-economic characteristic of households in total sample and three ethnicity groups.

| Socio-Economic Variables | Total Sample | | Batin Sembilan | Local Malayan | Immigrant Group | ANOVA |
| --- | --- | --- | --- | --- | --- | --- |
| | Mean | SD | | | | |
| Age of household head | 44.4 | 12.3 | 43.9 [a] | 45.1 [a] | 43.9 [a] | NS |
| Family size | 4.4 | 1.7 | 5.2 [a] | 4.7 [a] | 3.8 [b] | *** |
| Education (year of schooling) of household head | 6.6 | 3.9 | 1.2 [a] | 7.3 [b] | 7.8 [b] | *** |
| Land area owned (ha/aeu) | 1.1 | 1.9 | 0.8 [a] | 1.4 [b] | 0.9 [a] | NS |
| Total household assets | | | 287.6 [a] | 795.9 [b] | 938.4 [b] | *** |
| Total value of household implements (USD/aeu) | 746.5 | 967.9 | 283.8 [a] | 757.2 [b] | 887.1 [b] | *** |
| Total value of livestock (USD/aeu) | 39.3 | 167.1 | 3.7 [a] | 38.8 [b] | 51.3 [c] | NS |
| Total annual income (USD/aeu) | 1174.3 | 979.4 | 826.0 [a] | 1097.6 [b] | 1357.2 [c] | *** |
| Total natural forest income (USD/aeu) | 114.9 | 233.4 | 293.1 [a] | 91.3 [b] | 78.4 [b] | *** |
| Total non-natural forest income (USD/aeu) | 1059.4 | 993.8 | 532.9 [a] | 1006.3 [b] | 1278.8 [c] | *** |

Bonferroni Multiple Comparison Test: means followed by a common superscripted letter ([a], [b], [c]) indicate a difference between the three groups; the different superscripted letter illustrates significant difference at 5% level. *** *p*-value (ANOVA) < 0.01; NS: level of significance is >10%.

Except for the age of the household head, which is similar, all the socio-economic variables are found to be significantly different across the three sampled groups. Overall, Batin Sembilan households are shown to be the poorest group, both in terms of assets and income. The size of family ranges from 1 household member to 11 (Appendix A, Table A2), and the Batin Sembilan have the highest average family size. Household heads in the Immigrant groups have on average a higher level of education. Local Malayans owned on average more land than Indigenous people and Immigrants.

There is a substantial variation in household assets and annual income across the three ethnic groups. The Indigenous groups hold the least assets, almost three times less than locals and much less than Immigrants. The total asset endowment results from the variation in total income received by households annually. The asset level (both implements and livestock) of the Batin Sembilan is lower than the Local Malayan and Immigrant groups. Total annual net income per aeu averaged 1202 USD (ranging from 74 to 8391 USD). The heads of households of the Immigrant groups have received significantly more years of schooling than from the heads of other households.

### 4.2. Income Characteristics of Three Ethnic Groups

Table 6 presents a breakdown of the contribution of different income sources to total net annual household income for the three ethnic groups. The sources of income differed between the Batin Sembilan, Local Malayan, and Immigrant groups. The contribution from non-natural forest resources is higher than that from natural forest resources for all three groups. On average, the indigenous groups derived more income from natural forest resources (36%) than locals and immigrants (10% and 8%, respectively). Direct forest products harvested from natural forests remained the second main income source for the Indigenous group and contributed 29% (238 USD/aeu) of their annual net income. Aside from natural forest income contribution, the Indigenous, Local, and Immigrant households were all highly dependent (28%–37%) on non-forest wage income (274 USD/aeu, 269 USD/aeu and 387 USD/aeu, respectively). Non-forest labor engaged in by all three ethnic groups was mostly daily labor in oil palm plantations (Appendix B, Figures B4–B6). The Local Malayan households generated 30% (298 USD/aeu) of their annual net income from small-scale rubber plantations. Small-scale agribusiness contributes 18% (221 USD/aeu) and 27% (366 USD/aeu) to the annual net income for

Local Malayan and Immigrants households respectively. The minimum income from the agribusiness sector was −66 USD per aeu and −8 USD per aeu for Local Malayan and Immigrant groups, commonly occurring in the first year of agribusiness establishment (Appendix A, Table A1).

**Table 6.** Household income breakdown of three ethnic groups.

| No. | Income Sources | Indigenous Batin Sembilan | | | Local Malayan | | | Immigrant Groups | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No of HH | Absolute (USD/aeu) | Income Share (%) | No of HH | Absolute (USD/aeu) | Income Share (%) | No of HH | Absolute (USD/aeu) | Income Share (%) |
| A | Natural Forest Source *** | 29 | 293.1 [a] | 35.9 [a] | 41 | 91.3 [b] | 9.8 [b] | 25 | 78.4 [b] | 7.7 [b] |
| 1 | Direct Forest Product | 28 | 238.3 | 29.3 | 29 | 42.3 | 5.5 | 11 | 28.2 | 1.8 |
| 2 | Forest-derived Product | 8 | 36.2 | 3.7 | 14 | 23.6 | 3.2 | 13 | 38.5 | 5.1 |
| 3 | Forest Wage | 2 | 18.6 | 2.9 | 4 | 6.3 | 0.6 | 0 | 0 | 0 |
| 4 | Forest Business | 0 | 0 | 0 | 2 | 19.3 | 0.6 | 5 | 11.6 | 0.9 |
| B | Non-Natural Forest Source *** | 39 | 532.9 [a] | 64.1 [a] | 108 | 1006.3 [b] | 90.2 [b] | 119 | 1278.8 [c] | 92.3 [b] |
| 1 | Planted Forest (Rubber) | 17 | 99.7 | 13.5 | 70 | 298.1 | 29.9 | 21 | 88.5 | 6.1 |
| 2 | Plantation Wage | 8 | 37.2 | 4.7 | 27 | 52.4 | 4.8 | 23 | 43.8 | 3.4 |
| 3 | Agriculture | 8 | 24.9 | 2.4 | 60 | 221.4 | 17.6 | 80 | 366.3 | 27.2 |
| 4 | Non-Forest Wage | 26 | 273.9 | 31.1 | 74 | 268.8 | 28.0 | 94 | 386.5 | 36.9 |
| 5 | Non-Forest Business | 5 | 22.7 | 2.8 | 14 | 119.6 | 4.4 | 39 | 322.7 | 13.3 |
| 6 | Non-Forest Environmental | 31 | 29.9 | 4.2 | 43 | 11.5 | 1.6 | 17 | 5.7 | 0.6 |
| 7 | Livestock | 0 | 0 | 0 | 14 | 26.7 | 2.7 | 13 | 35.1 | 2.4 |
| 8 | Others | 14 | 44.6 | 5.4 | 22 | 7.8 | 1.2 | 27 | 30.4 | 2.4 |

Bonferroni Multiple Comparison Test: Means followed by a common superscripted letter ([a], [b], [c]) indicate the differences between the three groups; the different superscripted letters illustrate significant difference at the 10% level. *** $p$-value (ANOVA) < 0.01, for absolute and relative forest and non-forest income.

### 4.3. Types of Natural Forest Products Harvested by the Groups

Types of direct forest products harvested from Hutan Harapan are presented in Figure 2. Stumps were used by Batin Sembilan as firewood, and by immigrants for making charcoal. Bamboo was mostly processed together with rattan to make baskets and fish traps, and was combined with reed and nypa (*Calamus* sp.) to produce plaited mats and bags. Reed and nypa (*Calamus* sp.) were also processed to make roofs. Households collected birds to sell as domestic animals, while bushmeat was used as a protein source. Figure 2 shows that Batin Sembilan households were heavily engaged in harvesting all the observed forest products. This was not the case for the Local Malayan and Immigrant groups. While these latter groups have been shown to generate their income mainly from non-natural forest sources, they have also engaged in rattan, Dragon Blood, and bushmeat collection from restoration sites (Appendix B, Figures B2 and B3).
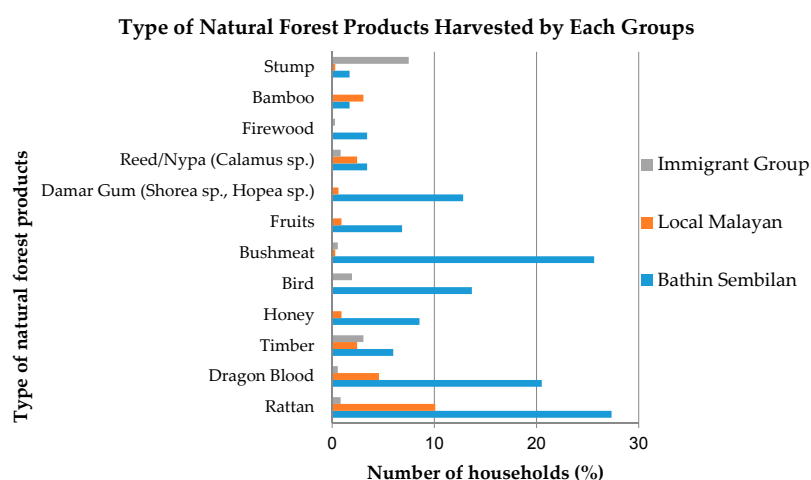


**Figure 2.** Type of natural forest products harvested by each group.

*4.4. Gap-Filling Function between Different Income Sources*

In this study area, the rainy season (H1) drives timber felling from the restoration site, as the Indigenous and Immigrant households use the flowing river current to transport logs (Appendix B, Figures B1 and B3). Non-forest wages appear to fill a gap in Batin Sembilan household income when income from direct forest products declines during the slack harvesting period. Figure 3 shows that the Batin Sembilan use non-forest wage income and direct forest income as substitutes in their income portfolio to compensate for the seasonality of both income sources. Figure 4 shows that the Local Malayan groups also use forest income to fill an income gap in periods when oil plantation incomes (and businesses incomes) are low. However, the analysis for the Immigrant Groups failed to document any gap-filling function attributable to natural forest and non-natural forest income sources.
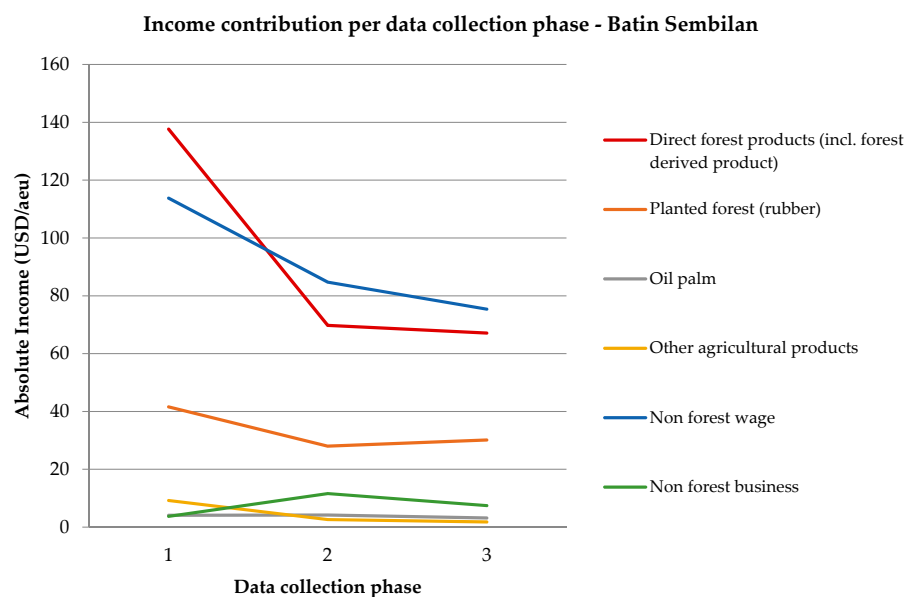
**Figure 3.** Gap filling between income sources in Batin Sembilan.
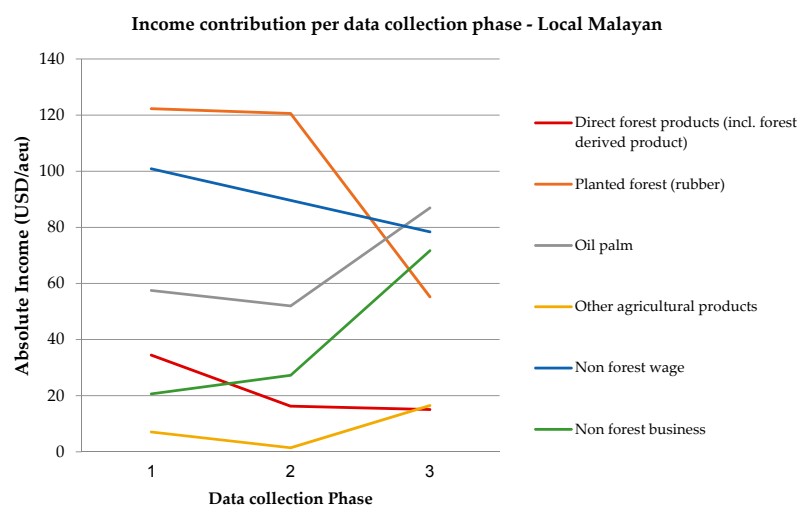
**Figure 4.** Gap filling between income sources in Local Malayan.

## 5. Discussion

### 5.1. Dependence on Forest Income

The reliance of rural communities on forests for sustaining their livelihoods is well known. Here, we have documented variations in forest reliance between different ethnic groups. This study is the first to provide links between forest reliance and ethnicity in a restoration area in Indonesia. The differences in total annual income and assets and ownership identified through this study show that the indigenous households of the Batin Sembilan are the poorest of the studied ethnic groups. Overall, the Indigenous households had a relatively high natural forest income (36%), while Local Malayan and Immigrant households had very limited natural forest reliance (10% and 8%, respectively). This result shows that the Batin Sembilan have a tradition of natural forest-related activities which require skills and experience (e.g., hunting, collecting forest fruits, and honey harvesting). A non-forest wage was the most important income source within Indigenous households (31%) and Immigrant households (37%), and the second-highest income source for Local Malayan households (28%). Hence, though Indigenous households rely to a high degree on traditional natural forest uses, they have taken up paid labor in surrounding timber and oil palm plantations, and this has now become an important income source.

Batin Sembilan groups generated 29% of their income from direct forest products harvested from the restoration site, and received 14% of their income from smallholder rubber plantations established within the restoration site. For Local Malayan groups, rubber was the most important income source (30%) while 18% was generated from small-scale agribusiness. Immigrant households generated 27% of their annual total income from agribusiness and 13% from non-forest business. This confirms an earlier study from West Kalimantan in that important income sources there were non-timber forest products (58%), rubber plantations (21%) and fruit gardens (9%) [42]. Similarly, Porro et al. [43], reporting from an Amazonian forest frontier in Peru, found that forest/environmental products provided nearly 40% of total income, while agriculture was also important for indigenous and local farmers of non-Amazonian origin.

None of the Batin Sembilan households generated income from forest businesses. Forest businesses require relatively high amounts of capital investment. Another difference was that none of the Immigrant households received income from forest wages, while the two other household groups received such income from labor at the restoration concession.

This study has revealed the continued importance of forest resources for indigenous Batin Sembilan households. Furthermore, poorer households generate a higher relative forest income from the restoration concession than wealthier households, which is consistent with previous findings [3,44–46]. Interestingly, the poorer Batin Sembilan households also generated a higher absolute forest income than non-poor households (in the Local Malayan and Immigrant groups), a finding contrary to many previous studies [4,47,48]. The higher absolute forest income generated by the Indigenous households reflects differences in tradition and culture. Furthermore, the Indigenous groups reside within the forest restoration area, while the Immigrant settlements are at the border of or in the vicinity of the restoration site, and this influences access to the forest. Availability of capital resources was not correlated with the ability of households to benefit from the forest restoration area. This is probably because extraction is limited to NTFPs that do not require expensive equipment, and because extraction of high-value products such as timber is prohibited.

### 5.2. Gap-Filling Function

Seasonal variations and religious festivals resulted in gaps of income from rubber and non-forest businesses. All three groups recorded daily labor at oil palm plantations: Batin Sembilan 45%, Local Malayan 36%, and Immigrant households 46%, respectively (Appendix B, Figures B4–B6). However, towards the end of our data collection period, plantations laid off workers due to a dramatic drop in the rubber price from 0.7 USD/kg during H1 to 0.4 USD/kg. Local Malayan households switched

to harvesting their own oil palm plantations and therefore had less time to tap rubber and involve themselves in non-forest labor. Batin Sembilan's households sought to maintain their income from non-forest wages at higher levels when their income from direct forest products dropped. They also preferred to generate income through informal forest-based livelihood strategies, which required less interaction with outsiders.

### 5.3. Influence of Ethnicity on Natural Forest Income

The role of blood ties and regionalism in defining households and individuals as part of groups, and groups as distinct from each other, has long been acknowledged [49]. More recently, results from livelihoods research have demonstrated that rural livelihoods are a product of both external factors (e.g., political and economic changes) and internal factors (i.e., household socio-economic characteristics), always influenced by ethnic identity and culture [50]. In this article, the role of ethnicity in shaping people's livelihoods has been shown to be crucial. For example, reliance on forests was shown to be strongly influenced by ethnicity. Local Malayan households and Immigrant households establish their own farmland and generate little income from the forest restoration area. Labor at oil palm plantations, establishment of small-scale rubber plantations, and non-forest businesses provide extra income, while collection of forest products is minimal or non-existent. In addition, it is common for poorer households to be relatively more dependent on forest products, particularly NTFPs [4,51]. Greater reliance on forest resources was associated with lower asset endowments, as in studies from Sri Lanka [52], Ethiopia [53] and China [54]. Hence, households with little capital were less likely to establish non-natural forest income sources, and relied to a greater extent on the restoration area.

It is important to note that ethnicity does not imply an unchanging form of identity rooted only in location and blood ties [55]. Instead, ethnicity is understood here to refer to personal and collective decisions and strategies that sustain a discrete and negotiable form of group identity [56]. Clearly, inter-ethnic cooperation and influence is a reality in the study area, and ethnic identity is an ever-changing, fluid concept. For example, even though this article argues that ethnicity influences rural livelihoods, it could also be argued that changes in livelihood strategies will affect ethnic identity through responses to important political or economic changes [57,58], as well as inter-ethnic mimicry and cultural diffusion. Nonetheless, this study is one of very few to demonstrate the role of ethnic belonging as a major determinant in the livelihood strategies of rural people.

Some relevant policy implications can be drawn from these findings. Overall, the results show that the indigenous groups have maintained much of their traditional way of life despite the forest conversion. Forest restoration activities should take the livelihoods of the indigenous households into consideration in the restoration activities. PT. REKI has facilitated marketing of forest products such as rattan, Dragon Blood, and damar gum (Appendix B, Figure B1) in order to enhance forest income. More needs to be done to improve the livelihoods of indigenous households, possibly by improving their collection and or cultivation of high-value forest products such as Dragon Blood.

## 6. Conclusions

This work provides the first comprehensive income quantification of households living within or near a forest restoration concession in Indonesia. The study shows that secondary and restored lowland rainforests remained essential for indigenous livelihoods. Besides forest incomes, indigenous households mainly generated income as daily laborers in oil palm and rubber plantations. Local Malayan and Immigrant groups mainly generated income from forest conversion and the establishment of private, small-scale plantations (rubber and oil palm). Non-forest wages contributed as one of the top three total annual incomes for all groups, with Local Malayan and Immigrant households more likely to engage in small businesses.

Instead of associating dependency on forest utilization with poverty solely, our analysis confirms a distinctive role of ethnicity in determining livelihood orientation. Ethnicity also proved relevant for determining household capital assets and annual total income. Batin Sembilan, as the most

marginalized ethnic group, remain the poorest group, with the highest absolute forest income and relative forest dependency. Thus results from this study coincide with findings from previous analyses of the relationship between poverty and reliance on forest income [19,44].

In order for the forest restoration concession to improve the livelihoods of the Batin Sembilan, it is suggested that PT. REKI secure its access and rights to harvest NTFPs within the concession area; continue and up-scale its support for the marketing and sale of high-value NTFPs collected by Indigenous groups; and engage the Batin Sembilan in the patrolling and protection of the concession area by offering reasonable incentives. It is important to acknowledge significant ethnic and socio-economic differences when developing policy and management interventions to support rural livelihoods and promote restoration goals.

Several limitations are acknowledged by the authors. Most of the respondents interviewed had difficulty recalling precise quantities of subsistence or cash income, especially for agriculture products (paddy, vegetables, and spices). To avoid misleading interpretation of our results and conclusions, total incomes from those products presented in this article represent total income, in both cash and kind, converted into value (USD/aeu). The selection of five indigenous groups was influenced by considerations of accessibility and household presence in the periods when data collection took place, and therefore might lead to systematic bias. However, repeat visits to check the presence of each Batin Sembilan group prior to the survey were undertaken to establish their representativeness as sample groups. We have also acknowledged that the selection of only non-mixed ethnic group marriages to decrease the influence of intra-household cultural diffusion leads to results that are not representative of all households in the community—that is, mixed-ethnicity households are under-represented.

**Author Contributions:** Nayu Nuringdati Widianingsih collected and organized all the data. The analyses were conducted by Nayu Nuringdati Widianingsih and partly guided by Mariève Pouliot. All authors conceived the outline and contributed to writing the manuscript.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

**Table A1.** Summary Statistics for Income Data (USD/aeu) from the Main Income Sources in Study Site: Mean, Standard Deviation (SD), Minimum (min) and Maximum (max).

| No. | Type of Income Sources | Batin Sembilan | | | | Local Malayan | | | | Immigrant Group | | | |
|-----|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| | | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max |
| A | Natural Forest Source | 293.1 | 286.9 | 0 | 955.3 | 91.3 | 217.1 | 0 | 1752.1 | 78.4 | 202.2 | 0 | 1066.0 |
| 1 | Direct Forest Product | 238.3 | 270.6 | 0 | 955.3 | 42.3 | 106.5 | 0 | 541.0 | 28.2 | 123.8 | 0 | 968.5 |
| 2 | Forest-derived Product | 36.2 | 95.6 | 0 | 393.7 | 23.6 | 81.2 | 0 | 439.4 | 38.5 | 134.4 | 0 | 812.4 |
| 3 | Forest Wage | 18.6 | 81.2 | 0 | 388.0 | 6.3 | 37.2 | 0 | 320.3 | 0 | 0 | 0 | 0 |
| 4 | Forest Business | 0 | 0 | 0 | 0 | 19.3 | 170.8 | 0 | 1752.1 | 11.6 | 64.8 | 0 | 523.4 |
| B | Non-Natural Forest Source | 532.9 | 381.4 | 11.7 | 1535.8 | 1006.3 | 825.7 | 0 | 6875.0 | 1278.8 | 1187.0 | 0 | 8390.8 |
| 1 | Planted Forest (Rubber) | 99.7 | 169.5 | 0 | 565.9 | 298.1 | 385.6 | 0 | 2135.2 | 88.5 | 239.5 | 0 | 1336.1 |
| 2 | Plantation Wage | 37.2 | 90.6 | 0 | 404.5 | 52.4 | 157.0 | 0 | 1259.3 | 43.8 | 131.4 | 0 | 980.6 |
| 3 | Agriculture | 24.9 | 81.2 | 0 | 366.1 | 221.4 | 221.4 | −65.8 | 3114.9 | 366.3 | 520.8 | −7.8 | 2920.2 |
| 4 | Non-Forest Wage | 273.9 | 330.7 | 0 | 1191.5 | 268.8 | 339.5 | 0 | 1894.5 | 386.5 | 363.9 | 0 | 1752.1 |
| 5 | Non-Forest Business | 22.7 | 83.5 | 0 | 486.7 | 119.6 | 703.4 | 0 | 6875.0 | 322.7 | 860.5 | 0 | 5470.6 |
| 6 | Non-Forest Environmental | 29.9 | 34.3 | 0 | 151.9 | 11.5 | 30.1 | 0 | 244.6 | 5.7 | 41.7 | 0 | 449.6 |
| 7 | Livestock | 0 | 0 | 0 | 0 | 26.7 | 100.3 | 0 | 769.7 | 35.1 | 143.5 | 0 | 1341.0 |
| 8 | Others | 44.6 | 167.7 | 0 | 1039.6 | 7.8 | 24.7 | 0 | 192.8 | 30.4 | 155.1 | 0 | 1485.1 |

**Table A2.** Summary Statistics for Observed Socio-economic Characteristics: Mean, Standard Deviation (SD), Minimum (min) and Maximum (max).

| Socio-Economic Variables | Batin Sembilan | | | | Local Malayan | | | | Immigrant Group | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max |
| Age of household head | 43.9 | 13.1 | 20 | 76 | 45.1 | 13.2 | 22 | 92 | 43.9 | 11.3 | 22 | 85 |
| Family size | 5.2 | 2.3 | 2 | 11 | 4.7 | 1.8 | 1 | 10 | 3.8 | 1.1 | 1 | 6 |
| Education (year of schooling) of household head | 1.2 | 2.7 | 0 | 12 | 7.3 | 3.3 | 0 | 16 | 7.8 | 3.2 | 0 | 16 |
| Land area owned (ha/aeu) | 0.8 | 1.3 | $5 \times 10^{-4}$ | 6.3 | 1.4 | 2.6 | $5 \times 10^{-4}$ | 20.9 | 0.9 | 1.0 | $9 \times 10^{-4}$ | 5 |
| Total household asset (USD/aeu) | 287.6 | 164.3 | 55.6 | 641.2 | 795.9 | 835.3 | 1 | 3966.2 | 938.4 | 1235.7 | 7.3 | 8753.4 |
| Total value of household implement (USD/aeu) | 283.8 | 162.1 | 55.6 | 641.2 | 757.2 | 805.0 | 0 | 3960.9 | 887.1 | 1189.6 | 6.9 | 8738.8 |
| Total value of livestock (USD/aeu) | 3.7 | 6.6 | 0 | 34.8 | 38.8 | 178.0 | 0 | 1751.7 | 51.3 | 182.6 | 0 | 1746.1 |
| Total annual income (USD/aeu) | 826.0 | 364.9 | 238.3 | 1535.8 | 1097.6 | 855.8 | 74.4 | 6875.0 | 1357.2 | 1168.7 | 126.2 | 8390.8 |
| Total forest income (USD/aeu) | 293.1 | 286.9 | 0 | 955.3 | 91.3 | 217.1 | 0 | 1752.1 | 78.4 | 202.2 | 0 | 1066.0 |
| Total non-forest income (USD/aeu) | 532.9 | 381.4 | 11.7 | 1532.8 | 1006.3 | 825.7 | 0 | 6875.0 | 1278.8 | 1187.0 | 0 | 8390.8 |

**Appendix B**
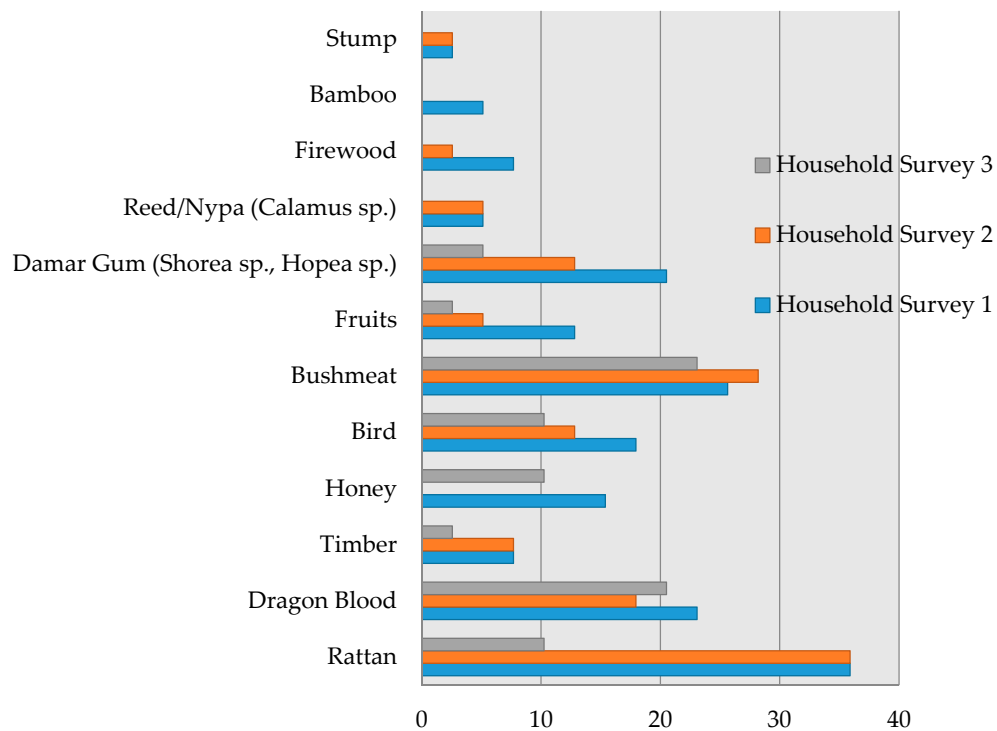


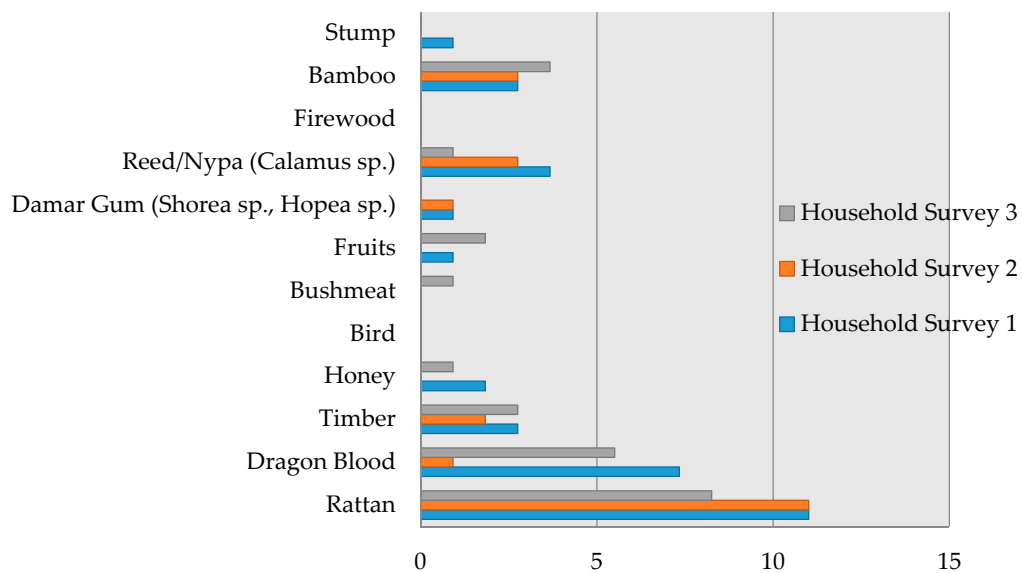**Figure B1.** Type of forest products harvested by Batin Sembilan (percent of households).



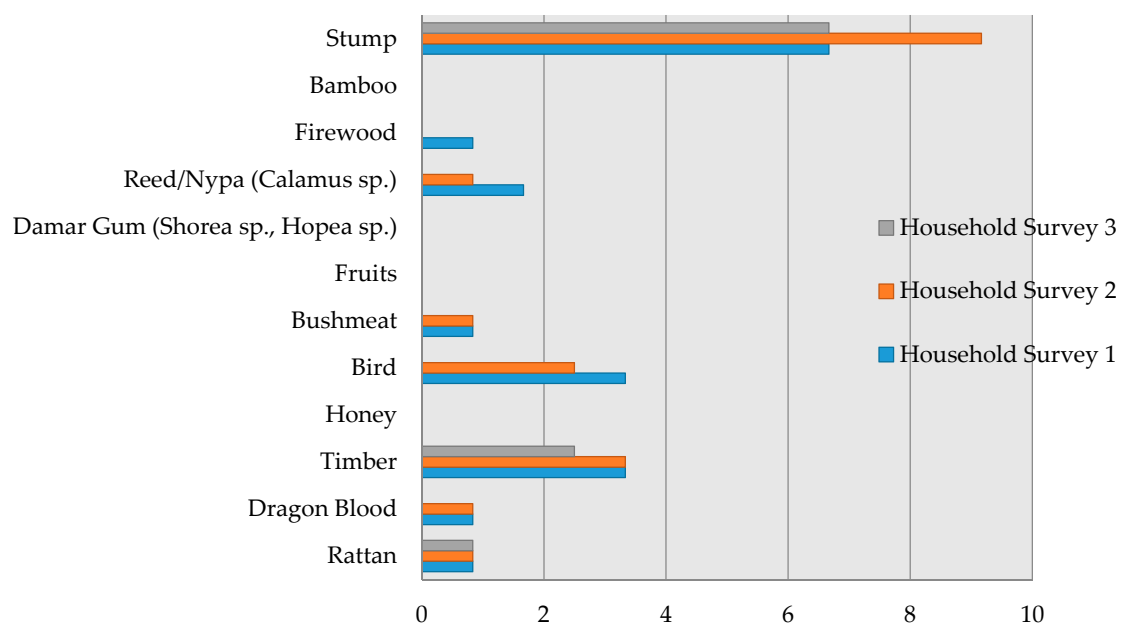**Figure B2.** Type of forest products harvested by Local Malayan (percent of households).

**Figure B3.** Type of forest products harvested by Immigrant Group (percent of households).
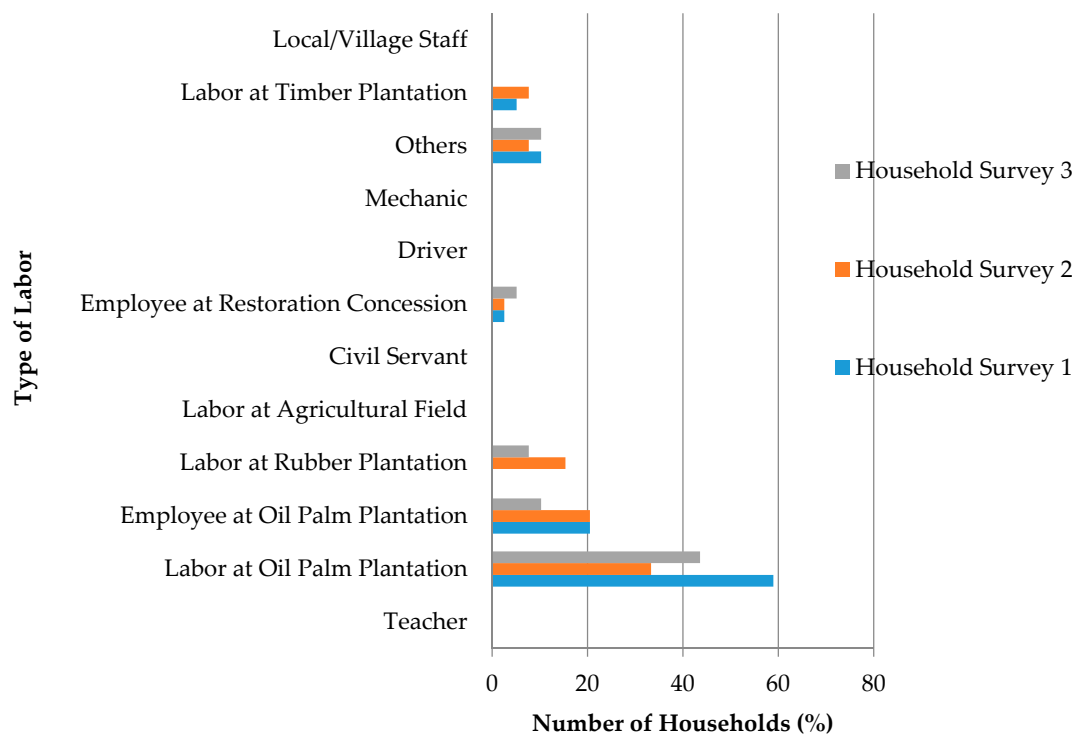
## Batin Sembilan
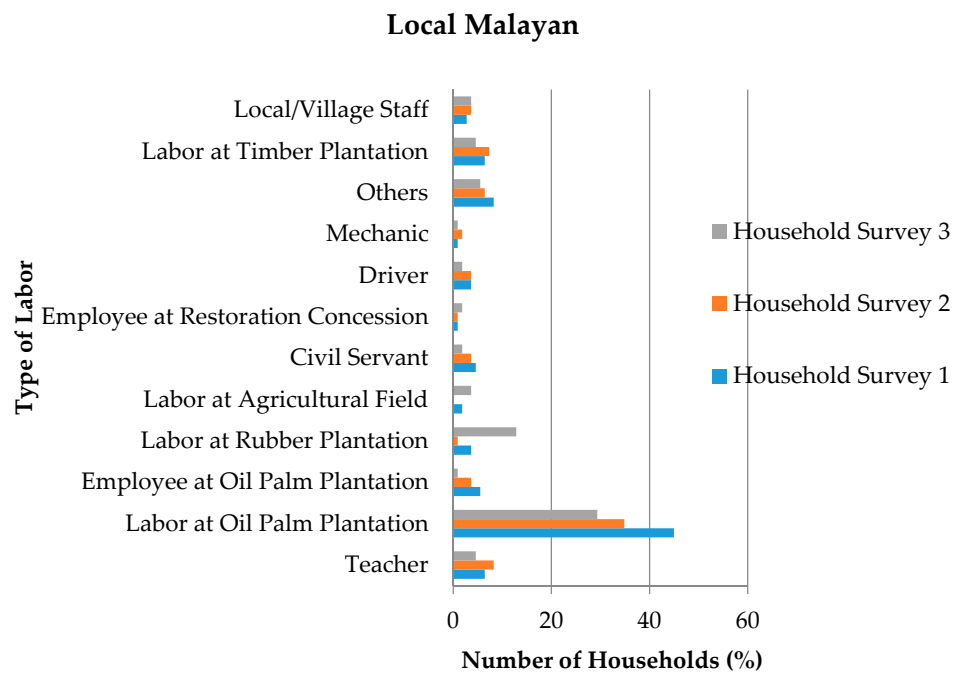


**Figure B4.** Type of employment, Batin Sembilan.

## Local Malayan



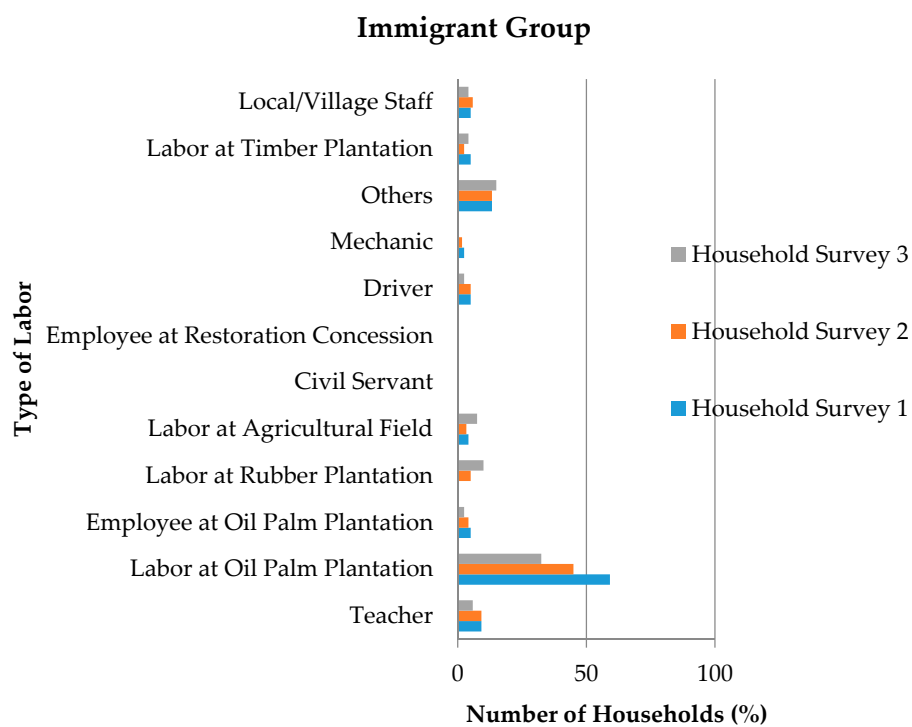**Figure B5.** Type of employment, Local Malayan.

## Immigrant Group



**Figure B6.** Type of employment, Immigrant Group.

## References

1. Vedeld, P.; Angelsen, A.; Sjaastad, E.; Berg, G.B. *Counting on the Environment: Forest Income and the Rural Poor, in Environmental Economics*; The World Bank Environment Department: Washington, DC, USA, 2004; p. 114.

2. Angelsen, A.; Jagger, P.; Babigumira, R.; Belcher, B.; Hogarth, N.J.; Bauch, S.; Börner, J.; Smith-Hall, C.; Wunder, S. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Dev.* **2014**, *64*, S12–S28. [CrossRef]

3. Angelsen, A.; Wunder, S. *Exploring the Forest–Poverty Link: Key Concepts, Issues and Research Implications*; CIFOR: Bogor, Indonesia, 2003.

4. Fisher, M. Household welfare and forest dependence in Southern Malawi. *Environ. Dev. Econ.* **2004**, *9*, 135–154. [CrossRef]

5. Cavendish, W. Quantitative methods for estimating the economic value of resource use to rural households. In *Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources*; Campbell, B., Luckert, K.M., Eds.; Earthscan: London, UK, 2002; pp. 17–65.

6. Shackleton, C.; Shackleton, S. The importance of non-timber forest products in rural livelihood security and as safety nets: A review of evidence from South Africa. *S. Afr. J. Sci.* **2004**, *100*, 658–664.

7. Belcher, B. Forest product markets, forests and poverty reduction. *Int. For. Rev.* **2005**, *7*, 82–89. [CrossRef]

8. Fisher, M.; Shively, G. Can Income Programs Reduce Tropical Forest Pressure? Income Shocks and Forest Use in Malawi. *World Dev.* **2005**, *33*, 1115–1128.

9. McSweeney, K. Natural insurance, forest access, and compounded misfortune: Forest resources in smallholder coping strategies before and after Hurricane Mitch, northeastern Honduras. *World Dev.* **2005**, *33*, 1453–1471. [CrossRef]

10. Paumgarten, F. The Role of non-timber forest products as safety-nets: A review of evidence with a focus on South Africa. *GeoJournal* **2005**, *64*, 189–197. [CrossRef]

11. Vedeld, P.; Angelsen, A.; Bojo, J.; Sjaastad, E.; Berg, G.K. Forest environmental incomes and the rural poor. *For. Policy Econ.* **2007**, *9*, 869–879. [CrossRef]

12. Sunderlin, W.D.; Dewi, S.; Puntodewo, A.; Mueller, D.; Angelsen, A.; Epprecht, M. Why Forests Are Important for Global Poverty Alleviation: A Spatial Explanation. *Ecol. Soc.* **2008**, *13*, 1–21.

13. Aronson, J.; Blignaut, J.N.; Milton, S.J.; Maitre, D.L.; Esler, K.J.; Limouzin, A.; Fontaine, C.; de Wit, M.P.; Mugido, W.; Prinsloo, P.; et al. Are Socioeconomic Benefits of Restoration Adequately Quantified? A Meta-analysis of Recent Papers (2000–2008) in Restoration Ecology and 12 Other Scientific Journals. *Restor. Ecol.* **2010**, *18*, 143–154.

14. Kaimowitz, D. The prospects for Reduced Emissions from Deforestation and Degradation (REDD) in Mesoamerica. *Int. For. Rev.* **2008**, *10*, 485–495. [CrossRef]

15. Gueze, M.; Reviriego, I.D.; Duda, R.; Fernandez-Llamazares, A.; Gallois, S.; Napitupulu, L.; Perez, P.; Pyhala, A.; Reyes-Garcia, V. *Abiocultural Approach to Conservation: What Can Conservationists Learn from Forest Use by Contemporary Indigenous Peoples?* LEK Project: Boston, MA, USA, 2015.

16. Mainusch, J. Attitudes to forestry and conservation in indonesia. In *Forests and Society–Responding to Global Drivers of Change*; IUFRO: Vienna, Austria, 2010.

17. Belcher, B.; Imang, N.; Achdiawan, R. Rattan, rubber, or oil palm: Cultural and financial considerations for farmers in Kalimantan. *Econ. Bot.* **2004**, *58*, S77–S87. [CrossRef]

18. Pfund, J.-L.; Watts, J.D.; Boissière, M.; Boucard, A.; Bullock, R.M.; Ekadinata, A.; Dewi, S.; Feintrenie, L.; Levang, P.; Rantala, S.; et al. Understanding and Integrating Local Perceptions of Trees and Forests into Incentives for Sustainable Landscape Management. *Environ. Manag.* **2011**, *48*, 334–349. [CrossRef] [PubMed]

19. Manik, Y.; Leahy, J.; Halog, A. Social life cycle assessment of palm oil biodiesel: A case study in Jambi Province of Indonesia. *Int. J. Life Cycle Assess.* **2013**, *18*, 1386–1392. [CrossRef]

20. Steinebach, S. *Der Regenwald ist enser Haus: Die Orang Rimba auf Sumatra zwischen Autonomie und Fremdbestimmung*; Universitätsverlag Göttingen: Göttingen, Germany, 2012; Volume 6.

21. Buckley, M.C.; Crone, E.E. Negative off-Site Impacts of Ecological Restoration: Understanding and Addressing the Conflict. *Conserv. Biol.* **2008**, *22*, 1118–1124. [CrossRef] [PubMed]

22. Mohammad Abdullah, A.N.; Stacey, N.; Garnett, S.T.; Myers, B. Economic dependence on mangrove forest resources for livelihoods in the Sundarbans, Bangladesh. *For. Policy Econ.* **2016**, *64*, 15–24. [CrossRef]

23. CESS-ODI. Links between forest and poverty in Indonesia. What evidence? How can targeting of poverty in and near forests be improved? In *Briefing Paper II*; CESS-ODI: London, UK, 2005.

24. Hansen, M.C.; Potapov, P.V.; Moore, R.; Hancher, M.; Turubanova, S.A.; Tyukavina, A.; Thau, D.; Stehman, S.V.; Goetz, S.J.; Loveland, T.R.; et al. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* **2013**, *342*, 850–853. [CrossRef] [PubMed]

25. Margono, B.A.; Turubanova, S.; Zhuravleva, I.; Potapov, P.; Tyukavina, A.; Baccini, A.; Goetz, C.; Hansen, M.C. Mapping and monitoring deforestation and forest degradation in Sumatra (Indonesia) using Landsat time series data sets from 1990 to 2010. *Environ. Res. Lett.* **2012**, *7*, 034010. [CrossRef]

26. Holmes, D. *Deforestation in Indonesia: A Review of the Situation in Sumatra, Kalimantan and Sulawesi*; The World Bank: Jakarta, Indonesia, 2000.

27. Holmes, D. *Where Have All the Forests Gone? Environment and Social Development East Asia and Pacific Region Discussion Paper*; The World Bank: Jakarta, Indonesia, 2000.

28. Nawir, A.A.; Murniati; Rumboko, L. *Forest Rehabilitation in Indonesia: Where to After More than Three Decades?* CIFOR: Bogor, Indonesia, 2007.

29. Uryu, Y.; Mott, C.; Foead, N.; Yulianto, K.; Budiman, A.; Takakai, F.; Purastuti, E.; Fadhli, N.; Hanato, R.; Siegert, F.; et al. *Deforestation, Forest Degradation, Biodiversity Loss and CO$_2$ Emissions in Riau, Sumatra, Indonesia*; World Wildlife Fund: Washington, DC, USA, 2008.

30. Hansen, M.C.; Stehman, S.V.; Potapov, P.V.; Loveland, T.R.; Townshend, J.R.G.; DeFries, R.S.; Pittman, K.W.; Arunarwati, B.; Stolle, F.; Steininger, M.K.; et al. Humid tropical forest clearing from 2000 to 2005 quantified by using multitemporal and multiresolution remotely sensed data. *Proc. Natl. Acad. Sci. USA* **2008**. [CrossRef] [PubMed]

31. Hauser-Schaeublin, B. *Adat and Indigeneity in Indonesia: Culture and Entitlements between Heteronomy and Self-Ascription. Vol. 7.*; Universitaetsverlag Goettingen, Goettingen Studies in Cultural Property: Göttingen, Germany, 2013.

32. Forbes, H.O. On the Kubus of Sumatra. *J. Anthropol. Inst. Great Br. Irel.* **1885**, *14*, 121–127. [CrossRef]

33. Faust, H.; Jonas, H. Conservation, REDD+ and the struggle for land in Jambi, Indonesia. *Pac. Geogr.* **2014**, *41*, 20–25.

34. Gouyon, A.; de Foresta, H.; Levang, P. Does 'jungle rubber' deserve its name? An analysis of rubber agroforestry systems in southeast Sumatra. *Agrofor. Syst.* **1993**, *22*, 181–206. [CrossRef]

35. Colchester, M.; Anderson, P.; Firdaus, A.Y.; Hasibuan, F.; Chao, S. *Human Rights Abuses and Land Conflicts in the PT Asiatic Persada Concession in Jambi. Report of an Independent Investigation into Land Disputes and Forced Evictions in a Palm Oil Estate*; Forest Peoples Programme, SawitWatch, HuMa: Bogor, Indonesia, 2011.

36. Jiwan, N. The political ecology of the Indonesian palm oil industry. In *The Palm Oil Controversy in Southeast Asia. A Transnational Perspective*; Bhattacharya, O.P.J., Ed.; Institute of Southeast Asian Studies: Singapore, 2013; pp. 48–75.

37. Klasen, S.; Meyer, K.M.; Dislich, C.; Euler, M.; Faust, H.; Gatto, M.; Hettig, E.; Melati, D.N.; Jaya, I.N.S.; Otten, F.; et al. Economic and ecological trade-offs of agricultural specialization at different spatial scales. *Ecol. Econ.* **2016**, *122*, 111–120. [CrossRef]

38. CIFOR. Poverty Environmental Network (PEN) Technical Guidelines. 2007. Version 4. Available online: http://www1.cifor.org/pen/research-tools/the-pen-technical-guidelines.html (assecced on 3 January 2014).

39. Angelsen, A.; Larsen, H.O.; Lund, J.F.; Smith-Hall, C.; Wunder, S. *Measuring Livelihoods and Environmental Dependence: Methods for Research and Fieldwork*; Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2011.

40. FAO. *FRA 2015: Terms and Definitions*; FAO: Rome, Italy, 2015.

41. OECD. *The OECD List of Social Indicators*; OECD: Paris, France, 1982.

42. Fahruk, E.; Kuncoro, I. Analisis Potensi dan Manfaat Kawasan Hutan Wisata Gunung Kelam Ditinjau dari Kontribusinya terhadap PEndapatan Masyarakat Desa Sekitarnya. *Equator* **2002**, *1*, 1–34.

43. Porro, R.; Lopez-Feldman, A.; Vela-Alvarado, J.W. Forest use and agriculture in Ucayali, Peru: Livelihood strategies, poverty and wealth in an Amazon frontier. *For. Policy Econ.* **2015**, *51*, 47–56. [CrossRef]

44. Mamo, G.; Sjaastad, E.; Vedeld, P. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *For. Policy Econ.* **2007**, *9*, 916–927. [CrossRef]

45. Kamanga, P.; Vedeld, P.; Sjaastad, E. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecol. Econ.* **2009**, *68*, 613–624. [CrossRef]

46. Illukpitiya, P.; Yanagida, J.F. Farming vs. forests: Trade-off between agriculture and the extraction of non-timber forest products. *Ecol. Econ.* **2010**, *69*, 1952–1963. [CrossRef]

47. Langat, D.K.; Maranga, E.K.; Aboud, A.A.; Cheboiwo, J.K. Role of Forest Resources to Local Livelihoods: The Case of East Mau Forest Ecosystem, Kenya. *Int. J. For. Res.* **2016**, *2016*, 4537354. [CrossRef]

48. Cavendish, W. Empirical Regularities in the Poverty-Environment Relationship of Rural Households: Evidence from Zimbabwe. *World Dev.* **2000**, *28*, 1979–2003. [CrossRef]

49. Rata, E.; Openshaw, R. (Eds.) *Public Policy and Ethnicity: The Politics of Ethnic Boundary Making*; Palgrave Macmillan: Basingstoke, UK, 2006.

50. Michaud, J.; Forsyth, T. (Eds.) *Moving Mountains: Ethnicity and Livelihoods in Highland China, Vietnam and Laos*; UBC Press: Vancouver, BC, Canada, 2011.

51. Heubach, K.; Wittig, R.; Nuppenau, E.-A.; Hahn, K. The economic importance of non-timber forest products (NTFPs) for livelihood maintenance of rural west African communities: A case study from northern Benin. *Ecol. Econ.* **2011**, *70*, 1991–2001. [CrossRef]

52. Illukpitiya, P.; Yanagida, J.F. Role of income diversification in protecting natural forests: Evidence from rural households in forest margins of Sri Lanka. *Agrofor. Syst.* **2008**, *74*, 51–62. [CrossRef]

53. Yemiru, T.; Roos, A.; Campbell, B.M.; Bohlin, F. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *Int. For. Rev.* **2010**, *12*, 66–77. [CrossRef]

54. Hogarth, N.J.; Belcher, B.; Campbell, B.; Stacey, N. The Role of Forest-Related Income in Household Economies and Rural Livelihoods in the Border-Region of Southern China. *World Dev.* **2013**, *43*, 111–123. [CrossRef]

55. Melucci, A.; Keane, J.; Mier, P. (Eds.) *Nomads of the Present: Social Movements and Individual Needs in Contemporary Society*; Hutchinson Radius: London, UK, 1989.

56. Jenkins, R. *Rethinking Ethnicity: Arguments and Explorations*; Sage: London, UK, 1997.

57. Sahlins, M. What is anthropological enlightenment? Some lessons of the twentieth century. *Ann. Rev. Anthropol.* **1999**, *28*, i–xxiii. [CrossRef]

58. Engel Merry, S. Transnational human rights and local activism: Mapping the middle. *Am. Anthropol.* **2006**, *108*, 38–51. [CrossRef]