
Forest Products and Household Incomes: Evidence from Rural Households Living in the Rainforest Margins of Central Sulawesi

Stefan Schwarze^{1*}, Björn Schippers², Robert Weber², Heiko Faust², Adhitya Wardhono¹, Manfred Zeller³, and Werner Kreisel²

¹ Institute of Rural Development, Georg-August-University, Waldweg 26, D-37073 Göttingen, Germany

² Department of Cultural and Social Geography, Institute of Geography, Georg-August University, Goldschmidtstr. 5, D-37077 Göttingen, Germany

³ Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, University of Hohenheim (490), D-70593 Stuttgart, Germany

*corresponding author: Stefan Schwarze, phone: +49-(0)551 393906, Email: s.schwarze@agr.uni-goettingen.de

Summary

Tropical forests play a key role in the world carbon cycle and in maintaining biodiversity, but agricultural activities as well as the extraction of forest products are threatening these functions. Empirical evidence from developing countries suggests that forest products play an important role as a source of income for rural households, particularly for the rural poor. There is, however, still a lack of quantitative studies on the link between poverty and forest products. The research presented in this chapter seeks to fill the gap in general knowledge on the link between poverty, livelihood systems, and extraction of forest products. Considering as an example the vicinity of the Lore-Lindu National Park (LLNP) in Central Sulawesi/Indonesia, this chapter analyses the importance of forest products, especially for the rural poor, and identifies underlying factors which drive households into the forest. Moreover, the paper investigates similarities and differences in the use of forest products in the village of Toro, where an agreement with the national park authority on the use of forest areas exists, and in the research area at large, where such agreements did not exist.

In the vicinity of the LLNP, 76% of the households collect forest products, with firewood being the most important product. The sale of forest products contributes only 7% to the total household income of all households, with 17%

Tscharnkte T, Leuschner C, Zeller M, Guhardja E, Bidin A (eds), The stability of tropical rainforest margins, linking ecological, economic and social constraints of land use and conservation, Springer Verlag Berlin 2007, pp 209-224

of the households participating in this activity. Almost three-quarters of the income from forest products originates from the sale of rattan. Differentiating forest product income by wealth groups shows the importance of forest products, especially rattan, as a source of income for the poorest households. 21% of the total household income of the poorest households originates from the selling of forest products and 30% of these households reported to have income from forest products. Participation in the sale of forest products is influenced by the wealth of the household, the area of land owned, education, ethnicity, and access to road infrastructure.

Based on participatory mapping, the area of the village of Toro is divided into six sections for which different use options are defined. In the so-called *pangale*, a 20-25 years old secondary forest, forest products can be collected for home consumption, but not for sale. Our empirical results reflect these regulations. 4 years after implementation of the village agreement, the share of households collecting forest products is significantly higher in Toro than in the research area. But, the share of households which sell their products as well as the mean sales value is much lower in Toro implying lower levels of extraction. This result is strengthened by the econometric analysis, which found that the village agreement has a strong negative influence on the likelihood of selling forest products beyond other factors.

Keywords: forest products, household income, poverty, village agreements, Central Sulawesi, econometric modelling

1 Introduction

Natural tropical forests play a key role in the world carbon cycle and in maintaining biodiversity, but agricultural activities as well as the extraction of forest products are threatening these functions. In this book, for example, the impact of human interventions on soil invertebrate fauna is investigated by Migge-Kleian et al. and on amphibian communities by Fiedler et al. Empirical evidence from developing countries suggests that forest products play an important role as a source of income for rural households. Besides timber, also non-timber forest products provide income to a large number of households in many countries (Neumann and Hirsch, 2000). In a meta-study, Vedeld et al. (2004) estimate that forest income contributes 22% to the total household income of rural households in developing countries. They conclude that even “if encumbered with substantial uncertainties and variations, the figures suggest that forest environmental incomes contribute significantly to the economic production of goods and services and to welfare levels in these societies” (Vedeld et al. 2004 p. 60). They also show that this share is much higher for poorer households than for the better-off households. There is, however, still a lack of quantitative studies on the link between poverty and forest products (Sunderlin et al. 2005). The research presented in this chapter seeks to fill the

gap in general knowledge of the role of forest products in rural livelihoods. While there have been many studies of forest products and livelihoods, the link between poverty, livelihood systems, and extraction of forest products is still poorly understood.

Considering as an example the vicinity of the Lore-Lindu National Park (LLNP) in Central Sulawesi/Indonesia, this chapter analyses the importance of forest products, especially for the rural poor, and identifies the underlying factors that drive households into the forest. Moreover, the paper investigates similarities and differences in the use of forest products in the village of Toro, where an agreement with the national park authority on the use of forest areas exists, and in the research area at large, where such agreements did not exist.

Specifically, the following research questions will be addressed: (1) Which forest products are gathered and sold? (2) How important are forest products as a source of income? (3) Do poor households differ in this respect from better-off households? (4) Which underlying factors influence participation in the sale of forest products? (5) What are the similarities and differences between the village of Toro and the research area concerning the use of forest products?

This research seeks to identify the underlying causes that drive rural household to collect forest products, and to detect so-called win-win outcomes. These are situations in which livelihood improvements are matched by gains in environmental protection. In this context, we investigate the influence of village agreements on the use of forest products which might be a possibility to conserve forests together with local communities.

Sources of data are the 2004 census of Project A1 in the village of Toro and the 2001 household survey of Project A4. During the census all 521 households living in the village of Toro have been interviewed. The Project A4 household survey interviewed 291 randomly selected households living in 12 villages in the vicinity of the Lore-Lindu National Park. Details on the sampling frame and on the selection of villages and households are described in Zeller et al. (2002). During the census and the survey the same questions concerning the use of forest products were used in the questionnaires.

2 Conceptual framework

The analysis is based on the livelihood approach, which emphasises the role of the household's resources as determinants of activities, and highlights the link between assets, activities, and incomes. Ellis (2000, p.10) defines a livelihood as consisting of "[...] the assets (natural, physical, human, financial, and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household". Although livelihood and income are not synonymous, they are nevertheless inseparably connected; income "at a given point in time is the most direct and measurable outcome of the livelihood process" (ditto).

Figure 2 illustrates the conceptual framework used in this work, which builds on the features of the livelihood approach.

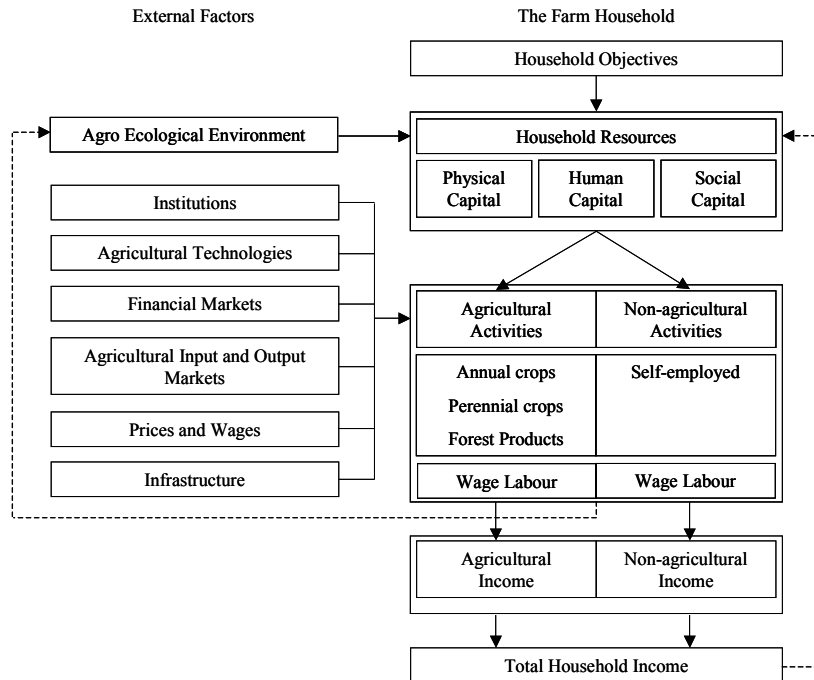


Fig. 1. Conceptual framework

According to its objectives, the household allocates its resources to activities, such as the collection of forest products, subject to factors which are external to the household (Figure 2). The collection of forest products generates outcome which will meet the objectives and which has an effect on the stock of resources available to the household as well as on the availability of forest products in the future. External determinants of the decision to collect forest products are the agro-ecological and socio-economic environment.

3 Hypothesis

An integral part of this study is the analysis of the link between poverty and the collection of forest products. As in Vedeld et al. (2004), we expect that the share of households collecting forest products as well as the share in total

household income is higher for the poorest households than for the better-off households.

As outlined in the conceptual framework, the household's capital endowment plays an important role in activity choice. We include the mayor physical assets needed for crop and livestock production into the econometric analysis, and expect that they have a negative impact on the selling of forest products, because they compete for family labour. Education is expected to have a negative influence because better-educated people have access to a wider range of income possibilities. For the research area, Schwarze et al. (2005) showed that better-off households have better access to non-agricultural income activities than poorer households.

Among the external factors conditioning household decisions, we include the ethnicity of the head of the household, the access to credit, and the access to road infrastructure into the econometric analysis. The influence of ethnicity highly depends on context. Non-indigenous groups may have no access to forest products in some area, whereas in others they may be restricted from other activities and may therefore be pushed into forest activities. In the research area, non-indigenous ethnic groups are particularly involved in perennial crop production and non-agricultural activities (Schwarze 2004), and do not need to get involved in the collection of forest products. As Vedeld et al. (2004) point out, an important role of forest income in rural livelihoods is to overcome unexpected reductions in income or cash needs. Access to credit can play the same role and, thus, we expect that access to credit has a negative influence on the selling of forest products. The influence of access to road infrastructure cannot be hypothesised a priori. Forest products are often associated with remote areas lacking road access, but road infrastructure is important for the marketing of forest products. It is nevertheless difficult to distinguish the effect of the distance to roads from other spatially fixed effects. To control for these effects, we include location dummies, which are equivalent to the four sub districts in the research area.

4 Measurement of income

Income measures both cash and in-kind contributions, where the cash-earning component consists of crop, livestock, and forest product sales, wages, rents etc. The consumption of own-farm products (crops and livestock) is taken into account in the in-kind contributions component. All the goods produced are valued at market producer prices regardless of their use. So all own-farm products are valued at the same price as if they were being sold. Cash outgoings incurred by the household in its production are subtracted from the gross-contribution to the material standard valued at market prices (Ellis, 2000).

In collaboration with village authorities and researchers working on forest gardens, we compiled a list of 30 forest products which can be collected in the

forest including hunting of animals. Firewood, which is mainly deadwood, is not traded locally and, thus, no market prices exist. A valuation using surrogate prices for alternative fuels, like for example kerosene, is not appropriate, because in large parts of the research area such alternatives are not available. A valuation might have been possible based on opportunity costs of time, which is, however, very data demanding. Information on who is collecting firewood, the time needed, and a measure of the value of time is required, but very intricate to collect. Due to these problems in valuing firewood, we decided to focus our analysis on the sale of forest products, which is much more relevant with respect to the LLNP. The main forest product sold is rattan, which is collected inside the park threatening its integrity. Rattan collectors are often the first people encroaching an area paving the way for others. All the other forest products, like firewood, are mainly collected at agro forestry plots or at the forest margin, but not further inside the national park. Income from forest products refers to the value of products sold in the last twelve months.

5 Measurement of poverty

As a measure of wealth we applied the poverty assessment tool as described in Zeller et al. (2005), which employs principal component analysis to select and eventually aggregate various indicators of poverty into a (0,1) normally distributed poverty index. It increases with wealth and measures the medium term relative welfare of households. Unlike the commonly used absolute measures of poverty such as a monetary poverty line, this method takes also into account other dimensions of poverty, such as education, food consumption and the condition of the dwelling. Details of this method are reported in Henry et al. (2001). The poverty index was estimated for each of the sample households (Abu Shaban 2001). It is computed from three asset-related indicators, four dwelling indicators, and two consumption indicators (Table 1). The poverty groups are the terciles of the poverty index: poorest (poverty group 1), poor (poverty group 2), and less-poor households (poverty group 3).

6 Econometric issues

Participation in the sale of forest products is measured by a binary variable, which is zero if the household does not sell any forest products. The binary variable takes on the value one if the household sells forest products. We are interested in how the vector of explanatory variables influences the possibility that the binary dependent variable takes on the value 1. The binary response Probit model is estimated by Maximum Likelihood Estimation (MLE) using the computer package Stata 8.2. Similar models have been widely used in the

Table 1. Indicators used for calculating the poverty index.

Asset-based indicators
- Total value of electronic appliances
- Value of transport assets
- Number of televisions owned
Dwelling-related indicators
- Access to electricity
- Type of wall
- Type of roof
- Type of floor
Consumption indicators
- per capita expenditures on clothes and footwear
- share of income spent on food out of a hypothetical increase in income of IDR 20,000 per week

Source: Abu Shaban (2001)

literature in similar settings by, for example, Corral and Reardon (2001) and Lanjouw et al. (2001).

A Probit model is estimated for the research area to identify factors influencing the households' decision to sell forest products. In addition, a second Probit model has been estimated to evaluate the influence of the village agreement on the sale of forest products beyond other factors. Therefore a random sample of 291 households from the village census in Toro has been drawn and merged with the data from the research area at large. The regression model includes variables from the first Probit model as well as a dummy variable indicating whether the household lives in a village with conservation agreement or not.

7 Collection and sale of forest products

In the vicinity of the LLNP, 76% of the households collect forest products. Apart from firewood, which is gathered by 72% of the households, they collect wood for construction, rattan, bamboo and the juice of the sugar palm. Except for rattan all of the products are collected at agro forestry plots or at the forest margin. Rattan collectors have to leave their villages for days or even weeks because rattan is only found farther inside the forest. They drag the rattan to rivers and streams and float it downstream to roadside access points, from where it is brought to the district capital of Palu on trucks. None of the

households reported to gather or hunt animal products. Firewood and bamboo is collected for home consumption only, whereas rattan is mainly collected for selling. 17% of the households collect rattan and 12% also reported to sell it (Figure 7).

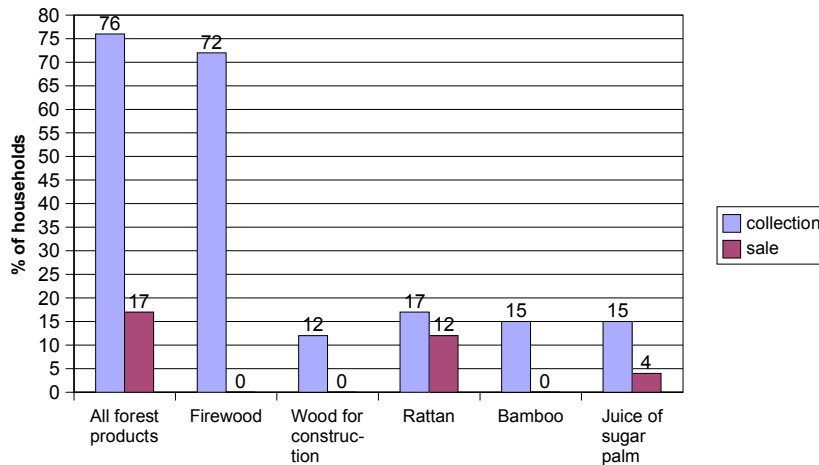


Fig. 2. Collection and sale of forest products. Source: STORMA project A4 household survey; Number of observations = 290

Overall, 17% of all households sell forest products, which accounts for 7% of the total household income (Table 2). Differentiating the forest income by product reveals the importance of rattan. Almost three-quarters of the income from forest products originates from the sale of rattan. The selling of the juice of the sugar palm accounts for 20% of the income from forest products and the remainder from selling wood for construction (Figure 3).

The analysis so far referred to all households, but how does this change if we look at different wealth groups? Table 2 shows the importance of forest products as a source of income for the poorest households. 21% of the total household income of the poorest households originates from the selling of forest products and 30% of these households reported to have income from forest products. The share of households selling forest products and the contribution to the total household income decreases with increasing wealth. Among the less-poor households only 4% collect forest products contributing to just 1% of their total household income.

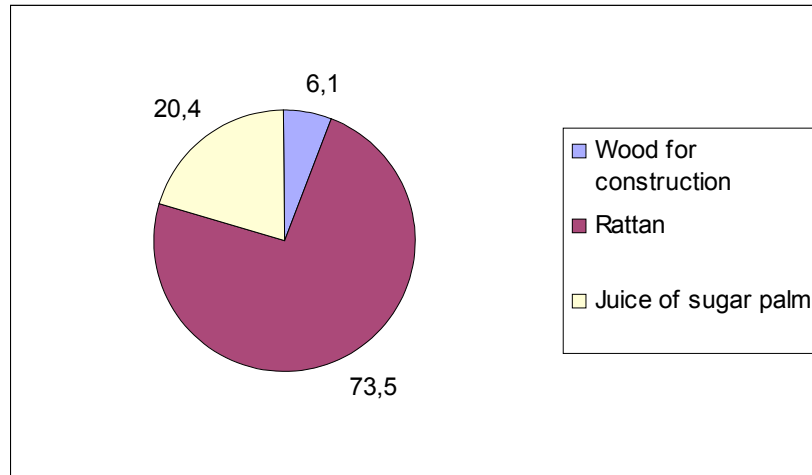


Fig. 3. Income from forest by product. Source: STORMA project A4 household survey; Number of observations = 290

Table 2. Income gained from forest products by poverty group.

	All households	Poverty-group 1 (very poor)	Poverty-group 2 (poor)	Poverty-group 3 (less poor)
Households selling forest products (%)	17	30	14	4
Share in total household income (%)	7	21	7	1

Source: STORMA project A4 household survey
 Number of observations=291

8 Results of the econometric analysis

Table 3 presents a description and summary statistics of the regressors used in the econometric analysis of participation in the selling of forest products.

Table 4 presents the estimated coefficients as well as their standard errors of the Probit model, with coefficients with a significance level greater than 90% in bold. Participation in the sale of forest products is significantly influenced by the poverty index, the area of land owned, the education level, ethnicity, and the access to road infrastructure. As expected, the poverty index has a negative influence on the probability of selling forest products. This means that with increasing wealth it is less likely that households are involved in the selling of forest products. An additional hectare of irrigated land owned decreases the likelihood of participation in the sale of forest products by 12%,

Table 3. Descriptions and summary statistics of the variables used in the econometric analysis of participation in the selling of forest products.

Variable	Mean	Standard deviation	Minimum	Maximum
Irrigated area owned (ha)	0.32	0.54	0	4.52
Rainfed area owned (ha)	1.34	1.67	0	10.50
Poverty index	-0.06	1.01	-1.84	3.48
Livestock units owned	0.58	0.91	0	6.36
Number of adult household members	3.42	1.63	1	8
Highest level of schooling of the adult household members				
not finished primary school	0.05	0.21	0	1
finished secondary school	0.29	0.45	0	1
finished tertiary school	0.27	0.44	0	1
Ethnicity of head of household (1=non-indigenous)	0.19	0.39	0	1.00
Access to credit (1=yes)	0.89	0.32	0	1.00
Walking distance house - road (hours)	1.43	3.62	0	13.00
Sub district dummies				
Sub district dummy for Palolo	0.22	0.42	0	1.00
Sub district dummy for Sigi-Biromaru	0.36	0.48	0	1.00
Sub district dummy for Kulawi	0.23	0.43	0	1.00

Source: STORMA project A4 household survey
 Number of observations=291

since the production of rice is very labour intensive. In contrast, the area of rainfed land owned has a positive influence on the selling of forest products. This pattern may be caused by a risk response to ensure livelihoods of households. While rainfed crop production exhibits high fluctuations in yields, irrigated crops provide a more stable income per hectare. Hence, households may be forced to extract forest products. Indeed Keil (2004) shows that households choose the sale of rattan as a coping strategy in response to drought.

The probability of participation in the selling of forest products increases by more than 18% when none of the adult household members finished primary school compared to households in which the highest level of schooling of the adult household members is primary school. Belonging to a non-indigenous ethnic group decreases the probability of participation in the sale of forest products by 9%. Every hour of increased distance to the road decreases the probability of participation by almost 3%.

9 Comparing the village of Toro with the research area

In the village of Toro regulations concerning the use of forest products, such as wood, bamboo, and rattan, have existed since generations. This set of tra-

Table 4. Probit results for participation in the selling of forest products

Regressors	Coefficient	Std. error
Irrigated area owned (ha)	-12.40	0.067
Rainfed area owned (ha)	3.31	0.013
Poverty index	-10.20	0.032
Livestock units owned	1.52	0.021
Number of adult household members	0.24	0.011
Highest level of schooling of the adult household members		
not finished primary school^a	18.11	0.139
Finished secondary school ^a	-2.77	0.043
Finished tertiary school ^a	-5.18	0.069
Ethnicity of head of household (1=non-indigenous)	-8.68	0.069
Household has access to credit (1=yes)	-0.77	0.054
Walking distance house - road (hours)	-2.52	0.006
Sub district dummy for Palolo ^b	-5.01	0.056
Sub district dummy for Sigi-Biromaru ^b	-6.69	0.044
Sub district dummy for Kulawi^b	14.82	0.076
Pseudo R ²	0.25	
% correctly predicted	83	

Source: STORMA project A4 household survey

Number of observations=291

Notes: The coefficients in the table are the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. Coefficients with a significance level greater than 90% are in bold.

^a In contrast to finished primary school.

^b In contrast to the sub district of Lore Utara.

ditional rules is part of the local traditions (*adat*), and forms the foundation of the Community Conservation Agreement with the national park authority. Based on participatory mapping, the area of the village is divided into six sections for which different use options are defined. There is an area for settlement and for agricultural production, but also forest land is defined, where access is prohibited. In another part of the forest, the so-called *pangale*, a 20-25 years old secondary forest, forest products can be collected when the *adat council* and the village headman have given permission. The collection of forest products is only allowed for home consumption, not for sale. The *adat council* is monitoring compliance with regulations and sanctioning offences. We expect that in Toro the selling of forest products is lower compared to the research area because of the village agreement.

4 years after implementation, the share of households collecting forest products is significantly higher in Toro than in the research area. In Toro, 93% of the households reported to collect products in the forest, whereas in the research area the share is 76%. However, the share of households that sell

their products is much lower in Toro. Whereas 17% of all households in the research area sell forest products, this share is only 11% in Toro. Moreover, the mean income gained from the selling of forest products is significantly lower in Toro than in the research area (Table 5).

Table 5. Income and participation in the research area and in the village of Toro

	Research area	Toro	z-value
Households collecting forest products (%)	76	93	-6.796***
Households selling forest products (%)	17	11	-3.168***
Mean income gained from selling conditional on selling (1000 IDR)	2384	489	-5.284***
Mean income gained from selling (1000 IDR)	309	51	-2.466**

** Mann-Whitney test significant at the 5% level of error probability.

*** Mann-Whitney test significant at the 1% level of error probability.

Source: Census of Project A1 and Project A4 household survey

From the descriptive analysis we can conclude that there is a difference in the sale of forest products between the research area at large and the village of Toro. We can, however, not deduct that the village agreement has caused the difference in behaviour. There might be other influencing factors. Because of a lack of data from before the village agreement, we conduct a regression analysis which controls for all other variables influencing the use of forest products. Both datasets have been merged and Table 6 presents a description and summary statistics of the regressors used in the econometric analysis of the influence of village agreements on participation in the selling of forest products. The regressors used are the same except for access to credit and access to road infrastructure because no data was available from the village of Toro.

Table 7 presents the estimated coefficients as well as their standard errors of the Probit model with coefficients with a significance level greater than 90% in bold. Participation in the sale of forest products is significantly influenced by the poverty index, the area of irrigated land owned, and ethnicity. All of these variables show the same signs as in chapter 9 referring to the research area at large. The dummy variable measuring the influence of the village agreement is also significant. The village agreement decreases the likelihood of participation in the sale of forest products by 11.5%.

10 Conclusions

Forest products, which are mainly collected inside the LLNP, are particularly important for the poorest third of the households. They contribute to 21% of

Table 6. Descriptions and summary statistics of the variables used in the econometric analysis of the influence of village agreements on participation in the selling of forest products

Variable	Mean	Std. dev.	Min.	Max.
Irrigated area owned (ha)	0.32	0.54	0	4.52
Rainfed area owned (ha)	1.34	1.67	0	10.50
Poverty index	-0.06	1.01	-1.84	3.48
Livestock units owned	0.58	0.91	0	6.36
Number of adult household members	3.42	1.63	1	8
Highest level of schooling of the adult household members				
not finished primary school	0.05	0.21	0	1
finished secondary school	0.29	0.45	0	1
finished tertiary school	0.27	0.44	0	1
Ethnicity of head of household (1=non-indigenous)	0.19	0.39	0	1.00
Access to credit (1=yes)	0.89	0.32	0	1.00
Walking distance house - road (hours)	1.43	3.62	0	13.00
Sub district dummies				
Sub district dummy for Palolo	0.22	0.42	0	1.00
Sub district dummy for Sigi-Biromaru	0.36	0.48	0	1.00
Sub district dummy for Kulawi	0.23	0.43	0	1.00

Source: STORMA project A4 household survey
Number of observations=582

their total household income. So any improvements in law enforcement concerning the collection of forest products within the national park will hit the poorest households hardest. Moreover, they are already the most constrained in terms of income generation as well as the most vulnerable concerning malnutrition and hunger. Our econometric analysis reveals possibilities to reduce the collection of forest products and, at the same time, improve the livelihood of the poorest households. Improving the access to primary education for the poor reduces the likelihood that they sell forest products and also improves their possibilities to find other sources of income. Another policy option is to foster the construction and improvement of irrigated rice fields, which are then cultivated by the poorest households. The labour demanding cultivation of irrigated rice reduces the time left to go into the forest. The harvested rice can improve the nutrition status of the family or can be sold on the market to gain additional income.

The distance to the tarmac road also has a negative influence on the likelihood that households sell forest products. This result strongly suggests to rethink the proposed road extension plans. In the political discussion, there are still plans to build new roads inside the national park, linking, for example the sub district of Lore Utara with Lore Selatan (ANZDEC, 1997). Alternative routes, which are further away from the national park but more costly (ANZDEC, 1997), are better suited to protect the integrity of the LLNP.

Table 7. Probit results for the influence of village agreements on participation in the selling of forest products

Regressors	Coeff.	std.error
Irrigated area owned (ha)	-12.17	0.039
Rainfed area owned (ha)	1.60	0.007
Poverty index	-5.58	0.017
Livestock units owned	-1.54	0.017
Number of adult household members	-0.19	0.009
Highest level of schooling of the adult household members not finished primary school ^a	3.27	0.064
Finished secondary school^a	-5.59	0.027
Finished tertiary school ^a	-3.39	0.032
Ethnicity of head of household (1=non-indigenous)	-7.37	0.023
Village agreement (1=yes)?	-11.52	0.026
Sub district dummy for Palolo ^b	-4.31	0.040
Sub district dummy for Sigi-Biromaru^b	-8.36	0.028
Sub district dummy for Kulawi ^b	2.02	0.042
Pseudo R ²	0.20	
% correctly predicted	85	

Source: Census of Project A1 and Project A4 household survey

Number of observations=582

Notes: The coefficients in the table are the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. Coefficients with a significance level greater than 90% are in bold.

^a In contrast to finished primary school.

^b In contrast to the sub district of Lore Utara.

The analysis also suggests that community agreements have an impact on the use of forest products. According to the agreement, the collection of forest products is only allowed for home consumption, not for sale. Our empirical results reflect these regulations. In the village with a community agreement the share of households collecting forest products is higher than in the research area, but less households sell the products. Hence, the use of forest products is mainly for home consumption and less for commercial use implying lower levels of extraction. This result is strengthened by the econometric analysis, which found that the village agreement has a strong negative influence on the likelihood of selling forest products beyond other factors. This outcome is even more striking when we consider that the village is located right close to the forest and rattan can still be found in the surroundings of the village. Our results suggest that community conservation agreements are a promising way to protect the integrity of the park. The outcome of such regulations,

however, always depends on the support of the local leaders as well as on the acceptance of the population.

References

- Abu Shaban A (2001) Rural poverty and poverty outreach of Social Safety Net programs in Central Sulawesi – Indonesia. MSc-Thesis, Institute of Rural Development, Georg-August University, Göttingen
- ANZDEC (1997) Report on the Central Sulawesi Integrated Area Development and Conservation Project. Central Sulawesi Integrated Area Development and Conservation Project, Palu
- Corral L, Reardon, T (2001) Rural nonfarm incomes in Nicaragua. *World Development* 29: 427-442
- Ellis, F (2000) *Rural livelihoods and diversity in developing countries*. Oxford University Press, Oxford
- Henry, C, Sharma, M, Lapenu, C, Zeller M (2001) Assessing the relative poverty of microfinance clients: A CGAP operational tool. The Consultative Group to Assist the Poor (CGAP), The World Bank, Washington D. C.
- Keil, A (2004) The socio-economic impact of ENSO-related droughts on farm households in Central Sulawesi, Indonesia. Shaker, Aachen.
- Lanjouw, P, Quizon, J, Sparrow, R (2001) Non-agricultural earnings in peri-urban areas of Tanzania: Evidence from household survey data', *Food Policy* 26: 385-403
- Neumann, RP, Hirsch, E (2000) Commercialisation of non-timber forest products: Review and analysis of research. Center for International Forestry Research, Bogor, FAO, Rome
- Schwarze, S, Zeller, M (2005) Income diversification of rural households in Central Sulawesi, Indonesia. *Quarterly Journal of International Agriculture* 44: 61-73
- Schwarze, S (2004) Determinants of income generating activities of rural households: a quantitative study in the vicinity of the Lore Lindu National Park in Central Sulawesi/Indonesia. Doctoral thesis, Institute of Rural Development, Georg-August University, Goettingen
<http://webdoc.sub.gwdg.de/diss/2004/schwarze/schwarze.pdf>
- Sunderlin, WD, Angelsen, A, Belcher, B, Burgers, P, Nasi, R, Santoso, L, Wunder, S (2005) Livelihoods, forests, and conservation: An overview. *World Development* 33: 1383-1402
- Vedeld, P, Angelsen, A, Sjaastad, E, Berg, GK (2004) Counting on the environment: Forest incomes and the rural poor. Environment Department Papers No. 98. The World Bank, Washington DC
- Zeller, M, Sharma, M, Henry, C, Lepenu, C (2006) An operational method for assessing the poverty outreach of development policies and projects:

Results of case studies in Africa, Asia, and Latin America. *World Development* 34: 446-464.

Zeller, M, Schwarze, S, van Rheenen, T (2002) Statistical sampling frame and methods used for the selection of villages and households in the scope of the research programme on Stability of Rainforest Margins in Indonesia (STORMA). STORMA Discussion Paper Series No. 1, Georg-August University, University of Kassel, Institut Pertanian Bogor, Universitas Tadulako, Bogor.