Differential Influence of Relative Poverty on Preferences for Ecosystem Services: Evidence from Rural Indonesia

Klaus Glenk[§], Jan Barkmann[§], Stefan Schwarze[§], Manfred Zeller[$] and Rainer Marggraf[§]

[§] University of Goettingen, Goettingen, Germany

[$] University of Hohenheim, Stuttgart, Germany

Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

1. Introduction

Are environmental goods luxury goods? From a rural development perspective, a generally affirmative answer to this question appears highly unlikely. Most peasants in developing countries rely directly on environmental goods for subsistence agriculture or small-scale production of cash crops. The poorer they are, the more they are vulnerable to a degradation of the resource base – and hence, income elasticities below one are expected. On the other hand, local species diversity with only limited direct resource use may display luxury goods characteristics. In this paper, we present data from two surveys in twelve rural villages in the Lore Lindu National Park Area (Central Sulawesi, Indonesia). We document differential influences of poverty as measured by a relative poverty index on the demand of a range of ecosystem services expressed by the marginal willingness to pay (MWTP) for these services.

2. Methods

2.1 Study area

The research region is located within the humid tropics about 1 degree south of the equator. It comprises 7 administrative districts in the Indonesian province of Central Sulawesi. In more than 115 villages, it holds a population of about 130.000 – mainly smallholder farmers on 7.220 km^2. Centred within the study region, the Lore Lindu National Park covers some 2.200 km^2 of mainly mountainous rainforest. A large number of species endemic to Sulawesi, including, for example the mammal anoa (*Bupalus sp.*), can be found in the National Park area, which is one of few large forest areas left on Sulawesi.

2.2 'Poverty' elasticity of Willingness to pay (WTP)

In order to assess differential influences of individuals with different welfare on the demand for goods, income is commonly used to derive elasticities of demand. Depending on the sign and magnitude of the elasticities, different types of goods are defined. We distinguish four (only partly exclusive!) types of goods. Normal goods have a positive elasticity of demand; inferior goods have a negative elasticity of demand; luxury goods have elasticity greater than one, whereas necessities are defined to have elasticity below one.

Measuring incomes of rural households in semi-subsistence economies poses many challenges concerning data collection and data analysis. Income surveys are in general time-consuming and costly because of the length of the interviews and the high demands with respect to human capital (enumerators, data analysis). Also, incomes of rural households tend to fluctuate highly between the years. Furthermore, income neither captures the multiple dimensions of welfare nor of poverty. Thus, we applied a simple, low-cost poverty assessment tool to estimate the medium term relative welfare of households (Zeller et al. 2006). Principal component analysis is employed to select and eventually aggregate various indicators of poverty into a (0,1) normally distributed variable which increases with wealth. Details of this method are reported in Henry et al. (2003). The poverty index was estimated for each of the sample households using three asset related indicators, four dwelling indicators, and two consumption indicators in 2001 (Abu Shaban 2001). We recalculated the index in 2005 using the same indicators and weights as in 2001. The poverty groups are the terciles of the poverty index. Because the index contains negative values we transformed the index by using its cumulative density function (CDF) which yields values for the poverty index between zero (the poorest) and one (the less-poor).

Demand for ecosystem services is expressed by MWTP. For the range of services described above, MWTP values were obtained from Multinominal Logit (MNL) results of the choice experiment as described below. By using the positive cumulative density function values of the poverty index, the effect of a (percentage) change in the quantity demanded on a percentage change of relative poverty was assessed. Hence, rather than deriving estimates of income elasticity of WTP, we observed what can be called "poverty elasticity" of WTP.

MNL models were calculated for each of the poverty groups as well as for the total sample. Using the parameter estimates for the attributes, mean MWTP and 90% confidence intervals around the mean were derived using a Krinsky and Robb (1986) procedure with 1000 random draws. Differences were calculated between three point estimates for demand expressed as the marginal willingness to pay of the three poverty groups. We stress again that we use a terminology that is usually applied to denote *income effects* on demand to describe *poverty effects* on demand.

The information about "poverty" elasticity of WTP can be useful for distributional reasons. If poverty elasticities of WTP are below zero, improving a service is relatively more beneficial to the poor in comparison to the less poor (Kriström and Riera 1996).

2.3 The Choice Experiment

In a choice experiment, respondents choose from alternatives or different 'goods' that alternative with the highest (expected) utility. In an environmental context, the alternatives usually consist of a number of "proposed changes" and a "status quo option". In our case the choice set presented to the respondent consists of two different management alternatives for the Lore Lindu area and the present situation. These 'goods' are characterized by a number of attributes. The attributes, in turn, are represented by quantitative or qualitative levels that the 'goods' take. Within and between the choice sets presented to the respondent the attribute levels and thus the goods or commodities vary according to an experimental design. Attributes and interactions of attributes with socioeconomic variables form the arguments of a linear and additive expression of the (indirect) utility function; the respective utility coefficients can be calculated by employing maximum likelihood estimation procedures, e.g. the MNL model. MWTP is calculated by dividing the environmental attribute's coefficient by the 'cost' attribute coefficient.

Selection of attributes and attribute levels were guided by an ecosystem service approach (Barkmann et al. *subm*), and facilitated by information gathered in individual and peer-group interviews in various villages of the Lore Lindu area. Additional information and data was obtained from scientists working in the region and from literature (e.g. Belsky and Siebert 2002; Keil 2004; Siebert 2003). We used 4 attributes: water for irrigation of wetland rice (number of months/yr with water scarcity); rattan availability in the forest (distance to rattan harvesting location); ways of cocoa cultivation (preponderance of cocoa plantations in the village along a shade tree gradient); population size of anoa (number of individuals). Bundles of these attributes were framed as a government development program. An additional 'cost' attribute was double split-sampled: (i) a rise in "house and land" tax *versus* a donation to a village fund affecting every household of the research region; (ii) a monthly *versus* a yearly payment scheme. For simplicity reasons, the attributes/ ecosystem services are denoted by 'water', 'rattan', 'cocoa', 'anoa' and 'cost'.

For the main-effects experimental design, an orthogonal fraction of 16 out of the 4^5 possible combinations of attribute levels was selected (Louviere et al. 2001), and combined into choice scenarios that consisted of two (generic) alternatives A and B and a *status-quo* option presented on choice cards. The choice sets of the experimental design were blocked into 4 versions so that each respondent faced 4 choices. In order to account for the heterogeneous environmental conditions of the research region, the status quo was offered as a self-explicated alternative for all attributes except anoa (regional average).

2.4 Expectations

We expected rattan to be an *inferior* environmental good (MWTP increases with higher poverty), and (ii) anoa is a *luxury* good (MWTP falls sharply with poverty). Water and cocoa were expected to behave as *necessity* goods (no clear effects of poverty but no luxury goods).

2.5 Data collection

The choice experiment survey was administered in-person to 249 randomly selected households in 12 villages of the research region from December-March 2004/05. Data for the calculation of the poverty index was collected from March-June 2004 in the same households using standardised, formal questionnaires. Details on the sampling procedure are given in Zeller et al. (2002).

3. Results

For the total sample, the MNL model was highly significant at the 99% level (χ^2 = 597.4, d.f. = 7). The overall model fit of this base model was assessed by the value of adjusted ρ^2 (Pseudo-R^2) over a model with no coefficients, which was 0.293. ρ^2 values between 0.3 and 0.4 correspond to R^2 values of 0.6 to 0.8 as in OLS regression models and indicate a good fit (Hensher et al. 2005).

Hausman-McFadden (1984) tests were performed to test for violations of the Independence of Irrelevant Alternatives (IIA) assumption that is implicit in MNL models. The results were somehow inconclusive as violations were found for dropping one alternative. However, the assumption could not be rejected when dropping the other two alternatives. Inclusive value parameters for branches of various nestings in nested logit (NL) models were not found to be significantly different from one, suggesting that the NL model can be collapsed to a MNL model (Louviere et al. 2001).

Table 1: MNL model results

Constant (ASC)	0.2111 (1.401)
Rattan	-0.0278** (-3.126)
Rattan*Collection	-0.0973*** (-3.375)
Water for irrigation of wetland rice	-0.5074*** (-7.228)
Water*Paddy Involvement	-0.7130*** (-7.044)
Cocoa (Shade)	-0.0101*** (-5.677)
Anoa	0.0012*** (3.537)
Tax rise/ donation to a village fund	-0.0259*** (-8.357)
Log-likelihood	-710.1272
Number of observations	996
Adjusted ρ^2 (Pseudo-R^2)	29.3 %

t-statistics in parentheses; significancies: ***p < 0.001; ** p < 0.01

All attribute coefficients are significant and have the expected sign. I.e., disutility was observed for more months with water scarcity, with a greater distance to rattan harvesting locations, and with paying tax or donating to a village fund. A utility gain was observed for bigger population sizes of the endemic dwarf buffalo anoa. The results concerning cocoa indicate higher preferences for less shade in cocoa (Tab. 1).

The sub-models of the three poverty groups are overall significantly different from zero at the 99% level. Model fit for the three models is quite good with values of pseudo-R^2 between 0.252 and 0.332. The MWTP for the three poverty groups and elasticities for moving from the poorest to the poor, as well as from the poor to the less poor, are listed in table 2.

Table 2: MWTP and elasticities

Attribute	**Poverty group**[a]	**Mean total MWTP (IDR**[b]**)**	**attributed to usage**	**Poverty elasticity**
Rattan	Poorest (1)	1,540 (1,219)[$]	1,540	0.244 (1 – 2)
	Poor (2)	2,069	0	-0.812 (2 – 3)
	Less poor (3)	1,278	0	
Water	Poorest (1)	33,518	14,650	0.257 (1 – 2)
	Poor (2)	45,680	23,233	-0.421 (2 – 3)
	Less poor (3)	36,634	15,467	
Cocoa	Poorest (1)	181	181	0.902 (1 – 2)
	Poor (2)	409	409	1.030 (2 – 3)
	Less poor (3)	607	607	
Anoa	Poorest (1)	70	n.a.	-0.497 (1 – 2)
	Poor (2)	21[§]	n.a.	3.342 (2 – 3)
	Less poor (3)	54	n.a.	

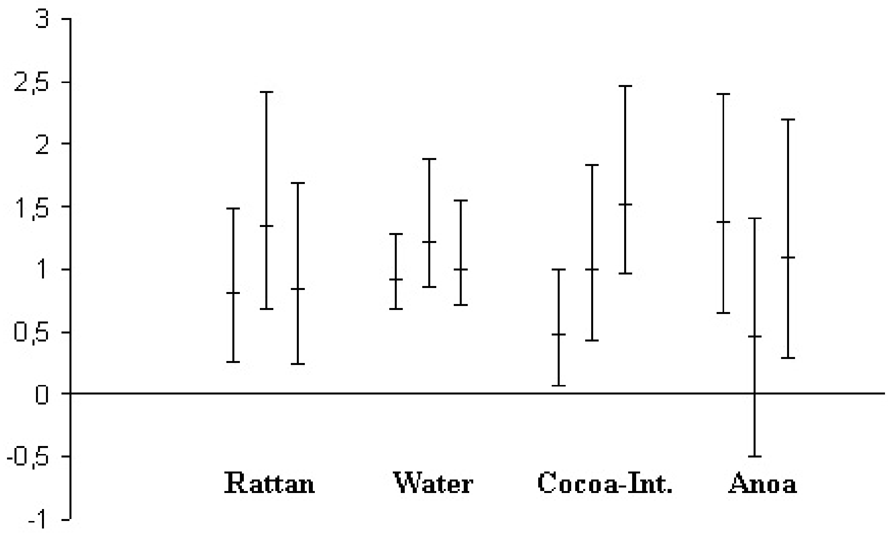
[a] mean CDF for poverty groups: (1): 0.218; (2): 0.525; (3): 0.772; [b] 1 US $ ~ 9000 IDR (October 2004); [$] non-usage component not significantly different from zero; [§] not significant from zero

90% confidence intervals of the MWTP values overlapped for all attributes and poverty groups (Fig. 1). Thus, we were not able to find *statistical* differences among the poverty groups with respect to their MWTP. At the 90% confidence level, elasticities for all attributes are therefore below one in consequence – and all attributes necessities in formal terms. Nevertheless, Figure 1 suggests the existence of interesting patterns of influence of poverty on MWTP that shall be further analysed for heuristic reasons.

Comparing only the difference between the *poor* and the *less poor* first, rattan tends to behave like an inferior good as MWTP increases with increasing poverty. Water behaves similarly. MWTP for intensification of cocoa increases at a rate of about 1 with declining poverty, suggesting that it is a normal, if not a luxury good. Anoa clearly behaves as a luxury good.

However, by including MWTP values for the poorest households, the picture gets more complex and - in the cases of rattan, water and anoa – cannot be interpreted in a straightforward manner in terms of the common definitions of the different types of goods. With regards to rattan and water, MWTP of the poorest households is lower compared to the poor households, and is – surprisingly – increasing for the anoa attribute. MWTP for cocoa intensification is lower for the poorest group in comparison to the poor. Thus, we observe a continuous and monotone trend for this attribute.

Figure 1: MWTP and 90 % confidence intervals



y-axis: mean MWTP; value for total sample = 1; poverty groups for each attribute (poorest, poor, less poor)

One may expect the MWTP values to be at least partly explained by whether the resource is *directly* used by respondents for production or not. As a first approximation, the attributes were interacted with a dummy for usage. The effect of usage on the total attribute effect is interpreted as the production value component; the remaining effect as the consumption value component. Table 3 lists shares of 'users' for the poverty groups as well as for the total sample.

For rattan, we find that active rattan collection explains almost all of the MWTP in the case of poorest households (31% users). In the other two groups, less than 5% of respondent households collected rattan. An interaction therefore leads to insignificant values or even singularities. MWTP ascribed to production can thus be assumed to be zero.

Table 3: 'Users' and poverty groups

Attribute	Sample	Users (%)
Rattan	Total sample	12,5
	Poorest	31,3
	Poor	4,8
	less poor	1,2
Water	Total sample	60,2
	Poorest	47,0
	Poor	67,5
	less poor	66,2
Cocoa	Total sample	75,5
	Poorest	73,5
	Poor	78,3
	less poor	74,7

Regarding water, 47% of the poorest households, 68% of the poor and 66% of the less poor households were involved in paddy rice cultivation. The share of MWTP explained by involvement in production rises from the poorest to the poor, which is probably due to a higher share of involvement among the poor households. It declines again when moving from the poor to the less poor although the number of users is almost equal in these two groups (see table 2). The non-use components, on the other hand, remain rather constant across all groups.

There are only small differences in the share of households of the single poverty groups that are engaged in cocoa cultivation compared to the high mean of all households (76%). It was not possible here to split cocoa preferences into production and consumption value component: An interaction of cocoa with the dummy for usage becomes significant but leaves the cocoa attribute itself insignificant. Consequently, MWTP for intensified cocoa cultivation has to be interpreted as mainly resulting from its production value. Data on usage is not available for wild anoas, as all forms of usage – above all hunting – are prohibited by law.

4. Discussion

Rattan collection is the most physically demanding regular work in the project region. It has a low social status, and it is carried out mainly by members of the poorest households. The share of households that has *ever* collected rattan is still high among the poor. This suggests that rattan availability may still have an option value to them, and serves as a potential income alternative for people. Additionally – as opposed to the poorest – the poor already have an income, which enables them to pay for keeping that option in the future. For less poor households this option of future rattan use is less important because these relatively better-off households are likely to be more resilient against negative income shocks. Less poor households possess more assets, and obtain a significant share of non-farm income (Schwarze 2004).

The constant MWTP for the consumption value component suggests that rice cultivation is perceived as a necessity that is of similar absolute importance for all poverty groups (as reflected by similar MWTP). This is not very surprising as rice is the main staple food in the research region. The "burden" in the form of cultivation risk, however, is mainly carried by households from the poorest and the poor groups. Higher shares of users explain the increase from the poorest to the poor group. Households in the poorest poverty group derive, on average, a higher share of income from agricultural wage labour – mainly in paddy rice cultivation. In contrast, poor households depend largely on agricultural activities for income generation although non-agricultural wage labour becomes more important. The drop to the relatively better-off group may be – as in rattan – due to a lower dependency on rice yields for securing household livelihood. Less poor households obtain about one forth of their income from self-employed work outside of agriculture (Schwarze 2004).

MWTP for anoa is higher among the poorest households than among the poor. Two lines of explanation suggest themselves: (i) the poorest are often – by not only collecting rattan – more closely linked to and dependent on the forest and its resources. This may result in a willingness to protect the livelihood of creatures living in the forest apart from direct use, symbolically expressed by a MWTP for anoa; (ii) although it is an illegal activity, there is some evidence that households also gain benefits from hunting of anoa (Glenk et al. 2006). In this case, the direct use, in e.g. the form of hunting, is unlikely to be important for the less poor. To them, however, consumption value components such as consuming the mere knowledge on the continued existence of anoa may result in a willingness to contribute to the maintenance of viable population sizes of this endemic animal. Higher income certainly facilitates this behavior typical for environmental 'luxury goods'.

Finally, MWTP for intensified cocoa production indicated by a shade gradient increases linearly with decreasing poverty, and elasticities are around one. The share of households cultivating cocoa is almost equal among all three poverty groups. The linear increase may display an increasing budget with decreasing poverty. The linear pattern of the cocoa attribute differs from the more complex, non-linear ones found for the other attributes.

Based on our findings, we pose the hypothesis that non-linearity can be induced (i) when an ecosystem service affects human well-being for different reasons in different poverty groups, and/or (ii) when the share of people deriving well-being from an ecosystem service in a specific way (e.g. related to direct use) differs among poverty groups. As an aside, the cocoa attribute is the only attribute that does not represent a common-pool natural resource.

It is interesting to discuss our findings along with literature on the link between poverty and environment, particularly on the relationship between income of rural households and their dependence on natural resources. As we lack the space for a more detailed discussion, we exemplarily point out Narain et al. (2005), who also provide an extensive literature review on this issue. They analysed the relationship of *actual* natural common-pool resource use (wood and fodder collection) with household income rather than using stated preferences to assess the demand for ecosystem services. Regarding wood collection, they found evidence of a U-shaped relationship (dependence first declines with income and then increases), while fodder collection monotonically increased with income. Furthermore, the probability of collecting any common-pool resources at all follows an inverse U-shaped relationship. Using data on household characteristics, they provide a detailed explanation of these results. Their findings are of consequence for our study for two reasons.

First, it seems to be difficult to establish regularities of the relationship between actual resource use and demand with rural household incomes that follow monotonistic concepts. Rather, the relationship may largely depend on the natural resource observed as well as on the social and economic local conditions.

Second, MWTP is an expression of scarcity of the service demanded, and need not be related to actual resource use. However, there is potential for *additional* insights into the poverty-environment link by using stated preference methods – particularly the choice experiment method explored in this study. This potential is based on the possibility of (i) assessing demand for natural resources along a gradient of *future changes* rather than being restricted to revealed preferences of actual past or present use; and of (ii) considering value components such as option or existence value. In our study, the differentiation of such value components contributed to a better understanding of the suspected relationships. Prospectively, considering them allows for a more comprehensive assessment of the distributional impact of improvements or degradation of the natural resource base on the welfare of rural households.

5. Conclusion

From a heuristic point of view, our results suggest that anoa is a luxury good if illegal hunting is disregarded. Also, rattan appears as an inferior good while water is a necessity if elasticities between the poor and less poor households are compared. If the poorest households are included in the analysis, and accounting for production and consumption value components, this analysis holds only for water and (cautiously) for anoa. Using data on household characteristics of the poverty groups observed it is possible to provide plausible explanations for the apparent tendencies across all three poverty groups. However, these differences cannot be fully captured by a monotonistic concept of effects on wealth on the demand for the ecosystem services analysed. Quite to the contrary, the results suggest inverted U-shaped relations for the common pool resources water and rattan availability.

Concerning distributional aspects, the poorest and poor households would benefit relatively more from improvements of the rattan and water attributes. As compared to the poor for anoa, both, the poorest and the less poor, gain relatively higher benefits, however for probably very different reasons.

Methodologically, the results of this study indicate that combining stated preference methods with a measurement of relative poverty can enrich the discussion on the poverty-environment link, particularly with respect to the relationship of the dependence of rural households on the use of (common-pool) natural resources and income.

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, University of Göttingen.

Barkmann, J., de Vries, K., Dietrich, N., Gerold, G., Glenk, K., Keil, A., Leemhuis, C., Marggraf, R. Confronting unfamiliarity with ecosystem functions: The case for an ecosystem service approach to environmental valuation with stated preference methods. (*submitted to Ecological Economics*)

Belsky, J. M., Siebert, F. S., 2002. Cultivating Cocoa: Implications of sun-grown cocoa on local food security and environmental sustainability, Agriculture and Human Values 20, 277-285.

Glenk, K., Barkmann, J., Marggraf, R., 2006. Unveiling regional preferences for biological diversity in Central Sulawesi: a choice experiment approach. STORMA Discussion Paper Series 15. Bogor, Indonesia: Universities of Göttingen and Kassel, Germany and the Institut Pertanian Bogor and Universitas Tadulako, Indonesia.

Hausman, J., McFadden, D., 1984. Specification Tests for the Multinomial Logit Model, Econometrica 52, 1219-1240.

Henry, C. J., Sharma, M., Lapenu, C., Zeller, M., 2003. Microfinance poverty assessment tool. Technical Tools Series 5, Consultative Group to Assist the Poor (CGAP) and TheWorld Bank, Washington, D.C.

Hensher, D. A., Rose, J. M., Greene, W. H., 2005. Applied Choice Analysis: A Primer. Cambridge University Press, Cambridge, 337 pp.

Huber, J., Zwerina, K., 1996. The Importance of Utility Balance in Efficient Choice Designs, Journal of Marketing research 33, 307-317.

Keil, A., 2004. The socio-economic impact of ENSO-related drought on farm households in Central Sulawesi, Indonesia. Ph.D. thesis, Institute of Rural Development, University of Goettingen.

Kriström, B., Riera, P., 1996. Is the Income Elasticity of Environmental Improvements Less Than One? Environmental and Resource Economics 7(1), 45-55.

Krinsky, I., Robb, A. L., 1986. On approximating the statistical properties of elasticities, Review of Economics and Statistics 68, 715–719.

Louviere, J., D. Hensher, Swait, J., 2001. Stated Choice Methods – Analysis and Application. Cambridge University Press, Cambridge.

Nairan, U., Gupta, S., van ’t Veld, K., 2005. Poverty and the Environment: Exploring the Relationship between Household Incomes, Private assets, and Natural Assets. Discussion paper 05-18. Washington, D.C.: Resources for the Future.

Schwarze, S., 2004. Determinants of Income Generating Activities of Rural Households, A quantitive Study in the Vicinity of the Lore-Lindu National Park in Central Sulawesi/Indonesia. Ph.D. thesis, Institute of rural Development, University of Goettingen.

Siebert, F. S., 2003. From shade- to sun-grown perennial crops in Sulawesi, Indonesia: implications for biodiversity conservation and soil fertility, Biodiversity and Conservation 11, 1889-1902.

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 1, Universities of Göttingen and Kassel, Germany and the Institut Pertanian Bogor and Universitas Tadulako, Indonesia.

Zeller, M., Sharma, M., Henry, C. J., Lapenu, C., 2006. An Operational Method for Assessing the Poverty Outreach Performance of Development Policies and Projects: Results of Case Studies in Africa, Asia, and Latin America. World Development 34(3), 446-464.