Locally Perceived Values of Biological Diversity in Indonesia – a Choice Experiment Approach

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Abstract:

Knowledge on preferences for ecosystem services at the rainforest margin can facilitate the development of economically sound conservation strategies as claimed by the Convention on Biological Diversity. A choice experiment was successfully employed in a tropical rainforest area around the Lore Lindu National Park, Indonesia to estimate values for rattan availability, water supply for irrigation, population size of anoa as well as different ways of cocoa cultivation along a shade tree gradient. While on average a willingness to contribute to the maintenance of the resource base was found for the first three attributes, respondents had preferences for more intensive ways of cocoa cultivation. Applying an ecosystem service approach facilitated the valuation of functional benefits of biodiversity. By using design features like a self-explicated status-quo alternative and the use of visualizations we successfully adjusted the design to a complex rural so-called developing country setting. Interactions with socio-demographic variables provide a more distinct view on the choice behaviour of respondents.

Keywords:

Ecosystem services, Biodiversity choice experiment, Environmental valuation, Rainforest, Indonesia

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1 Introduction

The Convention on Biological Diversity (CBD) stresses the importance to protect and to use biodiversity in a sustainable manner. In particular, the CBD Ecosystem Approach summons the contracting parties to adopt economically and socially sound conservation strategies. The Central Sulawesi, Indonesia, rainforests are part of the global Wallacea biodiversity hotspot (Myers et al. 2000), and Sulawesi's moist forests are among the world's most biologically valuable ecoregions (Olson and Dinerstein 1998). Because of their exceptional contribution to global biological diversity, the conservation of Central Sulawesi rainforests is an important case for an application of conservation strategies in line with the CBD Ecosystem Approach. Economically, Central Sulawesi is one of the poorest provinces in Indonesia (Suryahadi and Sumarto 2001). Local economic agents find themselves situated between globally defined conservation objectives and more locally perceived – often pressing - needs for development. This fact requires that the socio-economic impacts of any conservation measure on the local population be considered carefully. Thus, it is the overall objective of this study to generate knowledge that facilitates the design of economically informed and socio-economically sensitive conservation strategies for this ecoregion.

One of the most severe obstacles to the design and implementation of economically sound conservation strategies is the lack of knowledge on the economic value of non-market benefits generated by tropical forest ecosystems and the agricultural land use systems that replace them (cf. Balmford et al. 2002, Bawa 2004). This study contributes to filling this gap by making use of a *choice experiment* (CE) for an estimation of locally perceived values of biodiversity of inhabitants living around the Lore Lindu National Park in Central Sulawesi. Local residents are mainly smallholder farmers (Schwarze 2004). Rather than investigating different levels of biodiversity or ecosystem services holistically, we collected data on the

trade-offs made by individual respondents between a number of different ecosystem goods and services.

Developed in transport and marketing research, the CE became increasingly popular in environmental valuation of non-market goods in the recent years (Adamowicz et al. 1994, Bennet and Blamey 2001). Choice modelling is a stated preference (SP) technique that allows for simultaneous elicitations of multi-attribute benefits of both use *and* non-use value of policy scenarios (Bateman et al. 2002, Adamowicz et al. 1994). The application of SP techniques in general is not without dispute when applied to functional ecosystem values, such as the provisioning of water, or flooding or erosion control (e.g., Nunes and Bergh 2001, Gatto and de Leo 2001). In particular, the unfamiliarity of respondents with the scientific description of the ecosystem functions has prompted much critique. Non-expert respondents usually lack sufficient insight into the scientific background of ecosystem *functions* in order to make meaningful preference statements. Because of the complexity of the ecological subject matter, it is usually not possible to improve the situation sufficiently by including more detailed ecological explanations in the valuation interviews. In line with literature suggestions to focus valuation efforts on the actual benefit stream generated by ecosystem functions (Freeman III 1998, Carson et al. 1999), we developed and applied an explicit ecosystem *services* approach in this study. This approach reduces unfamiliarity problems effectively (for details, see Barkmann et al., *subm.*).

Despite widespread applications of the CE in so-called industrialized countries, applications with respondents from so-called developing countries are still comparably rare, particularly in rural areas. For metropolitan areas they are often applied to transport and sanitation issues (e.g. Abou-Ali and Carlsson 2004, Pham and Tran 2005). Seenprachawong (2003) in Thailand and Othman et al. (2004) in Malaysia both applied a CE to obtain non-use values of coastal respectively mangrove wetland ecosystems. To our knowledge, this is the first

study using a CE for the valuation of non-market benefits of specific ecosystem goods and services obtained by a tropical rain forest.

After describing some features of the research region (section 2), a brief introduction into the choice experiment method (section 3) is followed by design issues (section 4) – concerning the attributes, the framing and the experimental design used in this study. Thereafter, model results are shown (section 5) and discussed. Finally, we conduct a welfare analysis including implicit prices and an exemplarily scenario analysis (section 6). The paper ends with some concluding remarks (section 7).

2 The research area: around the Lore Lindu National Park

The research region is located in the humid tropics about 1 degree south of the equator. It comprises four main areas divided into seven administrative districts in the province of Central Sulawesi, Indonesia. In more than 115 villages, the project area holds a population of about 130,000 on 7,220 km^2. Lore Lindu National Park is centred within the study region and covers some 2,200 km^2, which is one of the few large forest areas left on Sulawesi. A large number of species endemic to Sulawesi, including, e.g., the mammals anoa (*Bubalus sp.*), babirussa (*Babyrousa babirussa*), and many endemic bird species can be found in the National Park area (Waltert et al. 2004).

The geophysical conditions of the research region vary to a large extend. Accordingly, a large variation of land use patterns can be found (Schwarze 2004). In the course of the 'cocoa boom' in Indonesia (Akiyama and Nishio 1996), cocoa became the dominant cash crop in the research region. Based household data surveys, cocoa and wetland rice together account for 57 % of the net crop income (Schwarze 2004). Concerning forest products, collection of fuel wood is widespread for private consumption, while rattan is the most important marketed forest product (Schwarze 2004).

3 The Choice Experiment method

In a CE, consumers state their preference by (repeated) choice among different alternatives or goods following an experimental plan. Having foundations in Lancastarian consumer theory (Lancaster 1966, 1991), the goods are being transformed into objective characteristics (attributes) from which the consumer is assumed to derive utility. In environmental choice modelling, the alternatives are often described as different development or policy options (Bennett and Adamowicz 2001). Another main pillar of choice modelling is random utility theory (RUT) (e.g Thurstone 1927, McFadden 1973, Manski 1977)[i]. Utility is partitioned into a deterministic, systematic component or 'representative utility' and a random part of utility "reflecting [the] unobserved individual idiosyncrasies of taste" (Louviere et al. 2001:38):

$$U_{ij} = V_{ij}(X_{ij}, S_i) + \varepsilon_{ij} \ \forall \ j \in C_i \qquad (1)$$

where U_{ij} is the utility an individual i is assumed to obtain from of alternative j in choice set C_i. V_{ij} is the deterministic part that is held to be a function of the attributes of alternatives X_{ij}, which is a vector of attributes as perceived by individual i for alternative j and characteristics of the individual S_i. ε_{ij} is the random term. As the analyst is unable to measure ε_{ij}, s/he cannot determine exactly why an individual chooses an alternative j out of a set of competing options $C_i \ \forall \ j,k \in C_i$ and i = 1,...I. However, the systematic component V_{ij} still allows him to make probabilistic statements about the choice. This leads to equation (2) and is called a *Random Utility Model* (RUM). Assuming utility maximization, the probability that alternative j is chosen by individual i over any alternative k out of choice set C_i can be expressed as:

$$P(j|C_i) = P\ (U_{ij}>U_{ik}) = P\ [(V_{ij}+ \varepsilon_{ij}) > (V_{ik} + \varepsilon_{ik})] \ \ \forall \ \ j,k \in C_i \text{ and } j \neq k \neq 0 \qquad (2a)$$

$$= P\,[(V_{ij} - V_{ik}) > (\varepsilon_{ij} - \varepsilon_{ik})] \;\; \forall \;\; j,k \in C_i \text{ and } j \neq k \neq 0 \qquad (2b)$$

In order to be able to estimate the probabilities of equation (2 a/b), assumptions have to be made about the nature of the random error term. The majority of discrete choice models assumes that the random term is independently and identically distributed (IID), and related to the choice probability with a Type I extreme-value (Gumbel, Weibull, double-exponential) distribution (with zero mean and a variance of μ^2). As a consequence of the IID assumption, the alternatives have to be independent from irrelevant alternatives (IIA). I.e., the ratio of probabilities of choosing alternative j over k out of a choice set C_i remains unaffected of the presence or absence of any other alternative. All assumptions are given now for the conditional or multinomial logit model (MNL, McFadden 1973):

$$P(j \mid C_i) \;=\; \frac{\exp^{\mu V_{ji}}}{\sum_{k \in C_i} \exp^{\mu V_{ki}}} \qquad (3)$$

where μ is the scale parameter usually set to 1 (constant error variances) and inversely proportional to the standard deviation of the error terms (Louviere et al. 2001). V_{ij} is assumed to be linear and additive in parameters:

$$V_{ij} \;=\; \alpha ASC_j + \sum \beta_n f(X_n) \qquad (4)$$

where X_n is the attribute level of attribute n of the jth alternative and β_n is the parameter value associated with attribute n. ASC_j is short for alternative specific constants that equal 1 for alternative j (otherwise: 0), and can be included for j-1 alternatives. If the alternatives are generic (unspecific, i.e. unlabelled), the ASCs are equal. Socio-economic variables can be interacted either with the ASC and/or the attributes. “It is the role of the ASCs to take up any

variation in choices that cannot be explained by either the attributes or the socio-economic variables" (Bennett and Adamowicz 2001:60). By using a statistical estimation technique such as 'maximum likelihood estimation' (MLE) as available in statistical software packages, e.g. LIMDEP (Green 2003), estimates for the coefficients associated with the attributes can be obtained.

If the variance of unobserved components of the utility function or scale is different among (subsets of) alternatives, e.g. due to heterogeneous preferences, the IID and IIA assumptions do not hold. One test frequently applied in literature is a Hausman type test (Hausman and McFadden 1984). If IIA is found to be violated, the MNL should not be used and models such as the Nested Logit (NL) (Louviere et al. 2001) or Random Parameters Logit (RPL) (Train 1998) should be considered that relax these assumptions (Louviere et al. 2001). Accounting for preference heterogeneity by interacting socioeconomic and/or attitudinal attributes may help to mitigate IIA violations (Train 1986).

As the parameters β_n in V_j are confounded with the scale parameter μ and thus are not separable, they cannot be interpreted in *absolute* terms. The estimated probabilities using equation (3) can, consequently, merely serve as an indication for the *relative* utility an individual obtains from choosing a particular alternative from a choice set. However, the scale parameters are cancelled out if marginal rates of substitution between any pair of attributes a and b are estimated. If one of the attributes (characteristics) reflects 'cost', the trade-offs are called implicit prices. For any attribute n, they can be calculated by:

$$\text{Implicit price } (n) = -\left(\frac{\mu\beta_n}{\mu\beta_{\text{cost}}}\right) = -\left(\frac{\beta_n}{\beta_{\text{cost}}}\right) \tag{5}$$

where β_n is the coefficient of attribute n, and β_{cost} is the coefficient of the 'cost' attribute. The implicit prices reflect the marginal willingness to pay (MWTP) for a marginal change in a single attribute on a *ceteris paribus* basis (Bennett and Adamowicz 2001).

If a base option is included, values of Hicksian compensating variation for a change in the state of the world from Z_0 to Z_1 can be estimated as:

$$CV(Z_0 \rightarrow Z_1) \quad = \quad -\frac{1}{\beta_{\cos t}}(V_0 - V_1) \tag{6}$$

In equation (6), V_0 is the deterministic part of utility for an unchanged 'State of the World' Z_0, while V_1 describes changed conditions in Z_1, both for multiple attributes. V_0 and V_1 can be calculated using equation 4 and the parameters of the MNL model, thus canceling out the scale parameter.

4 The Choice Experiment Design

"... the characteristics model of consumer behaviour is designed to simplify reality. Fitting it into any given situation ultimately involves some art as well as some science" (Lancaster 1991:67).

The design of choice experiments includes decisions about the nature of the stimuli of choice. These decisions are concerned with (i) the attributes of an alternative and their levels, (ii) the nature of the 'cost' attribute, (iii) the situation in which the alternatives are presented to the respondent ('framing'), (iv) the definition of a potential base (reference) option and (iv) the experimental plan that allows for statistical estimation of the attributes' coefficients. Besides the well-known issues as outlined in e.g. Bennett and Blamey (2001) or Bateman et al. (2002), we had to overcome several challenges and difficulties concerning (i) to (iv) arising

from a complex setting of the study in a rural area of a so-called developing country. Therefore, despite lacking space for a description of all details concerning the design, several issues are reported more exhaustively.

4.1 Attribute selection

Out of the universe of potential "characteristics" of biological diversity and ecosystem services from which people around the Lore Lindu National Park derive utility, which are to be selected? As a way to guide the decisions, a (multidimensional) space can be created, which is demarcated by (i) the objectives of the analyst and the research question, (ii) constraints imposed by the respondents (relevance, cognitive burden/ task complexity), (iii) the social context (e.g. problems concerning strategic behaviour) as well as (iv) specific features of the 'natural' environment of the research area.

The selection of relevant attributes and levels was based on information gathered in semi-structured individual and 'peer-group' interviews in various villages of the research region. Following Blamey et al. (1997), we screened all attributes suggested from a demand perspective. Furthermore, information and data obtained by experts as well as from literature (e.g. Belsky and Siebert 2003, Siebert 2002, Keil 2004) were incorporated for further adjustment. The attributes chosen and the respective levels are listed in Table 1 and are described in detail below.

In pre-tests, we used 5 attributes including 'cost' in two choice scenarios and a status quo alternative. First presented orally only, the bulk of information on attributes caused some fatigue and confusion among a number of respondents.. The education of 53 % of the respondents did not transcend elementary school, indicating a rather low level of literacy. Jae and Delvecchio (2004) found that the presence of a visual decision aid can improve choice by reducing task complexity and by facilitating the mediation of information to low-literacy con-

sumers. Paintings containing the main information were developed in cooperation with local farmers in order to meet their perception.[ii] The pictures and their respective informational background were simultaneously presented to the respondent during the explanation of the attributes. This way of presenting the context and attribute-specific information proved to be very successful in increasing the understanding of the choice task as well as raising interest and attention. Visualizations were also included in the choice cards[iii]. Overall, by using this tool, pre-tests suggested that respondents were able to cope with 5 attributes. For final refinement of the questionnaire, a pilot study was conducted (n = 96).

Rattan (*Calamus spp.*) is the most important marketed forest product in the region. It serves as a secondary income source for locals, particularly for poorer residents (Maertens 2004, Schwarze 2004). If harvests fail, e.g. caused by droughts or flooding, rattan serves as an important income alternative (Vedeld et al. 2004) – probably also for less poor residents. Thus rattan availability has an 'option' or insurance value component for respondents who are usually not involved in rattan extraction. Previous research in the region (STORMA 2003) showed that the encounter distance from the forest edge to harvesting locations increased from 4.4 km on average in 1990 to 14.5 km in 2001, indicating an overuse of rattan resources. While market demand is likely to remain strong (Vantomme 2003), the decline of commercially valuable large-diameter and long canes in the Lore Lindu region is likely to continue (Siebert 2001, Siebert 2004). Siebert (2004: 429) reports that "The declining availability of rattan cane was evident to collectors, who responded by … collecting in more distant areas, and shifting collection to less valuable rattan species." In practical terms, increased encounter distances mean that human disturbance extends deeper into the primary forest as the biggest share of rattan in the research region is collected in Lore Lindu National Park. The rattan attribute was operationalized by the encounter distance to the nearest extracting location. We expect a negative sign indicating a utility gain for decreasing distance.

Sufficient water for irrigation is essential for the production of wetland rice, the region's main food crop. There is anecdotic evidence prompting many locals to belief that deforestation on the hillsides leads to water shortages in the valleys in the dry months of the year. Particularly this appears to be the case when the water originates from small watersheds in combination with simple irrigation techniques (own data[iv], Burkard 2002). Keil (2004) showed that perceptions of the seasonal changes of precipitation and water availability fit quite well with measured data. Thus, an ecosystem level attribute on the provision of irrigation water was created. Although negative impacts of land conversion at the hillsides on water availability were mentioned to respondents, the levels of the water availability attribute make no reference to forest cover. Instead, they were simply described as months with water shortage for irrigation purposes in an average year. We expect a negative sign of the water attribute coefficient related to a utility gain associated with improved availability of water for irrigation. More details on the design of this specific attribute in accordance with the ecosystem services approach to environmental valuation with stated preference methods can be found in Barkmann et al. (*subm.*)

Cocoa (*Theobroma sp.*) is the dominant cash crop. Increasingly, the production is intensified, resulting in monocultures with no or merely low levels of planted shade trees (e.g. *Gliricidia sepium*). Despite higher mean yields, intensification to sun-grown cocoa leads to higher agronomic and socioeconomic risks, e.g. soil degradation and negative impacts on local food security (Belsky and Siebert 2003). Shade-grown cocoa farming can provide habitat for a wide range of native species, thus contributing to biodiversity conservation, while soil productivity may be retained (Siebert 2002). Thus, this attribute reflects trade-offs between (short-term) economic goals and (long-term) biodiversity conservation objectives by mapping a shade tree gradient (5-35-65-95 % under shade) for preponderance of cocoa plantations ranging from full-sun grown cocoa on one side, and cocoa cultivated beneath primary or secondary forest vegetation on the other side. Due to an observed tendency for intensification, we

expected a negative sign for the cocoa coefficient although advantages such as improved pest control were pointed out to respondents.

Table 1. Attributes and levels

	Attribute	Levels	Ecosystem service category	Value type (TEV)
Rattan	availability of rattan (*Calamus spp.*) as expressed in distance from village	[*km*] 5, 10, 15, 20	provisioning service	Direct use/ Option value
Water	availability of irrigation water for wet rice cultivation as expressed in number of months with water scarcity	[*No of months*] 0, 1, 2, 3	regulating service	Indirect use value
Cocoa	preponderance of cocoa plantations differing along a shade tree gradient	[*% under shade*] 5, 35, 65, 95	regulating services	Indirect use / Option value
Anoa	populations of different sizes of the endemic dwarf buffalo anoa (*Bubalus depressicornis/quarlesi)*	[*No of animals*] 10, 180, 350[§], 520	cultural/ provisioning service	Existence/ direct use value
'Cost' attribute	extra taxes or donation to village fund	[*1,000 IDR per year*] 0, 18, 36, 54, 72	-	-

[§] present state; 1 US$ ~ 8,500 IDR at the time of the survey

The Sulawesi region is an important centre for species endemism, and the Lore Lindu National Park harbours many of Sulawesi's endemic mammals and birds (Waltert et al. 2004, Whitten et al. 1987). However, large forest clearings inside the National Park show that the forest frontier in the research region is by no means secured (Weber 2005). To find out how conservation objectives are supported by the local population around the National Park, different population sizes of the endemic dwarf-buffalo anoa (*Bupalus depressicornis, B. quarlesi)* were included as an attribute in the choice experiment. Population sizes in the research region are in decline (STORMA 2003, Burton et al. 2005). Burton et al. (2005) identified the Lore Lindu National Park as one of the areas on which to focus conservation efforts of this animal. Individual interviews showed that anoa was the most widely known forest species. As a result of discussions with locals and experts[v], the present state was estimated as 350

individuals living in the forests of the Lore Lindu region. Differing population levels of anoa represent different TEV value categories. One is 'existence' value, e.g. the "… concern to protect […] although he or she has never seen one and is never likely to …" (Pearce and Moran 1994:12). Direct use value (e.g. hunting), bequest value (see Burton et al. 2005), or even fear of being injured by the animal may also influence choices. With the exception of fear, all other considerations point to the hypothesis that anoa is perceived as an asset leading to a positive sign for the anoa attribute coefficient.

4.3 Framing

"The questionnaire must strive to establish the frame in respondents' minds which is appropriate to the circumstances of the [...] decision being made" (Bennett and Adamowicz 2001: 51). This step is called 'framing'. An appropriate context must be developed, in which the hypothetical scenarios are presented to the respondent. If the context is misleading or not credible, there is little incentive for respondents to take the choice task seriously.

In the study, the 5 attributes were defined as results of alternative government development programs on a village scale. Multi-level development programs that address many different aspects are not unfamiliar to the locals. One example is the 'Central Sulawesi Integrated Area and Development Program' (ANZDEC 1997). Before making their choices, respondents were reminded emphatically of their budget constraints in order to reduce bias resulting from strategic behaviour or interviewer compliance.

4.2 The 'cost' attribute

The 'cost' attribute was double split-sampled. One half of respondents were confronted with a rise in "house- and land" tax (*Pajak Bumi Bangunan* (*PBB*)), the other half with a donation to

a village funds (*Iuran dana pembangunan desa*) affecting every household of the research region. Both payment vehicles are familiar and widely accepted within the region. The second split sample involved monthly versus yearly payments.

Exploratory studies have shown that all people are familiar with monetary issues even in remote areas, though some were hardly able to pay some of the higher amounts offered. Therefore, following Whittington (1998), the use and interpretation of stated preference values will be bounded by respondents' *ability* to pay and by their *willingness* to pay. As the wealth status of the inhabitants differed to a large extend, it proved to be a challenging task to derive an appropriate price range for the cost attribute. While a few households live in concrete houses, have access to satellite television and sometimes even own a car, others share a wooden hut without electricity. According to Whittington (1998), the highest price should be rejected by 90 % - 95 % of the respondents in closed-ended CVM studies. The levels were derived following this rule of thumb by using different 'prices' in pre-tests based on initial information obtained by a payment-ladder approach (cf. Bateman et al. 2002). Offering the highest price to the poor could embarrass them, and could make "the interviewers look insensitive and/or uninformed" (Whittington 1998: 8). Hence, the range of 'price' levels was cut at the high end, accepting an underestimation of WTP by ignoring the higher WTP of a low percentage of rather well-situated people. WTP values are calculated on a one years' basis.

4.4 Experimental design and status quo

Out of the 4^5 possible combinations of attribute levels, an orthogonal fraction of 16 was selected by means of experimental design techniques (Louviere et al. 2001) using SPSS. These were combined into choice scenarios that consisted of two (generic) alternatives A and B and a *status-quo* option presented on choice cards. A typical choice set is shown in appendix 1. The sets of the main-effects experimental design were blocked into 4 versions, so that each

respondent faced 4 choices. All attributes entered the analysis as continuous attributes using actual values as in table 1.

Inclusion of a status quo option allows for the estimation of economic welfare measures (e.g. Louviere et al. 2001). The status quo ('do-nothing') option is the reference from which the scenarios offered by the researcher to the respondents diverge. "Selection of a base may have an important influence on CM results by affecting the utility of the base option relative to others, and by influencing the framing of outcomes, for example, as gains or losses" (Blamey et al. 1997:14). The status quo was described as the present situation, because future attribute level changes could not easily be predicted and may differ in discrete villages. The respondents were directly asked for the perceived levels of all attributes being most similar to the present situation with an exception for 'anoa' and 'cost'. By this means, respondents created their 'individual' status-quo or "'self-explicated' alternative" (Blamey et al. 2001:137). We did so for the following reasons: (i) It addresses local heterogeneity of environmental and socio-demographic conditions better than a 'constant base reference'. Involving respondents in the preparation for the choice experiment and customising the status quo for the individual could suspend some 'disbelief' about the hypothetical nature of the choice task and the survey by accounting for this heterogeneity. As an implication for welfare measures, choices were thus consistently framed as gains or losses for each individual. (ii) Prior to the choice task, the respondents had to intensively engage themselves with the present situation regarding the attributes. As a result, it is likely that respondents were more confident about their choices as they became more familiar with the attributes.

Economic choices are inter alia related to people's perceptions (McFadden 2001). However, if people's perceptions diverge from actual (objective) measures, there are implications for welfare measures of impacts of objectively defined changes (Adamowicz et al. 1997). Despite there is various indication that perceived and actual status quo may not differ to a large extent such as, e.g., rather low variation within villages but rather high variation

between villages or the matching of perceived scores for water availability with measured precipitation data (Keil 2004), we cannot exclude the possibility of divergence. Furthermore, the most similar level can happen to be over- or understated due to the coarse resolution of the attribute level range. As nothing is known about the magnitude and direction of the deviation we assume that errors of over- or underestimation of levels are nullified over the total sample.

A dominant choice set was included prior to the actual choice experiment to test for rationality (Johnson and Mathews 2001, Bradley 1988, Bradley and Daly 1994, Hanley et al. 2000), also serving as a 'warm-up' task. This was achieved by keeping all attribute levels equal in option A and B expect for price. The dominant option in the choice set was the status quo.[vi]

4.5 Socio-demographic characteristics

Additional data collected included information about the choice task (e.g. difficulty, confusion) as well as data on several socio-demographic characteristics (SDC, e.g. age, education), inter alia. We included some socio-demographic variables as interactions with the ASC to better understand the choice pattern of respondents (table 2).

Table 2. Variables interacted with ASC

Variable	Description	Mean	Std. Dev.
KL	Dummy variable showing whether respondent is from Lore or Kulawi districts	0.52	0.50
UNDS	5 point Likert score for overall understanding of the choice task as perceived by the interviewer[$]	3.14	0.85
PRISEC	Indicator for perceived discretionary income: share of total household income spend on primary needs (rather than secondary)[$$]	1.96	0.69
YOUNG	Dummy variable for age of respondent ≤ 35 years	0.29	0.45
OLD	Dummy variable for age of respondent ≥ 55 years	0.27	0.45

[$]1: 'not at all'; 5: 'very well'; [$$]1: 1/4 up to ½; 3: 3/4 to everything

The dummy KL for respondents from Kulawi and Lore areas was created because forest degradation on hillsides is far less visible than in the Sigi Biromaru and Palolo areas, resulting e.g. in water shortages for irrigation as well as household purposes in the latter areas. Hence, the threat imposed by environmental degradation was more obvious than in Kulawi or Lore. This could increase the likelihood that respondents include unobserved attributes of environmental change associated with a development program into their decision making in an effort to halt a general downward trend, thereby increasing the likelihood to opt for a change rather than the status quo. Therefore, we expect the dummy to have a negative coefficient indicating a higher probability of choosing the status quo if people live in Kulawi and Lore.

The influence of respondents' comprehension of the choice task (UNDS) as evaluated by the interviewers immediately after the choice experiment using a 5-point Likert scale was also interacted with the ASC. The status quo option may be used as an 'easy way out' due to task difficulties (Kontoleon and Yabe 2003). We expect that the likelihood of choosing the status quo increases for decreasing scores of understanding, thus providing indication that this strategy has been used.

We used a perceptual measure of discretionary income modified from Green and Tunstall (1992) as a proxy for disposable income (PRISEC). The negative coefficient expected would mean that respondents who feel that they are less able to spend on secondary rather than primary needs are the more likely to choose the status quo. This may be an expression of more severely budget constraints of poorer households. Dummies for different age groups (YOUNG, OLD) were included without having prior expectations.

4.6 Data Collection

In order to enable aggregation of the (perceived) values for ecosystem services by a sampled population on a regional level in congruency with the research region, a stratified village

sampling frame was adopted. The strata for the sample were ethnicity composition, vicinity to the Lore Lindu National Park and population density of a village. Households were then randomly selected within each village. Details of the sampling are described in Zeller et al. (2002). The choice experiment survey was administered to 301 households in 12 villages of the research region (December 2004 - March 2005). Face-to-face interviews were conducted by 6 well-trained local enumerators. To minimize potential interviewer effects, enumerators were randomly assigned to the households.

5 Model results

All 301 households completed the choice task, and 235 made choices which at least once included either option A or B. 66 respondents (22 %) chose the status quo in all four choices. 53 respondents did so as they perceived the present situation to be the relatively best option, which is a consequence of the 'individual' status quo, or as they could additionally not afford the payment required in some choices. The remaining 13 respondents always chose the status quo because of 'protest', payment aversion and exceeding cognitive capability. They were classified as "…essentially not responding to the CE task." (Adamowicz et al. 1998b:68) and omitted. This leaves 288 responses for further analysis.

261 respondents or 91 % chose an option from the dominant choice set that was classified as rational. It is therefore assumed that respondents in general sufficiently understood the choice task. All attributes entered the models as continuous attributes 'anoa', 'water', 'cocoa' and 'rattan' using levels as in table 1. Model results are listed in table 3.

For the base model, it is assumed that each attribute reflects an individual's utility in a linear fashion. Overall, the base model was significant at the 99 % level. Except for the anoa attribute, which is significant at the 5 % level, all other choice set attributes are significant at the 1 % level or better. A positive sign shows that *more* of an attribute results in a higher

probability of an alternative being chosen, while a negative parameter signifies that *more* of an attribute has a negative effect on the odds of an alternative being chosen. 'Water' and 'Rattan' have - as expected – negative signs. The 'anoa' attribute is positive and significant, indicating that people do care for the maintenance of viable populations of this animal. For the 'cocoa' attribute, the coefficient is negative and significant, denoting a negative effect for more shade. We were interested in whether there was a threshold for preferences for intensification, reflecting a certain degree of risk aversion. Thus, we effects-coded the cocoa attribute, which then showed nonlinearity of preferences. Therefore, we included a quadratic term for cocoa in the model. The resulting utility function is more close to the effects-coded one (figure 1).

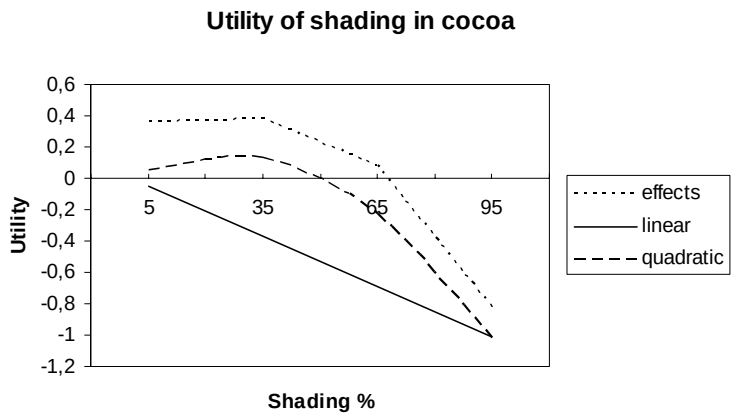
Table 3. MNL model results

Variable	Base model		Model 1		Model 2	
Rattan availability	-0.0354	***	-0.0404	***	-0.0408	***
	(-4.619)		(-5.179)		(-5.127)	
Water for irrigation of paddy rice	-0.88	***	-0.8943	***	-0.8885	***
	(-18.734)		(-18.772)		(-18.277)	
Cocoa Shade (linear)	-0.0105	***	0.0126	*	0.0126	*
	(-6.620)		(2.067)		(2.047)	
Cocoa Shade² (quadratic)			-0.0247	***	-0.0249	***
			(-3.913)		(-3.890)	
Anoa Population Size	0.0009	**	0.0009	**	0.0009	**
	(2.856)		(2.688)		(2.655)	
Cost (Tax rise/village fund donation)	-0.0262	***	-0.0254	***	-0.0256	***
	(-9.420)		(-9.146)		(-9.162)	
ASC (non-status quo choice)	0.3481	*	0.4892	***	2.1967	***
	(2.553)		(3.486)		(5.660)	
ASC*KL					-0.4039	**
					(-2.854)	
ASC*UNDS					-0.2842	***
					(-3.377)	
ASC*PRISEC					-0.2320	*
					(-2.240)	
ASC*YOUNG					-0.2851	
					(-1.651)	
ASC*OLD					-0.2731	
					(-1.575)	
Log-likelihood	-865.0992		-857.3425		-843.0408	
Number of observations	1152		1152		1152	
Adjusted ρ^2 (Pseudo-R^2)[§]	0.2583		0.2646		0.2753	

***: significant at $p < 0.001$; **: significant at $p < 0.01$; *: significant at $p < 0.05$; t-statistics in parentheses;
[§] Pseudo-R^2 as compared to constant-only model
Source: own calculations

The quadratic term for cocoa is negative and significant (model 1). There is some threshold for shade-related intensification, which would not have been detected by using the basic linear model. Utility peaks at a level of shading of approximately 28 %. We find a significant improvement of the quadratic specification as compared to the base model (LR test: 15.51, 1 d.f.) as well as for additionally including interactions with SDC in model 2 (LR test: 28.60, 5 d.f.).

Figure 1. Effects coding, linear and combined linear and quadratic effects for shading in cocoa



All interactions with SDCs are significant at the 5 % level or better except for the dummies for age groups. The overall model fit of all models was assessed by the value of adjusted ρ^2 (Pseudo-R^2) compared to the constants only model. Pseudo-R^2 was 0.258 for the base model, and increases for model 1 (0.265) and model 2 (0.275). These pseudo-R^2 values can be compared to values of R^2 as in OLS regression models, where values of ρ^2 of 0.3 correspond to R^2 values of about 0.6, representing a decent model fit (Hensher et al. 2005). In the following, we use model 2 to calculate welfare estimates.

A Hausman type test (Hausman and McFadden 1984) was conducted to test for violations of the IIA assumption. The model coefficients of an unrestricted choice set are compared for significant differences with the equally specified coefficients obtained from a restricted model (where one or more choice options are omitted). In other words, it is tested

whether the underlying choice behaviour remains the same when one alternative is being omitted. Hausman statistics were computed for the base model both with and without ASCs as well as for models 1 and 2 (table 4). While partial violations were found for a test without ASCs, the assumption could not be rejected for all options when ASCs were included for the test. This result can be compared with Morrison et al. (1998), where the inclusion of SDCs helped to minimise IIA violations.

Table 4. Results of the HM-tests to check for violations of the IIA assumption

	Alternative dropped (χ^2)[§]			
	A	**B**	**C**	**d.f.**
Base (no ASC)	7.02	15.54*	8.50	5
Base (ASC)	$\leq 0^{\$}$	8.54	9.68	5
Model 1	$\leq 0^{\$}$	4.85	9.56	6
Model 2	$\leq 0^{\$}$	3.65	10.79	6

[§] χ^2 critical value at $\alpha = 0.05$: 11.07 (5 d.f.), 12.59 (6 d.f.);
[$] If the chi square value is negative, evidence is given that the IIA assumption holds (Greene 2003);
* IIA assumption rejected at $\alpha = 0.05$
Source: own calculations

All models exhibit a positive and significant value for the ASC. This suggests that there is no particular propensity to choose the status quo option relative to the alternatives as more commonly reported in literature (e.g. Adamowicz 1998a). One exception are Mogas et al. (2002), who report a positive ASC in a study on afforestation in Catalonia. A preference for the status quo, all else equal, was often related to what is referred to as 'status-quo bias' (Samuelson and Zeckhauser 1988). One reason for status quo bias can be that the status quo is used as an 'easy way out' e.g. in case of decision difficulty and/or limited cognitive capability (Luce 1998). The positive ASC gives some evidence that this strategy was not particularly important in our study. People receive on average – everything else held constant – more utility from departing from the present situation than from keeping it. This could be due to a number of reasons like, inter alia, that respondents include unobserved attributes associated with a governmental programme, or task compliance. According to the high rate of status quo choices among all

choices (53 %) it is unlikely, however, that the respondents felt 'forced' to choose among the alternatives of change as a consequence of a falsely perceived compliance with the intentions of this research.

The interactions of the ASC with SDC can shed some light on potential reasons and their heterogeneous distribution among the sample population. The negative sign of the coefficient for ASC*KL means that the likelihood to move away from the status quo decreases if the respondent is from Kulawi or Lore areas, as we had expected. Surprisingly, respondents' understanding of the choice task as judged by the interviewers increases the likelihood of choosing the status quo relative to the alternatives. This finding further supports the assumption that respondents did not have a tendency to use the status quo as an 'easy way out' in case of difficulties associated with the choice task. Respondents that yield higher scores for understanding might make less use of unobserved attributes when making their decision.

The fewer respondents perceived they are able to spend on secondary rather than primary needs, the more likely they were to choose the status quo. This may be an expression of the limited ability to pay of poorer households. Neither young nor old age does have a significant impact on the ASC at the 95 % level.

6 Welfare analysis

6.1 Implicit prices

Using equation (5) and model 2, implicit prices (marginal WTP) were calculated for the attributes. Confidence intervals were derived using a Krinsky and Robb (1986) procedure with 1,000 random draws (table 5).

Implicit prices "can be used by policy makers to assign more resources to improving those attributes that have higher prices" (Colombo et al. 2005:89). However, care must be taken when comparing the implicit prices as the attribute units differ. MWTP to avoid 1

month of water scarcity for irrigation is about 34,800 IDR (~ 4.1 US $) per year, 100 more individuals of anoa is worth about 3,400 IDR (~ 0.4 US $) per year. MWTP for a 1 % change of the cocoa attribute is slightly lower (395 IDR) if calculated without a quadratic term. This is due to the dramatic decrease in utility for very high shade levels because of the quadratic relationship. A similar effect of using a quadratic term was found by Adamowicz et al. (1998b).

Table 5. Implicit prices in IDR/year (US$)

		Rattan	Water	Cocoa[§]	Anoa
Median		-1,598 (-0.19)	-34,803 (-4.1)	-481 (-0.06)	34 (0.004)
95%	**Lower bound**	-2,356 (-0.28)	-45,502 (-5.35)	-666 (-0.08)	10 (0.001)
	Upper bound	-946 (-0.11)	-28,453 (-3.36)	-339 (-0.04)	61 (0.007)

[§] calculated as mean slope between 5 % and 95 %
Source: own calculations

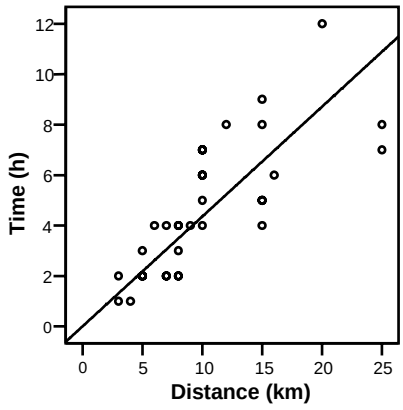
What can be said about the absolute magnitude of the MWTP values? Are they in a reasonable range or particularly low or high? We collected some background data related to attributes, allowing a vague assessment of the plausibility of the magnitude of MWTP values, particularly for rattan and water availability. The following comparisons should not be conceived as a formal proof of external validity. Still, they are helpful in anchoring the MWTP values within a broader context.

First, the average direct tax (*PBB: pajak bumi bangunan*) paid by households in the research region is about 15,000 IDR per year. Thus, MWTP for one month less with water scarcity for irrigation equals up to 200 % of the "house and land" tax people have to pay on average per year. A number of households in some villages pay irrigation fees of about 19,200 IDR per ha and year on average[vii]. Therefore, MWTP for improved water availability

expressed by the respondents can be considered to reflect a substantial amount for the inhabitants of the Lore Lindu region.

Concerning rattan, we conducted a linear regression of the time needed to reach the rattan harvesting locations (h) on the distance (km) (figure 2).

Figure 2. Regression of time on distance for rattan collection



Time = 0.4358 x Distance (R^2: 0.896);
calculated without constant in order to make sure that 0 km is associated with 0 h
Source: own calculations

One km less is associated with a time saving of about 0.4 hours (n = 37, significant at 99 % level). To derive a monetary value of time savings, they may either be related to the (local) wage labour market or calculated as the income forgone from collecting more of a (priced) resource (Köhlin and Amacher 2005). This is a very simplified assumption of farming in the research area, as we do know next to nothing about the potential utilisation of time savings[viii]. Average income from unskilled wage labour is about 10,000 IDR per day (10h). On average, people went to collect rattan 18 times per year. One km less can therefore be associated with 18 x 0.4h = 7.2 hours saved per year. Assuming perfect substitutability of time and labour, one km less would equal income forgone from wage labour of about 7,200 IDR/ yr for the average rattan collector. MWTP for 1 km less is about 1,600 IDR/yr, while rattan collectors

respond much stronger to changes in the rattan attribute (Glenk et al. 2006). The fraction of the sample selling rattan is 12.8 %.

Comparisons like that are more difficult for cocoa and particularly anoa due to the complexity of the benefits associated with these attributes on one hand, and to a lack of background data available on these benefits on the other hand. For the water and rattan attributes, however, there is indication that the MWTP values are in a reasonable range. Furthermore, Pattanayak and Kramer (2001) report a WTP of 2-3 US$ for drought mitigation services by watershed protection on Flores/ Indonesia derived by CVM. Although not directly comparable, their result for a similarly framed ecosystem service can provide some weak evidence that MWTP for water as calculated in this study seems to be neither completely over- or underestimated.

6.2 Scenario analysis

In 'State of the World' models (Bennett and Adamowicz 2001: 65) there are two general 'paths' to address change: first, attribute levels can be set to an equal value for the whole sample (e.g. the rattan attribute is set to 5 km). Second, attribute levels can be changed for every individual of the sample by a predefined amount (e.g. the rattan attribute is changed for every individual by 5 km less). We follow the second path. As we have an individual specific status quo, we do not assign a WTP for changes in certain attributes when it cannot be improved or changed any further.

There has been some discussion whether the ASC has to be included for calculating welfare estimates or not (Mogas et al. 2002). One strong argument for inclusion is that the ASC captures systematic but *unobserved* information on why respondents choose particular alternatives (Morrison et al. 2002). On the other hand, as ASCs do not explain choice in terms of the observable attributes they "cannot easily be used in predicting the effect of changes due

to attribute changes" (Adamowicz et al. 1997:73). If the ASC indicates that the probability of choosing the status quo was higher relative to that of choosing the management alternatives for reasons that are not explained by the attributes, neglecting the ASC for the calculation of CV measures would lead to an overestimation of WTP for a change that may be substantial (Adamowicz et al. 1998b, Colombo et al. 2005). In this study, however, we found a systematic deviation of the choice pattern in favour of the alternatives other than the status quo. Despite having a marked effect on the CV welfare measures, we omitted the ASC, therefore deriving a more conservative measure of WTP.

In order to extrapolate estimates from the sample to the population of the research region, sampling weights have to be applied due to the stratified sampling frame. For details about the calculation of sampling weights see Schwarze (2004). Mean values of WTP were calculated for each individual, averaged for each stratum, and finally aggregated to the total population using sampling weights (Morrison 2000). For the aggregation, the fraction of the population that has zero WTP has to be considered. Therefore, we assumed that those respondents who gave 'protest' answers have zero WTP (13 respondents). Protest respondents are assumed to be equally distributed over the population, as no clusters were found in certain strata.

We calculate estimates for three alternative scenarios. In different ways, a development program may target those ecosystem services mainly affected by changes at the forest margin (water availability, shading in cocoa cultivation), those mainly affected by changes of the forest interior (rattan stocks, anoa population) or both. Scenario 1 ('margin') describes a program focusing on production at the forest margin (intensification of cocoa) while neglecting the forest interior. This is assumed to lead to further depletion of forest resources. Scenario 2 ('integrated' management) takes all services into consideration. A strict enforcement of National Park borders is combined with conservation efforts at the forest margin (extensification of cocoa) in scenario 3 ('biodiversity'). We assume a decline of rattan availability in

Scenario 3 because strict enforcement leads to restricted access. Although the actual rattan stocks in the National Park increase or stay the same, individuals from villages bordering the National Park would have to collect rattan in forests which are further away - additionally increasing pressure on rattan resources in unprotected forests outside of the Lore Lindu National Park. For all scenarios, we assumed the impact of changes on water availability to be half as large for villages with technical or semi-technical irrigation systems as compared to villages with simple - local - irrigation systems. We did so because rice fields irrigated by water from small streams and watersheds might be affected first and more severely compared to those who receive water from larger watersheds.

Table 6. Scenarios and CV

	Status Quo (average)	**Scenario 1 'margin'**	**Scenario 2 'integrated management'**	**Scenario 3 'Biodiversity'**
Rattan [km]	10.61	15.03 (0.42)	7.55 (-0.29)[§]	15.59 (0.47)
Water [months]	1.32	0.74 (-0.44)[§]	1.03 (-0.22)[§]	1.03 (-0.22)[§]
Cocoa [%]	45.31	16.77 (-0.63)[§]	35.8 (-0.21)[§]	74.79 (0.65)
Anoa [N]	350	100 (-0.71)	350 (0)	500 (0.43)[§]
CV household [US$]	-	**-0.98**	**-2.12**	**1.45**
CV aggregated [US$]	-	**-20,135**	**-47,255**	**32,466**

[§] utility gain associated with change in attribute; percent changes compared to status quo in parentheses

Mean changes of the single attributes within each alternative scenario relative to the mean status quo as well as the resulting CV measures are summarized in table 6. While benefits are largest for scenario 2, they are much lower, if management of the forest resources (anoa, rattan) is neglected (Scenario 1). Restricting access to the forest resources in combination with extensification of cocoa, i.e., more shading trees - leads to welfare losses (Scenario 3). It is

important to note that these measures are net benefits of the investigated non-market goods alone. The financial costs of actually implementing the scenarios are not considered here.

7 Concluding remarks

With a carefully adjusted instrument, a choice experiment on the valuation of four mostly functional biodiversity services was successfully conducted on one of Indonesia's outer islands. The respondents understood the choice task sufficiently; statistical diagnostics indicate very reasonable model performance. The MNL model results provide some evidence that the choice experiment can be applied to the valuation of complex ecological functions if the functions are translated into ecosystem services attributes relevant to respondents' lives.

The design strategy to adjust the status-quo to the perceptions of the individual respondents contributed essentially to this result. One of the major advantages of using individual-specific perceived levels for the status-quo is its ability to account for heterogeneous environmental conditions. This enhances credibility among respondents, and frames the attribute levels of the alternative options properly as gains and losses. The bio-physical heterogeneity of the research region is reflected in differing livelihood strategies, farming structure and perceptions of environmental risks. Such factors, in turn, explain preference heterogeneity among respondents (Barkmann et al. *subm.*, Glenk et al. 2006).

Measures of MWTP for an improved provision of ecosystem services ('water', 'rattan', 'anoa') were documented. The magnitude of MWTP is quite substantial considering the living conditions of the inhabitants of the Lore Lindu region. The conflict between economic development and conservation is clearly reflected in people's preferences. They indicate a willingness to contribute actively to the maintenance of their natural resource base. Even for maintaining viable population sizes of the local endemic dwarf buffalo anoa, residents have

small MWTP although direct or indirect use benefits are likely to be very low. In the fast growing sector of cocoa agroforestry systems, on the other hand, respondents indicated an unexpectedly clear preference for more intensively managed plantations with less shade trees. Thus, biodiversity conservation measures aiming at more sustainable ways of cocoa cultivation (measured here by a shade tree gradient) will be unlikely to be successful without creating economic incentives for the cocoa farmers. One such incentive could be a price premium for "biodiversity-friendly" cocoa production.

We calculated CV measures for alternative management scenarios. As the scenario analysis (i) includes only a limited number of non-market benefits, (ii) does not account for the implementation costs of the scenarios, (iii) does not consider impacts on market goods, it cannot be finally judged which scenario is relatively more beneficial to the society of the research region in welfare economic terms. This study was not designed to generate comprehensive cost-benefit data; still, the presented scenario analysis provides essential non-market data for such an endeavour.

Even if the WTP of respondents as, e.g., in the 'integrated' scenario would be realised on a village or regional scale, it is doubtful whether an effective resource management could be financed merely by the contribution of the locals. In fact, numerous issues hinder the success and resource management programs in the project area. Examples are unresolved property rights conflicts around and in Lore Lindu the National Park, weak law enforcement, and continuously increasing pressure from population growth and agricultural intensification. Hence, the influence of our findings on the resource management in the Lore Lindu region should not be exaggerated. However, the importance ascribed to the attributes should encourage decision makers to find solutions that sufficiently consider the local demand for the provision of the ecosystem services observed.

There is still much to be learned about economic benefits of non-market goods and particularly of functional ecosystem services in tropical rainforest areas (Balmford et al. 2002)

as well as in so-called developing countries in general. Our results should be conceived as a point of reference for future research in this field. Among alternative approaches available, the choice experiment promises to be a useful tool for such an endeavor.

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Endnotes:

[i] Further theoretical input was obtained from research of informational processing in judgement and decision-making in psychology (e.g. Luce 1959, Slovic and Liechtenstein 1971).

[ii] Painting was preferred to the use of photographs as people's interest in the latter very often consisted of the specific location shown on the picture, and in deviations from the conditions in their village. Contrarily, the visualization was also aimed at a generalization of the issues (attributes) in order to make sure that village-specific details (all of which could not possibly be addressed) became less important, while the key information was pointed out.

[iii] cf. www.storma.de/DPS/pdf/SDP16b.pdf

[iv] E.g. in the village of Sintuwu, one of the streams providing water for irrigation dried up, in another the water declined to such an extend that irrigation is hardly possible any more.

[v] The authors would like to thank TNC Palu and Muhammad Yasin Paada from UNTAD.

[vi] As any clear objective improvement to the status quo could not be defined for the cocoa attribute, the choice set was not *clearly* dominant. The level included for cocoa in options A and B was 95 % shade, while payment was less for option A. If people stated to have chosen option A because they preferred very high shade in cocoa, the answer was still counted as rational. Respondents choosing A or B for other reasons were given a brief repetition of the explanation of the choice task.

[vii] Mean value over four planting seasons (2003 – 2004) for households that paid irrigation fees in 6 of the sample villages. The authors like to thank Alwin Keil (University of Hohenheim, Germany) for the provision of this data.

[viii] Our data suggests that income from rattan per day is invariant on the distance of the rattan harvesting locations. Rattan collectors always look for locations where there are still enough large diameter canes, as they are far better priced than smaller diameters (and where transport is still feasible). Hence, it is justified to use time savings rather than changes in income in order to derive an estimate of the marginal economic impact of the distance of rattan harvesting locations.