AN ANALYSIS OF LOCAL STAKEHOLDER VALUES FOR TROPICAL PROTECTED AREAS IN MADAGASCAR

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Abstract.—The continued delivery of ecosystem services produced in tropical areas is essential to economic prosperity and human welfare. The success of tropical land protection strategies may depend on the input and support of local people, who often have an intimate and dependent relationship with the land. This study uses conjoint analytic techniques to assess and analyze local stakeholder values with respect to establishment and regulation of two large protected areas in Madagascar. The primary focus is on survey design and analytical methods. Preliminary analyses indicate that watershed protection was the most important attribute for local stakeholders and that there are regional differences in the preferences of local stakeholders.

1.0 INTRODUCTION

Natural ecosystems and the biological diversity contained within them provide a range of goods and services that include biodiversity conservation, carbon sequestration, watershed protection, soil formation, and scenic beauty. Economic prosperity and human welfare depend on the continued delivery of these services. Madagascar is one of 18 recognized mega-diversity countries that represent 80 percent of the world's biodiversity and are a high priority for international conservation efforts. The majority of the biodiversity in Madagascar is found in the forests, which are also the direct source of livelihood for more than 90 percent of the country's population. An annual population growth rate of 3 percent and a subsistence dependency on slash and burn agriculture pressure the remaining forests. As in other developing countries, the standard approach to slow ecosystem degradation has been to establish protected areas and to regulate access. Effectiveness has been limited because establishment of protected areas often takes place at considerable social and economic costs to local communities in terms of access to land, timber, wildlife, and other resources.

Effective management for the provision of ecosystem services must consider tradeoffs over varying geographic and institutional scales (Hein et al. 2006). Local stakeholders may be asked to bear the burden of opportunity costs for protected resources while receiving little benefit. For example, carbon is sequestered at the local level while the benefits are primarily global. Stakeholders at different scales may have different perspectives on the values of ecosystem services based on cultural background, dependency on resources for their livelihood, and other socio-economic characteristics. This disparity often leads to different visions for management and conflicts of interest. Because local people are on site and often have an intimate and dependent relationship with the land, their input and support can be crucial to the success of any tropical land protection strategy. If local residents are not included in the design and implementation of the protection measures, there is a very real threat that protected areas can become "paper" parks with protection falling far below the mandated standards.

This study uses conjoint analytic techniques to assess and analyze local stakeholder values with respect to establishment and regulation of two large protected areas in Madagascar. The Masoala National Park contains 568,000 acres of rainforest and 25,000 acres of marine park, and the Makira Conservation Site is a 1.1 million-acre tropical forest with many lake and river habitats. Conjoint techniques are well suited for soliciting and analyzing preferences in environmental decisions that frequently entail tradeoffs between costs and benefits that are not represented efficiently in market transactions (Dennis 1998). We used a conjoint ranking survey to elicit local stakeholder values and acceptable tradeoffs for varying levels of four attributes that are related to the protected areas: watershed protection (water quality and quantity), wildlife habitats, availability of opportunities for recreation and ecotourism, and the type and extent of the protection or conservation strategy employed for the protected areas. See Table 1 for a description of the attributes and levels used in the study. Both linear and quadratic effects were estimated.

Although preliminary results are reported and discussed, the primary focus of this paper is on an overview of the problem, survey design, development of the conjoint or choice model, and analytical capabilities. Future analyses will examine the marginal rates of substitution (tradeoffs) among the attributes at differing values, as well as regional and demographic differences in preferences among stakeholders.

2.0 METHODS

Conjoint analysis, a form of choice modeling, is a technique for measuring psychological judgments that is used frequently in marketing research to measure consumer preferences for products with multiple attributes (Green et al. 1988). Respondents choose between alternative products or scenarios that display varying levels of selected attributes. The utility or preference for each attribute can be inferred from the respondent's overall evaluations. These partial utilities, or partworths, indicate the relative importance of each attribute's contribution to overall preference or utility. They can be combined to estimate relative preferences for any combination of attribute levels.

Table 1.—Attributes and levels

Watershed protection (water quality and quantity)
1. Water quality for irrigation is insufficient and water quality for drinking and downstream fish habitats is bad most of the year over the next 15 years.
2. Every year there is a 2- or 3-month shortage in water supply for irrigation, and water quality for drinking and downstream fish habitats is good all year over the next 15 years.
3. Water supply for irrigation is guaranteed and water quality for drinking and downstream fish habitats is better all year long over the next 15 years.
Wildlife habitat
1. Deterioration of wildlife habitat that protects rare and endangered species.
2. Maintenance of the current level of improvement in wildlife habitat that protects rare and endangered species.
3. High improvement of wildlife habitat that protects rare and endangered species.
Recreation/ecotourism
1. Deterioration/decrease from the current level of tourism revenue.
2. Maintenance of the current level of increase in tourism revenue (10 percent per year) over the next 15 years.
3. 15-percent increase in tourism revenue per year over the next 15 years.
Type of protection/conservation strategy
1. Limited access to forest resources through "transfert de gestion" [a] to COBA [b] but with no government supervision/regulation.
2. Limited access to forest resources through "transfert de gestion" [a] to COBA [b] but with government supervision/regulation.
3. No access/strict government control.

[a] "Transfert de gestion" is to transfer management of public forest to local communities. There is new legislation that gives the government authority to enter into contractual arrangements with communities for land management.
[b] COBA stands for "communaute de base" in French, which is a community-level forest association. The COBA is made up of local forest users, primarily residents who use forests for firewood, timber, medicinal plants, food, and cultural practices. To be granted a contract, a COBA must have official standing as an association and be sanctioned by the mayor's office.

2.1 Analytical Model

A random utility model is used to explain local stakeholder preferences toward various environmental, economic, and social aspects associated with designation and management of protected areas. When presented with a set of alternatives, individuals are assumed to make choices that maximize their utility or satisfaction. The utility that the i^{th} individual derives from the j^{th} alternative (U_{ij}) can be represented as:

$$U_{ij} = X'_{ij}\,\beta + e_{ij} \qquad (1)$$

where X_{ij} is a vector of variables, which may include transformations of variables, that represent values for each attribute of the j^{th} alternative to the i^{th} individual; β is a vector of unknown parameters; and e_{ij} is a random disturbance, which may reflect unobserved attributes of the alternatives, random choice behavior, or measurement error. In the empirical study under consideration, a respondent's utility level (U_{ij}) for each alternative is not observed, but a ranking (r_j) is observed that corresponds to the order of his or her underlying utilities. The probability of alternative 1 being ranked above other alternatives is:

$$\begin{aligned} P_{i1} &= \Pr(U_{i1} > U_{i2} \text{ and } U_{i1} > U_{i3} \ldots \text{ and } U_{i1} > U_{iJ}) \qquad (2)\\ &= \Pr[(e_{i2} - e_{i1}) < (X'_{i1}\,\beta - X'_{i2}\,\beta) \ldots \text{ and}\\ &\qquad (e_{iJ} - e_{i1}) < (X'_{i1}\,\beta - X'_{iJ}\,\beta)] \end{aligned}$$

Similar expressions hold for each of the remaining alternatives being chosen next in the choice set, and the P_{ij}'s become well defined probabilities once a joint density function is chosen for the e_{ij} (Judge et al. 1985).

McKelvey and Zavoina (1975) developed a polychotomous probit model to analyze ordinal-level dependent variables. They assume that the e_{ij}'s are distributed normally with mean 0 (the variance is standardized to unity), and that the observed variable (Y_{ij}, the ranks for the J alternatives) is related to the true unobserved utilities (U_{ij}) in the following way:

$$Y_{ij} = 0 \text{ if } U_{ij} \le \mu_{i1},\ Y_{ij} = 1 \text{ if } \mu_{i1} < U_{ij} \le \mu_{i2}, \ldots\ Y_{ij} = J\text{-}1 \text{ if } U_{ij} > \mu_{iJ-1}. \qquad (3)$$

The μ_{ik}'s define the boundaries of the intervals for the unobserved utilities that correspond to the observed ordinal response. Since the μ's are free parameters, there is no significance to the unit distance between the set of observed values of Y; they merely provide the ranking.

Estimates are obtained by maximum likelihood and the probabilities entering the log-likelihood function are the probabilities that the observed ranks (Y_{ij}'s) fall within the J ranges defined by J+1 μ's. The parameters to be estimated are J-2 μ's plus the β vector; μ_0 and μ_J are assumed to be negative and positive infinity, respectively. McKelvey and Zavoina (1975) describe the model and maximum likelihood estimators in greater detail.

In the polychotomous probit model, the estimated value ($X'_{ij}\,\beta$) for an observation determines the position of the mean of the distribution of response categories over the underlying scale. The μ's delineate ranges in the unobserved underlying variable (utility) that correspond to the observed response categories. The estimated probability that a response will fall in each category or rank in the case under consideration is measured by the area under the normal standard density curve [$f(X'_{ij}\,\beta)$] and bounded by the respective μ's. These probabilities can be computed using the estimated model parameters:

$$\begin{aligned} \Pr(Y_j = k\text{-}1) &= \Pr(U_j \text{ is in the kth range})\\ &= F(\mu_k - X'_j\,\beta) - F(\mu_{k-1} - X'_j\,\beta) \qquad (4) \end{aligned}$$

where k indexes the rankings and F(•) is the cumulative standard density function, assumed normal for the probit specification. Thus, the effect of a discrete change in the level of the nth independent variable (x_{nj}) on the estimated probability that a response will fall within each of the categories (ranks) can be calculated by substituting the estimated parameters (β and μ's) into Equation 4. In probit analysis the estimated coefficients (β) represent the effect of a unit change in an independent variable on the underlying scale given by $X'_j\,\beta$. Graphically, this change is shown as a shift in the distribution of responses over the underlying scale. The effect of that change on the probability of a particular response occurring will depend on the original position as determined by all the estimated parameters and associated variables.

2.2 Survey Design and Administration

A conjoint ranking survey was used to assess stakeholder values. The survey was translated into Malagasy and pretested with park staff from diverse backgrounds. Based on this pretesting, the survey was revised to minimize technical terms and reduce the length of descriptions. The revised survey was administered to individual stakeholders within a group meeting setting. With help from the Masoala National Park and Makira Conservation Site staffs, we selected four villages in which to hold meetings and identified potential stakeholders to invite. Twenty-five people representing different socioeconomic and demographic groups from each village were invited to participate in the meetings. Invitations were sent out by park managers and village leaders with care taken to include as many stakeholder groups as possible (e.g., farmers, fishers, men, women, and youths). In each meeting facilitators gave an overview of the nature and purpose of the survey and a detailed explanation of the choice attributes and levels. Participants had the opportunity to ask questions or discuss their concerns. Respondents who could not read or write were assisted in a manner that would not influence their choices.

Each respondent ranked nine alternatives, each with one level for each of four attributes. The combinations of attribute levels for the alternatives were chosen using an orthogonal design that allows estimation of linear and quadratic main effects over the entire 81 (3^4) possible attribute combinations, with the least number of choice responses. Table 1 lists the attribute levels and Figure 1 shows a sample alternative. Respondents also completed a series of socioeconomic and demographic questions.

An ordered probit model (described in Section 2.1) was used to analyze the responses to the ranking survey. The dependent variable is the ordinal ranking of the alternatives, which is coded 0 to 9; higher scores are associated with greater utility. The independent variables (attribute levels 1, 2, 3 in Table 1) were coded, respectively, -1, 0, 1 for the linear form and 1, -2, 1 for the quadratic form. This coding scheme maintains the ordinal relationship for the linear term and provides for an orthogonal contrast with the quadratic term.

Alternative #1 ***Packet #-------***

Water supply for irrigation is guaranteed and water quality for drinking and downstream fish habitats is better all year long over the next 15 years.

Deterioration of wildlife habitat that protects rare and endangered species

Maintain the current level of increase in tourism revenue (10% per year) over the next 15 years

No access/Strict government control

RANK

Figure 1.—A sample alternative.

3.0 RESULTS AND DISCUSSION

The survey was given to 87 stakeholders living in the Masoala and Makira regions. Each respondent ranked nine alternative scenarios for a total of 783 preference rankings. Preliminary analyses indicate that all linear effects were significant at the 5 percent level and the quadratic effect was significant only for the recreation/ecotourism attribute (Table 2). The relative importance scores shown in Figure 2 were computed by dividing the utility range for each attribute by the sum of the utility ranges for all attributes. These scores indicate how important a particular attribute was in the overall preference for alternatives but not whether changes in the level of the attribute had a positive or negative influence on preference. The signs and magnitude of the estimated coefficients or partworths supply that information.

Watershed protection was the most important attribute for local stakeholders. Water is important for domestic use in both regions. In the Makira region, respondents indicated that improved water supply would enhance prospects for agricultural irrigation while those in the Masoala region cited enhanced fisheries as a benefit of an improved water supply.

Changes in opportunities for recreation and tourism were the second most important attribute. The significance and magnitude of the quadratic effect indicate that respondents preferred either to allow tourism to deteriorate or to enhance possibilities for tourism over maintaining the current level of increase in tourism (Fig. 3). Verbal comments and discussions indicated that they felt this way because they see little benefit from the current trend.

Stakeholders clearly preferred a high improvement in wildlife habitat (level 3) but showed only a slight preference between levels 1 and 2. Apparently they were not satisfied with the current trends.

Local stakeholders opposed strict government control and losing all access to protected areas (level 3). Beyond this basic view, initial analyses indicated that there was a marked difference between stakeholders in the two study regions. The Masoala National Park has been protected for many years and the local people feel that they have seen little economic benefit. In this region stakeholders preferred the least amount of government control to their access (level 1). But in the Makira region, which is not yet a designated national park, local respondents were more willing to accept government supervision of access (level 2) with the hopes that they will see improved economic and ecological benefits as a result of protection.

Table 2.—Parameter estimates for an ordered probit model

Variable	Coefficient	Std. Error	Pr>ChiSq
Linear effects:			
Water	0.717	0.0487	<.0001
Wildlife	0.405	0.0793	<.0001
Tourism	0.267	0.0638	<.0001
Protection	-0.133	0.0646	0.0391
Quadratic effects:			
Water	-0.003	0.0261	0.9136
Wildlife	0.105	0.0693	0.1305
Tourism	0.202	0.0528	0.0001
Protection	-0.063	0.0518	0.2269
Boundary parameters:			
μ_1	-1.5600		
μ_2	-0.9518		
μ_3	-0.5143		
μ_4	-0.1374		
μ_5	0.2227		
μ_6	0.5792		
μ_7	0.9792		
μ_8	1.4889		

Log likelihood = -1,561.
N = 783 (87 respondents, 9 preference rankings each)

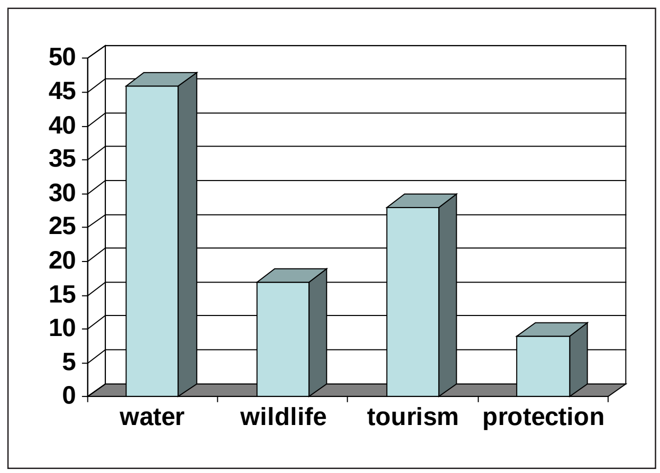

Figure 2.—Relative importance scores.

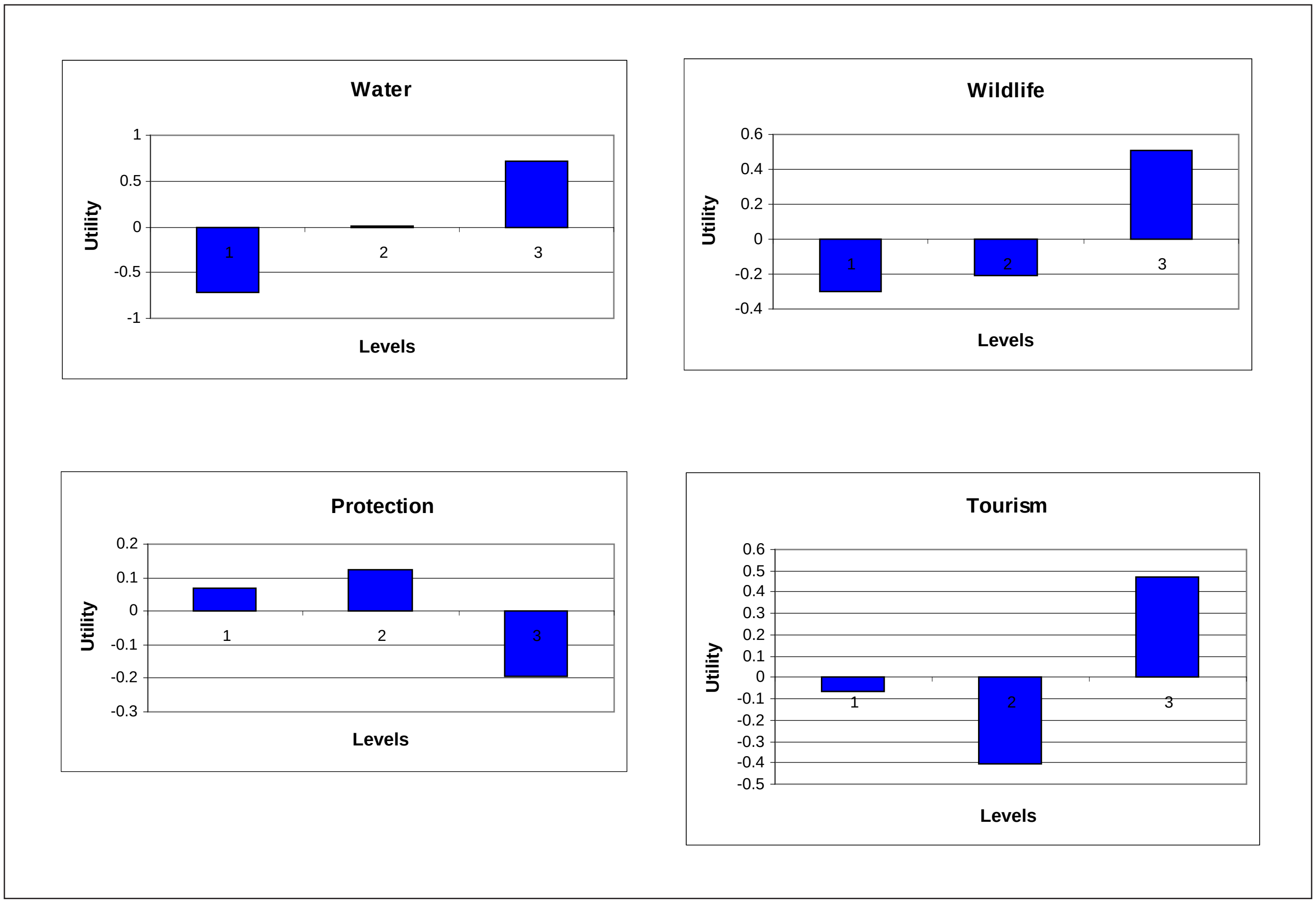

Figure 3.—Partial utilities (partworths) for each attribute level.

4.0 CONCLUSIONS

An understanding and consideration of the values of local stakeholders is deemed important to the ultimate success of protected area management. A conjoint model was given to local stakeholders adjacent to protected areas in Madagascar. Preliminary results indicate a hierarchy of importance in the various attributes associated with protected area management. Water quality and quantity were clearly of the greatest concern to local stakeholders. They were also dissatisfied with current trends in wildlife management and the economic benefits they receive from ecotourism. Although stakeholders in both regions were against strict government control and losing their access to the protected areas entirely, stakeholders in the Makira region were more willing to accept some government regulation and limits to their access in the hopes of seeing improvements in the quality of their lives from the ecological benefits (primarily improved watersheds) and perceived economic gains that might result from protected areas.

5.0 CITATIONS

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