ARE CHARCOAL MAKERS WILLING TO PARTICIPATE IN A SCHEME OF PAYMENT FOR ENVIRONMENTAL SERVICES: A CHOICE EXPERIMENT IN THE COASTAL FOREST OF TANZANIA

Kahyarara, G.

University of Dar-es-Salaam

ABSTRACT

Economic instruments such as Payment for Environmental Services (PES) have become very popular to jointly address poverty alleviation and sustainable management of natural resources. In this paper we focus on the suppliers of the environmental services in a case study in the Coastal Belt Forests of Tanzania. A Choice Experiment is conducted to determine charcoal makers' willingness to participate in a PES scheme and the compensation necessary to make them give up their destructive – but vital income generating – forest activities, mainly charcoal production. We find that this willingness does exist, especially if other cash generating alternatives are offered. However we also conclude that a PES alone will not be sufficient to halt the destruction of the Coastal Forests if nothing is done to curb the growing urban demand for charcoal.

INTRODUCTION

During the last two decades, economic instruments such as Payment for Environmental Services (PES) have been implemented all around the world, trying to jointly address poverty alleviation and sustainable management of natural resources (Landell-Mills and Porras 2002; Pagiola *et al.* 2002). Popular markets include, among others, markets for watershed services and carbon sequestration. Tanzania is not an exception. In recent years, the concept of PES has been recognised in Tanzania as one of the pillars of policies on forest conservation. To test the feasibility of PES in Tanzania, special attention has been given to potential buyers of environmental services. Elaborate surveys have been conducted to test the willingness to pay (WTP) of water companies, irrigation schemes, and other beneficiaries to participate in PES programmes. Obviously, this is a first crucial step in setting up a new market for environmental goods and services.

Although not completely ignored, the supply side of environmental services – the forest dwellers – receive much less attention in the development of PES schemes. Apparently, suppliers are by definition assumed to be willing to substitute their current unsustainable practices for activities that fit in the concept of sustainable forest management. Whether such an assumption is justified, and under which conditions suppliers may be willing to participate, is rarely tested.

The main objective of this paper is to determine the forest dwellers' willingness to accept compensation and participate in a PES scheme. The forest dwellers are from the Coastal forests and beneficiaries are in Dar es Salaam. Since 1988, some parts of Tanzania's Coastal Forests have experienced very high deforestation rates. Moreover, the level of poverty in this region is very high and increasing due to

disappearing forests. To determine these forest dwellers' willingness to participate and increase our understanding of their motives, a choice experiment (CE) has been conducted among 360 potential suppliers of environmental services.

The paper is structured as follows. In Section 2, the study area and survey setup and results are described, with a special focus on the forest dependence of the forest dwellers. Section 3 presents the CE and its results. Finally, in Section 4, the results of the CE are discussed in the larger context of forest management and charcoal supply and demand in and around Dar es Salaam. The feasibility of setting up a PES scheme is specifically addressed.

METHODOLOGY OF THE STUDY

Site selection

Two forest reserves within the Coastal Belt Forests were selected for this study: Pugu and Kazimzumbwi Forest Reserves. Even though these forests are relatively small –together covering a little more than 7000 hectares – they are interesting case studies because of their proximity to Dar es Salaam. This has made them especially attractive for charcoal production and timber extraction, and despite being officially protected, they are characterised by very high deforestation rates.

This deforestation within the reserves mainly took place after the 1980s. Between the

1950s and 1980s the areas outsides the reserves were largely converted from open woodland and bush- land to tree crops, but the reserves themselves were largely spared (see Figure 1).

Methods

A choice experiment (CE) is a stated preference technique, meaning that respondents are asked to evaluate hypothetical goods or scenarios. Respondents are presented with a choice set of alternative scenarios and asked which alternative they prefer. These alternatives are described by a number of attributes, which have multiple levels that differ in each alternative. Usually, choice experiments are conducted to derive a monetary value of a certain (public) good, and therefore one of the attributes is often a monetary cost. For instance, a certain nature park could be described by a number of attributes and the monetary cost attribute could be an entrance fee people would have to pay. This is comparable to the contingent valuation method, where, after a description of the park, people would also be asked if they would be willing to pay a certain entrance fee. The advantage of a choice experiment is the ability to understand more accurately what exactly people would be willing to pay for, because a monetary value can be derived for each of the attributes.

It is very important to carefully select the relevant attributes and assign their levels.

Relevant attributes should be considered important characteristics of the good by the target population, and it has to be possible to influence them by for instance a policy change. What people think are important attributes and realistic levels can be investigated in focus group discussions (Bateman *et al.* 2002). While it is vital to describe the good accurately, care has to be taken not to overstretch the analytical capacities of the respondents. Too many attributes will make it impossible for them to easily evaluate the alternatives. As a result, respondents might base their choices on just one or two attributes, or even lose interest in the choices all together and either refuse to participate or select the alternatives arbitrarily.

After the relevant attributes and levels have been determined, the next step is to

construct the alternatives from the different attribute levels and the choice sets from the different alternatives. One of the alternatives is always a non-of-the-above option, which can be considered a choice for the status quo or no-change. These designs have to meet certain criteria to warrant meaningful results. We refer to (Louvierre *et al.* 2000) for further information about how to construct these designs.

Theoretical foundation of CE

$$P(i)=P\{V_i + \varepsilon_i > V_j + \varepsilon j;\ \forall j \epsilon C\}$$

where *C* is the choice set. Specific choices of error distributions lead to methods for the estimation of the parameters of this utility function and to quantitative representations of trade-offs between attributes. An assumption of Type I extreme value distributed errors produces the conditional specification of the probability of choice or

$$P(i) = \frac{e^{vi}}{\sum_{j \in c} e^{vj}}$$

This function can be estimated using the conditional logit model (McFadden 1974).

Design of the CE

The goal of choice experiment differs a bit from the usual environmental valuation. In particular, it intends to know if respondents would be willing to reduce their destructive forest activities in return for compensation and what kind of compensation they preferred. The experiment therefore asked respondents to choose between several scenarios in which they would reduce their destructive forest activities, mainly charcoal production, and would receive several forms of compensation. Here, the 'cost' attribute, which in most CE studies is some sort of monetary value like an entrance fee, is the reduction in destructive forest activities.

The theoretical foundation of the CE is the random utility theory. In random utility theory, a person's utility *U* from a certain alternative *i* is described by the following utility function.

$$U_i = v_i + \varepsilon_i$$

This utility is made up by an objective or deterministic component (*Vi*) and a random error component (ε_i) Alternative *i* will be chosen if its utility is greater than that of alternative *j*. The probability of choosing alternative *i* over *j* is:

To determine the relevant attributes and get an idea of realistic levels, the study first consulted experts from local development agencies, and aimed at linking up compensation schemes with existing alternative livelihood strategies implemented in the region. This would ensure that people were familiar with our attributes and also reduce the chance of unrealistic scenarios. We consequently held focus group discussions in the study areas in which we discussed the attributes and levels. Based on this we constructed a tentative design, and conducted 40 pre-tests to see if we were on the right track. The results from this pre-test, however, were counter-intuitive in that 'cost' attribute had a positive utility. This means that people received a positive utility from giving up their destructive forest activities. Even though it is very hard work to make charcoal and not a first choice occupation for most, it is the most important source of income, especially cash income, and we did not expect people to want to give this up without some form of compensation.

Since the pre-tests interviews had already given impression that respondents had a hard time understanding the choices, the experiment decided to reduce the number

of attributes in each alternative from five to four. It also reduced the levels of the compensation attributes to make these less attractive.

The results from a second pre-test were much more encouraging. All attributes behaved as expected and the choices were about equally divided over the status quo and hypothetical scenarios, indicating a well-balanced design.

In the final survey each choice set contained two hypothetical scenarios and the possibility to choose the status quo. Next to the "loss of income from destructive forest activities" we used the attributes "training for alternative livelihoods", "jobs in forest management", and "provision of a soft loan to set up a business". Table 4 shows the attributes and levels.

The 'train' attribute was explained as a fixed number of days of training that would help people in setting up a small business, like a poultry farm, processing honey, etc.; 'jobs' are jobs in forest management. We explained the kind of activities such a job would entail, and described the jobs as being for one day in the week, and paying 2000 TZSs per day. They would be provided at community level and it would not be certain that the respondent would land one of the jobs himself. The 'loan' attribute represents a soft loan carrying an interest rate of 5% that would have to be paid back in installments over the next two years (the first installment being due after six months).

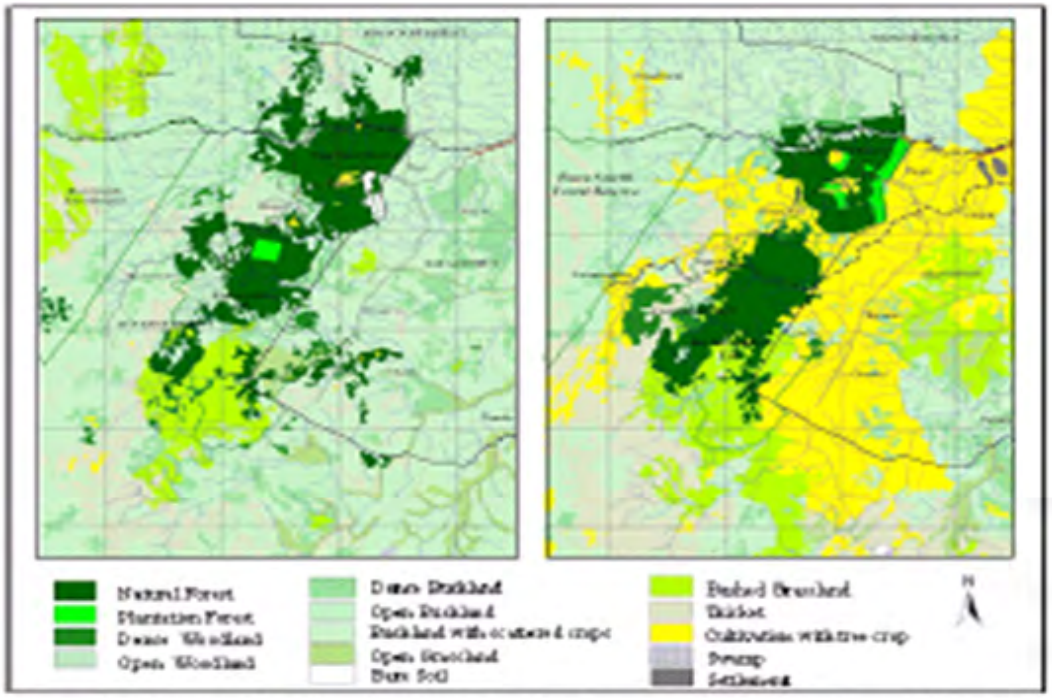


Figure 1 Land cover of the Pugu/Kazimzumbwi forest reserves and surroundings 1953-1988

Table 1 even shows a small increase in natural forest in this period. This increase took place in the southern Kazimzumbwi reserve. In the northern Pugu reserve, on the other hand, there was some encroachment with plantation forests and cultivated tree crops

Table 1 Land cover of the Pugu/Kazimzumbwi forest reserves in hectares

Land cover type	1953		1987		2005		Percentage	Percentage
	Area (unit)	%	Area (unit)	%	Area (unit)	%	Change 1953-1988	Change 1988-2005
Natural forestry	3833	53	3959	54	531	7	3	-87
Woodland	479	7	327	4	1773	24	-32	443
Bushland	371	5	387	5	1192	16	4	208
Bushland with scat cult	1002	14	216	3	474	7	-78	120
Cult with tree crops	69	1	998	14	1754	24	1343	76
Grassland	1328	18	1179	16	1401	19	-11	19
Other	183	3	201	3	141	2	10	-30
Total	7266		7266		7266			

After 1987 the encroachment in Pugu forest continued, and most of the natural forest has degenerated into dense woodland (see Figure 2). However the major difference between the two periods is the disappearance of natural forest in the Kazimzumbwi reserve. Some of it has also degenerated into dense woodland, but most of it is now bushland or bushed grassland.

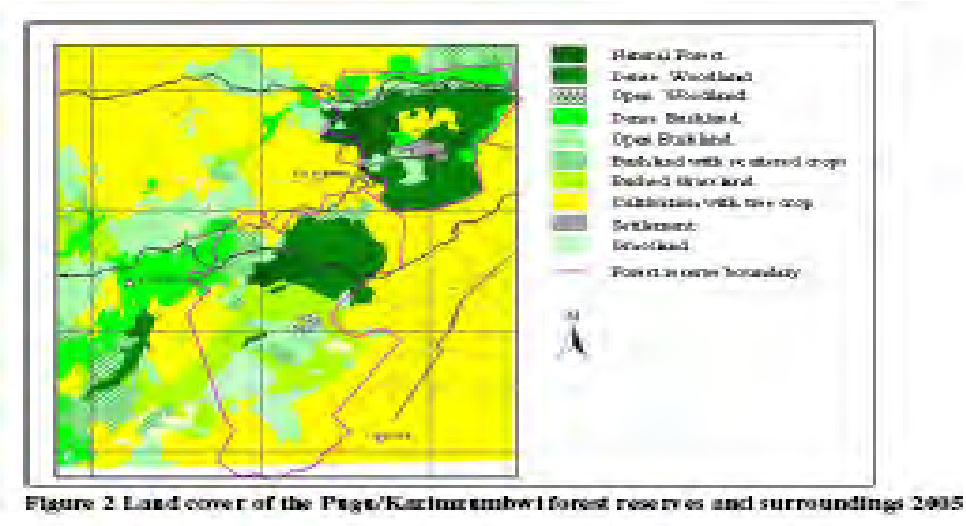


Figure 2 Land cover of the Pugu/Kazimzumbwi forest reserves and surroundings 2005

Figure 2 Land cover of the Pugu/Kazimzumbwi forest reserves and surroundings 2005

Sampling

The choice model questions were part of a household questionnaire in which we elicited information on among other things education, land holdings, income sources, charcoal production, timber extraction, the collection of forest products and environmental awareness.

Eight villages around the Pugu and Kazimzumbwi Forest Reserves were selected for the survey. People from these villages are the main users of the forests, although some people from more distant villages are also active in the forests. Here we will report on the data collected from seven villages. One village, Chanika, was used in the second pre-test and even though the questionnaire did not change significantly after that pre-test, it has not

been tested yet if the data from Chanika are consistent with those from the main survey.

The sample for the survey was drawn from the village registers maintained both at the village as well as the District administration authorities in the respective areas. Since our central interest was to interview villagers whose daily activities involve cutting down trees, and particularly making charcoal, we requested village leaders and other important people in the villages with in depth knowledge of the major economic activities of each village member to compile a sample frame that contains village members that are involved in these activities. The share of households that are involved in such activities differs per village as can be seen in Table 2. In all villages, however, the share of household involved in unsustainable forest activities is considerable. From the final sample frame of 1825 households we randomly drew 360 households, which were interviewed in the winter/spring of 2005. Besides charcoal makers, we also interviewed a number of timber extractors. These are included in the reported results here, but we focus mostly on charcoal makers, since this is by far the largest group and charcoal production is the main cause of deforestation in our study areas.

Table 2 Share of households involved in charcoal

Village	Total population	Total number of household	Share involved in charcoal
Kazimzumbwi	1734	311	43%
Kifuru	1272	213	40%
Maguruwe	937	289	35%
Kisanga	1640	394	31%
Kola	2878	135	67%
Buyuni	541	654	40%
Pugu	18085	4110	22%
Total	27087	6106	28%

Table 2: Importance of charcoal in household income

	All (n=360)	Charcoal maker(n=185)	Farmer (n=138)
Total income	979225	890725	663524
Median total income	678,100	808,000	437,471
Share charcoal	58%	80%	38%
Share crops	14%	7%	25%
Share livestock	1%	0%	3%
Share forest product	17%	12%	26%
Cash income	884219	800646	549649
Median of cash income	540,000	666,000	308,100
Share cash	81%	87%	71%
Share charcoal	69%	91%	50%
Share corps	16%	6%	33%
Share livestock	1%	0%	3%
Share forestry product	3%	2%	5%

SURVEY RESULTS

For some of the household heads the production of charcoal was the main activity, but there is also a big group that farm as a main activity. We use this distinction throughout this section because the two groups are different in their production of charcoal.

Reliance on charcoal

As can be seen from Table 3 households are very dependent on charcoal as a source of income. Even for those who indicated to be farmers first, charcoal made up the biggest share of household income. It is also clear from the table that charcoal is especially important for households' cash income.

Almost everyone interviewed also farmed, but this is mainly subsistence farming.

Cassava is the staple crop in this area, but some people also grow maize and beans.

Cassava leaves are harvested as the most common vegetable. Very few households had fruit trees or grew other vegetables. Livestock rearing is also uncommon in these villages and forms only a very minor share of both the cash and total income. Even if only households are selected that own livestock its share in total income only amounts to 7%

Most households also collected other forest products. This is almost exclusively firewood, but building poles, forest fruits, mushrooms, medicines, thatching grass and ropes are also collected. Building poles are usually sold, but the other products are predominantly for own use.

The production of charcoal takes up most of the time of the people involved. Both respondents who indicated to produce charcoal as their main activity, as well as those who claimed to be farmers first, spend around 220 days a year in the forest making charcoal. The first group, however, is a lot more efficient. On average, they produce

267 bags a year, while the farmers do not produce more than 171 bags. The kilns used by charcoal makers are also almost twice as large. Based on these figures, we can roughly estimate how much charcoal is produced yearly in these two reserves. Our estimates will be on the low side, because we miss the other forest users from more distant villages. Extrapolating our survey data to the seven selected villages, we come to a total of around 400,000 bags. If we include Chanika, which is similarly close to the forests as the other seven villages, in the extrapolation we come to around 500,000 2 bags. Estimates for total charcoal demand from Dar es Salaam range between 15 and 18 million bags.

Even though charcoal is currently a very important source of income for these people, this income is not durable. We already saw that the forests are being depleted, and it will take more and more time to produce the same amounts of charcoal. People will have to travel further and use smaller trees. Besides, during our research it became clear that charcoal making is not a popular occupation due to the hard work and its illegal character. The forest dwellers have also started to notice the negative affects of deforestation themselves, which should motivate them to consider other options. In the next section we give an overview of the results from the environmental awareness section in our questionnaire.

Environmental awareness

In all seven villages environmental and development groups are active. The three main NGOs that support environmental village groups are the Forest Conservation Group (TFCG), Wildlife Society of

Tanzania (WCST) and CARE. They work together in a joint project called WAHIPUKA, which is the Swahili abbreviation of "The Advocates of the Pugu and Kazimzumbwi Forests". Through the WAHIPUKA project a forest committee has been set up in each village which is supposed to form a local area forest conservation network. Another active organisation in the area is MISAKA. It tries to enhance alternative livelihoods for the villagers through savings and credit schemes. More than three quarters of all respondents were aware of presence of these organisations. At less than 10% membership of the village groups is much lower.

Unsurprisingly almost everyone (95%) said to have noticed the disappearance of the forests, and 80% expected there to be very little or nothing left of the forests in ten years time. The respondents confirmed our earlier conclusion that the production of charcoal had done most damage to the forest, when compared with for instance clearing land for farming or timber extraction.

Even though initiatives are being set up to give villages greater control over the forests and decentralising control to lower levels is often suggested as a way out of the current ineffective forest management, our respondents mostly expected the central government to act (see Figure 3).

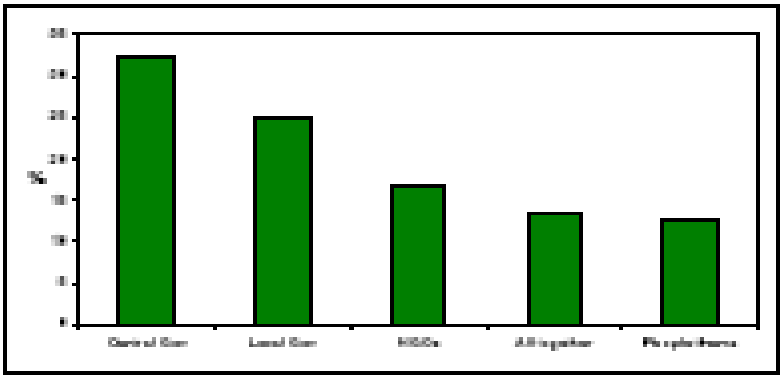


Figure 3 Main perceived responsible actor to stop deforestation

We also let respondents rate possible measures to reduce deforestation. The variation in the answers is not enormous, but we can see that stricter control by forest officials is least popular, and respondents saw a structural move away from charcoal as the main fuel used in urban areas as most promising. The high score for supporting alternative livelihoods is encouraging, but may have been influenced by the fact that this section came after the choice experiment. Respondents may have been triggered by the scenarios in the choice experiment.

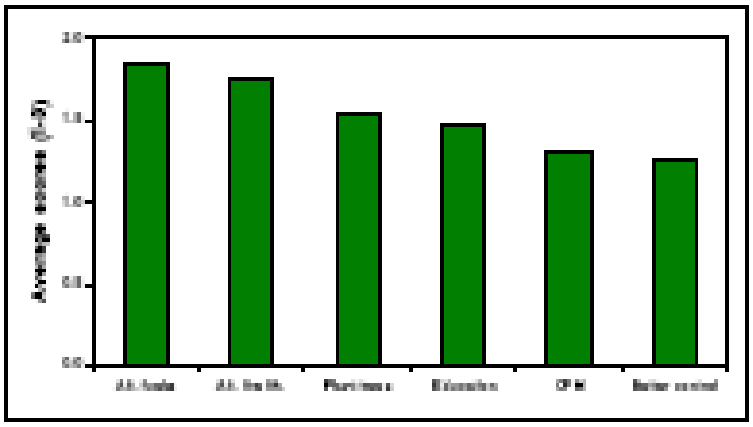


Figure 4 Possible measures to reduce deforestation

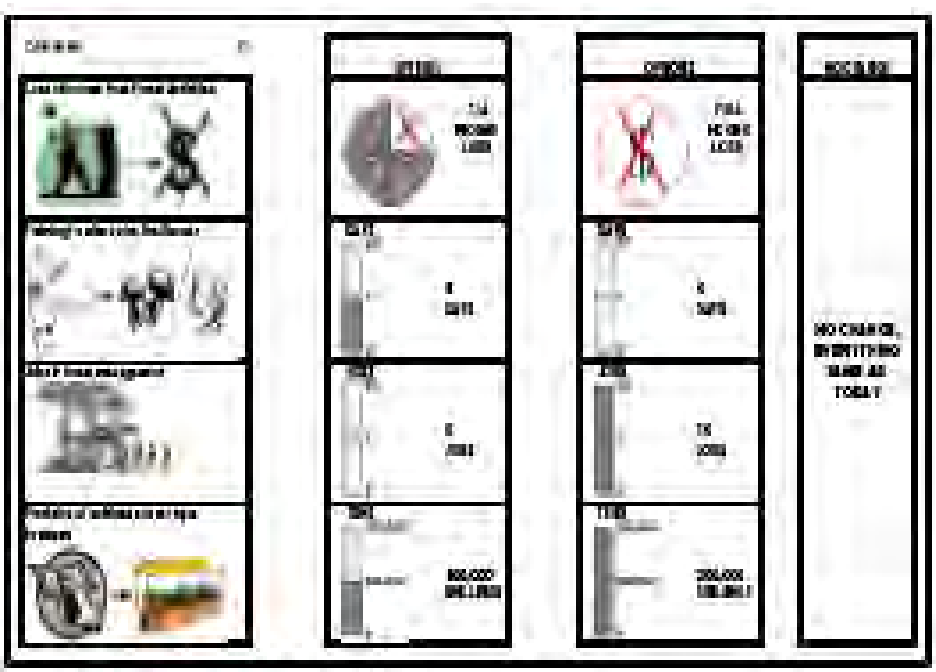
Considering the awareness of the problems together with the fact that charcoal is not a preferred occupation make us expect that people would be willing to give up their destructive forest activities if they had alternative options to earn a reasonable (cash) income. To test this more explicitly and to find out what form of compensation was preferred, we conducted a choice experiment among the forest dwellers. The preliminary results of which are described in the next section.

Table 4 Attributes and levels of the choice experiment

Attributes	Levels	Abbreviation
Loss of income from		
destructive forest activities	4 (25%;50%;75%;100%)	tree
Training for alternative live hood		
(No. of days of training)	3 (0;5;10)	train
Jobs in forest management (No. of		
Jobs per community)	3 (0;5;10	job
Provision of a soft loan to set up a		
business (TZS)	3 (0;5;100,000;200,000)	loan

Choice experiment results

We used a fractional factorial design (Louviere *et al.* 2000) that considers only main effects and ignores potential interactions among attributes. That meant having 24 alternatives. We divided this over four versions with six choice sets each. Each respondent therefore had to make six different consecutive choices. An example of a choice set is provided in Figure.



Source: A sample of Experiment cards designed by the author

RESULTS AND DISCUSSION

Table 5 shows the results from the model. All coefficients are have expected signs and are highly significant. Specifically, the tree coefficient is negative and significant. Such results suggest disutility of partly giving up tree cutting as one of income. The other coefficients are all positive. In sum they indicate gain in utility after participation in the PES scheme. The model provides a relatively good fit of the data as demonstrated by a pseudo R squared of 0.22. As a rule of thumb a good model should have an R-squared between 0.2 and 0.4. However, it should be noted that beyond significance, sign, and relative size the interpretation of the coefficient values is not straightforward. They do not have any simple interpretation like being equal to the marginal increase in probability for choosing a certain alternative.

This problem can partly be handled by calculating the marginal effects, or the elasticity. However, the interpretation of the marginal effects is not always straightforward either. It is therefore meaningful to compute the marginal rates of substitution (MRS) between the attributes using the coefficient 'tree' as the numeraire.

$$MRS = -\frac{\beta_{A1}}{\beta_{A2}}$$

The MRS is the rate at which respondents are willing to trade-off one attributes for another given that everything else is held constant. As can be seen jobs in forest management is the most preferred form of compensation. Respondents are willing to give up 10.3% of their forest income in exchange for one community job. Similarly they are willing to give up 5.4% of their forest income for one day of training. With regard to "loan", respondents are willing to give up 0.88% of forest income for a loan of 1,000 TZSs.

Table 5 Estimated choice model forest

Attributes	Model 1	MRS
Constant	-1.5144	
	(0.1292)	
Tree	-0.0181	
	(0.0014)	
Train	0.0991	5.47
	(0.0094)	
Job	0.1816	10.29
	(0.0096)	
Loan	0.0159	0.88
	$(6.2*10^{-4}$	
Pseudo R^2	0.22	
No. of observations	2160	

Note: Standard errors are in brackets

It is not surprising that jobs are the most popular of the compensation attributes. They offer cash income, and that is exactly the attraction of the destructive forest activities.

The fact that loans are not a highly preferred compensation option is probably influenced by people's unfamiliarity with loans. Moreover, our survey results showed that many people do not take out loans because they worry they may not be able to pay them back.

CONCLUSIONS

The survey and the CE show that forest dwellers consider charcoal making as a means of last resort. The income generated is sufficient to meet the most basic needs, yet the labour conditions are poor and the constant threat of being arrested make charcoal making a relatively unpopular occupation. Moreover, the growing awareness of the increasing scarcity of forests for charcoal making also provide an incentive for alternative livelihood. Therefore, if reliable options for alternative livelihood are provided, forest dwellers in the Coastal Forest of Tanzania proved to be willing to switch to these other types of employment. PES can thus be considered a welcome instrument to facilitate this transition towards more sustainable forest management. One major obstacle in achieving the switch from a charcoal based forestry sector towards a sector that provides environmental services, is the continuing increase of charcoal demand in Dar es Salaam. The city's charcoal intake represents about half the national urban demand. It is estimated by prem study that about 85% of its population depends on charcoal as a source of energy for cooking purposes. Charcoal is often used in combination with kerosene and more rarely with electricity. Both kerosene and electricity have comparatively higher prices than charcoal and are mainly used for lighting. Electricity, in particular, is almost exclusively a privilege of high-income groups. Apart from price related reasons, charcoal is the most used fuel by the majority of urban and rural people because of its availability, reliability of supply, and low initial investments costs; charcoal stoves are quite inexpensive and need almost zero maintenance. Eliminating the supply of charcoal will lead to major distortions in the energy market, which in turn may increase the attractiveness to restart charcoal production. Therefore, introducing PES involves more than only

connecting demand and supply of environmental services. The demand side of charcoal also needs to be addressed.

Finally, the results of this study demonstrate that the Choice Experiment is a useful tool for valuing benefits in the context of PES and can be used in a complementary manner with more traditional economic valuation methods. The CE is an efficient means of collecting information, since choice tasks require respondents to simultaneously evaluate multi-attribute profiles. In addition, economic values are not elicited directly but are inferred by the trade-offs respondents make between monetary and non-monetary attributes. This makes it especially suitable for retrieving information from respondents whose level of poverty is not determined by cash income alone. This non-monetary dimension of CE is especially useful in the context of PES because the actual payment in the schemes often also takes place in the form of non-cash compensation such as health facilities, education and infrastructure. A further advantage of the CE is that research is not limited by pre-existing market conditions, since the levels used in a choice experiment can be set to any reasonable range of values. As such, the CE can also be used as a policy tool for exploring proposed or hypothetical futures such as a PES scheme.

REFERENCES

Bateman, J. *et al.*, 2002. Economic valuation with stated preference techniques: a manual, Edward Elgar.

Landell-Mills, N. and Porras, I.T., 2002. Silver bullet or fools' gold? A global review of markets for forest environmental services and their impacts on the poor. Research report by the International Institute for Environment and Development (IIED), London.

Louvierre, J.D. *et al.* 2000. Stated Choice Methods: Analysis and Application. Cambridge, Cambridge University Press.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behaviour. Frontiers in Econometrics. in P. Zarembka. Frontiers in Econometrics, New York, Academic Press. pp105-142.

Pagiola S., Bishop J., and Landell-Mills, N., 2002. Selling forest environmental services.