Journal of Environmental Management 92 (2011) 2634–2646

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

A conjoint analysis of landholder preferences for reward-based land-management contracts in Kapingazi watershed, Eastern Mount Kenya

Bedru Babulo Balana [a,*], Thomas Yatich [b], Miika Mäkelä [b]

[a] The James Hutton Institute; Social, Economic & Geographic Sciences Group, Craigiebuckler, Aberdeen AB15 8QH, Scotland, UK
[b] World Agroforestry Centre (ICRAF), United Nations Avenue, Gigiri, PO Box 30677, Nairobi 00100, Kenya

ARTICLE INFO

Article history:
Received 23 July 2010
Received in revised form
23 May 2011
Accepted 1 June 2011
Available online 22 June 2011

Keywords:
Landholders
Watershed services
Land-management contract
Conjoint analysis
Rewards for environmental services
Attributes
PRESA

ABSTRACT

Unsustainable land-use decisions and agricultural practices have become the key drivers of deteriorating watershed services in developing countries. However, landholders may have little or no incentives to take these impacts into account in their decision-making process. In recent years, reward-based provision of environmental services has emerged as an important market-based incentive for motivating landholders to adopt environmentally friendly land-use changes and agricultural practices. In this regard, for instance, the Pro-Poor Rewards for Environmental Services in Africa (PRESA) project has emerged as a large network to support and facilitate reward mechanisms in Africa. However, in many African rural settings, little is known about landholder attitudes and preferences related to the alternative land-management schemes.

Using locally identified sets of six key land-management attributes, this paper applies conjoint methods to evaluate landholder preferences towards alternative land-management schemes aimed at enhancing the provision of watershed services in the River Kapingazi catchment in central Kenya. Data were collected from primary sources through focus groups and a questionnaire based conjoint survey. Three conjoint models were used; a traditional conjoint ratings model, a binary logit model, and an ordered logit model.

Results from the focus groups indicated that shortage of water for both domestic use and irrigation was perceived as the most acute environmental problem in the area. Deforestation, poor river bank management and agricultural practices were identified as the major causes of the problem. Results from conjoint models show that the three principal attributes influencing landholder's ratings and probability of adopting the proposed land management options were 'size of land area to be committed', 'length of contract period', and 'granting or prohibiting rights to harvest environmental products from the committed land'. Thus, these attributes should be the focal points in designing land-management contract for watershed services in the study area.

1. Introduction

Ecosystems provide people with a range of benefits that are fundamental to human well being. However, many of these ecosystem services are being degraded or used unsustainably (MEA, 2005). Watershed environmental services are among the ecosystem services that have been degraded globally, particularly in developing countries. Land-use decisions and agricultural management practices appear to be the key factors that affect the provision of watershed services. Landholders[1] upstream can affect water quantity and quality downstream through their decisions on land-management practices and land-use changes, but they have little or no incentives to take these external impacts into account in their private decision calculus (Pagiola et al., 2002; Smith et al., 2006).

Reward for environmental services (RES) has emerged as an important market-based incentive mechanism to translate external, non-market values of the environment into real financial incentives for local actors to provide environmental services (Engel et al., 2008; Pagiola, 2008; Smith et al., 2006). The theoretical foundation of this market-based instrument was described several decades ago (Coase, 1960). According to Coase, environmental externalities can be solved through private bargaining between people who are willing to pay in order to reduce environmental damages and people are willing to accept compensation in order to reduce their activities that generate the damages. However, the practical implementation of this theory as an instrument for

* Corresponding author. Tel.: +44 1224 395290; fax: +44 1224 395036.
E-mail address: bedru.balana@hutton.ac.uk (B.B. Balana).

[1] In this paper we use 'landholders' and 'farmers' interchangeably.

0301-4797/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jenvman.2011.06.001

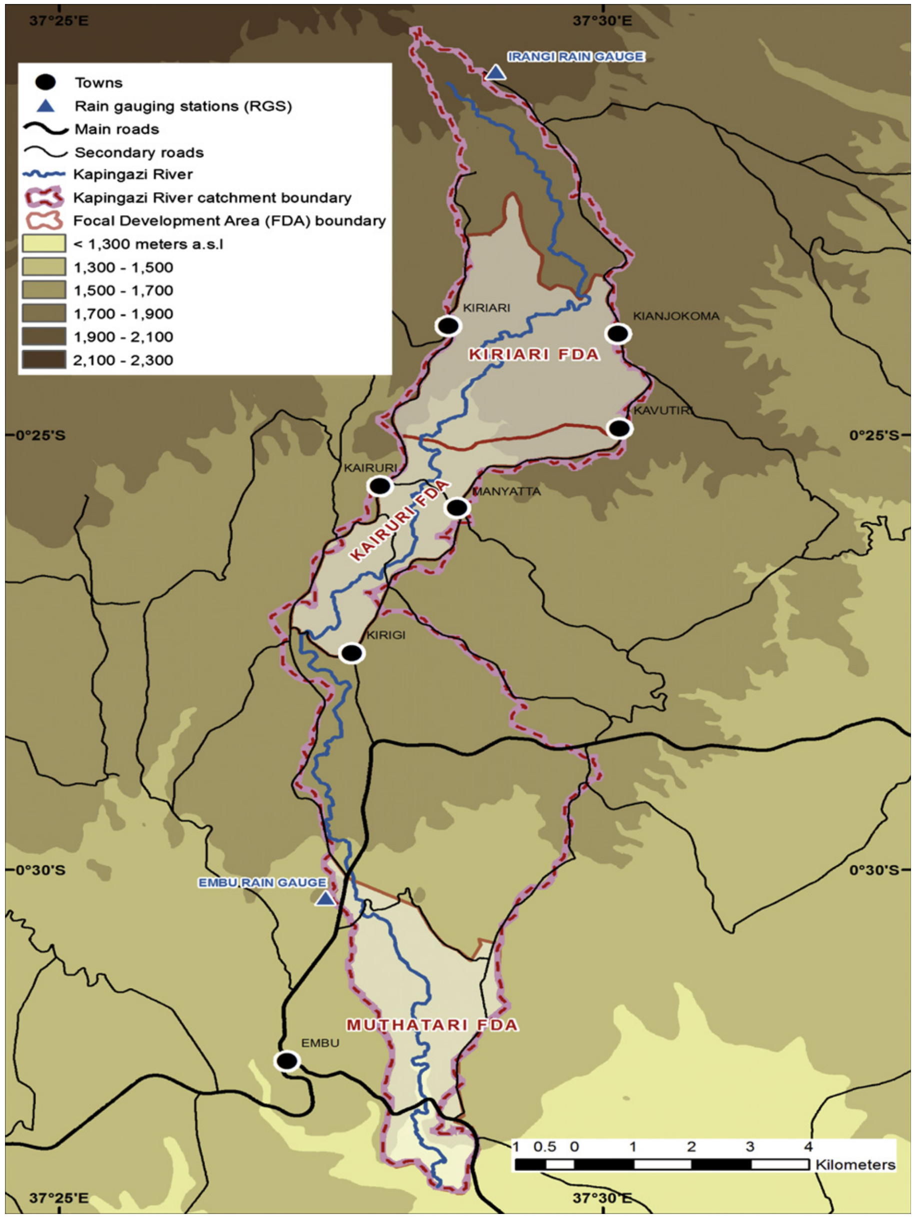

Fig. 1. Location of the study sites in the Eastern Mount Kenya region.

tackling natural and environmental resource management problems has started only more recently.

In recent years there has been growing interest in rewards for watershed services as a tool for watershed management in developing countries. Schemes using these principles include; Working for Water (WfW) Program in South Africa (Turpiea et al., 2008), Pimampiro municipal watershed-protection scheme in Ecuador (Wunder and Alban, 2008), Payment for Hydrological Environmental Services (PSAH) Program in Mexico (Munoz-Pina et al., 2008), and the Lake Naivasha environmental services contract in central Kenya. The Lake Naivasha contract is part of a joint World Wide Fund for Nature (WWF) and CARE-Kenya scheme known as Equitable Payment for Watershed Services (EPWS) (Kimenga, 2010).

Most recently, the World Agroforestry Centre (ICRAF) has initiated the Pro-Poor Rewards for Environmental Services in Africa (PRESA) project to support and facilitate reward mechanisms in Africa. PRESA is working at sites in Kenya, Tanzania, Uganda and Guinea. One of the sites in Kenya that PRESA is interested in is along River Kapingazi watershed in Eastern Mount Kenya region. Losses of forest cover, land-use changes and unsustainable agricultural practices have caused surface run-off and soil erosion. The concomitant siltation of streams, reservoirs and dams become the major hydrological threat in Kapingazi watershed.

Reward mechanisms could create incentives for landholders to adopt environmentally friendly land uses and best management practices. In this regard, PRESA plays an intermediary role in facilitating reward-based conservation. Landholders are intended to be the potential providers of the environmental services, whilst hydroelectric power generators, municipal water companies, and irrigators will be among the major potential beneficiaries or buyers.

However, little is known about landholder attitudes and preferences related to alternative land-management schemes in River Kapingazi catchment. Understanding landholder preferences for the attributes of the intended land-use changes and new management practices is a vital component of designing and planning sustainable watershed management. Such an understanding is crucial for designing a reward scheme for environmental services and negotiating with potential buyers of ecosystem services. Using the method of conjoint analysis the aim of the present study is to assess landholder preferences over explicit attributes of reward-based land-management contracts, in the Kapingazi catchment in central Kenya. Conjoint methods have been widely applied to deal with similar issues (Alvarez-Farizo and Hanley, 2002; Arifin et al., 2009; Sayadi et al., 2005; Stevens et al., 1999; Wynn et al., 2001). The specific objectives of this study were to: (i) identify specific sets of attributes and attribute levels in a participatory environment to characterize land-management schemes; (ii) assess the relative importance of different attributes in conditioning landholder preferences; (iii) evaluate landholder preferences towards alternative land-management schemes; and (iv)draw policy implications in designing reward-based local resource management schemes.

The remainder of the paper is organized as follows. Detailed descriptions of the study area, sampling design, data, and the conjoint models applied in the study are presented in Section 2. Section 3 presents the empirical implementation of conjoint methods where attributes, attribute levels and conjoint experimental design are discussed. A qualitative summary of focus group findings is presented in Section 4. Section 5 provides the results of conjoint analysis including descriptive statistics and findings from ordinary conjoint model, binary logit and ordered logit models. Conclusions and policy implications are presented in Section 7.

2. Materials and methods

2.1. Description of the study area

River Kapingazi is a major tributary of the larger Rupingazi River, which run in parallel on the South-eastern slope of Mount Kenya, in central Kenya. The Kapingazi eventually drains into the Rupingazi approximately 3.5 km southeast of Embu town (Fig. 1). The total area of Kapingazi catchment is about 62 km^2. The bounding coordinates of the catchment are approximately 37°27′–37°31′ E and 0°20′–0°34′ S. The catchment's elevation varies from about 1200 to 2100 m above sea level (m.a.s.l).

The Kapingazi River begins at the forest boundary on the Eastern slope of Mount Kenya at approximately 2000 m.a.s.l. It flows southeast joining the larger, Rupingazi River 750 m lower. The Kapingazi has an average inclination of 3% which is about four times steeper than the remaining journey of the Rupingazi River. At about 1000 m.a.s.l. the meandering Rupingazi eventually reaches the Kamburu reservoir, which is the second biggest reservoir in a series of six reservoirs along the large Tana River. Flowing east across the entire country, the Tana eventually discharges into the Indian Ocean, about 60 km north of the coastal town of Malindi. The rainfall pattern within the Kapingazi catchment is bimodal. Between March and May heavy rainfall is followed by a dry period from June to September, with an average annual rainfall between 1220 and 1800 mm on the lower and upper part of the catchment, respectively. Temperature varies with a mean maximum of 27.1 °C to the mean minimum of 21.2 °C.

With an estimated population density of 402 persons/km^2, the population density in Embu district is much higher than the Kenyan national average of 68 persons/km^2 (Ministry of Planning and National Development, 2005). As a result of high population pressure, the catchment is characterized by small landholdings and increasing agricultural intensification (Boserup, 1965; Demont et al., 2007). Only the most northern tip of the catchment is under forest cover, due to it being within the Mt. Kenya forest reserve. Dominant crops in the catchment include tea, coffee, maize and beans. The cropping pattern varies along the catchment with tea zone in the upper part of the catchment, especially in Kiriari (Fig. 1). A transition zone where both coffee and tea are dominant is in the middle part of the catchment (Kairuri) and the coffee zone in the lower part of the catchment (Muthatari) (Fig. 1). Zero grazing livestock farming is also practiced in the catchment. Due to population pressure on land, fallowing is not a common practice in the area.

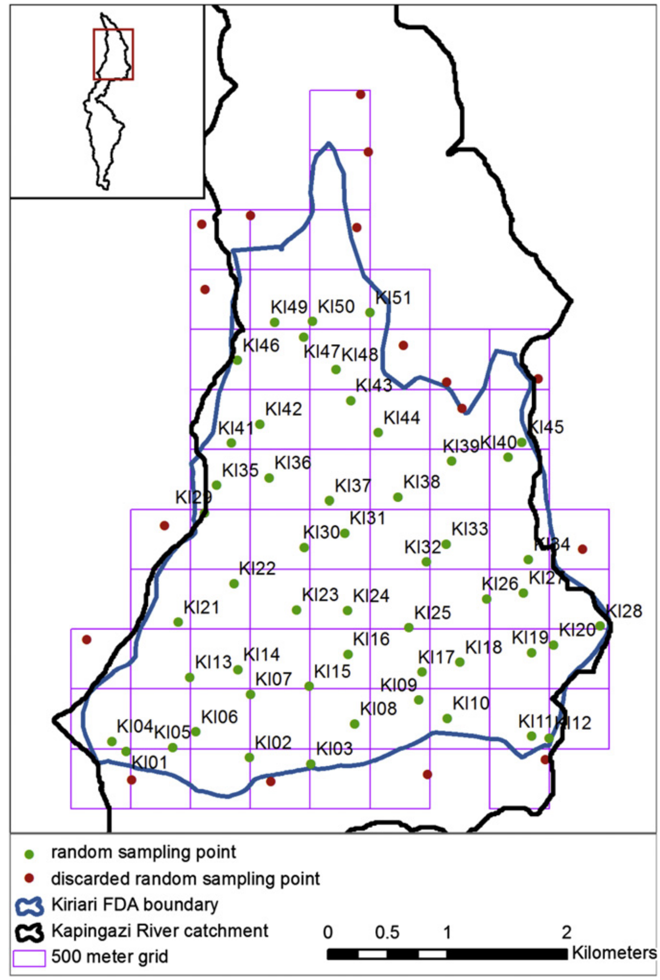

Fig. 2. Random sample points (RSP) for the Kiriari survey site.

2.2. Survey sites and sampling design

Focus group discussions and a conjoint survey were administered in three community groups, locally termed as the Focal Development Area (FDA). The FDAs were previously demarcated by the Mount Kenya East Pilot Project (MKEPP)[2] which aimed to promote sustainable natural resource management within the Kapingazi watershed and the larger Upper-Tana region. The FDAs included in the survey were Kiriari, Kairuri, and Muthatari (see Fig. 1) in the upper, central, and lower part of the study catchment respectively.

[2] MKEPP is a project operating in 8 districts in Eastern province of Kenya (eastern side of Mt. Kenya). Its prime focus is on natural resource management with six project components: water resource management, rural livelihoods, environmental conservation, community empowerment and coordination and management. The sites surveyed in this study fall within this region.

Selection of the sample households was based on a spatial sampling technique referred to as the Systematic Unaligned Pattern presented by McCoy (2005). In each of the three FDA, a 500 m × 500 m grid was overlain with the repeating shapes tool programmed by Jenness (2006). Using the in-built "create random points" tool in ArcGIS 9.3, a random point was generated within each cell. Using the "completely within" geographical selection operator, all random points within the FDA boundary were selected as random sampling points (Fig. 2). A total of 125 unique random sampling points (RSP) were generated (51 in Kiriari, 32 in Kairuri, and 42 in Muthatari). The original sample point datasets were then converted to the GPS exchange file format (GPX) after which the sample points were uploaded to GPS units. Enumerators were supplied with paper maps and GPS units to navigate and identify the nearest household to the RSP. If an RSP fell in an irrelevant location; for instance, in the middle of a wetland or tea plantation, the nearest household relative to that location was considered for interview. Given the more or less even distribution of population in the study area, the spatial sampling design employed in the study ensures the randomness of sample household selection.

2.3. Data collection

The data used in this study were obtained from primary sources through focus group discussions and conjoint survey. In each of the three FDAs, four focus groups were convened (12 groups in total). The number of participants in each group ranged from 8 to 15 persons. The four groups were: (i) a women's group, (ii) a youth group, (iii) local community leaders, and (iv) farmers group. Participants in all groups were selected in consultation with community leaders and local government officers. Each focus discussion session took 2–3 h and all the discussions were held in the local language of '*kikuyu*'. Each group discussion was moderated by a principal facilitator and an assistant. The principal facilitator's role was providing clear explanation of the purpose of the meeting, helping people feel at ease, facilitating interaction between group members, probing additional query or information when necessary, and keeping the discussion appropriately focused. The assistant facilitator kept notes of the discussion and recorded bullet points on a flip chart. All the facilitators possessed good knowledge of the study area and had field experience in similar research projects.

For quantitative data, a group of trained enumerators administered the conjoint survey. Pre-testing of the questionnaire was conducted with fourteen respondents selected from all the three survey sites. This tested for weaknesses in the presentation and comprehension of the questionnaire by both the enumerators and respondents, and identified the most appropriate response formats for different questions. After pre-testing the questionnaire in the field, a debriefing meeting was held with the enumerators and field supervisors. Key issues and concerns identified during the pre-testing were thoroughly discussed and reflected in the revised final version of the questionnaire. The final survey work was supervised on a day-to-day basis to ensure enumerators' compliance with established survey procedures.

2.4. Conjoint models

Three conjoint models were employed: a traditional conjoint ratings model, a binary logit model, and an ordered logit model. A binary logit model was used to assess the effect of the different attribute levels on farmers' preference for '*definitely*' choosing a particular land management scenario, from amongst the different options presented during the conjoint experiment. For the analysis of the rating data an ordered logit model was employed.

2.4.1. Traditional conjoint model

The statistical method primarily used in traditional conjoint analysis was ordinary least squares (OLS) method. The use of this method presumes that the rating scale responses satisfy the numerical properties associated with interval scales, i.e., humans can use rating scales to provide meaningful differences between scenario profiles, and the units of the rating scales represent equal differences (Louviere et al., 2005). Thus, strong assumptions are required to be satisfied in traditional conjoint analysis. A farmer's rating for each land-management scenario is assumed to be a proxy for individual utility. Let the rating assigned by respondent n to land-management scenario j be denoted as R_{nj}, and assume that: (a) the rating scale intervals are equal, (b) the individual's utility function is strictly additive and linear in the model parameters, and (c) the errors are distributed normally and independently with constant variance, then we can express the observed rating data as a linear regression, as follows:

$$U_{nj} = \beta_0 + \beta_1 R_{nj} + \varepsilon_{nj} \tag{1}$$

where β_0 and β_1 are unobserved "true" parameters that linearly relate the observed ratings to the unobserved latent utilities, U_{nj}. If the assumptions are satisfied, the ratings provide information about the true utilities, and Eq. (1) allows us to specify the rating data as a linear regression of attribute levels (k attributes each with m number of attribute levels) as follows (Stevens et al., 1999; Louviere et al., 2005):

$$R_{nj} = \alpha_0 + \beta_1 X_{1,1} + \beta_2 X_{1,2} + \cdots + \beta_{m-1} X_{1,m-1} + \cdots + \beta_{k(m-1)} X_{k(m-1)} + \varepsilon_{nj} \tag{2}$$

where β's are utility or preference estimates (sometimes called "part-worths") associated with each attribute level, X's are dummy-coded attribute levels, and ε_{nj} is an error term that must satisfy the usual OLS assumptions of zero mean, constant variance and independence. If the assumptions are satisfied, the estimated β's can be interpreted as part-worth utilities, representing the conditional response means associated with each attribute level.

2.4.2. Logit model

Following the random utility theory (RUT) tradition (Train, 2003), suppose that farmer n ($n = 1, \ldots, N$) faces a choice among J alternative land-management scenarios. Let $U_{nj},\ j = 1, \ldots, J$ denote the utility that n obtains from alternative j. The farmer would reveal to undertake alternative i if and only if $U_{ni} > U_{nj},\ \forall j \neq i$. On the basis of RUT, the utility (U_{nj}) that a farmer obtains from alternative j is decomposable into two components V_{nj} and ε_{nj} where V_{nj} is the portion of U_{nj} that can be represented from the observed attributes of the alternatives, labelled $X_{nj},\ \forall j$, and individual's socio-economic characteristics, labelled H_n, and ε_{nj} random disturbance term reflecting intrinsically random choice behaviour, measurement or specification error and unobserved attributes of the alternatives that affect utility but are not captured in V_{nj}. Then the utility function can be represented as:

$$U_{nj} = V_{nj} + \varepsilon_{nj},\quad \forall j = V(X_{nj}, H_n) + \varepsilon_{nj} \tag{3}$$

Denoting the joint density of the random vector $\varepsilon_n = \varepsilon_{n1}, \ldots, \varepsilon_{nJ}$ by $f(\varepsilon_n)$ and assuming that ε_n is identically and independently distributed (iid), the logit probability (Babulo et al., 2008; Train, 2003) that farmer n chooses land-management contract i can be expressed as

$$p_{ni} = \frac{e^{(\beta' X_{ni} + \gamma' H_n)}}{\sum_j e^{(\beta' X_{nj} + \gamma' H_n)}} \tag{4}$$

where β are γ the coefficients. For the binary choice logit, the probability of choosing the ith scenario would be:

$$p_{ni} = \frac{1}{1+\sum_{j=1}^{2} e^{(\beta' X_{nj}+\gamma' H_n)}} \tag{5}$$

2.4.3. Empirical econometric (binary logit) specification

Expanding Eq. (3), the utility that farmer n derives from the observed attributes of the ith land-management scenarios can be represented as (Eq. (6)):

$$V_{ni} = \beta_1 X_{1i} + \cdots + \beta_6 X_{6i} + \alpha_1 H_1 + \cdots + \alpha_s H_s \tag{6}$$

where $X_{1i}, \ldots, X_{6i}$ are levels of the six attributes identified; $H_1, \ldots, H_S$ are a respondent's individual socio-economic characteristics; $\beta_1, \ldots, \beta_K$ and $\alpha_1, \ldots \alpha_S$ are unknown parameters.

The conjoint rating experiment provides information about farmer's ratings of alternative scenarios. For the purpose of logit modelling we created a binary dependent variable Y and set $Y = 1$ for only those individuals who said they would definitely enter into a given contract scenario, and otherwise set $Y = 0$ (i.e., Y takes a zero value for ratings = 1–4). In this approach, only those individuals who said they would definitely accept each management scenario were counted as participating (Stevens et al., 1999). It assumed that individual's decision to participate depends upon programme attributes (such as the land area to be committed and length of contract) and individual socio-economic characteristics (such as age, education, and land size owned). The rational farmer will prefer to enter into the ith contract scenario if the utility he expects to derive from i is greater than to the utility he would expect to derive from other alternative contract scenarios. In other words:

$$\begin{aligned} Y_i &= 1, \quad \text{if} \quad U_{ni} > U_{nj}, \quad \forall_{j \neq i} \text{ and} \\ Y_i &= 0, \quad \text{if} \quad U_{ni} \leq U_{nj}, \quad \forall_{j \neq i} \end{aligned} \tag{7}$$

Substituting Eq. (6) in Eq. (7) the probability that farmer n will enter into contract scenario i can be expressed as:

$$\begin{aligned} \Pr(Y_i = 1) &= \Pr\left[(V_{ni} + \varepsilon_{ni}) > (V_{nj} + \varepsilon_{nj})\right] \\ &= \Pr\left[(\varepsilon_{ni} - \varepsilon_{nj}) > (\beta_1 X_{1j} + \cdots + \beta_K X_{Kj} + \alpha_{1j} H_1 + \cdots \right. \\ &\quad + \alpha_{Rj} H_R) - (\beta_1 X_{1i} + \cdots + \beta_K X_{Ki} + \alpha_{1i} H_1 + \cdots \\ &\quad \left. + \alpha_{Ri} H_R)\right] \end{aligned} \tag{8}$$

where X, H, β and α are as defined before.

Assuming that the ε's are iid and that the utility difference $(\varepsilon_{ni} - \varepsilon_{nj})$ is logistically distributed, the logit model fitted with maximum likelihood will be an appropriate estimation technique. The logit technique has the advantage over other probability models, such as probit, in that the logit parameter estimates are easily interpreted as the logarithm of the odds ratios. For a given attribute, an odds ratio of one indicates that the attribute has no effect on the odds that respondents will prefer the hypothetical scenario to another alternative scenario. An odds ratio of less than one would imply that higher levels of the attribute reduce the odds of respondents preferring that specific hypothetical contract, versus the alternatives. An odds ratio of greater than one implies that higher levels of the attribute increase the odds that respondents will prefer the contract under consideration, compared to other alternative contracts.

2.4.4. Ordered logit model

For the analysis of the rating data, an ordered logit model was applied. The dependent variable is the ratings between 1 (a respondent stated he would definitely not enter into a scenario's scheme) and 5 (a respondent preferred he would definitely enter into a scheme in a scenario), while the independent variables are the levels of the 6 attributes (X_n) and respondents' specific characteristics (H_n). Any contract that the farmer rates with a high number was assumed to be preferred over any other contract that he rates with a lower number, but the intervals between the ratings were not assumed equal. The ratings therefore are characterized as discrete and ordered, but not ordered by an equal interval. Assuming a logistic function of error terms, ordered logit fitted by maximum likelihood is an appropriate analytical approach (Greene, 1993).

Following Greene (1993), Train (2003) and Arifin et al. (2009), the indirect utility derived from a hypothetical contract scenario is a function of the attributes of the contract (X_n) and the respondent's characteristics (H_n). While the indirect utility derived from a particular contract cannot be observed, we observe the ratings 1–5, where:

$$\begin{aligned} \text{Rating} &= 1 \quad \text{if} \quad V_i \leq \mu_1 \\ \text{Rating} &= 2 \quad \text{if} \quad \mu_1 < V_i < \mu_2 \\ \text{Rating} &= 3 \quad \text{if} \quad \mu_2 < V_i < \mu_3 \\ \text{Rating} &= 4 \quad \text{if} \quad \mu_3 < V_i < \mu_4 \\ \text{Rating} &= 5 \quad \text{if} \quad V_i > \mu_4 \end{aligned}$$

where $\mu_1, \ldots, \mu_4$ are estimated cut-off points. The probability that the farmer will give a rating of j to the ith land-management contract is given by:

$$\begin{aligned} \Pr(\text{Rating} = j) = \Pr\Big[\Big(\mu_{j-1} &< (\beta_1 X_{1j} + \cdots + \beta_K X_{Kj} \\ &+ \alpha_{1j} H_1 + \cdots + \alpha_{Rj} H_R)\langle \mu_j \rangle\Big)\Big] \end{aligned} \tag{9}$$

Fitting ordered logistic regression with maximum likelihood method with *'rating'* as an ordered-category variable yields the probabilities for each category of *'rating'*.

3. Empirical implementation

3.1. Application of the conjoint analysis

This study used conjoint analysis (CA) to evaluate landholders' preferences over the locally identified set of attributes of land-management schemes for watershed services in the Kapingazi catchment of the eastern Mt. Kenya region. The term conjoint analysis is used in many different ways. It refers to an overall approach and group of quantitative techniques that can be used to determine respondent preferences for the attributes that make up a product or service, with the total worth of a product determined by the part-worths of its attributes (Sayadi et al., 2005). A fundamental characteristic of this approach is that the utility derived from a product or service can be decomposed into part-worths relating to the different attributes of that product (Lancaster, 1966). The CA methodology has long been associated with research in the fields of marketing, psychology, and transportation, where it has been used to evaluate and understand consumer preference for products or services (Adamowicz et al., 1998; Anderson, 1982; Green and Srinivasan, 1978; Hensher, 1994; Louviere, 1988; Roe et al., 1996). Recently, the number of applications of CA in environmental and natural resource management has started to grow (Alriksson and Oberg, 2008).

Most CA applications involve a series of techniques, that stem from several common hypotheses (Alvarez-Farizo and Hanley, 2002; Louviere et al., 2005; Sayadi et al., 2005). These may be summarized as follows:

(1) The product or service may be defined using an aggregate of features or attributes that take certain levels or values.

Table 1
Attributes and attribute levels used for designing land-management contracts in the study catchment.

Attributes	Levels			
	Level 1	Level 2	Level 3	Level 4
1. Land area to be committed	10% of your land	20% of your land	40% of your land	–
2. Length of commitment period	5 years	15 years	30 years	–
3. Right to harvest products (grass/fodder/beekeeping)	Permitted	Partially permitted	Not permitted	–
4. Reward scheme/incentive scheme	Waive annual water use cost per acre of land committed	Cover 50% of annual extension service fee per acre of land committed	Waive 50% of annual electricity cost per acre of land committed	Ksh. 4500 per acre of land committed per year
5. Local scheme administering agency	Water Resource Users Association (WRUA)	Focal Development Area Committee (FDAC)	Community Forest Association (CFA)	–
6. Required free labour contribution related to the contractual scheme per month	1 day	2 days	4 days	–

(2) Different levels of the features define different versions of the product or service under consideration.
(3) Product appraisal by individuals is a function of the value or worth which they assign to the product's features.
(4) During the decision-making process, individuals appraise the worth of each combination, and their rating, ranking or choice demonstrates prioritization among the different combinations of features.

3.2. Attributes and attribute levels

On the basis of extensive review of related literature on land-management contract evaluation, PRESA's prior knowledge about the study area, and the information obtained from community leaders, local government and non-government agencies operating in the area; the research team identified the initial set of attributes and their levels. This set was modified and amended during the participatory stakeholders' workshop, which resulted in the final set of six attributes (i.e., land area, contract length, harvest right, reward scheme, programme administration, and labour contribution). Five of these attributes were with three levels each and one attribute had four levels. A summary of the attributes and their levels are presented in Table 1. Each of the six attributes is described below.

1. *Land area to be committed*: land is the most important factor of production in rural economic activities (cropping, livestock, and forestry) particularly in densely populated areas such as the study region. This implies that any land-use change or land-management agreement must explicitly indicate the size of land that a landholder is willing to commit. For the purpose of experimental design a 10%, 20%, and 40% level was assigned to this attribute.
2. *Length of contract period*: for communities in the study area whose livelihood is highly dependent on land, and where landholdings are becoming increasingly fragmented, the length of period farmers commit their land is an important factor in designing land-management contract. Drawing on existing land-contract practices uncovered during the stakeholders' workshop, contract periods of 5, 15, and 30 years were identified as the three levels for this attribute.
3. *Right to harvest products from committed land in environmentally friendly manner*: given the scarcity of land in the study area, farmers may be interested to maintain their rights to harvest some environmental products, for instance fodder for cattle or dead wood for fuel even after they committed land for the contract. Providing this right may influence farmers' preference for alternative land-management schemes and the degree of scheme adoption. The three qualitative levels of this attribute were; (i) permitting, (ii) partially permitting, and (iii) not permitting.
4. *Reward scheme/incentive scheme*: putting in place an appropriate compensation scheme seems to be one of the important factors in evaluating landholders' preference. Workshop participants identified three community priority areas, namely; water for domestic use and irrigation, electricity, and agriculture extension services. We reached an agreement that compensation schemes for any proposed land-management contract should be based on these community priorities. Accordingly, three of the four levels assigned to this attribute were: (i) 'waive annual water use cost per acre of land committed', (ii) 'cover 50% of annual extension service fee per acre of land committed', and (iii) 'waive 50% of annual electricity cost per acre of land committed'. 'Direct annual cash payment of Ksh[3] 4500 per acre of land committed' was added as a fourth attribute level.
5. *Local scheme administering agency*: effective local-level land-management contracts with smallholders necessitates the involvement of a local scheme administering unit/agency. This agent can act as an intermediary unit between suppliers and buyers of environmental services, may be involved in negotiations, undertake scheme monitoring, and facilitate the actual implementation of rewards. After evaluating the appropriateness and relevance of existing local-level community organization, workshop participants have identified three local organizations; Water Resource Users Association (WRUA), Focal Development Area Committees (FADCs), and Community Forest Association (CFA). These were considered in conjoint experimental design.
6. *Required free labour contribution related to the contractual scheme*: it is important to acknowledge that a land-management contract may entail landholders' periodic contribution of free labour services in terms of establishing and maintaining the structure, certain forms of collective actions, training, attending scheme meetings, etc. This may play an important role in shaping farmers' preferences towards proposed management schemes. Three attribute levels were identified for this attribute: (i) 1 day, (ii) 2 days, and (iii) 4 days per month of free labour contribution.

[3] Ksh. = Kenyan Shilling, the legal currency in the Republic of Kenya. In October 2009 (survey period) the exchange rate was 1US $ = 78.43 Ksh.

Table 2
Hypotheses regarding the effect of the attributes on ratings.

Attributes[a]	Hypothesised effect on respondent ratings
1. Land area to be committed	Negative and relatively important. Given the small landholdings in the study area, farmers will be not interested to commit more land
2. Length of commitment period	Negative and relatively important. Longer contract/commitment periods imply loss of other economic opportunities from the land by tying-up the land for longer periods. Hence, the longer the contract period the less the preferred the scenario.
3. Right to harvest products (grass/ fodder/beekeeping)	Positive and relatively important; having right to harvest environmental products from committed areas imply more potential benefits from the land and hence contracts that grant harvest rights may be more preferred than those do not allow such rights.
4. Reward scheme/incentive scheme	Untenable to hypothesize the effect or sign *a priori*; individual farmer can favour any of the reward schemes
5. Local scheme administering agency	Untenable to hypothesize the sign *a priori*; a farmer can favour any of the three local administering agency
6. Required free labour contribution related to the contractual scheme	Negative and relatively unimportant; more days of free labour contribution discourages farmers from program participation but farmers may still consider this as a worthwhile contribution

[a] As land is scarcer than labour due to high population density in study area, we expect the relative importance of attributes 1 and 2 to be higher than attribute 6.

3.3. Conjoint survey design

Once the attributes and levels to be included in constructing the hypothetical land-management contract were selected and defined, the next task was the design of stimuli[4] to be evaluated by the respondents. Following Arifin et al. (2009) we employed a *factorial design* method using the six attributes described above (five attributes with three levels each and the remaining one attribute with four levels). This generated a total of 972 scenarios ($3^5 \times 4$). From field pre-tests of the conjoint questionnaire, we determined that nine scenarios was an appropriate number for a respondent to rate. To cover the full set of scenarios, 108 respondents were therefore required, where each respondent responded to a unique set of 9 scenarios (9 scenarios $\times$ 108 respondents $=$ 972 scenarios). The 972 scenarios were divided among the 108 respondents in a way that gave a design as near orthogonal as possible. This experimental design was created using AlgDesign package from the R statistical system (Wheeler, 2008).

Each respondent was asked to compare nine scenarios. A total of six enumerators (two enumerators per site) and three field supervisors were deployed to administer the survey. The survey was administered in face-to-face interviews with the respondents. The questionnaire was written in English but the interview was conducted using the local language, '*kikuyu*', in order to improve communication between enumerators and respondents.

The survey questionnaire consisted of two parts. The first part consists of respondent characteristics such as demographics, socio-economics, and experience on natural resource management and environmental conservation. The second part presents the main conjoint questions that included descriptions of the environmental situation and the proposed changes and series of alternative land-management arrangements that each respondent was asked to rate.

Before asking the rating question respondents were given detailed description of each of the hypothetical land-management contract scenarios. The attributes and their levels were summarized in the questionnaire within a simple one-page table that could be easily understood by the respondent. Each respondent was asked to rate nine scenario options. An example of the format of scenarios presented to each respondent is shown in Table 3. Respondents were asked to provide ratings on a scale of 1–5 for each hypothetical contract in terms of the likelihood that he would participate, with a score of five indicating a scenario where the respondent would definitely enter into the scheme, and a score of one indicating a scenario where he would definitely not enter into the scheme. Where the respondent was unsure, he could use a score of two, three or four to indicate how likely he would be to enter the scheme. Each version of the arrangement consisted of different combinations of levels of the six attributes.

4. Insights from focus groups

This section presents the qualitative synthesis of major issues raised during the focus group discussions held in three communities from 6 to 9 October 2009. Focus group discussion involves a way of learning about opinions, views, attitudes, and experiences from a selected group of individuals about a particular topic (Balana et al., 2010). To keep the discussion focused, the following open-ended discussion guides were identified.

(a) Key local environmental problems in the area.
(b) Main drivers of environmental change.
(c) Trends of environmental changes/conditions in the last 2–3 decades.
(d) Ways to tackle environmental problems in the area.
(e) Local environmental management priorities.
(f) Major benefits of conserving/managing local natural and environmental resources.
(g) Existing soil and water conservation experiences in the community.
(h) Local perceptions on reward-based ecosystem services provision.
(i) Major constraints to adopting land-use changes and best management practices.
(j) Limitations and strengths of the community as a group in terms of local natural resource and environmental management.

4.1. Key environmental problems, their drivers, and trends of environmental change

Community members highlighted shortage of water for both domestic use and irrigation as the top environmental problem in the area. This is due to the drying up of water sources, including not only the River Kapingazi and its tributaries, but also wetlands, springs, boreholes, siltation of reservoirs and water courses. In addition, reduced and erratic rainfall was coupled with prolonged drought. Land degradation was identified as the second major environmental problem in the area. Community members asserted that the underlying drivers of their environmental degradation were poverty, population pressure, lack of alternative energy sources, and lack of environmental awareness. Community members indicated that their environment had undergone significant changes over time, such as reductions in the base flow at River Kapingazi and its tributaries, disappearance of some wildlife,

[4] This refers to hypothetical product/service scenarios created by combinations of different attribute levels.

Table 3
An example of the nine land-management scenarios presented for a respondent for rating.

Options	Land area committed	Commitment period	Right to harvest	Reward scheme	Local administering agency	Required free labour contribution per month	Your rating (scale 1–5)
Option 1	10% of land	15 years	Not permitted	Waive water costs	Community Forest Association (CFA)	3 Days	
Option 2	40% of land	5 years	Not permitted	Cover 50% extension fees	Community Forest Association (CFA)	2 Days	
Option 3	10% of land	30 years	Not permitted	Waive water costs	Water Resource Users Association (WRUA)	1 Day	
Option 4	20% of land	15 years	Partially permitted	Waive 50% electricity costs	Focal Development Area Committee (FDAC)	1 Day	
Option 5	10% of land	30 years	Permitted	Annual cash payment (4500 Ksh/acre)	Water Resource Users Association (WRUA)	1 Day	
Option 6	20% of land	15 years	Partially permitted	Waive water costs	Community Forest Association (CFA)	3 Days	
Option 7	20% of land	30 years	Partially permitted	Cover 50% extension fees	Water Resource Users Association (WRUA)	3 Days	
Option 8	40% of land	30 years	Permitted	Annual cash payment (4500 Ksh/acre)	Focal Development Area Committee (FDAC)	2 Days	
Option 9	40% of land	5 years	Permitted	Waive 50% electricity costs	Focal Development Area Committee (FDAC)	2 Days	

unpredictable rainfall pattern, increased water pollution, rapid deforestation, and loss of soil fertility.

4.2. Local environmental management priorities

Environmental management measures that are locally prioritized, designed and implemented using participatory methods are often considered an effective approach to tackling local environmental problems (Balana et al., 2010; Baland and Platteau, 1996; Herath, 2004; Ostrom, 1990). Community members suggest riparian area management, removal of eucalyptus trees along river banks, planting water efficient indigenous tree species, training on best management practices and environmental awareness in order to restore their environment. Participants claimed that cutting trees for domestic energy was the major factor driving the deterioration of forest resources in the area. In the absence of alternative energy sources such as biogas and solar energy, the rising demand for fuel wood coupled with the rapidly growing population would be the major threat for forests. Participants also suggested that livelihood diversification, for example into beekeeping and poultry, could result in a 'win-win' economic and environmental impact. Studies in drier agro-ecological zones in Africa have also highly recommended such a shift in livelihood strategy choice (Babulo et al., 2008; Barrett et al., 2005).

4.3. Existing local environmental management experiences

Basing new environmental management measures on indigenous knowledge and existing local practices may result in better outcomes. The discussion under this topic was aimed to explore existing local knowledge, experiences and practices on environmental management activities. Community members indicated that they were undertaking different environmental protection measures and participating in some conservation initiatives. These initiatives had been introduced both by the government and non-governmental agencies such as the MKEPP. River bank management (e.g. planting Napier grass strips along river banks), soil and water conservation structures (e.g. terracing and field margin hedges) were some of the activities that communities claimed to have good experience of. Participants also indicated that some farmers had been using energy saving cooking devices, locally called '*njiko*' so as to conserve firewood, and that some other farmers had established tree nurseries to promote local species. Community participation in local pro-environment associations such as Community Forest Associations was also reported as an important experience, and had contributed towards building social capital in the area.

4.4. Local constraints and community strengths

According to the participants, a high prevalence of poverty and hence lack of resources were the major factors that constrained their involvement in long-term environmental management measures. Scarcity of indigenous tree seedlings and inadequate knowledge on best farm management practices were also identified as constraints. Gender and youth related issues, especially on land-ownership and decision-making were also among the important constraints. This was because women and youths usually do not own lands, and hence they have no power to make decisions over its use. A similar study by Kabubo-Mariara (2007) in Kenya also highlighted the effect of property right and population density on the land conservation decision and the type of conservation practices.

Despite constraints and limitations, the community felt that they had some strength which could be used to their advantage. For instance, community members have registered environmental groups that can serve as the entry point for any environmental conservation programme. To mitigate critical resource constraints, the community had already started a local scheme called 'environmental fund'. In some communities they had also started tree nurseries owned by members. Communities also indicated that their environmental initiatives had been recently gaining support and recognition from both the government and development partners such as MKEPP and ICRAF-PRESA. Most importantly, they mentioned that there exist huge utilized youth labour forces.

4.5. Local perception on reward for environmental services (RES)

The final discussion was on local views and perceptions of reward-based provision of environmental services. Because of PRESA's objectives and the recent arguments (Engel et al., 2008; Smith et al., 2006) for Payment for Environmental Services (PES), it was important to elicit local views on the subject. In this regard all the groups unanimously agreed that introducing a reward mechanism for environmental services could be a useful policy option for incentivising landholders to provide environmental services. However, they wished the process and mechanism design to be participatory. The participants indicated that cooperation between the upstream and downstream communities would be valuable. For example, downstream beneficiaries of watershed services such as hydroelectric companies and irrigators could compensate upstream land managers for the environmental services they provide. However, community members warned that in order to succeed the scheme would have to be transparent and participatory and the parties involving would have to identify feasible and binding agreements.

5. Respondent characteristics

5.1. Description of the respondent characteristics

Thirteen demographic and socio-economic characteristics were selected to be used in the conjoint models. Demographic variables such as age, sex, household size and education level have often been found to influence individuals' preferences. For instance, a higher level of education makes it more likely an individual will participate in environmental management or protection programmes. Household's 'main livelihood income source' can influence preferences on land-management contract. For instance, households who earn their major livelihood income from agricultural activities may be reluctant to enter into a land-management contract that limits their access to land. Conversely, households deriving their major income from non-agricultural sources may consider a land-management contract to be a worthwhile engagement.

'Land size owned' becomes the key factor in influencing household's preference for a land-management contract. During the focus discussion and stakeholders' workshop, landholding fragmentation was identified as one of the major problems in the study area. Since a large number of farmers are smallholders, they do not favour land-management contract schemes that limit their access to the land, unless an appropriate compensation scheme is put in place. Other things being equal, households owning larger land area are more likely to commit part of their land for the proposed contractual scheme compared to smallholders. The important factors that influence household's preference for a particular land-management contract included: previous experience in environmental conservation practices; participation status in existing environmental protection project, specifically in the MKEPP project; and respondent prior information on market-based reward schemes for environmental services provision. For instance, all other things being equal, households who are already participating in an MKEPP scheme or practicing environmental conservation measures were more likely to enter a given land-management scheme than those who were not. We also identified 'access to credit' as another important factor in conditioning individual preferences for entering into a scheme. Households who had fewer constraints on their financial resources were more likely to pursue alternative livelihood strategies and surrender their land for the contract (Babulo et al., 2008).

5.2. Descriptive statistics of respondent characteristics

Table 5 presents the descriptive statistics for selected socio-economic and demographic characteristics of the respondents. The average respondent in the survey was about 54 years of age with minimum of 22 and maximum of 85 years. A total of 61% and 39% of survey respondents were male and female respectively. Taking into account the male-dominated nature of most African rural cultures, and their influence on major household level decisions (including land-use decisions), the observed sex distribution is not unusual. For instance, a similar study in Indonesia noted that the male-dominated culture compelled Arifin et al. (2009) to sample 100% male respondents.

Only 11% of the respondents had attained education levels beyond secondary level. For the remainder 16% reported 'never any schooling', 31.5% 'primary schooling' and 41.6% 'secondary schooling'. With an average family size of six persons, the survey sites generally reflected household sizes of a typical Kenyan village.

Table 4
Name and description of respondent characteristics used in the conjoint analysis.

Variable name	Variable label	Description
Sex	sex	Sex of the respondent (household head or spouse). [Dummy: sex = 1 for male and 0 for female.
Age	age	Respondent's age in years.
Education	edu_primary edu_secondary edu_AboveSec	Respondent's highest level of education; dummy variable with four categories. The base category for illiterate i.e., respondents having never any schooling takes 0; then 1, 2, and 3 for primary, secondary and above secondary (college or university) levels of education respectively.
Household size	hhsize	Total household size (head count).
Agricultural income	Agri_income	Net household income from agricultural activities (cropping and livestock activities) in Ksh.
Non-agricultural income	NonAgri_income	Net household income from non-agricultural sources such as off-farm employment, transfers, pensions, interest income, etc. in Ksh.
Land size owned	LandSize	Total land size owned by the household in acres.
Management practices	Env_mgt	Previous/existing experience in land or environmental management practices; dummy (yes = 1; no = 0)
Participation in MKEPP	MKEPP	Whether the household is participating in Mount Kenya Pilot Project (MKEPP); dummy (yes = 1; no = 0)
Access to finance	Fina_access	Whether the household has got access to financial services (i.e., credit); dummy (yes = 1; and no = 0)
Prior information on RES scheme	Envi-info	Whether the household has received any prior information about market-based provision of environmental services; dummy (yes = 1; no = 0)

Table 5
Descriptive statistics of explanatory variables (respondent's characteristics) used in the empirical conjoint models.

Variable	Mean	Std. dev.	Min	Max
Age	54.32	14.84	22	85
Sex (1 if male)	0.6111	0.4877	0	1
Edu_primary	0.4167	0.4933	0	1
Edu_secondary	0.3148	0.4647	0	1
Edu_AboveSec	0.1111	0.3144	0	1
Hhsize	5.94	2.81	1	13
Agri_Income[a]	61629.00	87028.78	3000	580,000
NonAgri_income[a]	38805.94	67210.62	0	360,000
LandSize (acres)	3.18	2.97	0.5	20
Env_mgt	0.7963	0.4029	0	1
MKEPP	0.2685	0.4434	0	1
fina_access	0.9159	0.2777	0	1
Env_info	0.2129	0.4096	0	1

[a] Income is in units of Kenyan Shilling (Ksh.), the legal currency in the Republic of Kenya. In October 2009 (survey period) the exchange rate was 1US $ = 78.43 Ksh.

Survey respondents were asked to report their net income from both agricultural and non-agricultural sources. Incomes from both sources were distributed unevenly, with a mean annual income of Ksh. 61629 (std. 87028) for agricultural income and Ksh. 38805 (std. 67210) for non-agricultural income. Both agricultural and non-agricultural incomes were normalized as follows: (X_i − Min. value) ÷ (Max. value − Min. value); where X_i = observed value of agricultural or non-agricultural income; Min. value = the minimum value in the series and, Max. value = the maximum value in each of the income series. Normalized values were used in both the binary and ordered conjoint logit models (Tables 7 and 8).

In terms of landholdings, the study area was generally characterized by smallholdings with an average of 3.2 acres/household. Only 36% of survey respondents possessed a holding greater than this. Households in the first quartile possessed no more than one acre. As the size of landholdings is anticipated to play a key role in respondent's preference for the proposed programme, it is expected that smallholdings could induce respondents to state low ratings for most contractual schemes. Access to financial resources was perceived to be good, as almost 92% of respondents stated that they could access local financial sources. Access to financial resources therefore seems to have a negligible impact on decisions to implement land-management schemes that require additional funds. In terms of experience and information in prior environmental management practices, about 80% of the respondents responded 'yes' for the question "*have you had any environmental resource management practices on your private land*?" About 27% were participating in the MKEPP scheme; but only 21% of the respondents possessed information about market-based provision of environmental services. The remaining 73% reported that they knew nothing about payment based provision of ecosystem services.

6. Result from conjoint analysis

This section presents the econometric results from traditional conjoint analysis, binary logit and ordered logit models.

6.1. Results from traditional conjoint analysis

Results of the traditional conjoint analysis are reported in Table 6. Using Eq. (2), we run an OLS regression of '*Rating*' on coded attributes of management scenarios. Signs of estimated coefficients were generally consistent with prior expectations. Size of land areas to be committed (both *LandArea20percent* and *LandArea40percent* attribute levels), length of commitment period (*Commitperiod40yrs* attribute level), and prohibition of harvest right (*HarvestNotPermitted* attribute level) were negative and highly significant (at 1% level of significance) in conditioning respondent's rating of options. Land-management options that required more land commitment and longer contract period were rated lower. Similarly, contracts that prohibited owner's rights to use or harvest some environmental products, such as grass, during the contract period were not preferred by respondents. Waiving electric bills (*RewardElectricity* attribute level) as a reward scheme did not motivate respondents into higher ratings (i.e. ratings decline as this reward scheme was presented).

In contrast, ratings increased with FDAC as local scheme administrator and 'providing and waiving water cost' as a reward scheme; but these attributes were statistically insignificant. However, the positive coefficient for the attribute level '*RewardWater*' in Table 6 signals that people preferred 'water provision and water cost waiving' as a reward scheme compared to the base category (i.e., direct cash payment). The coefficients to '*FreeLabourdys*' variable do not change signs, whilst changing the number of required free labour days was also statistically insignificant. This implies that the number of free labour days required for a scheme was not an important factor in the contract. A possible explanation may be that labour was not the major constraint in the area. With a growing population and diminishing landholdings, labour abundance is becoming a common feature in many rural African villages. There was also no clear preference for the different local-level scheme administrators.

Table 6
Traditional conjoint model results.

Attributes of the scheme	Estimated coefficient	Standard error	*t*-Value	$p > \|t\|$ (*p*-Value)
LandArea20percent	−0.6116***	0.1156	−5.29	0.000
LandArea40percent	−1.4514***	0.1158	−12.53	0.000
CommitPeriod15yrs	−0.0704	0.1161	−0.61	0.544
CommitPeiod40yrs	−0.8489***	0.1172	−7.24	0.000
HarvestNotpermitted	−0.7952***	0.1164	−6.83	0.000
HarvestPartial	−0.1291	0.1165	−1.11	0.268
RewardExtensionFee	−0.1853	0.1337	−1.39	0.166
RewardElectricity	−0.2479*	0.1315	−1.89	0.060
RewardWater	0.1544	0.1318	1.17	0.242
LocalAdminFDAC	0.1673	0.1147	1.46	0.145
LocalAdminCFA	0.0145	0.1129	0.13	0.898
FreeLabour2dys	0.1652	0.1148	1.44	0.151
FreeLabour4dys	0.1093	0.1165	0.94	0.348
Cons	4.0777***	0.1772	23.01	0.000

*Significant at 10% level; ***Significant at 1% level.

In general, the results from the traditional conjoint model show that, '*land area to be committed*, '*length of commitment period*', and '*right to harvest products*' were the three principal attributes that influence landowners' ratings for various proposed land-management options.

6.2. Results from binary logit model

The probability that landholders would 'definitely enter into' any of the management scenarios presented during the survey was

Table 7
Logit conjoint model results on preferences to undertake proposed management contract.

Variables	Coef.	Std. err.	*Z*	$P > z$	Odds ratio
Constant	1.7021**	0.7624	2.23	0.026	–
LandArea20percent	−0.9951***	0.2114	−4.71	0.000	0.3696
LandArea40percent	−2.2900***	0.2792	−8.20	0.000	0.1012
CommitPeriod15yrs	−0.2985	0.2132	−1.40	0.162	0.7419
CommitPeriod40yrs	−1.8199***	0.2620	−6.94	0.000	0.1620
HarvestNotpermitted	−1.6508***	0.2686	−6.14	0.000	0.1918
HarvestPartial	−0.3047	0.2124	−1.43	0.151	0.7372
RewardExtensionfee	−0.5538**	0.2674	−2.07	0.038	0.5747
RewardElectricity	−0.5109*	0.2701	−1.89	0.059	0.5999
RewardWater	0.1606	0.2485	0.65	0.518	1.1743
LocalAdminFADC	0.0217	0.2246	0.10	0.923	1.0219
LocalAdminCFA	−0.0064	0.2231	−0.03	0.977	0.9935
FreeLabour2dys	0.3469	0.2209	1.57	0.116	1.4147
FreeLabour3dys	0.2351	0.2339	1.01	0.315	1.2650
Sex	−0.0666	0.2228	−0.30	0.765	0.9356
Age	−0.0208**	0.0082	−2.52	0.012	0.9794
env_mgt	0.7261***	0.2663	2.73	0.006	2.0671
MKEPP	0.4697**	0.2316	2.03	0.043	1.5996
fina_access	−0.0468	0.3319	−0.14	0.888	0.9541
env_info	−0.3400	0.2732	−1.24	0.213	0.7117
edu_primary	−0.6098*	0.3348	−1.82	0.069	0.5434
edu_secondary	−0.0052	0.3356	−0.02	0.988	0.9947
edu_AboveSec	0.5993	0.4069	1.47	0.141	1.8208
Hhsize	−0.0293	0.0368	−0.80	0.426	0.9710
LandSize	−0.0637*	0.0376	−1.69	0.090	0.9382
NrmAgri_Income	−0.2408	0.7319	−0.33	0.742	0.7859
NrmNonAgri_income	0.1001	0.5493	0.18	0.855	1.1052

*Significant at 10%; **Significant at 5%; ***Significant at 1%.
LR chi2(26) = 218.14; Prob > chi2 = 0.0000; Log likelihood = −383.63177; Pseudo R^2 = 0.2214.

estimated using Eq. (8). The dependent variable in the model took the value of 1 for management scenarios which received a conjoint rating of 5, and 0 otherwise. A binary logit model was run using programme attributes defined in Table 2 and socio-economic and demographic explanatory variables defined in Table 4. Table 7 reports the results of this analysis. Both the estimated coefficients as well as the transformed coefficients (i.e. odds ratio) are reported in this table. The probability of scenario adoption decreased for options that required commitment of larger land areas, a longer contract period, and increased restriction of harvest rights. These three attributes were found to be the most important factors influencing a landholder's potential adoption of the proposed management schemes.

On the basis of individual level socio-economic and demographic characteristics, all other things being equal, people with prior experience in environmental management practices and those who were already involving in the existing MKEPP projects are more likely to undertake a proposed management scheme. The likelihood of programme adoption was not statistically related to the sex of the respondent, level of education, access to financial markets, and household size. The statistical insignificance of education is a pattern that was not anticipated. Previous studies have shown that education and local environmental awareness can play significant roles in environmental management programmes in many developing countries (e.g. Babulo et al., 2008). This unexpected finding may indicate that local community have already possessed sufficient environmental awareness and knowledge. Thus, the marginal contribution of formal education in the study area would not have resulted in a significant environmental management outcome. The implication is that attention should be paid to factors other than formal education such as general environmental awareness and livelihood diversification schemes. Age of the respondent had a significant and negative effect. An important implication of this may be that younger people would possess more appreciation and understanding of environmental problems and hence more likely to adopt environmental management programmes.

The most unexpected result from the binary logit model was the relationship between 'land size owned' and the likelihood of programme adoption. Because of the prevalence of smallholdings in the study area, it was expected that land size and programme adoption would be positively related. Contrary to this expectation, we found a negative relationship between land size and programme adoption. The explanation for this may be that respondents having larger land size are relatively rich and hence the proposed reward scheme may not be sufficient to motivate them for programme adoption.

These findings may have important implications for practical issues of environmental management in areas where small landholdings dominate. On the basis of our results, as long as appropriate incentive schemes are put in place, the size of landholdings may not be a major constraint in implementing soil and water conservation and other environmental management programmes. Farmers could implement environmental management programmes despite having smallholdings, as is often the case in village economies of developing countries, where land degradation and fragmentation of landholdings increases over time.

The odds ratio shown in the sixth column of Table 7 shows that there were preferences for management options that required a commitment of smaller land areas, shorter contract period, and fewer restrictions on harvest right. All other things being the same, a contract that required 40% of one's landholding to be committed would be 0.10 times as likely to be chosen as a contract requires only 10% of land. Similarly, a contract with 40 years commitment period would be 0.16 times likely to be chosen as a contract that requires a 5-year commitment period. People with prior experience of environmental management practices were 2.1 times more likely to adopt a given contract compared those without such prior experience.

Table 8
Ordered logit results on ratings of hypothetical land-management contract options.

Variables	Coef.	Std. err.	Z	$P > z$	Odds ratio
LandArea20percent	−0.8454***	0.1530	−5.52	0.000	0.4293
LandArea40percent	−2.0024***	0.1666	−12.02	0.000	0.1350
CommitPeriod15yrs	−0.1644	0.1515	−1.09	0.278	0.8483
CommitPeriod40yrs	−1.2918***	0.1624	−7.95	0.000	0.2747
HarvestNotpermitted	−1.1612***	0.1585	−7.32	0.000	0.3131
HarvestPartial	−0.2711*	0.1532	−1.77	0.077	0.7624
RewardExtensionfee	−0.3524**	0.1779	−1.98	0.048	0.7029
RewardElectricity	−0.3781**	0.1768	−2.14	0.033	0.6851
RewardWater	0.1899	0.1737	1.09	0.274	1.2091
LocalAdminFADC	0.2098	0.1527	1.37	0.170	1.2334
LocalAdminCFA	−0.0305	0.1495	−0.20	0.838	0.9699
FreeLabour2dys	0.2330	0.1521	1.53	0.126	1.2624
FreeLabour3dys	0.1518	0.1540	0.99	0.324	1.1639
Sex	−0.4878**	0.1492	−3.27	0.001	0.6139
Age	−0.0091*	0.0054	−1.69	0.092	0.9909
env_mgt	0.3738**	0.1699	2.20	0.028	1.4533
MKEPP	0.6590***	0.1582	4.16	0.000	1.9328
fina_access	−0.0178	0.2209	−0.08	0.936	0.9822
env_info	−0.3427*	0.1816	−1.89	0.059	0.7098
edu_primary	0.0269	0.2173	0.12	0.901	1.0273
edu_secondary	0.4799**	0.2283	2.10	0.036	1.6159
edu_AboveSec	0.4456	0.2722	1.64	0.102	1.5615
Hhsize	−0.0285	0.0238	−1.20	0.231	0.9718
LandSize	0.03129	0.0225	1.38	0.166	1.0316
NrmAgri_Income	1.0199**	0.4466	2.28	0.022	2.7729
NrmNonAgri_income	0.6484*	0.3553	1.82	0.068	1.9126
/cut1	−2.6450	0.5185		−3.660	−2.6451
/cut2	−2.1460	0.5167		−3.158	−2.1460
/cut3	−1.8780	0.5158		−2.889	−1.8780
/cut4	−0.2168	0.5119		−1.220	−.21679

*Significant at 10%; **Significant at 5%; ***Significant at 1%.
LR chi2(26) = 323.44; Prob > chi2 = 0.0000; Log likelihood = −1221.7316; Pseudo $R^2 = 0.1169$.

6.3. Results for ordered logit model

Like in the binary logit model, the explanatory variables used in the ordered logit model also included contract attributes and characteristics of the respondents. The response variable in this analysis was the respondent's ratings for the alternative management scenarios. Ordered logit results were generated using Eq. (9). Table 8 presents results from the ordered logit analysis of landholder preferences for the hypothetical land-management contract options. In qualitative terms the results from the ordered logit model were largely very similar to that generated by the binary logit model. The ordered logit result also indicated that land area required to be committed, length of contract period, and rights to harvest products from committed land exerted a strong influence in conditioning preferences.

The respondent characteristics that had a significant effect on preferences included; current participation in the MKEPP, sex of respondent, experience in environmental management practices, secondary level education, and household income level from agricultural sources. The odds ratio also confirmed that agriculture income was an important influence on preferences.

7. Conclusions and policy implications

We have found that reward-based provision of environmental services, such as that initiated by PRESA to landholders, can encourage pro-environmental behaviours. However, uptake of the schemes depended on the size of the land area to be committed, the scheme's length of contract period and restrictions on rights to harvest environmental products. This is an important finding, as degradation of watershed services is a key problem in developing countries, and there is an urgent need for schemes that will effectively encourage behaviours that safeguard water resources. On the basis of our findings, we suggest that effective design and implementation of such schemes requires a thorough understanding of landholders' attitudes and preferences towards alternative land-use options and agricultural practices. In this instance, the role PRESA is playing as an intermediary in initiating, supporting, and facilitating participatory, fair and effective reward-based agreements between rural stewards and beneficiaries of environmental services is an important step in Africa.

Using locally identified set of land-management attributes and their levels and applying the method of conjoint analysis, this paper has assessed landholder preferences for alternative land-management schemes aimed at enhancing watershed services in the River Kapingazi catchment. The paper demonstrates that conjoint methods provide an analytical framework for evaluating landholders' preferences to hypothetical land-management contract design. Results from the conjoint models indicate that, 'the size of one's land area to be committed', 'the length of commitment period', and 'the level of restriction imposed on the rights to harvest products from land under the scheme' were the three principal attributes that significantly influence landholder's ratings and potential adoption of the proposed land-management contract. The probability of adopting a given land-management scheme decreases for schemes that require the commitment of larger land areas, longer contract period, and greater restriction of harvest rights. Furthermore, results from the ordered logit model show that respondent's characteristics such as current and past experience in environmental management, education, and household income level also exert significant influence in conditioning landholder preferences. Thus, in order to achieve environmental objectives and contribute to poverty reduction, the design of reward-based provision of environmental services should be based on rigorous assessment of landholders' preferences from local perspectives. Environmental interventions, negotiation approaches, and design of reward mechanisms should take into account the prioritized preferences of landholders.

Three important policy implications can be advanced. Firstly, the design of any land-management contract proposal in the study are should pay due attention to the three important land management attributes identified in this study. Secondly, the incidence of poverty, population pressure, and lack of alternative energy sources were identified as the underlying drivers of local environmental problems. This was stated unanimously by community members in focus group discussions. Hence, concerned governmental and non-governmental agencies taking part in environmental management activities should focus on ways of easing these problems, and integrate environmental objectives with local developmental concern. For instance, investment in technologically and economically feasible source of rural energy would make alternative energy sources available and could play an important role in mitigating forest degradation. Similarly, creating local opportunities for livelihood diversification could ease the pressure on land, which ultimately will result in outcomes that are compatible with both economic and environmental objectives. Thirdly, results from the conjoint analysis shed an important light on the relationship between the size of one's landholding and the likelihood of programme adoption. Contrary to the *a priori* expectation of a positive and significant relationship between the size of landholding and likelihood of programme adoption, we rather found no statistically significant relationship between the two. This implies that the size of one's landholdings may not be a major constraint for the adoption of environmental management schemes, at least in the study area. Stakeholders such as farmers and local leaders, government units, and intermediary players (e.g., PRESA) need to be fully engaged in the design and implementation of processes of the reward scheme. As long as such schemes are designed in a participatory environment and appropriate incentive mechanisms are put in place, despite small landholdings, environmental management programmes could be realized in village economies of the developing countries. However, further research is needed to validate this finding in different socio-economic settings.

Acknowledgment

The authors gratefully acknowledge the valuable comments of two anonymous reviewers. We would like to thank Kerry Waylen of the James Hutton Institute for her valuable comments on the original draft of the paper; Klaus Glenk of the Scottish Agricultural College for sharing his thoughts on the initial conjoint design; and Richard Coe of ICRAF for his inputs in the process of attributes identification and conjoint experimental design. We also thank Esther Mbugua and Frederick Mokua, MSc students for their apprentices in ICRAF during the survey period, for their contribution in the field survey. Our thanks also go to the local community leaders, local government officers, farmers, and enumerators for their valuable contribution in the process of data collection. Finally, we gratefully acknowledge the support from PRESA/ICRAF project for this study.

References

Adamowicz, W., Louviere, J., Swait, J., 1998. Introduction to attribute-based stated choice method. Final report submitted to NOAA, USA.
Alriksson, S., Oberg, T., 2008. Conjoint analysis for environmental evaluation: a review of methods and applications. Environmental Science and Pollution Research 15 (3), 244–257.
Alvarez-Farizo, Hanley, N., 2002. Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms: an example from Spain. Energy Policy 30, 107–116.
Anderson, N., 1982. Methods of Information Integration Theory. Academic Press, Inc, New York.
Arifin, B., Swallow, B.M., Suyanto, S., Coe, R.D., 2009. A conjoint analysis of farmer preferences for community forestry contracts in the Sumber Jaya Watershed, Indonesia. Ecological Economics 68, 2040–2050.
Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2008. Household livelihood strategies and forest dependence in the highlands of Tigray, Northern Ethiopia. Agricultural Systems 98, 147–155.
Balana, B.B., Mathijs, E., Muys, B., 2010. Assessing the sustainability of forest management: an application of multi-criteria decision analysis to community forests in northern Ethiopia. Journal of Environmental Management 91, 1294–1304.
Baland, J.M., Platteau, J.P., 1996. Halting Degradation of Natural Resources: Is There A Role for Rural Communities? Clarendon Press, Oxford, England.
Barrett, C., Bezuneh, M., Clay, D.C., Reardon, T., 2005. Heterogeneous constraints, incentives and income diversification strategies in rural Africa. Quarterly Journal of International Agriculture 44 (1), 37–60.
Boserup, E., 1965. The Conditions of Agricultural Growth. George Allen & Urwin, London.
Coase, D., 1960. The problem of social cost. Journal of Law and Economics 3, 1–44.
Demont, M., Jouve, P., Stessens, J., Tollens, E., 2007. Boserup versus Malthus revisited: evolution of farming systems in Northern Côte d'Ivoire. Agricultural Systems 93, 215–228.
Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecological Economics 65, 663–674.
Green, P.E., Srinivasan, V., 1978. Conjoint analysis in consumer research: issues and outlook. Journal of Consumer Research 5, 103–123.
Greene, W.H., 1993. In: Econometric Analysis, second ed. Macmillan, New York.
Hensher, D.A., 1994. Stated preference analysis of travel choices: the state of the practice. Transportation 21 (2), 107–133.
Herath, G., 2004. Incorporating community objectives in improved wetland management: the use of the analytical hierarchy process. Journal of Environmental Management 70, 263–273.
Jenness, J., 2006. Grid Tools (Jenness Enterprises). Jenness Enterprise, USA.

Kabubo-Mariara, J., 2007. Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. Ecological Economics 64, 25–35.

Kimenga, G., 2010. Connecting highland communities to Lake Naivasha water users. Available from: http://presa.worldagroforestry.org/blog/2010/06/21/connecting-highland-communities-to-lake-naivasha-water-users/ (accessed on 26 June 2010).

Lancaster, K., 1966. A new approach to consumer theory. Journal of Political Economy 74, 132–157.

Louviere, J.J., 1988. Analyzing decision making: metric conjoint analysis. In: Sage University Papers, Series No. 67. Sage Publications, Inc., Newbury Park, CA.

Louviere, J.J., Eagle, T.C., Cohen, S.H., 2005. Conjoint analysis: methods, myths and much more. CenSoc Working Paper No. 05-001.

McCoy, Roger M., 2005. Field Methods in Remote Sensing. The Guilford Press, New York.

MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and Human Well-being: Synthesis. Islands Press, Washington.

Ministry of Planning and National Development, 2005. District strategic plan 2005–2010 for implementation of the national population policy for sustainable development, Nairobi.

Munoz-Pina, C., Guevara, A., Torres, J.M., Brana, J., 2008. Paying for the hydrological services of Mexico's forests: analysis, negotiations and results. Ecological Economics 65, 725–736.

Ostrom, E., 1990. Governing The Commons: The Evolution of Institutions for Collective Actions. Cambridge University Press, USA.

Pagiola, S., 2008. Payments for environmental services in Costa Rica. Ecological Economics 65, 712–724.

Pagiola, S., Landell-Mills, N., Bishop, J., 2002. Market-based mechanisms for forest conservation and development. In: Pagiola, S., Landell-Mills, N., Bishop, J. (Eds.), Selling Forest Environmental Services. Earthscan, London.

Roe, B., Boyle, K.J., Teisl, M.F., 1996. Using conjoint analysis to derive estimates of compensation variation. Journal of Environment Economics and Management 31, 145–159.

Sayadi, S., Roa, M.G.G., Requena, J.C., 2005. Ranking versus scale rating in conjoint analysis: evaluating landscapes in mountainous regions in south-eastern Spain. Ecological Economics 55, 539–550.

Smith, M., de Groot, D., Perrot-Maîte, D., Bergkamp, G., 2006. Pay – Establishing Payments for Watershed Services. IUCN, Gland, Switzerland.

Stevens, T.H., Dennis, D., Kittredge, D., Rickenbachs, M., 1999. Attitudes and preferences toward co-operative agreements from management of private forestlands in the North-eastern United States. Journal of Environmental Management 55, 81–90.

Train, K.E., 2003. Discrete Choice Methods with Simulations. Springer, Berkley, USA.

Turpiea, J.K., Marais, C., Blignaut, J.N., 2008. The working for water programme: evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. Ecological Economics 65, 788–798.

Wheeler, B., 2008. The AlgDesign Package. Available from: http://cran.r-project.org/.

Wunder, S., Alban, Montserrat, 2008. Decentralized payments for environmental services: the cases of Pimampiro and PROFAFOR in Ecuador. Ecological Economics 65, 685–698.

Wynn, G., Crabtree, B., Potts, J., 2001. Modelling farmer entry into the environmentally sensitive area schemes in Scotland. Journal of Agricultural Economics 52 (1), 65–82.