The economic valuation of dryland ecosystem services in the South African Kgalagadi area and implications for PES involving the Khomani San

Abstract

The economic importance of the dryland ecosystem services in the Kgalagadi area is generally unknown, as is the distribution of benefits from use of the ecosystem services. This study seeks to value ecosystem services in the Kgalagadi area by applying the Choice Experiment technique and thereafter assess the potential for ecosystem services to contribute to the Khomani San livelihoods through a payment for ecosystem services (PES) scheme. The values placed on dryland ecosystem services by tourists are estimated using a Conditional Logit model, Random Parameter Logit model and a Random Parameter Logit model with interactions. The park visitors prefer getting more pristine recreational opportunities, increased chances of seeing predators and show disapproval of granting more access inside the Kgalagadi Transfrontier Park to local communities. This scenario shows that there is a possibility to craft a PES scheme where park visitors could compensate the local communities to accept a restriction of resource use in the Kgalagadi area.

Keywords: choice experiment, conditional logit, ecosystem services, Khomani San, random parameter logit

1. Introduction

The Kgalagadi area in South Africa is around 160 000 square kilometres with dried-up rivers, sparse scrubland and desert (Encounter South Africa, 2011). As is the case with many other dryland areas, the Kgalagadi area produces ecosystem services which benefit the broader society.[1] Most visitors to the area mostly enjoy the recreational amenities. Most important to note is that some of the ecosystem services from the area are produced on land owned by the Khomani San (i.e. their communal land and the portion of the Kgalagadi Transfrontier Park (KTP) which was allocated to them under land restitution).

The economic importance of the dryland ecosystem services in the Kgalagadi area is generally unknown, as is the distribution of benefits from use of the ecosystem services. This information can be obtained from an economic valuation of ecosystem services. Most of the ecosystem services are not sold on actual markets hence their economic valuation requires the use of non-market valuation techniques. Economic valuation of non-traded environmental resources is underpinned by the same principle as valuation of any marketed goods and services in that the main aim is to quantify the benefits that people obtain from their services.

This study assesses the economic value of ecosystem services in the Kgalagadi area in an attempt to (i) identify the beneficiaries of ecosystem services in this area, and (ii) assess the distribution of such benefits to the local communities especially the Khomani San.

This study seeks to value ecosystem services in the Kgalagadi area by applying the Choice Experiment (CE) technique and thereafter assess the potential for ecosystem services to contribute to the Khomani San livelihoods through a payment for ecosystem services (PES) scheme. By assessing the dryland ecosystems in the study area, we acknowledge the importance of these systems; seek to understand the trade-off between non-consumptive use and conservation through use of market instruments in a manner that will incentivise the locals and visitors to utilize these assets sustainably. The value of particular attributes can be

[1] According to the MEA (2005), an ecosystem service is a direct benefit that people obtain from ecosystems and an ecosystem is a dynamic complex community of plants, animals, and smaller organisms' communities and the non-living environment. Ecosystem services are classified into provisioning services (e.g. food and fodder); regulating services (e.g. climate regulation); supporting services (e.g. crop pollination); and cultural services (e.g. spiritual and recreational benefits).

used as a starting point in the negotiations about price between demanders and suppliers of the service. Should these ecosystems services be proved to emanate from restituted land and that they benefit non-owners, then it can be argued that there be setting up of a PES scheme to generate rewards for local communities' role in conservation.

The reasons for rarely applying PES programs include the un-competitiveness of the market, equity concern in program design and the lack of information on benefits estimates. The PES concept is expanding both in academic and in policy circles. Dedication of journal special issues by *Ecological Economics* and *Environmental and Development Economics* to PES is evidence of this expansion. Furthermore, the United States Department of Agriculture recently created an Office of Ecosystem Services and Markets to aid create "new technical guidelines and science based methods to assess environmental service benefits which will in turn promote markets for ecosystem services including carbon trading to mitigate climate change (Liu, Costanza, Farber and Troy, 2010).

The CE approach is an ideal method for valuing individual attributes of ecosystems, in addition to estimating the total value of the environmental asset as a whole. There are different categories of land and land tenure in the Kgalagadi area, and there are different categories of beneficiaries from the ecosystem services in that area. The CE approach is therefore preferred as it can help unravel the different values assigned to specific ecosystem services by their suppliers and demanders. According to Liu et al., (2010) valuation of this natural capital is an attempt to provoke stakeholders to acknowledge ecosystems contribution and significance.

Although there are several studies that have used CE for valuation, its application in dryland ecosystems with contractual parks involving local communities is limited, if not unavailable. This paper contributes to the scant literature on estimation of values of dryland ecosystem services by tourists using CE, and is the first application of its kind to be undertaken in South Africa.

2. Literature review

Most ecosystem services are neither rival nor excludable; hence they are likely to be subjected to market failure. The implication of this failure is that markets cannot send the appropriate price signals to determine the suitable provision of ecosystem services. It is for this reason that a variety of methods have been developed to value ecosystem services, including both non-monetary valuation methods such as ecosystem benefit indicators and, environmental and natural resource methods (Liu et al., 2010).

The CE technique was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983) as conjoint analysis in a multi-attribute preference elicitation format in marketing literature (Louviere et al., 2000). Despite similarity to conjoint analysis, choice experiments have a more direct link with economic theory. The approach has its roots in Lancaster's profile of value, as well as in random utility theory and experimental design (Adamowicz et al., 1998a; 1999).

Lancaster's theory of derived utility implies that a consumer's satisfaction is defined over a bundle of attributes of a purchased good or service (Gravelle and Rees, 1992). As a result of budget considerations, a change in price can lead to a discrete switch from one bundle of services to another that is consistent with cost-efficiency combination of attributes. The link between the Lancasterian theory of value and consumer demand models for discrete choices enhances the understanding of the underlying theory of choice experiments (Hanemann, 1984 and 1999).

The CE approach combines elements of experimental design, survey questionnaires, and discrete choice modelling to produce estimates of demand as a function of attributes of the services and/or goods and alternatives (Naidoo and Adamowicz, 2005). A study by Adamowicz, Boxall, Williams and Louviere (1998) was the first study to use this technique (CE) to value non-market environmental services. Ever since, there have been a noteworthy and ever-increasing number of studies in the environmental economics literature (Alpizar, 2002).

CE design primarily involves four steps, firstly defining the service to be valued with regard to its attributes and the levels these attributes take; followed by experimental design; questionnaire design; and sample choice. According to Hearne and Salinas (2002) by soliciting people's preferences for distinct hypothetical packages involving different levels of each respective attribute, including price, welfare measures and values can be estimated.

According to Raheem et al. (2009) each attribute contributes to the overall utility that an individual derives from the good or service in question. The fundamental idea of a CE is to assess how people simultaneously make trade-offs given a multitude of attributes. The fact that people have different beliefs and preferences results in them choosing different options, which makes it possible to estimate and statistically distinguish WTP for each attribute.

In a CE study, given a hypothetical setting, a respondent is asked to select their most preferred alternative among a choice set (set of alternatives) and are asked to repeat this choice for several sets. The alternatives involve different combinations of attribute levels (Kataria, 2007). By assessing the choices made by individuals, it is possible to reveal the driving factors which influence their choice (Campbell, Hutchinson and Scarpa, 2007). For a more detailed overview of CE's, refer to Louviere, Hensher and Swait (2000) and Alpizar, Carlsson and Martinsson (2003).

Given the nature of choice data generated from surveys, the CE method usually uses probabilistic choice models such as the logit, probit and conditional logit to generate welfare measures (Kataria, 2007). CE-generated welfare estimates are consistent with utility maximisation and demand theory because the econometric analysis is based on a random utility model that exactly parallels the theory of rational, probabilistic choice (Bateman et al., 2003). The basis for random utility theory is the hypothesis that respondents will make choices based on the profile of the good or service along with some degree of randomness (Snowball, Willis and Jeurissen, 2008). This randomness can be attributed to either a component of random preferences of the respondent or the incomplete information set that is made available to the respondent by the researcher.

The researcher can make use of a set of observed discrete choices to determine different marginal values for each attribute used in explaining the policy alternatives, instead of a single value for the whole policy scenario. The possibility of only getting the latter is considered as a constraint of the CVM, which unlike the CE's is not able to trace out the underlying WTP for each attribute. Nonetheless, the efficiency of the multi-attribute estimates relies on the choice of experimental designs i.e. how attributes and attribute levels are combined to create synthetic alternatives and eventually choice sets to provide as much information on the model parameters.

3. Methodology

3.1 Generic versus specific alternative designs

A distinction is generally made between generic and specific alternative titles. Generic alternative experiments give generic titles to alternatives from which respondents can choose e.g. *Alternative 1*, *Alternative 2*, etc. A generic title for an alternative such as *Alternative 1* does not convey any information to the respondent other than that it is the first of the alternatives. Generic alternative experiments have the benefit that they do not require the identification and use of all alternatives within the universal set of alternatives (Hensher et al., 2005). When the alternatives are given specific titles such as national park or game farm, such experiments are known as specific alternative experiments (Alpizar et al., 2001; Hensher et al., 2005).

Since we are interested in the trade-offs made by respondents between attributes, we focus on a generic main-effects model (i.e. without interaction effects) and therefore the degrees of freedom (df) are calculated as $df = L - A$ where A denotes the number of attributes and L refers to the number of levels of attributes. Treatment combinations (i.e. the number of parameters which we would like to estimate) should be greater than or equal to df. Furthermore, one additional degree of freedom is needed to account for the random error component of the model (Hensher et al., 2005).

3.2 Determining the sample size

Given a desired list of attributes and attribute levels, we can apply the following rule of thumb to calculate the sample size needed for the CE survey:

$$N = 500\frac{NLEV}{NALT \times NREP} \quad \textbf{(1)}$$

where *N* is the sample size, *NLEV* is the largest number of levels in any attribute, *NALT* is the number of alternatives per choice set, and *NREP* is the number of choice sets/questions per respondent. Therefore, a suitable experimental design requires a number of initial judgments on the number of levels of attributes, the number of alternatives per choice set, and the number of choice sets per respondent. Generally, it has been found that the number of alternatives and the number of attribute levels do not have significant effects on eventual estimates (Johnson et al., 2006). Taking lessons from literature and the circumstances in the study area, the following decisions were made: the largest number of levels in any attribute is 4, the number of alternatives per choice set is 3, and each respondent is presented with 4 choice sets. Therefore, applying the formula to our CE design yields a sample size of 104 for the visitors.

The designs that SPSS ordinarily produces are known as *orthogonal fractional factorial designs*. Recently, researchers have suggested that from a statistical perspective, experimental designs underlying stated preference tasks should impart the maximum amount of information about the parameters of the attributes relevant to each specific choice task, something that cannot be guaranteed with an orthogonal fractional factorial design. This has resulted in the introduction of a class of designs known as *optimal or statistically efficient designs*.

By construction, orthogonal fractional factorial designs are such that the attributes of the design are *statistically independent* (i.e. uncorrelated). Orthogonality between the design attributes represents the foremost criterion in the generation process; the statistical efficiency of the design is rarely considered. Thus, while optimal designs optimize the amount of information obtained from a design, the construction process for orthogonal fractional factorial designs minimizes to zero the correlations evidenced within a design. Optimal designs will be statistically efficient but will likely have correlations; orthogonal fractional factorial designs will have no correlations but may not be the most statistically efficient design available. Hence, the type of design generated reflects the belief of analysts as to what is the most important property of the constructed design (Hensher et al., 2005).

We used the orthogonal fractional factorial designs as we believe that orthogonality (variation of the attributes should be uncorrelated) is of paramount importance. Thus, we are mainly interested in estimating the linear main effects, effect of each attribute on utility and not interaction between them. The final design used in the study was balanced and orthogonal.

3.3 Choice modeling framework for Kgalagadi dryland ecosystem services

The questionnaire[2] generally seeks to gather information on general attitudes to ecosystem services, the choice modelling scenario and socio-economic characteristics. A total of eight versions of the questionnaires were finally produced. These were then divided to give eight blocks, allocation of respondents to a particular block were randomized. An equal amount of respondents were required to answer each version.

Visitors are defined as those who had come to the Kgalagadi area for purposes of tourism particularly entering the Kgalagadi Transfrontier Park. The attraction of this semi-arid area is based on an assortment of natural and cultural attributes, which collectively contribute to visitor experience.

In the choice modelling framework, the focus is on attributes of Kgalagadi ecosystem services that are deemed important. The attributes and attribute levels are developed based on reviews of the literature, personal observation spanning from 2009 to 2011, communications with stakeholders and other researchers working in the study area. The attribute descriptions

[2] As pointed out by the reviewer, two major concerns with respect to the study's validity exist. First, whether the questions included in the questionnaire were tested for validity. Second, if an internal assessment was conducted to test content and construct validity. One of the shortfalls of this study is that the questionnaire did not ask respondents which attributes they put greatest weight on when choosing between alternatives. Therefore we cannot shed light on compensatory decision-making or the lack thereof. Nonetheless, the questionnaire used in the survey underwent numerous revisions following on from focus groups and a pilot study. Thus, we are confident that the study is credible.

and their levels[3] are shown in Table A1 in the appendix. However, Table 1 shows one of the typical choice sets presented to visitors:

Table 1: A typical choice set presented to visitors[4]

Attribute	Status Quo	Alternative 1	Alternative 2
Camel thorn trees	6.75 kg/ 3/4 bundle	6.75 kg/ 3/4 bundle	9 kg / 1.5 bundles
Predator	448	700	1050
Recreational restriction	No Restrictions	No Restrictions	Wilderness Experience & Primitive
Medicinal plants	0.3 kg	1.2 kg	0.3 kg
Bushman cultural heritage	2 months	4 months	6 months
Grazing opportunities	719 large stock KTPs	958 large stock KTPs	1198 large stock KTPs
Levy	R 0	R 150	R 200
Your Choice (tick)			

Our choice set entails asking respondents to choose between two possible alternatives to enhancing ecosystem services preservation, and the status quo (SQ). The SQ is the base line for valuation. Alternative options to the status quo would entail a cost to the households. However, the subtle message is the status quo is that while no payment would be required for it, the ecosystem would naturally continue to be under severe pressure going forwards.

The inclusion of the status quo option may mean that respondents may always select the status quo option, which would suggest that they apply a simple decision rule and fail to make the necessary trade-offs. As a result, the information on trade-offs is lost if individuals prefer the status quo for all choices, but this is also more realistic in terms of generating policy-relevant results. Therefore, it is crucial that a test is performed to check for status quo bias, see table 2 below:

[3] As far as the data setup is concerned, it should be noted that there is no dummy coding of quantitative variables (i.e. camel thorn trees, predator, medicinal plants, bushmen cultural heritage and grazing opportunities). Instead, the actual values are used. As pointed out by the reviewer, dummy coding of qualitative variables (i.e. recreational) is undesirable. We agree that effects coding is more appropriate. Hensher et al. (2005) provide compelling reasons for the use of effects coding as opposed to dummy coding in CE studies (one being the issue of confounding). Following comments from the reviewer, effects coding is used for qualitative variables (i.e. recreational attribute). The authors are indeed grateful to the contribution made by the reviewer in this regard.

[4] A reviewer has pointed out that one of the major content validity issues in CE is that of scenario design (i.e. whether the attributes and their levels described in an understandable and clear manner). This is correct, hence the authors undertook a pilot study prior to finalizing the questionnaire. For example, in the case of the predator attribute, the levels were defined both as the chance of viewing predators and the absolute number of predator at a waterhole. Our observation from the fieldwork is that there was no confusion with regard to attribute definitions.

Table 2: Choice frequencies for Kgalagadi Transfrontier Park visitors

Choice	**Frequency**	**Percent**
Alternative 1	238	57
Alternative 2	178	43
Status Quo	0	0
Total	416	

Table 2 shows the number of times each alternative was chosen (out of 104 x 4 choice sets = 1 248 choice sets across all respondents), and shows there was no status quo bias (was never chosen at all). This implies that the park visitors preferred enhancing ecosystem services preservation. Therefore, there is no status quo bias. We conclude that the park visitors have not applied a simple decision rule and have therefore made the necessary trade-offs.

3.4 The economic model and estimation technique

The main aim of our analysis is to estimate welfare measures. To be more specific, we intend to obtain the marginal rates of substitution (MRS) or marginal willingness to pay (MWTP). In order to evaluate the welfare effects of changes in the attributes, information regarding visitors and local's preferences for attributes of the Kgalagadi dryland ecosystem services is needed. According to Bennett (1999), the MRS between attributes can be estimated by modelling how respondents switch their preferred alternative in response to the changes in the attribute levels. Note that we assume a linear utility function:

$$V_{ik} = \beta a_i + \mu \chi_1 \qquad \text{Where} \quad \chi_1 = M_k - P_1 \tag{2}$$

Our goal is to express the monetary value that respondent *k* attaches to a change in attribute *i*. In a case of small changes, we can approximate changes in *V* by:

$$\Delta V_{ik} = \frac{\partial V_{ik}}{\partial a_i} \Delta a_i + \frac{\partial V_{ik}}{\partial \chi_1} \Delta \chi_1 \tag{3}$$

By setting $\Delta V_{ik} = 0$ we can solve the equation for $\Delta \chi_1$.

$$\Delta\chi_i = -\left(\frac{\partial V_{ik}}{\partial a_i} \Big/ \frac{\partial V_{ik}}{\partial \chi_1}\right) \Delta a_i \quad [5] \qquad \textbf{(4)}$$

The MRS or MWTP between an attribute and money is:

$$MRS/\,MWTP = \frac{\partial V_{ik}}{\partial a_{ik}} \Big/ \frac{\partial V_{ik}}{\partial \chi_1} = \frac{-\beta_i}{\mu} \qquad \textbf{(5)}$$

Thus marginal values are estimated from the MRS between a coefficient β_i and the coefficient for the price parameter, μ (i.e. amount visitors would be willing to forego to conserve dryland ecosystems). By using the monetary attribute (cost to the respondent), we are able to estimate the average individual's MWTP. Note that, since this is a ratio, the scale parameters cancel each other out. Therefore, we can compare across models. A vital point to note is that this welfare measure is not comparable to welfare estimates from CVM-generated estimates for the whole good as this is the MWTP for one attribute only (Carlsson, 2008).

There are two sources of variation (Haab and McConnell, 2002): variation across individuals and uncertainty from the randomness of parameters. There is no preference uncertainty since the error term does not enter the MRS expression. Variation across individuals can be obtained by including socio-economic factors which are interacted with the attributes. This makes it possible for the average individual MRS for the various socio–economic groups. A point to note is that interaction with the alternative specific constant (ASC) does not affect MWTP. For policy purposes it is of interest, that we obtain the distribution of the welfare effects (Krinsky and Robb, 1986). Uncertainty from the randomness of parameters can be handled in various ways: Delta method, Bootstrapping or by the Krinsky-Robb method.

To illustrate the basic model behind the CE presented here, consider a Kgalagadi visitor or local resident's choice for a dryland ecosystem conservation initiative and assume that utility depends on choices made from a set *C*, i.e., a choice set, which includes all the possible conservation options. The representative visitor is assumed to have a utility function of the form:

[5] What change in real income would bring utility back to the initial level (i.e. prior to the occurrence of change in *a*).

$$U_{ij} = V(Z_{ij}) + \varepsilon\,(Z_{ij}) \qquad \textbf{(6)}$$

where for any respondent i, a given level of utility will be associated with any ecosystem conservation alternative j, V is a nonstochastic utility function and ε is a random component. Utility (U_{ij}) derived from any of the conservation alternatives is assumed to depend on the attributes (Z), such as probability of seeing predators and recreational restrictions. The attributes may be viewed differently by different individuals, whose socio-economic profiles will affect utility.

The Conditional Logit Model (CL) has been the work-horse model in CE. The main reason is simplicity to estimate. However, the last 10 years or so has seen a rapid development of other models as computer capacity and algorithms has made this model somewhat less important. Given that the CL is restrictive (Alpizar, Carlsson and Martinsson, 2001), we also consider a number of extensions. These extensions "solve" different shortfalls encountered in the CL models.

The Mixed Logit Models (ML) and Latent Class Model (LCM) are such extensions which can approximate any random utility model (McFadden and Train, 2000). The former obviates the limitations of the CL as the alternatives are not assumed to be independent, i.e. the model does not exhibit IIA, there is an explicit account for *unobserved* heterogeneity in taste by modelling the distribution and it is possible to extend to panel data. Thus, the stochastic component of the indirect utility function for alternative i and individual k is now decomposed into two parts: one deterministic and in principle observable, and one random and unobservable:

$$V_{ik} = ba_{ik} + \eta_k a_{ik} + \varepsilon_{ik} = \beta_k a_{ik} + \varepsilon_{ik} \qquad \textbf{(7)}$$

where β is the ASC which captures the effects on utility of any attributes not included in the choice specific ecosystem conservation initiative attributes. The coefficient vector can be expressed as $\beta_k = b + \eta_k$ where the first term expresses population mean and the second is the individual deviation that represents the visitors and local's taste relative to the average tastes in the respective population groups. Now we assume that the error term ε_{ik} *is* IID type I extreme value, in which case the model is now referred to as a ML (or random parameter logit - RPL) (Alpizar, Carlsson and Martinsson, 2001). The individual deviation term is a random term with mean zero. It can take on a number of distributional forms such as normal, lognormal, or triangular. This also determines the distribution of β. If $\beta \sim N\ (b, w)$, the model aims to estimate the density function with the two moments b and w (note that the average individual deviation is estimated). We now assume that the individual coefficients (the preferences) vary in the population with a distribution with density:

$$f(\beta \mid \Theta) \qquad \textbf{(8)}$$

First we can illustrate the choice probabilities for a given set of preferences (beta vector). This is called the conditional probability, which is estimated as:

$$L_k(i|\beta) = \frac{\exp(\beta a_i/\tau)}{\sum_{j \epsilon s_m} exp(\beta a_j/\tau)} \qquad \textbf{(9)}$$

A point to note is that the researcher cannot condition on unknown preferences. The unconditional probability is the integral of the standard logit probabilities over all possible values of beta.

$$P_k(i|\Theta) = \int L_k\left(\frac{i}{\beta}\right) f\left(\frac{\beta}{\Theta}\right) d\beta = \int \frac{\exp(\beta a_i/\tau)}{\sum_{j \epsilon Sm} exp(\beta a_j/\tau)} f\left(\frac{\beta}{\Theta}\right) d\beta \qquad \textbf{(10)}$$

The choice probability in mixed logit is a weighted average of the logit formula at different values of beta, with the weights given by the density ƒ (beta). The estimation is more complex since the integrals cannot be evaluated analytically (i.e. open-form). Thus gradient-based optimization method (such as Newton-Raphson or BFGS) cannot be applied unless we can express the probabilities to choose the alternatives. As a result of this difficulty, we rely on some type of simulation method, called maximum simulated likelihood. These estimation techniques were developed in the past decade or so (see Hensher and Greene, 2003). Moreover, the computer capacity has of course improved dramatically. The simulated maximum likelihood technique simply replaces the $P\ (i|\Theta)$ argument in the likelihood function, which lacks closed form solution, with its simulated counterpart SP_k. Our aim is to estimate the moments (b,W) of the distribution θ:

$$P_k(i|\Theta) = \int L_k\left(\frac{i}{\beta}\right) \mathrm{f}\left(\frac{\beta}{\theta}\right) \mathrm{d}\beta \qquad \textbf{(11)}$$

In a nutshell, from a given distribution θ, a draw of the individual specific values of β is taken. From each draw we approximate the choice probability using the standard logit. The mean of *Z* such draws is the approximate choice probability for individual k, denoted L_k.

$$SP_k = \left(\frac{1}{Z}\right) \sum_{r=1}^{Z} L_k \; (\beta_r) \qquad \textbf{(12)}$$

By construction, this is the unbiased estimator of $P_k(i|\Theta)$. The simulated log likelihood is then where subscript *n* index sampled individuals. The maximum simulated likelihood estimator is the value Θ that maximizes the simulated log-likelihood that is found by gradient search given some starting values. In terms of determining the parameters which should have a random distribution, there is a specification test, which is rather simple. For instance, it does not allow for testing where the panel data nature of the data is taken into consideration (Carlsson, 2008). Thus, we opt as is common procedure in this kind of analysis to keep only the cost parameter fixed. The implication of such an approach is that we know the distribution of the MRS and as a result avoid exploding MRS's.

Determining the distribution of each parameter is very tricky because economic theory has very little to offer to guide these decisions (see Hensher and Greene, 2003). A point to note in these RPL models is the assumption with regards to the distribution of each random parameter. Normal distribution and log-normal distribution are the two common formulations. The log-normal distribution stands out due to its restriction of all respondents to have the same sign of the coefficients. However, we know that the log-normal distribution can have a huge impact i.e. mean WTP. Moreover, a log-normal distribution imposes a positive preference on everyone. Therefore if one expects a negative preference, estimate the model with the negative values of that attribute. Thus, caution should be exercised when using this distribution.

Recent applications of the RPL models seem to suggest that this technique is superior to the CL models of overall fit and welfare estimates (Breffle and Morey, 2000; and Carlsson et al., 2003). In this paper, the CL and RPL models (see Greene and Hensher, 2010; Carlsson et al., 2010; Scarpa et al., 2011) and marginal effects are estimated using LIMDEP 9 NLOGIT 4 (see Greene 1993, 1998).

The ratio of choice probabilities between two alternatives in a choice set is unaffected by what other alternatives that are available in the choice set and the levels of the attributes of the other alternatives. This requirement may or may not be satisfied, in many cases not. Violations of IIA imply error heterogeneity resulting from omitted variable bias (see McFadden, 1986), applying the CL model assumes that the CL model is the true model in the application of interest and that IIA is fulfilled (Carlsson, 2008). If there is a violation of this assumption, then the HEV or RPL models can also be estimated and reported. The Hausman-McFadden test for IIA violation should be performed (1984).

3.5 Data collection and descriptive statistics

A survey was conducted in May 2012 with randomly picked park visitors (only park goers, and those who already paid to get to the park) at the Kgalagadi Transfrontier Park. Due to the vast size of the park, the surveys were mainly carried out at the gates, accommodation facilities and designated resting sites inside the park. Our sample composition is in line with the visitor profile at the park.

During the interviews, a map of the Kgalagadi dryland ecosystem location and colour photographs were shown to each respondent and enumerators described the Kgalagadi dryland ecosystem, its location, ecological importance and enumerated the ecosystem services.

A total of 104 visitors were interviewed. In addition to the CE questions, the survey gathered personal information of respondents to gain more insights about factors that affect the way people feel about dryland ecosystems. The information is used as explanatory variables to investigate heterogeneity in preferences. The descriptive statistics of the sub-samples are presented in Table 3:

Table 3: Summary statistics of the respondents

KGALAGADI TRANSFRONTIER PARK VISITORS[6]		
Variable	*Mean*	*Std.Dev.*
Willingness-to-pay land owners (San) to ensure there is continued provision of dryland ecosystem services[7]	0.394	0.489
Regular visitor	0.678	1.263
Main attraction for visiting area – Birds	0.982	0.135
Main attraction for visiting area – Predators	.030	0.170
Main attraction for visiting area – Diversity of plains & Game	0.962	0.190
Main attraction for visiting area – Landscape	0 .971	0.167
Main attraction for visiting area – Hiking Trails	0.096	0.295
Main attraction for visiting area – 4X4 Drivers (Trails)	0.115	0.320
Main attraction for visiting area – San Rock Engravings	0 .115	0.320
Main attraction for visiting area – Presence of San	0.135	0.341
Main attraction for visiting area – Other	0.202	0.468
Actual number of nights spent at the Park	7.606	5.321
Involved in tracking with the San people	0 .077	0.267
Buy crafts from the San	0 .126	0.332
Involved in taking photos with the San	0.087	0.282
Take photos with San in exchange for cash	0 .029	0.167
Visit the area again in 5 years	0 .726	0.446
Gender of respondent	0 .486	0.500
Age of respondent	58.596	12.588
Responsible for paying household bills	0 .808	0.394
Household size	2.394	1.139
What best describes where you currently live (1=city; 2=town; 3=suburb; 4=small town; 5=farm; 6=rural area)	2.423	1.574
Education years of respondent	14.548	1.380
Respondent employment status (1=fulltime employment; 2=part-time employment; 3=self-employment; 4=fulltime student; 5=part-time student; 6=retired; 7=other)	3.750	2.333
Household Income (Rands)	277 692.00	246 280. 00

The descriptive statistics for the visitors reveal that most of the park visitors are not willing to pay the land owners (Khomani San) to ensure that there is continued provision of dryland

[6] It should be noted that the Khomani San people as co-owners of the park have resource rights inside the park. This implies that the San are entitled to collect medicinal plants, consider grazing opportunities inside the park and collect firewood. In fact, some of the San people are already collecting medicinal plants inside the park. Their actions will impact on visitor experience, hence it is vital that we assess their preferences in this regard. If the activities that locals want are in conflict with what tourists want, there will be a conflict. The conflict would be detrimental to conservation in the Kgalagadi area, hence it's vital the visitors views about these potential possibilities are better understood.

[7] As indicated earlier, the payment vehicle was tested beforehand to ensure its credibility. The fact that most respondents believe that the government should pay for conservation does not imply that the use of a special fund did not convince respondents to pay. These policies (resource use restrictions) cannot be implemented without proper funding. The San communities alone cannot fund these activities.

ecosystem services in the broader area. One of the main reasons cited against such a scheme was that the money would be wasted, as well as that ecosystem conservation should be financed by the government. Abundance of animals, plants and the unique landscape is cited as the main reason for visiting the study area, in particular the park. Approximately 68 percent of respondents are regular visitors to the park. Moreover, majority indicated that there would visit the park again in the next 5 years.

On average, Kgalagadi visitors visited the park for about 7.6 nights. Our data show that there is limited interaction between the visitors and the local communities such as the Khomani San. The most cited interaction is taking of photos with the Khomani San, with a mere 3 percent having been involved in that activity. In contrast to local communities, park visitors are much older, have a significantly smaller household size, have completed secondary school (15 years) and have a significantly higher disposable household income. About 49 percent of the respondents are male and 51 percent are female. A picture that also emerges is that only a mere 4.81 percent of the park visitors were unemployed, with 35.58 and 17.30 employed and self-employed respectively.

4. Results and discussion

In most cases, we observe respondents making several choices. Stated preference literature often assumes that the preferences are stable over the experiment. As a result, the utility coefficients are allowed to vary among respondents but they are constant among the choice sets for each individual. In a case where we have ASCs that are randomly distributed, then we would have a random effects model.

We estimate CL and RPL[8] models taking into consideration that respondents are making repeated choices – the panel nature of the data. Although RPL model can account for unobserved heterogeneity, the model is unable to identify the sources of heterogeneity (Boxall and Adamowicz, 2002). The inclusion of interactions of respondent socio-economic

[8] Given that we want to use the RPL, we firstly just run the RPL model where all the attributes are random (except the cost attribute). Then we check which of the standard deviations of the random attributes are significant. Thereafter, we run the RPL model again and have only those attributes with significant standard deviations random. Since if the standard deviation are not significant you do not have any unobserved heterogeneity in tastes of the respondents and there would be no need to have those attributes random.

characteristics with choice specific attributes and/or with ASC in the utility function is one way to detect the sources of heterogeneity while accounting for unobserved heterogeneity (Birol, Karousakis and Koundouri, 2006). Thus, we also estimate a RPL[9] model with interactions.

Thus we estimate a CL and two RPL models. RPL model results are obtained using Halton sequences used for simulations, based on 500 draws. The RPL model was estimated with all attributes being randomly and normally distributed. The choice of distribution and which parameters should be random is a difficult choice. There is hardly any model specification which shows a clear dominance. Nonetheless, a specification test was undertaken. We keep everything else beside the cost parameter fixed. There are several reasons for choosing the normal distribution.

First, the normal distribution has been widely used and entails some convenience features. Second, in a situation where there are high parameter values, the probability that a value is on the `wrong' side is very low. Thus, the normal distribution can still be a good approximation (Meijer and Rouwendal, 2006; Sillano and de Dios Ortand, 2005). Third, given that at times

[9] A reviewer has pointed out that because of the use of different distributions in the RPL models it would be more prudent to estimate implicit prices in the 'willingness to pay space'. We are aware that a "hot" topic for the past few years is modelling in WTP space. A study by Hole and Kolstad (2010) found that models in preference space fit the data better than the corresponding models in WTP space although the difference between the best fitting models in the two estimation regimes is minimal. Furthermore, the WTP estimates derived from the preference space models turn out to be unrealistically high for many of the job attributes given by the ratio of two randomly distributed terms. Depending on the choice of distributions for the coefficients this can lead to WTP distributions which are highly skewed and that may not even have defined moments. Depending on the choice of distributions for the coefficients this can lead to WTP distributions which are heavily skewed and that may not even have defined moments. A common solution to dealing with this potential challenge is to specify the cost coefficient to be fixed. This is a convenient assumption as in this case the distribution of the willingness to pay for an attribute is simply the distribution of the attribute coefficient scaled by the fixed price coefficient. The problem with such an approach is that it is often unreasonable to assume that all individuals have the same preferences for cost (Meijer and Rouwendal, 2006), so this approach implies an undesirable trade-off between reality and modelling convenience. An alternative approach which permits the preferences for cost to be heterogeneous is to specify that the cost coefficient is log-normally distributed. This ensures that the WTP measures have defined moments since the cost coefficient is forced to be positive, but the resulting WTP distribution can be heavily skewed which may produce unrealistic estimates of the means and standard deviations of WTP. Train and Weeks (2005) argue that a way to circumvent this problem is to estimate the mixed logit model in WTP space rather than in preference space. This involves estimating the distribution of WTP directly by re-formulating the model in such a way that the coefficients represent the WTP measures. The researcher then makes a priori assumptions pertaining to the distributions of WTP rather than the attribute coefficients. According to Hole and Kolstad (2010) this approach has been found to produce more realistic WTP estimates. The WTP space approach is not yet widely used, probably partly because it has not been implemented in standard econometric software packages. With our econometric package (i.e. LIMDEP 9 for NLOGIT 4) we actually have this constraint. To the best of our knowledge, only LIMDEP 10 in NLOGIT 5 pioneers the new developments for estimation on "WTP space", hence we fail to report WTP in space. Nonetheless, we are grateful to the reviewer for this useful input and intend to estimate WTP in space in future work.

the data is gathered in third world countries where illiterate respondents may make up a significant portion of the sample size, it is likely that due to limited understanding, the choices are made in an irrational way. Yet it is not possible to identify these `wrong' choices, it is likely that some respondents actually have positive parameters for cost. Hence, a wrong sign is a problem of data collection rather than of the statistical and behavioral assumptions (Sagebiel, 2011).

Fourth, after estimating several models with different parameter distributions, the model with all parameters being normally distributed gives the best results. Finally, using different distributions that force the parameter to have a positive sign only leads to further challenges with interpretation and estimation (Sillano and de Dios Ortand, 2005). The CL and RPL model results for the park visitors are presented in table 4[10]. The attribute levels details are shown in Table B1 in the appendix.

[10] The reviewer suggested that we undertake Klein's test and the test of auxillary regressions to make sure that the initial design was correct. We are grateful to the reviewer for this valuable input. The easiest ways to test for multicollinearity is to run auxiliary regressions. To test for multicollinearity for the Kgalagadi ecosystem choice experiment, we first ran the full regression and then ran an auxiliary regression and compared the two R^2 values. Using **Klein's Rule of Thumb**, if the R^2 for the auxiliary regression is higher than for the original regression, then we probably have multicollinearity. Our test/s suggests that multicollinearity was not found to be a problem, see Appendix C. In addition we examined the Variance Inflation (VIF) factors to see if there is multicollinearity in our sample, and it was not found to be a problem.

Table 4: CL, RPL and RPL with interactions – Kgalagadi Transfrontier Park visitors

CL Model[11]		*RPL Model*		*RPL Model with Interactions*	
|Variable|	***| Coefficient (s.e)***	***|Variable|***	***| Coefficient (s.e)***	***|Variable|***	***| Coefficient (s.e)***
	Normal Distribution		*Normal Distribution*		*Normal Distribution*
Alfa	*32.091 (0.000)*	***Random Parameters in Utility Functions***		***Random Parameters in Utility Functions***	
Cost	*-0.005*** (0.001)*	*Recreational Restrictions 1*	*0.684 (0.476)*	*Recreational Restrictions 1*	*2.182** (0.946)*
Predator	*0.000** (0.000)*	*Recreational Restrictions 2*	*1.797** (0.717)*	***Nonrandom Parameters in Utility Functions***	
Tree	*-0.019 (0.016)*	***Nonrandom Parameters in Utility Functions***		*Alfa*	*32.092 (122233.464)*
Recreational Restrictions 1	*0.404** (0.177)*	*Alfa*	*36.029 (1300.843)*	*Cost*	*-0.007*** (0.002)*
Recreational Restrictions 2	*0.794*** (0.215)*	*Cost*	*-0.010*** (0.003)*	*Predator*	*0.001 (0.001)*
Recreational Restrictions 3	*0.593*** (0.180)*	*Predator*	*0.001 (0.000)*	*Tree*	*-0.021 (0.022)*
Grazing Opportunities	*0.000 (0.000)*	*Tree*	*-0.060* (0.035)*	*Recreational Restrictions 2*	*1.356*** (0.358)*
Experiencing Bushman Cultural Heritage	*-0.001 (0.031)*	*Recreational Restrictions 3*	*0.943*** (0.248)*	*Recreational Restrictions 3*	*0.861*** (0.230)*
Medicinal plants	*-0.257 (0.199)*	*Grazing Opportunities*	*-0.000 (0.000)*	*Grazing Opportunities*	*0.000 (0.000)*
		Experiencing Bushman Cultural Heritage	*-0.033 (0.075)*	*Experiencing Bushman Cultural Heritage*	*-0.017 (0.047)*
		Medicinal plant	*-0.331 (0.365)*	*Medicinal plants*	*-0.240 (0.290)*
		Derived Standard Deviations of Parameter Distributions		***Heterogeneity in mean, Parameter: Variable***	

[11] Essentially, if IIA is satisfied then the ratio of choice probabilities should not be affected by whether another alternative is in the choice set or not. One way of testing IIA is to remove one alternative and re-estimate the model and compare the choice probabilities. Although you can test for IIA, for generic experiments we often get problems with attributes with little variation when we drop an alternative (Carlsson, 2008). With our data we actually have this problem. According to Carlsson (2008), a mixed logit model is a CL model with random coefficients that are drawn from a cumulative distribution function. One of the advantages of mixed models is that the alternatives are not assumed to be independent, i.e. the model does not exhibit IIA. Thus, inclusion of RPL addresses the IIA concerns.

		Recreational Restrictions 1:	*3.828*** *(1.818)*	*Employment status*	*-0.375* *(0.200)*
		Recreational Restrictions 2:	*3.828*** *(1.818)*	***Derived Standard Deviations of Parameter Distributions***	
				Recreational Restrictions 1	*3.218* *(1.756)*

There are not many significant coefficients in this table. However, the few significant ones meet expectations and are plausible. The CL model shows that the intercept is positive implying that with everything constant the respondents would prefer one of the new alternatives to the current state. It is however insignificant. The cost attribute is significant and has a negative effect on the likelihood of the alternative to be chosen. The predator, recreational 1, recreational 2 and recreational 3 attributes all have positive and significant effect on the likelihood of an alternative to be chosen.

The fact that the recreational 1 (wilderness experience & primitive) and recreational 2 (wilderness experience, primitive & comfortable - access roads only open to visitors) attributes are statistically significant proves that there are differences in preferences (see the standard deviation section on the output table - column 4). This implies that there exists taste heterogeneity in the visitors sample for the recreational 1 and recreational 2 attributes. The intercept is insignificant. The cost coefficient is negative and significant which implies that an increase in costs reduced the likelihood that the alternative is chosen. Recreational 3 attribute is positive and significant which suggest that improved conditions for visitor experience increases the likelihood that an alternative to the status quo is chosen. The negatively signed and significant tree attribute implies that park visitors are not in favour of harvesting of firewood in the Kgalagadi area. It is the only big tree in the area. Thus this suggests that harvesting of firewood decreases the likelihood that such an alternative is chosen.

Column 6 results show that the employment status of the park visitor's interaction with the recreational 1 does not matter. Recreation 2 and 3 attributes are also positive and significant. Furthermore, the standard deviation results indicate that there exists no taste heterogeneity in the visitor's population for the recreational 1 attribute. Table 5 reports the implicit prices for each of the dryland ecosystem attributes.

Table 5: Marginal Willingness to Pay (MWTP) for dryland ecosystem attributes

Attributes	CL Model (R)	Confidence Interval	Attributes	RPL Model (R)	Confidence Interval	Attributes	RPL Model with Interactions (R)	Confidence Interval
Predator	0.08*	0.04 – 0.121	Recreational Restrictions 1	67.40	45.468 – 140.192	Whole	1929.78 **	920.773 – 1879.914
Tree	-3.54	*3.025 – 9.327*	Recreational Restrictions 2	177.08 **	66.282 – 204.366			
Recreational Restrictions 1	76.96 **	*36.76 – 113.344*	*Predator*	0.07	0.047 – 0.145			
Recreational Restrictions 2	151.22 ***	*49.878 – 153.782*	*Tree*	-5.96 *	2.951 – 9.099			
Recreational Restrictions 3	112.85 ***	*39.853 – 122.881*	*Recreational Restrictions 3*	92.93 ***	28.707 – 88.513			
Grazing Opportunities	0.01	*0.044 – 0.136*	*Grazing Opportunities*	-0.05 ***	0.046 – 0.094			
Experiencing Bushman Cultural Heritage	-0.28	*5.588 – 17.23*	*Experiencing Bushman Cultural Heritage*	-3.29	6.900 – 14.088			
Medicinal plants	-48.94	*38.072 – 117.388*	*Medicinal plants*	-32.66	33.817 – 69.043			

In column 2, keeping other things constant, the respondents are willing to pay R76.96 (US$9.08) to have the park consisting of wilderness experience and primitive (i.e. recreational 1), which is significant at 5% level. The marginal WTP for wilderness experience, primitive and comfortable (i.e. recreational 2) is R151.22 (US$17.83) and R112.85 (US$13.31) for wilderness experience, primitive, comfortable and developed (i.e. recreational 3), both effects are significant at all levels. The implication of this is that people have a higher preference for wilderness experience, primitive and comfortable than wilderness experience, primitive, comfortable and developed and wilderness experience and primitive. The MWTP for improved chances of viewing predators is R0.08 (US$0.01), which is significant at 10% level.

In column 6, recreational 2 and 3 are the most important, with the highest significant MWTP.

Kgalagadi park visitors have a MWTP to have the park consisting of the wilderness, primitive and comfortable zones (i.e. recreational 2) of R177.08 (US$20.88), on average. The MWTP for those who want the zoning to include a developed section in addition to recreational 2 (i.e. recreational 3) is R92.93 (US$10.96), on average. The park visitors are MWTP R5.96 (US$0.70) and R0.05 (US$0.01) to discourage local communities from harvesting firewood and grazing more livestock respectively.

The results for visitors suggest that they want more recreational zones which entail preventing local from extensive use of environmental resources in the area. On the other hand visitors derive a much larger value from expansion of pristine tourism opportunities. Therefore, there seems to be able to compensate the locals and ask them to cut down on destructive activities on nature. Thus, there seems to be grounds to suggest that a PES scheme can potentially resolve the conflict and develop more sustainability in the Kgalagadi ecosystem. Of course, the modalities of visitors pay and how local receive and what actions locals should desist from would require a more detailed analysis. But it seems there is a prima facie case for a PES scheme.

5. Conclusion

This paper uses a choice experiments technique to analyse preferences of park visitors towards the preservation of the Kgalagadi dryland ecosystem, and to evaluate the economic values of dryland ecosystem attributes. We contrasted two different modelling models, namely the CL and RPL (without and with interaction).

The park visitors are more concerned about recreational restrictions within the park as a whole. Given the highly fragile Kgalagadi ecosystem, it is not surprising that park visitors are sensitive about the kind of activities undertaken inside the park. Our estimates of MWTP suggest that there are significant benefits to be obtained from a program aimed at imposing resource use restrictions inside the park.

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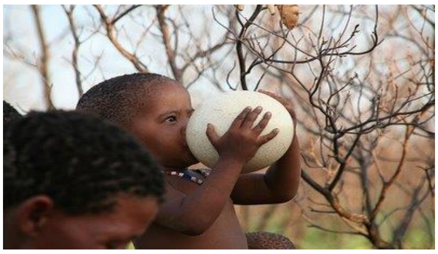
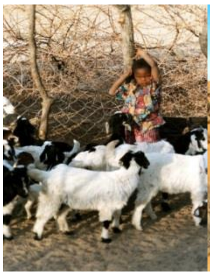
Appendix A

Table A1: Attributes and attribute levels in Choice Modelling (CM) questionnaires

Attributes	Description	Attribute Levels
Camel thorn trees (Communal land)  	It is the only big tree in the area. The shade of the tree provides a favourable microclimate for many animals. The shade also benefit human as they tend to camp where these trees are located, tend to undertake important traditional, cultural activities beneath the branches of Camel thorns and also provides firewood. **The San households harvest on average 9kg (1bundle) of firewood daily**.	**Level 1:** 9 kg - 6.75 kg (three quarters of a bundle) - **25% decline** **Level 2:** 9 kg (1 bundle) **-Current level** **Level 3:** 9 kg - 13.5 kg (1 and a half bundles) **-50% increase** **Level 4:** 9 kg - 18 kg (2 bundles) - **100% increase**
Chances of seeing Predators (Lion Population)  	The park is renowned for predator watching: Cheetah, Leopard, Brown and Spotted Hyena and Black-Manned Lion. All along the river bed are man-made waterholes fed with water from solar pumps. Along the 120km of the Auob river and the 300km of the Nossob there is a waterhole every 8-12km.The waterholes make for spectacular place for game viewing. The main attraction is lions; hence our focus is on lions.	**Level 1**: 448: 40 waterholes - **2005 estimate** **Level 2:** 700: 40 waterholes – **Current level** **Level 3:** 1050: 40 waterholes - **50% rise** **Level 4:** 1400 : 40 waterholes - **100% rise**
Bush Food (on San Communal Land) 	The San live off the land. They collect natural foods: bush food and wild fruits (i.e. water melon). **The Khomani San households collect approximately 0.84kg of the bush food on a weekly basis.**	**Level 1:**0.84 kg – 0.42 kg (Half Container) – **50% decline** **Level 2:** 0.84 kg (1Container) - **Current** **Level 3:** 0.84 kg – 1.26 kg (1.5 Containers) - **50% increase** **Level 4:** 0.84 kg – 1.68kg (2 Containers) - **100% increase**
Recreational Restrictions 	The area is characterized by a striking landscape of wide vistas, attractive red sand dunes, large Camel thorn trees and a desert bloom. One of the great advantages afforded by the Kgalagadi landscape is the ability to watch animals in an open, uncluttered landscape. SANParks (Park agency) are currently thinking of introducing a zoning programme. Current information on mapping sensitivity analysis and value of the biophysical, heritage and scenic resources of the park lead to SANParks having 4 zoning categories.	**Level 1:**No Restrictions **Level 2:** Wilderness Experience (no facilities and access by foot) & Primitive (controlled access by numbers, frequency and size of group) **Level 3:** Wilderness Experience; Primitive & Comfortable (access roads only open to visitors) **Level 4:** Wilderness Experience; Primitive; Comfortable Developed (access by sedan with larger self-catering camps and shops)
Medicinal Plants (Both inside and outside the Park)	The San categorized thousands of plants and their uses, from nutritional to medicinal. **Medicinal plants** are **used** to treat many illnesses and play a role when performing traditions. The most used medicinal plants include	**Level 1:** 0.3 kg (Half Container)- **50% decline** **Level 2:** 0.6 kg (Container) – **Current level**

	Gamaghoe and Devil's Claw as well as the famous Bushman's appetite suppressant Hoodia (Xhoba).	**Level 3:** 0.9 kg (1.5 Containers) - **50% more** **Level 4:**1.2 kg (2 Containers) - **100% more**
Bush meat Traditionally Hunted (on Khomani Farmlands) 	Hunting has been a way of life for the San for thousands of years although it is now a dying art as a result of loss of access to traditional hunting. Game meat is an essential part of their diet.	**Level 1:** 2 stingboks - **50% less** **Level 2:** 4 stingboks – **Current level** **Level 3:** 6 stingboks - **50% more** **Level 4:** 8 stingboks - **100% more**
Experiencing Bushman Cultural Heritage (in the Kgalagadi Transfrontier Park)  	The !ae!hai Heritage Park which was developed in 2009 gives Park visitors the opportunity to interact with the San. It can be entered through San Community gate and has overnight facilities at Imbewu or Sebobugas camp. San guides provide interpretive experience, evening walk with a knowledgeable guide and sunrise morning walk to see which animals came overnight.	**Level 1:** 2 months - **50% less** **Level 2:** 4 Months – **Current level** **Level 3:** 6 months - **50% more** **Level 4:** 8 months - **100% more**
Grazing Opportunities (on Khomani San Communal Land)  	Around 36 000 hectares of farmland outside the park, on Khomani San restored land is for grazing and game farming. The San farmlands are located in an arid savannah with some areas densely covered with grasses, trees and shrubs. The carrying capacity is around 958 large stock KTPs. The land has become overgrazed (two-thirds of the range) and was not productive (stocking rates should be kept to a minimum until vegetation had recovered).	**Level 1:** 719 large stock KTPs - **25% less** **Level 2:** 958 large stock KTPs – **Current level** **Level 3:** 1198 large stock KTPs - **25% less** **Level 4:**1437 large stock KTPs – **50% more**
Your One-Off Levy (Rands) 	The money from the levy would go into a special trust fund specifically for Maintaining Ecosystems.	**Level 1:** R50 **Level 2:** R100 **Level 3:** R150 **Level 4:** R200

Appendix B

Table B1: Attributes levels in Choice Modelling

|Variables|
Predator: chances to see more lions
Tree: harvesting of more firewood by the San people
Recreational Restrictions 1: Wilderness Experience (no facilities and access by foot) & Primitive (controlled access by numbers, frequency and size of group)
Recreational Restrictions 2: Wilderness Experience; Primitive & Comfortable (access roads only open to visitors)
Recreational Restrictions 3: Wilderness Experience; Primitive; Comfortable Developed (access by sedan with larger self-catering camps and shops)
Grazing Opportunities: Grazing larger stock
Experiencing Bushman Cultural Heritage (in the Kgalagadi Transfrontier Park): Interact more with the San
Medicinal plants: More collection of medicinal plants by the San people

Appendix C

Testing for multicollinearity

Table C1: Full regression

Source	SS	df	MS	Number of obs		1248
Model	4202819.25	8	525352.406	F(8, 1239)		238.38
Residual	2730514.09	1239	2203.805	Prob > F		0.000
Total	6933333.33	1247	5560.011	R-squared		0.606
				Adj R-squared		0.604
				Root MSE		46.945
Cost	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Pred	0.006	0.005	1.25	0.211	-0.003	0.015
Tree	0.383	0.375	1.02	0.306	-0.352	1.119
Recre1	24.326	2.892	8.41	0.000	18.653	30.000
Recre2	36.370	2.933	12.40	0.000	30.615	42.124
Recre3	30.404	2.975	10.22	0.000	24.56796	36.239
Graz	0.008	0.006	1.35	0.179	-0.004	0.019
Bushm	-1.343	0.690	-1.95	0.052	-2.697	0.011
Medic	9.216	4.803	1.92	0.055	-0.208	18.640
Cons	83.317	8.081	10.31	0.000	67.463	99.171

Table C2: An auxiliary regression

Source	SS	df	MS	Number of obs	1248
				F(7, 1240)	91.47
Model	55857232.6	7	7979604.65	Prob > F	0.000
Residual	108172815	1240	87236.142	R-squared	0.341
Total	164030048	1247	131539.734	Adj R-squared	0.337
				Root MSE	295.36
Pred	Coef.	Std. Err.	t	P>t [95% Conf.	Interval]
Tree	1.789	2.357	0.76	0.448 -2.835	6.413
Recre1	129.835	17.817	7.29	0.000 94.880	164.790
Recre2	73.567	18.335	4.01	0.000 37.596	109.538
Recre3	96.800	18.512	5.23	0.000 60.482	133.117
Graz	0.015	0.036	0.43	0.667 -0.055	0.0861
Bushm	7.760	4.336	1.79	0.074 -0.746	16.266
Medic	76.691	30.143	2.54	0.011 17.554	135.828
Cons	691.700	46.895	14.75	0.000 599.697	783.703