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The Economic Valuation of Dryland Ecosystem Services in the South African Kgalagadi Area and Implications for PES Involving the Khomani San

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The Economic Valuation of Dryland Ecosystem Services in the South African Kgalagadi Area and Implications for PES Involving the Khomani San

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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 then assessing the potential for ecosystem services to contribute to the Khomani San livelihoods through a payment for ecosystem services (PES) scheme. Instead of finding the value of the whole ecosystem, this study seeks to value selected ecosystem services from the point of view of visitors. 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 more pristine recreational opportunities and increased chances of seeing predators, but they disapprove of granting more access inside the Kgalagadi Transfrontier Park to local communities. The visitors have a higher marginal willingness to pay (MWTP) for the services that they want than the MWTP of the locals to engage in the competing activities. This scenario shows that it is possible to craft a PES scheme where park visitors could compensate the local communities for accepting restrictions on resource use in the Kgalagadi area. Those who value the services more can pay those who value the services less to refrain from activities that degrade the ecosystem.

Key Words: choice experiment, ecosystem services, Khomani San, random parameter logit

Contents

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Johane Dikgang and Edwin Muchapondwa*

Introduction

This study seeks to value ecosystem services in the Kgalagadi area of South Africa by applying the Choice Experiment (CE) technique and then assessing the potential for ecosystem services to contribute to the Khomani San livelihoods through a payment for ecosystem services (PES) scheme. Instead of finding the value of the whole ecosystem, this study seeks to value selected ecosystem services from the point of view of visitors. The results show that park visitors prefer more pristine recreational opportunities and disapprove of granting more grazing opportunities to local communities. The visitors have a higher marginal willingness to pay (MWTP) for the services that they want than the MWTP of the locals to engage in the competing activities. This scenario shows that there is a possibility of crafting a PES scheme where park visitors could compensate the local communities for accepting restrictions on resource use in the Kgalagadi area.

Our study area is located in the Siyanda District Municipality (comprising six local municipalities) of the Northern Cape province of South Africa, bordering Botswana and Namibia. The district is approximately 120,000 square kilometres and includes large areas in the Kgalagadi desert. The Mier Local Municipality (one of the six local municipalities) is located next to the Kgalagadi Transfrontier Park.

The Kgalagadi area in South Africa is around 160,000 square kilometres, with dried-up rivers, sparse scrubland and desert (Encounter South Africa 2011). Despite this harsh dryland

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ecosystem environment, this area harbours unique biodiversity (both animals and plants). Thus, like many other dryland areas, the Kgalagadi area produces ecosystem services which benefit the broader society.[1] In fact, the area provides a wide variety of ecosystem services, including medicinal plants, wild fruits, fuel wood, water, grazing (i.e., provisioning services); erosion control; climate regulation (i.e., regulating services); Carmel thorn trees (i.e., supporting services); and eco-tourism, cultural and spiritual benefits (i.e., cultural services). Most visitors to the area 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 in 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 then assessing 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 consumptive use and conservation; and propose using market instruments in a manner that will incentivise the locals and visitors to utilize these assets sustainably. The value of particular attributes can be used as a starting point

[1] According to the MEA (2005), an ecosystem is a dynamic complex community of plants, animals, and smaller organisms' communities and the non-living environment, and an ecosystem service is a direct benefit that people obtain from ecosystems. 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).

in the negotiations about price between demanders and suppliers of the service. If ecosystems services that benefit non-owners emanate from land that has been restored to indigenous people, then it can be argued that a PES scheme should be set up to generate rewards for local communities' role in conservation.

PES programs are not used as often as they could be. The reasons include the absence of a competitive market, concerns about equity in program design, and the difficulty of quantifying benefits. However, the PES concept is expanding in both academic and policy circles. For example, *Ecological Economics* and *Environmental and Development Economics* have dedicated special issues to PES. Furthermore, the United States Department of Agriculture recently created an Office of Ecosystem Services and Markets to aid in the creation of 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 et al. 2010).

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 available at all. This paper uses CE to contribute to the scant literature on estimation of the value that tourists place on dryland ecosystem services, and is the first application of its kind to be undertaken in South Africa.

Literature Review

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 a cost-efficient 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; 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 et al. (1998) was the first study to use this technique (CE) to value non-market environmental services. Ever since, there has been a noteworthy and ever-increasing number of studies in the environmental economics literature (Alpizar 2002).

CE design primarily involves four steps: defining the service to be valued with regard to its attributes and the levels of each attribute; 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 CE is to assess how people simultaneously make trade-offs given a multitude of attributes. The fact that people have different beliefs and preferences causes them to choose different options, which makes it possible to estimate and statistically distinguish Willingness to Pay (WTP) for each attribute.

In a CE study, given a hypothetical setting, a respondent is asked to select the preferred alternative among a choice set (set of alternatives) and 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 et al. 2007). For a more detailed overview of CE's, refer to Louviere et al. (2000) and Alpizar et al. (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 et al. 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 a constraint of the Contingent Valuation Method (CVM), which, unlike CE, 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 as possible on the model parameters.

Methodology

Choice Modeling Framework for Kgalagadi Dryland Ecosystem Services

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

Visitors are defined as those who had come to the Kgalagadi area for purposes of tourism – specifically, to enter 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 the 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[3] are developed

2 As pointed out by the reviewer, there are two major concerns with respect to the study's validity. The first is whether the questions included in the questionnaire were tested for validity. The second is whether 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 focus groups and a pilot study. Thus, we are confident that the study is credible.

3 As far as the data setup is concerned, it should be noted that there is no dummy coding of quantitative variables (i.e., Carmel 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.

based on reviews of the literature, personal observation spanning from 2009 to 2011, and communications with stakeholders and other researchers working in the study area. 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
Carmel 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 the status quo (SQ) and two possible alternatives to enhancing ecosystem services preservation. 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 for the status quo is that, while no payment would be required, the ecosystem would naturally continue to be under severe pressure going forward.

The inclusion of the status quo option means that a respondent can select the status quo for all attributes; in that case, the individual is applying a simple decision rule and failing 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-

[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 are 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 predators at a waterhole. Our observation from the fieldwork is that there was no confusion with regard to attribute definitions.

relevant results. Therefore, it is crucial that a test is performed to check for status quo bias; see Table 2 below.

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. In fact, the status quo was never chosen at all. This implies that the park visitors preferred enhancing ecosystem services preservation. We conclude that the park visitors have not applied a simple decision rule and have therefore made the necessary trade-offs.

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 is needed regarding visitors' preferences for attributes of the Kgalagadi dryland ecosystem services. 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:

$$V_{ik} = \beta a_i + \mu \chi_1 \qquad \text{Where} \quad \chi_1 = M_k - P_1 \tag{1}$$

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

$$\Delta V_{ik} = \frac{\partial V_{ik}}{\partial a_i} \Delta a_i + \frac{\partial V_{ik}}{\partial \chi_1} \Delta \chi_1 \tag{2}$$

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

$$\Delta\chi_i = -\left({}^{\partial V_{ik}}/_{\partial a_i} \; / \; {}^{\partial V_{ik}}/_{\partial \chi_1} \right) \Delta a_i \quad (3)$$[5]

The MRS or MWTP between an attribute and money is:

$$MRS/\,MWTP = {}^{\partial V_{ik}}/_{\partial a_{ik}} \; / \; {}^{\partial V_{ik}}/_{\partial \chi_1} = \frac{-\beta_i}{\mu} \quad (4)$$

Thus, marginal values are estimated from the MRS between a coefficient β_i and the coefficient for the price parameter, μ, (i.e., the amount visitors would be willing to forgo 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, because 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 because 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 to obtain 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: the Delta method, Bootstrapping or the Krinsky-Robb method.

To illustrate the basic model behind the CE presented here, consider a Kgalagadi visitor'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:

$$U_{ij} = V(Z_{ij}) + \varepsilon\,(Z_{ij}) \quad (5)$$

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

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 in estimation. However, the last 10 years or so have seen a rapid development of other models as computer capacity and algorithms have made this model somewhat less important. Given that the CL is restrictive (Alpizar et al. 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 extensions that 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 explicit accounting for *unobserved* heterogeneity in tastes 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:

$$V_{ik} = ba_{ik} + \eta_k a_{ik} + \varepsilon_{ik} = \beta_k a_{ik} + \varepsilon_{ik} \quad \textbf{(6)}$$

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 visitor'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 et al. 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:

$$ƒ(\beta \mid \Theta) \quad \textbf{(7)}$$

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:

$$L_k(i|\beta) = \frac{\exp(\beta a_i/\tau)}{\sum_{j \epsilon s_m} exp(\beta a_j/\tau)} \quad \textbf{(8)}$$

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.

$$P_k(i|\Theta) = \int L_k\left(\frac{i}{\beta}\right) ƒ\left(\frac{\beta}{\Theta}\right) d\beta = \int \frac{\exp(\beta a_i/\tau)}{\sum_{j \epsilon Sm} exp(\beta a_j/\tau)} ƒ\left(\frac{\beta}{\Theta}\right) d\beta \quad \textbf{(9)}$$

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 because the integrals cannot be evaluated analytically (i.e., open-form). Thus, a gradient-based optimization method (such as Newton-Raphson or BFGS) cannot be applied unless we can express the probabilities of choosing each alternative. As a result of this difficulty, we rely on a 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 a closed form solution, with its simulated counterpart SP_k. Our aim is to estimate the moments (b,W) of the distribution θ:

$$P_k(i|\Theta) = \int L_k\left(\frac{i}{\beta}\right) ƒ\left(\frac{\beta}{\Theta}\right) d\beta \quad \textbf{(10)}$$

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.

$$SP_k = \left(\frac{1}{Z}\right) \sum_{r=1}^{Z} L_k\ (\beta_r) \quad \textbf{(11)}$$

By construction, this is the unbiased estimator of $P_k(i|\Theta)$. 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 which parameters 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. It should be noted that different parameters can have different distributions and that some parameters can be fixed (Carlsson 2008).

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 regard 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 on mean WTP. Moreover, a log-normal distribution imposes a positive preference on everyone. Therefore, if one expects a negative preference, it is necessary to estimate the model with the negative values of that attribute. Thus, caution should be exercised when using this distribution.

Thus, as is common procedure in this kind of analysis, we opt to keep 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.

Recent applications of the RPL models seem to suggest that this technique is superior to the CL models with respect to overall fit and welfare estimates (Breffle and Morey 2000; 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 not affected by the alternatives available in the choice set or by the levels of the attributes of the other alternatives. This requirement may or may not be satisfied; in many cases, it is not. Violations of IIA imply error heterogeneity resulting from omitted variable bias (see McFadden 1986), while applying the CL model assumes that it is the true model in the application of interest and that IIA is fulfilled (Carlsson 2008). If there is a violation of these assumptions, then the HEV or RPL models can also be estimated and reported. The Hausman-McFadden test for IIA violation should be performed (1984).

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 and its location and ecological importance, then enumerated the ecosystem services.

A total of 104 visitors were interviewed. In addition to the CE questions, the survey gathered personal information about 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

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, collect firewood, and have their animals graze in the park under certain conditions. In fact, some of the San people are already collecting medicinal plants inside the park. Their actions will have an impact on visitors' experiences; hence, it is vital that we assess their preferences in this regard. If the activities that locals want are different than what tourists want, this conflict would be detrimental to conservation in the Kgalagadi area. Hence, it's vital that visitors' views about these possibilities are better understood.

7 As indicated earlier, the payment vehicle was tested beforehand to ensure its credibility. Although most respondents believe that the government should pay for conservation, respondents were willing to pay into a special fund for conservation. This implies that visitors realize resource use restrictions cannot be implemented without proper funding, and that the San communities alone cannot fund these activities.

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 ecosystem services in the broader area *outside* the designated park. 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. They were, however, willing to pay into a special fund dedicated to conservation *within* the park.

Abundance of animals and plants and the unique landscape are cited as the main reasons for visiting the study area, the park in particular. Approximately 68 percent of respondents are regular visitors to the park. Moreover, a majority indicated that they 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 photos with the Khomani San, with a mere 3 percent having been involved in that activity. Moreover, compared to the local residents, park visitors are much older, have a significantly smaller household size, have completed secondary school (15 years) and have 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 a mere 4.81

percent of the park visitors were unemployed, with 35.58 and 17.30 employed and self-employed, respectively.

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 ASC's 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 the 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 characteristics with choice specific attributes and/or with ASC in the utility function is one way

[8] Given that we want to use the RPL, we first run just 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 as random only those attributes with significant standard deviations. This is because, if the standard deviations are not significant, there is no unobserved heterogeneity in tastes of the respondents, and therefore no need to have those attributes random.

to detect the sources of heterogeneity while accounting for unobserved heterogeneity (Birol et al. 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 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 fixed except for the cost parameter. There are several reasons for choosing the normal distribution.

First, the normal distribution has been widely used and has some convenient 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

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[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 modelling in WTP space has been a "hot" topic for the past few years. 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. 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 because 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 our study's inability 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

et al. 2006; Sillano and de Dios Ortand 2005). Third, given that, at times, 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. Because 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 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]

[10] The reviewer suggested that we undertake Klein's test and the test of auxiliary regressions to make sure that the initial design was correct. We are grateful to the reviewer for this valuable input. The easiest way 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, then ran auxiliary regressions, and compared the two R^2 values. Using Klein's Rule of Thumb, if the R^2 for the auxiliary regressions are higher than for the original regression, then we probably have multicollinearity. Our tests suggest that multicollinearity was not a problem. 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*
Alpha	*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)*

[11] Essentially, if IIA is satisfied, then the ratio of choice probabilities should not be affected by whether or not another alternative is in the choice set. One way of testing IIA is to remove one alternative, re-estimate the model, and compare the choice probabilities. Although one can test for IIA, for generic experiments there often are problems with attributes with little variation when an alternative is dropped (Carlsson 2008). We have this problem with our data. Thus, we could not confirm its validity. Accordingly, we ran the RPL. 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.

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***	
		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. This finding 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 effects on the likelihood of the respondent choosing an alternative.

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. However, the intercept is insignificant. The cost coefficient is negative and significant, which implies that an increase in costs reduces the likelihood that a respondent chose the alternative. The recreational 3 attribute is positive and significant, which suggests that improved conditions for the 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 local residents harvesting firewood from the Carmel thorn tree, which is the only big tree in the area.

This suggests that harvesting of firewood decreases the likelihood that such an alternative is chosen.

The results in Column 6 show that the interaction of the park visitor's employment status with 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 Opportunitie s*	-0.05 ***	0.046 – 0.094			
Experiencing Bushman Cultural Heritage	-0.28	*5.588 – 17.23*	*Experiencin g 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 consist of wilderness experience and primitive amenities (i.e., recreational 1), which is significant at the 5% level. The marginal WTP for wilderness experience, primitive and comfortable (i.e., recreational 2) is R151.22 (US$17.83). For wilderness experience, primitive, comfortable and developed (i.e., recreational 3), the MWTP is R112.85 (US$13.31). Both effects are significant at all levels. The implication is that people have a higher preference for wilderness experience, primitive and comfortable than for wilderness experience, primitive, comfortable and developed or for 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 MWTP, which is significant. Kgalagadi park visitors have a MWTP to have the park consist 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' MWTP to discourage local communities from harvesting firewood and grazing more livestock are R5.96 (US$0.70) and R0.05 (US$0.01), respectively.

The results for visitors suggest that they want more recreational zones, which entails preventing locals from extensively using 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 the possibility of compensating the locals if they cut down on activities that are destructive to nature. Thus, there seem 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 how visitors pay, how locals receive payments, 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.

Conclusion

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

The park visitors are 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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