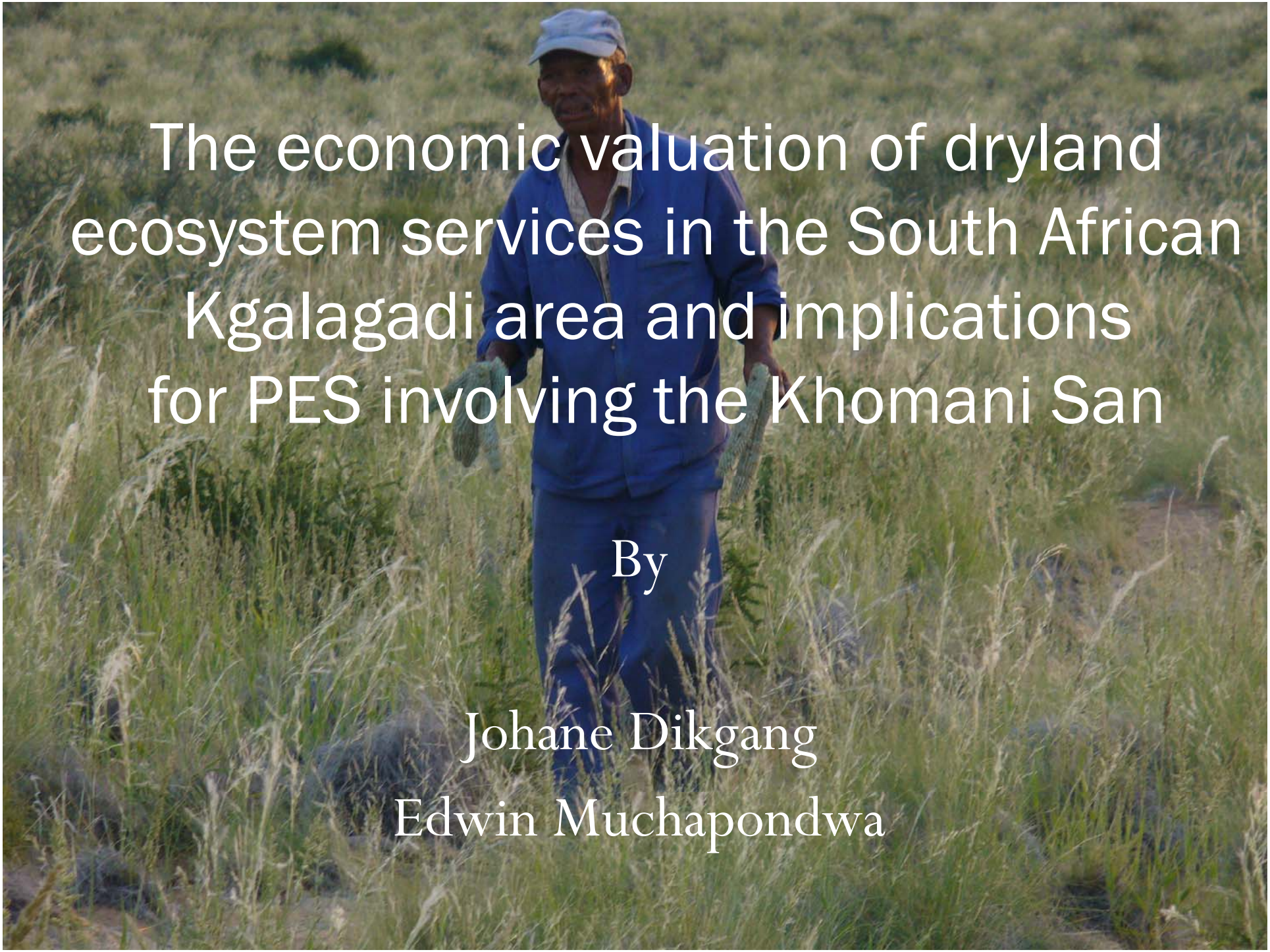

The economic valuation of dryland ecosystem services in the South African Kgalagadi area and implications for PES involving the Khomani San

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Introduction

- The Khomani San people land provide ecosystem services.
- The relative value placed on attributes of dryland ecosystem services is unknown, as is a better understanding of those who benefit from their presence.
- Most of the ecosystem services are not sold on actual markets hence their valuation requires the use of non-market valuation techniques.
- Valuation of ecosystem services is not only of economic interest, but also has social and political implications.
- Thus, the policy implication of valuing environmental services is that when budget allocations are made, there can also be fairly considered by taking into consideration their costs and benefits.

- The findings in this study are crucial because they have a bearing on land use decisions, such as setting-up of payment schemes for the ecosystem services.
- This study applies a CE technique to assess the potential for ecosystem services to contribute to the Khomani San people through payment for ecosystem service (PES).

Background

- The focus of this study is on the Khomani land because of the form of land holding - communal land & Contract Park.
- History shows they have been involved in sustainable resource use in the Kgalagadi desert for thousands of years, and that it can be argued that they are part of the ecosystem.
- There is a need to go commercial and use the land to generate income, especially in terms of non-consumptive/extractive use.
- The status of dryland ecosystems affects the well being of local communities.

Study Area

- The Kgalagadi area is around 160 000 square kilometers with dried-up rivers, sparse scrubland and desert.
- Despite the harsh Kgalagadi dryland ecosystem environment, its ecosystems harbour a unique biodiversity (animals and plants).
- Most importantly for the San indigenous people, the Kgalagadi dryland ecosystem enables them to practice their culture and heritage.
- In terms of visitors to the area, ecosystems services provide recreational amenities.

Literature Review

- Valuation of environmental and natural resources has come a long way since the first work carried out in the United States of America in the 1960s.
- While valuations of drylands ecosystem services have been studied elsewhere, the focus tends to be on estimating the value of a single attribute, our study focuses on multi-attribute valuation. For this reason, CE is preferred.
- A study by Adamowicz, Louviere and Williams (1998) was the first study to use this technique (CE) to value non-market services.
- Several studies conducted in the past 14 years show that CE has many advantages over the Contingent Valuation (CV).

- Although there are several studies that have used CE for valuation, the economic literature of this technique in contractual park community and dryland ecosystem services is limited, if not unavailable.

Methodology

- CE 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 consumers' satisfaction are defined over a bundle of attributes of a purchased good or service (Gravelle and Rees, 1992).
- Thus each attribute contributes to the overall utility (Raheem et al. 2009).
- 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.

- In a CE study, a respondent is asked given a hypothetical setting 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).
- 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 unique value for the whole policy scenario.
- 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.

Choice Experiment Design

- There is a vast amount of literature on CE design. Likewise, there is also a number of customized software designed to handle CE's design and analysis. The current design is modelled using SPSS and the resulting design is tested using Limdep.
- For the purposes of the design at hand, it is generally believed that a simple main-effects design predicts choices fairly well and is therefore adequate for the task at hand.
- We specify seven attributes associated with the Kgalagadi ecosystem namely Camelthorn trees (X_1), Predators (X_2), Recreational Restrictions (X_3), Medicinal Plants (X_4), Bushman Cultural Heritage (X_5), Grazing Opportunities (X_6) and the bid vehicle (X_7).
- The simple choice model for visitors would evaluate design *i* in terms of:

$$Z_i = f\ (X_{1i} + X_{2i} + X_{3i} + X_{4i} + X_{5i} + X_{6i})$$

Assessing Kgalagadi Dryland Ecosystem Services

- A face-to-face survey is undertaken in the broader Kgalagadi area in an attempt to determine how preferences for particular dryland areas are formed.
- For the purposes of data collection, the questionnaire used for Park Visitors differs from the one administered to Local Residents.
- We evaluate Local Residents and Park Visitors demand for ecosystem services.
- 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 attributes and their levels are shown in the table below:

Attributes	Description	Attribute Levels
Camelthorn trees	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	The park is renowned for predator watching: Cheetah, Leopard, Brown and Spotted Hyena and Black-Manned Lion. The park has around 700 lions, 200 cheetahs and good population of leopards. 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**: 700 - 448 : 40 WATERHOLES - **2005 ESTIMATE**
		Level 2: 700 : 40 WATERHOLES – **CURRENT LEVEL**
		Level 3: 700 - 1050 : 40 waterholes - **50% rise**
		Level 4: 700 - 1400 : 40 waterholes - **100% rise**

Attributes	Description	Attribute Levels
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 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)
Experiencing Bushman Cultural Heritage (in the Kgalagadi Transfrontier Park)	The !ae!hai Heritage Park which was developed in 2009 gives Transfrontier Park visitors the opportunity to interact with the San. It can be entered through San Community gate and can stay overnight 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**

- Our choice set entails asking respondents to choose between two possible alternatives to enhancing ecosystem services preservation, and the status quo. An example (abstract from questionnaire) of one of the choice sets - You can notice that, while the levels of attributes in the status quo always stay the same, the levels in the column of the alternative option change in each set:

Attribute	Status Quo	Alternative 1	Alternative 2
Camel thorn trees	6.75 kg	9 kg	13.5 kg
Predator	448	448	700
Recreational restriction	No Restrictions	Wilderness Experience; Primitive; Comfortable & Developed	No Restrictions
Medicinal plants	0.3 kg	0.6 kg	0.9 kg
Bushman cultural heritage	2 months	4 Months	6 months
Grazing opportunities	719 large stock units	1198 large stock units	1437 large stock units
Levy	R 0	R 100	R 150
Your Choice (tick)			

The Economic Model

- The main aim of our analysis is to estimate welfare measures – MRS or MWTP. The MRS or MWTP between an attribute and money is:

$$MRS/\ MWTP = \frac{\partial V_{ik}}{\partial a_{ik}} \Big/ \frac{\partial V_{ik}}{\partial \chi_1} = \frac{-\beta_i}{\mu}$$

- To illustrate the basic model behind the choice experiment, consider a visitor's choice for a dryland ecosystem preservation initiative and assume that utility depends on choices made from a set *C*.

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

- where for any respondent *i*, a given level of utility will be associated with any ecosystem preservation alternative *j*, *V* is a nonstochastic utility function and ε is a random component. Utility U_{ij} derived from any of the preservation alternatives is assumed to depend on the attributes (Z),

- The Conditional Logit Model (CL) has been the work-horse model in CE. However, the last 10 years or so a rapid development of other models, computer capacity and algorithms has made this model somewhat less important.
- The Mixed Logit Model (ML) is one such extension which can approximate any random utility model (McFadden and Train, 2000).
- It 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:

$$V_{ik} = ba_{ik} + \eta_k a_{ik} + \varepsilon_{ik} = \beta_k a_{ik} + \varepsilon_{ik}$$

- Where β is the alternative specific constant (ASC) which captures the effects on utility of any attributes not included in the choice specific ecosystem preservation initiative attributes.
- Now we assume that the error term ε_{ik} IID type I extreme value, in which case the model is now referred to as a mixed logit model (or random parameter logit - RPL).
- In terms of determining the parameters which should have a random distribution, 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.

- 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; Layton and Brown, 2000; Carlsson et al., 2003; Kontoleon, 2003; Lusk et al., 2003; Morey and Rossmann, 2003).

Descriptive Statistics

- Now that the Choice Sets and Choice Experiment questionnaires have being crafted, a survey was undertaken in and around the Kgalagadi Transfrontier Park from the 3rd – 19th May 2012. In all, 312 questionnaires were administered.

Variable	Mean %	Standard Deviation
Regular	66	1.19
San Crafts	12	33
Visit Again	73	44
Sex (Male)	49	50
Age (Years)	59	13
H/H Size	2.4	1.15
Education (No of Years)	15	1.37
Income (Rands)	272 373	249 632

Model Results

- In our analysis, the CL model and marginal effects are estimated using LIMDEP 9 NLOGIT 4 (see Greene 1993, 1998).
- We estimate a standard CL model using the data in Park Visitors.lpj. In the choice experiment, each choice set consisted of three alternatives, where one was a status quo alternative.
- Moreover, we calculate marginal willingness to pay (MWTP) for the different attributes in the choice experiment.

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+-----------------------------------------+
| Notes No coefficients=> P(i,j)=1/J(i).      |
|       Constants only => P(i,j) uses ASCs    |
|         only. N(j)/N if fixed choice set.   |
|         N(j) = total sample frequency for j |
|         N    = total sample frequency.      |
|       These 2 models are simple MNL models. |
|       R-sqrd = 1 - LogL(model)/logL(other)  |
|       RsqAdj=1-[nJ/(nJ-nparm)]*(1-R-sqrd)   |
|         nJ   = sum over i, choice set sizes |
+-----------------------------------------+
+--------+-------------+---------------+--------+--------+
|Variable|      Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+-------------+---------------+--------+--------+
 ALFA    |    -.14113302      .22236589          -.635       .5256
 B_COST  |    -.00963493      .00159859         -6.027      .0000
 B_TREE4 |    33.8720354     .276171D+07       .000        1.0000
 B_PRED4 |    4.63155937      1.05317049         4.398      .0000
 B_RECRE4|    34.1163824     .245938D+07       .000        1.0000
 B_MEDIC4|    33.1257947     .268922D+07       .000        1.0000
 B_BUSHM4|    33.7951859     .265344D+07       .000        1.0000
 B_GRAZ4 |    33.8337761     .257105D+07       .000        1.0000
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+-----------------------------------------+
| WALD procedure. Estimates and standard errors |
| for nonlinear functions and joint test of     |
| nonlinear restrictions.                       |
| Wald Statistic            =     15.26573     |
| Prob. from Chi-squared[ 6] =       .01829     |
+-----------------------------------------+
+--------+-------------+---------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+-------------+---------------+--------+--------+
 Trees |      3515.54597     .286636D+09      .000  1.0000
 Predator|   480.705091      123.032523     3.907   .0001
 Recreati |   3540.90651     .255257D+09      .000  1.0000
 Medicine |   3438.09436     .279112D+09      .000  1.0000
 Bushman |  3507.56984     .275398D+09      .000  1.0000
 Grazing |    3511.57507     .266847D+09      .000  1.0000
```

Concluding Remarks

- It is clear that the benefits of ecosystem services on the Khomani San people's land are currently not being transferred to the local community due to the failure to identify and value their services.
- The value of particular attributes can be used as a starting point in the negotiations about price between demanders and suppliers of the service.
- With an increased focus on nature-based resource management and the need for payments for environmental goods and services, discussions on setting-up payment schemes for ecosystem services have intensified.
- 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.
- Without external beneficiaries, the value computed can be added to the value of resource extraction to derive a full natural income measure.
- A value estimated in this study can still be used in the absence of direct beneficiaries to setup a PES to compensate dryland ecosystem services' Khomani San for the positive externality that is being provided.


THANK YOU!