

# A Case Study of Botswana's Kalahari

## Applying a Multi-Criteria Decision Analysis to identify ecosystem service trade-offs under four different land uses in Botswana's Kalahari Rangelands

### 1. Introduction

This policy brief outlines the multi-criteria decision analysis (MCDA) approach used to identify key ecosystem service trade-offs associated with four different land uses in Botswana's Kalahari rangelands (Box 1). MCDA provides an interdisciplinary framework that allows monetary-based techniques to be integrated with the analysis of non-monetary ecological and cultural values. Underpinning data in our Kalahari case study includes semi-structured interviews, policy and price data, ecological assessments and benefit transfer data identified through literature review.

### 2. Applying Multi-Criteria Decision Analysis

MCDA ranks alternative options by quantifying, scoring and weighting a range of quantitative and qualitative criteria. In this study MCDA was applied to analyse four land uses in relation to the ecosystem services they provide, and is one of only a few methods that is able to incorporate data from a range of different sources. MCDA follows a four step process:

- i. Problem definition & identification of options
- ii. Criteria definition & assessment
- iii. Criteria weighting
- iv. Derivation of each option's overall preference score

#### i. Problem definition & identification of options

In some parts of Botswana's southern Kalahari, rangeland degradation has led to extensive bush encroachment; reducing access to good quality grazing and reducing economic returns, and threatening the delivery of ecosystem services: the benefits humans obtain from ecosystems. The research problem to be tackled was defined as: Which land uses and land management strategies are best placed to deliver specific ecosystem services in Kalahari rangelands in Botswana's southern Kgalagadi district?

#### ii. Criteria definition & assessment

The performance of each land use was assessed according to its capacity to deliver ecosystem services for the year 2013. Nine criteria were identified, supported by 14 indicators (Table 1), where possible drawing upon financial data or quantitative values.

### B O X 1

#### Land uses in Botswana's southern Kalahari

Rangelands are used in a variety of ways and are the main source of rural income in Botswana. They support livestock grazing, tourism and wildlife management as well as collection of fuelwood and veld products for household use. In doing so, they deliver a variety of ecosystem services. Four land uses were considered in this study:

1. Communal livestock grazing
2. Private cattle ranches
3. Private game ranches
4. Wildlife Management Areas

#### iii. Criteria weighting

Each criterion was weighted in order to reflect its relative importance for policy-making. Weighting was based on a policy analysis where the main goals and priorities of national land, agriculture, development, tourism and wildlife policies were identified. Alternatively, weightings can be derived from multiple stakeholders, which can then be normalised and aggregated.

#### iv. Derivation of each option's overall preference score

Each criterion was scored on a homogeneous 100-point scale (where 0 = less important, 100 = most important). Scores for each criterion were multiplied by the criterion weights derived in the previous step to derive an overall weighted score (or preference score) for each land use. Final preference scores are presented in Figure 1. The sensitivity analyses showed that results are robust when the weighting system is changed, indicating that multi-stakeholder consultations may not be needed to establish socially representative weights.

Communal livestock grazing delivered the widest range of ecosystem services, followed by Wildlife Management Areas, private cattle ranches and private game ranches. High scores achieved by communal grazing areas are

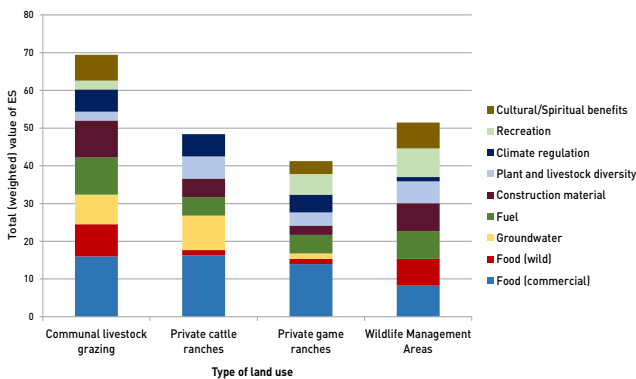
T A B L E 1

Criteria (shaded) and indicators used to assess capacity to deliver ecosystem services

|                   |  |                       |  |                       |   |
|-------------------|--|-----------------------|--|-----------------------|---|
| Food (commercial) | Net profit of meat production (US\$/ha/yr); Stocking level (ha/Livestock Unit) | Construction material | Collection of thatching grass and poles for fencing                                  | Climate regulation    | Value of carbon sequestration (US\$/ha/yr)  |
| Food (wild)       | Gathering of veld products; Subsistence hunting                                | Ground water          | Value of water extracted (US\$/ha/yr)  | Recreation            | Revenues from Community Based Natural Resource Management, trophy hunting & photographic safari (US\$/ha/yr); Ecotourism potential; Wild animal diversity |
| Fuel              | Firewood collection  | Genetic diversity     | Genetic diversity between forage species; Genetic diversity between livestock breeds | Spiritual inspiration | Presence of landscape feature or species with spiritual value   |

F I G U R E 1

Overall MCDA scores for each option



mainly linked to their use for food production, with the management practices used in these areas also allowing wild food production, fuel, construction material, climate regulation and spiritual use values to be retained.

3. Limitations of the Multi-Criteria Decision Analysis method

Like any tool, MCDA faces a range of theoretical and practical limitations. In instances where more participatory approaches are used, it assumes that all stakeholders agree on the need to tackle land degradation and move towards sustainable land management. The scoring and weighting of the criteria relies on judgements, which may be difficult to make in cases where reliable data are lacking. Judgements made may also not always correspond with the preferences of society as a whole, with the risk of generating biases increasing when judgements are made based on policy analyses (such as in this study), or with input from only small

samples of stakeholders. There is potential for double-counting when using multiple criteria and this problem needs to be addressed carefully. Finally, the capacity to generate economically sound decisions through MCDA is challenged by the integration of monetary and non-monetary based techniques.

4. Limitations of MCDA in its application to the Kalahari case study

A lack of reliable data specifically for the study area made it challenging to make informed judgements. Use of the farm scale as the unit of analysis in our study hampered assessment of the aggregate interaction of land management options across landscapes. It also separated ecosystem services into their various categories, underplaying the interactions between them within a single land use. This is an important limitation for the Kalahari context, where mobility, links and flows of both wildlife and water, shape the delivery of ecosystem services. MCDA also did not include any consideration of access to land and land tenure, which may limit land use options available to specific socio-economic groups and delivery of ecosystem services. Equity considerations could be better captured through stakeholder consultations.

5. Conclusion

MCDA has helped us identify communal livestock management as the preferred land use for which a more detailed economic valuation can be carried out in further studies. By highlighting which land uses are best placed to deliver specific ecosystem services, our case study provides useful information for informed development of policy, markets and incentives that can influence ecosystem services delivery.