Case studies in Environmental Economics

Compendium to the Course book Introduction to Environmental Economics

Prepared by the Centre for Applied Research

for

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Preface

This report details case studies (based on existing literature) in support of the DEA initiative on Environmental Economics and Natural Resource Accounting. The aim is to demonstrate that the concepts and tools discussed during the course can be used in 'real' life. It is therefore expected that this report will deepen the understanding of Environmental Economics and Natural Resource Accounting and contribute to increased use of this discipline in development planning and natural resources management.

This should foster the adoption of a systematic approach towards the integration of resource management and development, cutting across individual economic sectors and recognising the linkages between natural resources. This initiative should further enhance the regular assessment of sector comparative advantages and help to assess and evaluate trends in natural resource stock and flows. The general foundation would be the adoption of the polluter pays principle and user pays principle.

The case studies were selected by the project team 'Environmental Economics and Natural Resource Accounting', consisting of staff from the DEA and the Centre for Applied Research (CAR). The draft report was reviewed and edited by the project team.

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Mr. Steve C. Monna
Director, Department of Environmental Affairs
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1. Introduction

This document discusses environmental economics case studies that have been developed to support the training course book on "Introduction in Environmental Economics" prepared by the Centre for Applied Research (CAR) and the Department of Environmental Affairs (DEA) in 2006. The case studies are presented according to the modules of the course book. Case studies have been developed for the following topics:

I. Resource valuation

II. Project evaluation and the environment

III. Natural resources accounting

IV. Economic instruments and the environment

The objectives of this case study book are to:

- Show the application of environmental economics concepts and tools;
- Improve the understanding of course participants; and ultimately to
- Increase the applications of environmental economic analysis in Botswana.

The target group is the development planners in central government as well as district economic and physical planners. At the end of each case study, questions have been formulated to test the reader's understanding of the subject at hand.

2. Resource valuation

2.1 Economic value of Namibia's protected area system (2003)

Source: Turpie J, Lange G, Martin R, Davies R, and Barnes J (2004). Strengthening Namibia's system of National Protected Areas: economic analysis and feasibility study for financing. Ministry of Environment, Wildlife and Tourism, Namibia, GEF and UNDP.

2.1.1 Introduction

This case study describes the protected area (PA) system of Namibia and evaluates its economic value. Furthermore, it outlines the options for improving financing of Protected Areas (PA) in Namibia and the policy implications. The specific objectives of the case study are to:

- Demonstrate how an economic valuation of a land use system can be done with existing data; and to
- Discuss the implications and application of economic valuation of PA system in Botswana.

The case study was chosen because of its comprehensive analysis of the value of protected areas and its potential use in Botswana. Hitherto Namibian valuation studies have focused only on private and communal lands.

2.1.2 Background of Namibia's wildlife and tourism

Namibia is a semi-arid country located in the western part of southern Africa. The economy is heavily reliant upon natural resources. The tourism sector is one of the most important industries in Namibia of which emphasis is on the wildlife resource and other natural resources. More than 14% of Namibia's land surface area is formally protected within twenty-one national parks, reserves and recreational areas. It is expected that this area will be expanded with the proclamation of the' Sperregebiet' (located in south-west Namibia on the border with South Africa with a large coastal area). The PA system can be categorised into desert parks, developed and less developed wildlife parks, as well as the reserves, resorts and recreational sites (Table 1). The PA system provides a significant core to a system of conservation areas which are ecologically and economically linked. In addition, there are conservancies and privately protected areas on private and communal lands just outside the PAs and these constitute 14% of Namibia's land surface.

The tourism industry has achieved a significant growth in visitors over the years. Visitors can be local, from the region and from elsewhere. In 2004, it was estimated that the sector had a total turnover of N$1.5 billion and total value added of N$1.2 billion, the equivalent of 4% of the gross domestic product (GDP). This supports more than 2 200 tourism-related businesses especially accommodation businesses. Nature-based tourism is very critical to the overall tourism sector. In the same year, at least 70% of total tourism expenditures were attributed to this kind of tourism clearly highlighting the importance of natural resources.

Table 1*: Namibia's protected area system (2003) and their characteristics*

Protected area	Area (km^2)	Big game viewing
Desert parks		
Namib-Naukluft Park	49768	
Skeleton Coast Park	16390	
National West Coast recreational area	7800	
National diamond coast recreational area		
Sperregebiet (not yet proclaimed)		
Ai-Ais Hot springs	461	
Huns Mountains	3000	
Developed wildlife parks		
Etosha National Park	22270	Yes
Waterberg Plateau Park	405	Yes
Less developed wildlife parks		
Mamili National Park	320	Yes
Mudumu National Park	1010	Yes
Caprivi Game Park	6000	Yes
Mahango Game Reserve	225	Yes
Khaudum Game Reserve	3842	Yes
Manghetti Game Reserve	480	Yes
Small reserves, resorts and recreational sites		
Popa Game Park	0.25	
Hardap Recreation Resort	252	
Daan Viljoen Game Park	40	
Von Bach Recreation Reserve	43	
Gross Barmen Hot Springs	1	
Naute Recreation Resort	225	
South West Nature Park	0.04	
Cape Cross Seal Reserve	60	

2.1.3 Valuation framework

The study was largely based on existing information.

The total economic value (TEV) of the PA system can be assessed using the following framework:

Total Economic Value = Use value + Non use value

The classification of TEV components differs from author to author but the variations are however negligible. For instance, some authors capture TEV as *direct + indirect use value + option value +*

existence value. These slight variations do not affect the usefulness of the TEV concept as all values are captured.

a. The use value comprises of the direct and indirect use values.

- Direct use values result from economic activity and are generated through consumptive and non-consumptive use of the PA resources. It includes activities such as game viewing, consumptive activities such as sale of live game, game transfers and use in drought relief programmes. Hunting also takes place in protected areas and this is carried out in concessions allocated in specific portions of the parks through the Directorate of Parks and Wildlife.

- Indirect use values are values generated by outputs from the PA system that form inputs into production by other sectors of the economy or that contribute to net economic outputs elsewhere in the economy by saving on costs. These are obtained from ecosystem functions such as carbon sequestration, wildlife refuge and water infiltration. These would also include benefits and costs like the provision of source areas for wildlife populations.

b. The non-use value covers the option and existence values. The option value of the PA system is the value of having the option to use resources within the parks in the future while the existence value is the value of knowing that the resources or biodiversity within the parks are protected. In this study, a quasi-option value has been used. This is "the amount that a society is willing to pay to retain the option of using these resources in the future". These are usually expressed in the society's willingness to pay (WTP) to conserve these resources.

2.1.4 Methodology

Direct use value: tourism

To solicit the value of tourism and recreation, the Travel Cost Method was used. This method assumes that the PA value can be best measured through estimating travel costs. This method requires data on travel costs (e.g. park entry fees), the number of visitors and the number of visits.

The following steps were used:

a. Estimation of the number of visitors by origin and the number of days they visited the parks by park and then in total. Categories of origin are domestic, regional visitors and overseas tourists.
b. The average trip expenditures in PAs are estimated in the form of park fees, accommodation expenditures, and other costs related to protected area visits;
c. Estimate the total tourism expenditures attributed to PAs based on the number of visitors and existing survey data. To derive this, average trip expenditures by tourists is multiplied by the total number of visitors by origin.

The first step attempts to estimate the number of visitors per park by origin and the actual numbers have been estimated and are represented as the *upper bound*. Estimates for the *lower bound* take into consideration the assumption that tourists may visit more than one park in a single trip. The estimates are based on a visitor exit survey that was undertaken in 2003 to determine the number of visitors per park. Based on these estimates, it was suggested that on average, foreign visitors visit 2.3 parks and that domestic tourists visit half this number of parks per single trip.

Indirect use values

The study did not attempt to quantify the ecosystems functions of the PAs. It is quite difficult to measure some components of indirect use value because this requires a significant amount of biophysical information. However, the following techniques can be used to estimate the indirect use value of PAs:

- Damage costs avoided;
- Prevention and mitigation measures;
- Replacement costs; and
- Effects on production.

For carbon sequestration, an approach that is normally applied is based on damage and/or mitigation costs. This entails estimating the carbon sequestration of land (in tons/ha) multiplied by the estimated value of a captured ton of carbon.

Option and existence values

These are normally measured as part of the contingent valuation method (CVM). This method requires extensive data collection. The values assigned to these components are based on existing data from surveys conducted in earlier years. Assumptions were made based on these figures. The study considers the society's willingness to pay for conservation (tourists) and the donations made by local and international organisations for the development and maintenance of the country's protected areas. However, for the donor contributions, data was available for 2003-2004.

2.1.5 Data sources

The study uses information mainly supplied by the Namibian Wildlife Resorts (NWR), individual park data provided by the park wardens and managers and various literature. There was no time to carry out a detailed survey in order to arrive at the true value of the Namibia's protected area system.

2.1.6 Total Economic Value of PA system in Namibia

Direct use values (tourism and hunting)

Step (a): Estimating park visitor numbers by origin

The origin of visitors is important in that overseas visitors tend to spend more per day than domestic tourists and the former's consumer surplus is higher. Table 2 presents the total number of people that visited Namibia's protected areas in 2003 by origin. Taking into account multiple visits (lower bound), it is estimated that that there were at least 214 000 visitors in 2003 of whom 55% are foreign.

Table 2: Estimated number of PA visitors by origin in 2003

	Assumptions	**Domestic**	**Regional**	**Overseas**	**Total**
Upper bound	1 park per visitor	109,825	92,580	180,034	382,439
Lower bound	1.15 parks per domestic visitor, 2.3 parks per foreign visitor	95,500	40,252	78,276	214,028

Step (b): Estimating travel expenditures

Estimated expenditures on accommodation are available for the wildlife resorts. The income from accommodation is calculated by multiplying the number of days during the year which a specific accommodation unit was occupied by the per unit rate. Tourist expenditure on protected areas was estimated to be N$ 52.4 million in 2003. Expenditures on park fees are mostly in the form of gate fees. This was estimated on the basis of visitor and vehicle numbers for all resorts collected by NWR and data from park managers. Other types of expenditure are allocated for instance to restaurants, car rentals, air fares, domestic travels, handicrafts, cultural and recreational activities. The overall estimated average trip expenditures by tourists of different origins for protected areas are presented in Table 3.

Table 3: Average trip expenditure (N$) by tourists of different origin

	Domestic	**Regional**	**Overseas**
Average trip expenditures	2,440	3,650	9,183

Step (c): Total PA tourism expenditures

Total expenditures by wildlife viewing tourists are estimated to be between N$ 1.1 – 2.3 billion (Table 4). The hunting tourism expenditures due to hunting concessions in protected areas were estimated to be N$ 73 million. The PA tourism expenditures have been taken to represent the value of the TCM or the total value of Namibia's PA tourism.

Table 4*:* Total expenditure by wildlife viewing tourists in Namibia's protected areas (N$ millions)

	Domestic	Regional	Overseas	Total for wildlife viewing	Total including hunting & viewing	Total in million US$
Upper bound (382 439 visitors)	268	337.9	1653.2	2259.1	**2332.4**	384.8
Lower bound (214 028 visitors)	233	146.9	718.8	1098.7	**1172**	193.4

Indirect use values

The study concluded that the most critical indirect use values of protected areas are carbon sequestration, water supply and regulation, wildlife refuge and cultural value. These are briefly explained below without any quantitative values assigned to them. It was not possible to quantify these values because of both a lack of sufficient data and time constraints.

Carbon sequestration offsets the damages caused by increasing atmospheric carbon and climate change. Vegetation captures carbon thereby mitigating global warming. Such studies have not been sufficiently undertaken in Namibia. However, research suggests that conserved natural systems within dry land areas would yield higher values as carbon sinks than the heavily grazed areas outside PAs.

The indirect use value of water supply and regulation has not been sufficiently researched. In northern areas such as the Caprivi and Etosha, which has large rivers and considerable wetland systems, protected areas may act as important areas for water supply for the local communities.

Wildlife is the key resource for tourism and hunting in the protected areas. These areas provide an important refuge for a variety of wildlife species including potentially endangered and threatened species. PAs are also a source area for genetic material and biota that could otherwise be found outside protected areas. This value is largely reflected in the donor funding that is normally directed at conserving and maintaining PAs.

Cultural values include contribution to education, scientific knowledge and the spiritual wellbeing of the local and global populations. It is not easy to quantify this value. However, attempts can be made in estimating the amount of use by for instance, educational groups and scientists but it is not possible to quantify the true contribution this makes to the whole society.

Option and existence values

These values are often reflected in the donations that local and international community make or are willing to make to ensure conservation of the protected areas. Data for the year 2003 could not be attained. It was however estimated that in 1996 the domestic tourists were willing to pay on average N$104 per person which amounts to an average of N$ 28.7 million for conservation of wildlife.

For the international community, their willingness to pay is expressed in the donations made towards the conservation of wildlife. For 2003-2004, a total of N$ 54 million was raised for conservation related projects. However, it is not clear as to how much was specifically associated with protected areas. It is assumed that probably at least N$ 2.5 million is attributed to conservation and management of protected areas in Namibia. The existence value is therefore assumed to be N$ 2.5 million in 2003.

Table 5 represents the TEV of Namibia's protected area system for 2003. Ideally the TEV should include direct use value, indirect use value and the non use value (option and existence value). The study has taken the direct use value to represent the total value of Namibia's protected areas. However, this estimate is just for the tourism component and is therefore an underestimate. Indirect use values and the non-use values have not been estimated.

Table 5: TEV of Namibia's protected areas (in million N$; 2003)

	Lower	**Upper**
Direct use value	1,172.0	2,332.4
Indirect use value	n/a	n/a
Option+ existence value	2.5	2.5
Total:	**1,174.5**	**2,334.9**

Note: n/a means not available.

2.1.7 Discussion

Protected areas perform a variety of roles in the economy. The study does not cover all components of the total economic value of protected areas. It is a partial valuation study and mainly focuses on the tourism value of protected areas. The study indicates the importance of tourism in protected areas and the need to maintain these areas for conservation of biodiversity to the benefit of current and future generations.

Accurate data on visitor use patterns is critical in such a study. It is therefore essential that surveys capture comprehensive data on the number of visitors, visitation rates, duration of their stay, and other characteristics of their trips. Non-availability of comprehensive data and non accuracy of the available data limited the analysis of the above study. Characteristics of protected area demand are also vital for such a study as well as the quality of the area. This would aid in understanding how the improvement of

protected areas might influence the overall tourism demand and consequently on assessment of what likely returns on investments would be.

Policy implications

The direct value added and total value added by tourism in PAs into the national economy was also estimated. The expenditures generate direct value added to the gross domestic product (GDP). The direct value added would be the income generated within the tourism sector. Whereas the indirect value added is generated through tourism businesses purchasing goods and services from other sectors thus stimulating production in these sectors. In deriving the value added, enterprise models and macroeconomic models (social accounting matrix) are used to analyse the impacts of tourism on the economy. This however requires technical expertise and time. Botswana's tourism is mostly based on protected areas and contributes significantly to the national economy. According to the World Travel and Tourism Council, tourism currently accounts for 5.3% of the total GDP and increase to 7.4% if indirect activities (e.g. supply and marketing) are included. This is more than in Namibia. Growth perspectives are considered to be good (5% real growth). It is therefore important to value the protected areas which form a significant part of the tourism industry in Botswana and realise their worth given other land uses. This would help make a case for PAs against other land uses.

Extensive data is required when undertaking valuation studies. It is therefore important to have improved databases to enable the assessments. Resource valuation should ideally involve collaboration with different stakeholders such as ecologists and economists for ease of data provision. In Botswana, the economic values of the Okavango Delta and the RAMSAR site have been determined in 2006. However, there has not yet been an economic assessment of the entire PA system in Botswana.

Limitations of the study

The study was limited to the direct use value of protected areas, mostly tourism. This was primarily due to time constraints and data limitations. A full survey could not be undertaken and therefore the study relied primarily on existing data and literature from various sources.

Botswana can learn from this study as it can be applied to our protected areas. This kind of valuation requires that a lot of in-depth surveys be carried out with both visitors and the park authorities. Other important functions of PAs such as ecological functions need to be analysed in order to get the real value of PAs. However, this requires extensive data.

Questions for discussion

1. How could this study be applied to Botswana? How could it be improved?
2. What are the data needs and what data can be collected?
3. What additional methods can be used to value the PA system?
4. What would be the policy implications of such a study for Botswana?

2.2 Economic impacts of climate change in Florida

Source: Stanton E.A and Ackerman F, 2007. Florida and climate change: *the costs of inaction*. Global Development and Environment Institute, Tufts University. United States of America.

2.2.1 Introduction

The case study emanates from a study undertaken in Florida, United States of America, which analysed the potential impacts of climate change for Florida's economy and consequently the environment and people's livelihoods. Global climate change is one of the greatest challenges facing the world today and requires significant attention in order to address the issues related to it and to overcome the impacts or mitigate them. Not taking action against climate change leads to significant costs as indicated in this case study. The discussion also alludes to a similar study undertaken for the Caribbean Islands.

Global climate change and its impacts require long-term development planning that includes measures that deal with the phenomenon. This entails participation of all stakeholders including the communities, private sector, academia and non-governmental organisations amongst others. It is often assumed that if no action is taken to combat climate change, then it will be cost free. This assumption is however incorrect as illustrated in this case study. The study emphasises that, as much as it is important for individuals to insure their lives, it is also necessary to take action against global climate change. It further argues that the impacts can largely be avoided if action is taken soon so as to stabilise the green house gas emissions and if adaptation strategies are put in place and implemented.

The study examined the potential costs to the state of Florida if the green house emissions remain unchecked. This was analysed by comparing two scenarios: 'optimistic or rapid stabilisation' and the 'pessimistic or business as usual case'. The scenarios represent what will happen if the world succeeds in the fight against climate change versus what will happen if little is done. The costs of inaction is described as the " *damage that society can avoid by engaging in ambitious , large scale reductions of green house gas emissions, beginning in the near future and continuing throughout the century".* This is the difference between the two scenarios mentioned above. This is a narrow interpretation of the costs of inaction. The real costs of inaction are higher as they comprise *all* economic, social and ecological costs of failure to take action.

The purpose of this case study is to show that Botswana will incur costs if action is not taken against climate change. The study is relevant for Botswana as it gives an indication as to what governments can do to tackle issues of climate change and the related costs of not taking action at all. It is also applicable in that issues of land use suitability, tourism impacts, droughts and water impacts are highlighted in the study and these are some of the problems that Botswana will incur in light of climate change. A similar study could be undertaken in Botswana and be integrated into the development planning process.

2.2.2 Global climate change

Global climate change is a serious issue that has received considerable attention over the last few decades. The earth's climate has changed over millions of years, sometimes slowly and sometimes quickly. Changes in atmospheric concentrations of green house gases and aerosols, land cover and solar radiation lead to global climate changes. According to several assessments undertaken by the International Panel on Climate Change (IPCC), as of 2006, the past twelve years had been the hottest years ever recorded. The temperature increases have been widespread over the globe and the land regions have warmed much faster than the oceans. Sea surface temperatures have been rising since 1961 with contributions from thermal expansion, melting glaciers and ice caps amongst others. There have also been decreases in the extent of snow and ice cover. Generally, mountain glaciers and snow cover have declined in both the northern and southern hemispheres. Furthermore, it has been observed that precipitation has increased in some parts of the world such as northern Europe, north and South America and central Asia, but has declined in the Sahel, southern Africa, the Mediterranean and parts of southern Asia. Observational evidence further indicates that globally, the overall area affected by drought has increased since the 1970s and that cold days and nights as well as frosts have become less frequent over most land areas, and hot nights and days occur more frequently. Furthermore, many natural systems and biodiversity have been affected by global climate change.

Emissions of global green house gases such as carbon dioxide, nitrous oxide and methane are largely due to human activities and have increased since pre-industrial times. The emissions arise primarily from the burning of fossil fuels, agriculture, waste, energy, deforestation, decay of biomass and motorised transport.

It has been projected that global green house gas emissions will continue to increase over the next few decades (by 25 to 90% by 2030).This will cause further warming and induce many changes in the climate system and these changes are likely to be more severe than those observed in the past. For instance, heavy rainfall, increases in tropical cyclone intensity, changes in the ecosystems, increase in extreme and frequent heat waves, further melting of sea ice and snow covers as well as decreases in water resources especially in the Mediterranean, southern Africa and western parts of the United States. In Africa, the following impacts have been projected (IPCC, 2007[1]):

- By 2020, between 75 and 250 million of people will be exposed to increased water stress;
- In some countries, harvests from arable production could be reduced by up to 50% and agricultural production in general will be adversely affected;
- Sea level rise will affect low lying coastal areas with high populations, and adaptation costs could be at least 5 to 10% of Gross Domestic Product; and
- There will be increases of between 5 to 8% arid and semi-arid land in the continent.

[1] IPCC, 2007. Climate change 2007: Synthesis report (summary for policy makers).

The impacts of climate change are overwhelmingly negative and will affect the poor and vulnerable/marginal groups of the society severely. These communities are often the least responsible for causing climate change and have limited resources to adapt to the changes. Efforts are being made in attaining the Millennium Development Goals, but if unchecked, climate changes will hamper this in most parts of the world leaving people in poor conditions and unable to sustain themselves.

The tragedy of global climate change is not without hope but further action is required urgently. Through the concerted efforts of governments, scientists, communities and other stakeholders, it is possible to prevent even greater tragedies and hence protect our planet for future generations.

2.2.3 The study area

Figure 1: Map of Florida

The state of Florida lies in the south-eastern region of the United States. Most of the state is a large peninsula[2] with the Gulf of Mexico on its west and the Atlantic Ocean on its east. It has a surface area of 170 409 km^2 with sixty-seven counties and is the twenty second largest state out of the fifty states that make up the USA. The total land area constitutes about 82% of total area while the remainder is the

[2] An arm of land surrounded by water on three sides.

water area. It is the fourth most populous state in the US with an estimated population of 18 million people (2007) and a population density of 119/km^2. In economic terms, the gross state product (GSP) of Florida was estimated at $ 491 billion in 2001. Several sectors make up Florida's economy with the major ones outlined below:

- International trade (40% of all U.S. exports to Latin and South America pass through Florida);
- Tourism – about 76.8 million tourists visited Florida in 2004 and this has made the state the top travel destination in the world. The tourism industry has an economic impact of $ 57 billion on Florida's economy;
- Space Industry - The space industry represents $4.5 billion of the state's economy. The average annual wage of aerospace workers is approximately $52,000. The number employed at Kennedy Space Centre alone is 15,000 and Florida ranks 4th among the states in overall aerospace employment with 23,000 jobs;
- Agriculture – Florida leads the southeast region in farm income. Florida produces about 75% of the domestic production of oranges and accounts for about 40% of the world's orange juice supply.
- Construction - This industry's strength results from the steady growth stream of new residents and visitors.

Florida is known around the world for its balmy weather. The state has mild winters and summers can be long and hot with showers providing much appreciated relief during the rainy season. Coastal areas also experience gentle breezes during the summer. The climate is tempered by its proximity to water. It has a humid subtropical climate. Florida is a hurricane prone state, with water on three sides and a long coastline. These occur seasonally from June to November. It is rare for a hurricane season to take place without any impact being felt.

The state is rich in natural resources such as wildlife, marine life, birds, wetlands and forests. With climate change, the state of these resources will be altered. Florida is ranked forty-fourth in terms of level of energy consumption and only 4% of the energy in the state is generated through renewable resources. In July, 2007, it was planned that new pollution standards would be adopted so as to encourage reductions in greenhouse emissions. The target for reduction was 80% of the 1990 levels by year 2050 which is flagged in this case study.

2.2.4 Methodology and assumptions

The costs of inaction have been estimated in monetary values for four major categories of the economy:

- Loss of tourism revenue:
- Increased hurricane damages:
- Value of residential real estate that is at risk from sea level rise: and
- Increased costs of generating electricity as temperatures rise and hence the demand for air conditioners.

These have been estimated by the comparison of two future climate scenarios for Florida. Other costs to the economy (e.g. agriculture and infrastructure) have not been included and therefore the cost of inaction must be considered as a conservative estimate.

The costs of inaction are calculated as the difference between the two scenarios, which are described below:

a. *Scenario 1: Optimistic or Rapid stabilisation*. This scenario depicts the best possible 'climate' future and is more optimistic than the 'best' IPCC scenario. It assumes immediate large scale reductions in green house gas emissions and that it is still possible to have fewer changes in the global climate system. In order to keep global average temperatures from exceeding 2 ^{o}F above year 2000 levels[3], the global atmospheric concentrations of carbon dioxide should be kept at or below 450 parts per million (ppm). To achieve this, global emissions of green house gases must be reduced by 50% of their current levels by 2050 and by 80% by 2100. The goal and assumption for the US and Florida is to reduce emissions by 80% by the year 2050. Precipitation and hurricane intensities will remain constant, extreme heat waves will be rare and only brief events which leave manageable impacts will be incurred in Florida.
b. *Scenario 2: Pessimistic or business-as-usual.* This scenario assumes steadily increasing green house gas emissions throughout the century. Here the atmospheric concentrations of carbon dioxide will exceed the 450ppm mark by 2030 and reach 850ppm by 2100[4]. Average temperatures will increase and for Florida, these will be 5^{o} F higher than they are currently by year 2050 and 10^{o}F[5] higher in 2100. Hurricane intensity will increase, precipitation will be highly variable and heat waves will become more severe and there will also be increases in ocean temperature as well as acidity levels. With less rainfall, there will be an increase in drought conditions. Sea level will rise under this scenario by 69 cm in 2060 (using geological survey maps and GIS technology). The affected land (i.e. vulnerable zone) covers 9% of Florida. About 1.5 million people or one-tenth of the population live in this zone. This sea rise will have adverse impacts on the transportation infrastructure. Economic impacts are discussed in the next section.

[3] This is a threshold for preventing complete melting of the Greenland Iceland sheet and other climate change severe impacts.
[4] IPPC's A2 scenario
[5] ^{0} C = 5/9(^{o} F -32).

Table 6: Characteristics of the two scenarios

Scenario 1: very optimistic	**2025**	**2050**	**2075**	**2100**
Average temperature increase (in ^{0}F as compared to 2000)	0.6	1.1	1.7	2.2
Sea level rise in cm.	4.6	8.9	13.5	18.5
Change in precipitation	0	0	0	0
Change in hurricane intensity	0	0	0	0
Scenario 2 business as usual	**2025**	**2050**	**2075**	**2100**
Average temperature increase (in ^{o}F as compared to 2000)	2.4	4.9	7.3	9.7
Sea level rise in cm.	22.6	45.0	67.6	89.9
Change in precipitation	down	down	down	down
Change in hurricane intensity	up	up	up	Up

Population growth and economic growth are assumed to be the same under both scenarios. Using existing forecasts, it is assumed that the Gross State Product (GSP) will increase six fold during the 21st century.

Assumptions have been made for each of the four cost categories in order to calculate the difference between the two scenarios, i.e. the costs of inaction.

Tourism

The impact on tourism is estimated as the difference between the values of the tourism sector in scenario 1 as compared to scenario 2. Under scenario 1, it is assumed that scenario 1 has no impact on tourism. Tourism will grow as a constant percentage of the Gross State Product (GSP), which is expected to grow six-fold in this century.

In scenario 2, the tourism sector will be hard hit by climate change. Warmer temperatures will scare away tourists and the area may not be appealing to visitors. Beaches may disappear due to high sea level rise; marine life will be destroyed including species such as the crocodiles and fish and other endangered species. Wetland swamps, which are of great significance to different aquatic species, will also be degraded as well as coral reefs. It is assumed that Florida will receive at least 5 million visitors every month regardless of the weather conditions. This is the current lowest level of monthly tourist arrivals that seems to be independent of adverse weather conditions. Tourism and recreational activities will decline steadily to 75% of the scenario 1 level by 2100.

Real estate

Assumptions

- The value of real estate will grow consistently in all parts of Florida in proportion to GSP throughout the century;
- The fraction of the state's residential property at risk is proportional to the extent of sea level rise;
- The starting value of the real estate in the vulnerable zone or 0.69 mt of sea level rise is $130 billion (2000).

Electricity

Global change has a mixed impact on electricity consumption. Higher temperatures will lead to an increase in air conditioners but to a decrease in heating demand during winter. Increased variability leads to an increase in peak demand, which determines the required electricity supply capacity.

In calculating the costs of inaction, a simulation model for electricity demand and supply to the year 2100 was developed. This simulation model takes into consideration changes in population, per capita electricity demand as well as temperature but holds fuel prices and the costs of new electricity plants constant. Based on the supply and demand model, future electricity consumption is estimated to increase by 1.54 % per annum, irrespective of climate change. The extra demand caused by climate change under both scenarios has to be added. Assuming that this extra demand is proportional to the increase in temperature, the extra electricity demand was estimated for both scenarios.

The following assumptions are made:

Scenario 1:

- Efficiency in the use of fuel and renewable energy;
- Adoption of policies to reduce emissions;
- Phasing out use of oil and coal; and
- The temperature increase and above measures lead to an estimated extra electricity demand of 0.07% per annum. The annual increase in electricity demand thus becomes 1.61%.

Scenario 2:

- Maintaining the current use of oil and coal;
- Increases in the number of gas, oil and coal plants (construction every year);
- Increased use of water for cooling purposes; and

- The temperature increase and above measures lead to an estimated extra electricity demand of 0.34% per annum. The annual increase in electricity demand thus becomes 1.88%.

Effects of hurricane damages

The costs of hurricanes were based on the estimated chance of being hit by a hurricane of categories 1-5 multiplied by the expected damage and number of deaths associated with each hurricane.

i. Chances of a hurricane occurrence

The likelihood of a hurricane occurrence has been estimated based on empirical figures for the period 1990-2006 and national data for the last 50 years. These data resulted in the following estimated chances of being hit by hurricane in an average year: category 1: 28%, category 2: 21%, category 3: 19%, category 4: 4% and category 5: 1 to 2%.

ii. Economic damage and death

Three factors were considered to estimate the damage and number of fatalities:

- Population growth and coastal development. These are assumed to be the same under both scenarios;
- Sea level rise: the study has used the finding of Norgaard (2006) that economic damage and deaths double for each metre of sea level rise.
- CO_2 concentration and sea-surface temperature. The study has used another finding from Norgaard (2006) that economic damage and death double for a doubling of the CO_2 concentrations.

The above assumptions have been used to estimate future costs under both scenarios as compared to the baseline situation.

Estimated baseline situation

The study used hurricanes striking the state from 1990 to 2006 as a baseline for estimating future economic damages and deaths from hurricanes. Based on the hurricane trends over the last fifteen years, the state can expect to suffer four out of ten mainland US hurricanes and two thirds of all mainland U.S category 5 storms. The probabilities are summarised in Table 7. The estimated baseline costs are $ 3.7 billion of damage and eight fatalities.

Table 7: Estimated impact of hurricane strike on Florida

	Average impacts in USA (1990 to 2006)			Estimated impact of hurricane strike in an average year in Florida	
Hurricane category	**Damages (billions of 2006 $)**	**Deaths (scaled to 2006)**	**Annual probability of occurrence in Florida**	**Damages (billions of 2006 $)**	**Deaths (scaled to 2006)**
1	0.7	6	0.28	0.2	2
2	3.9	15	0.21	0.8	3
3	7	6	0.19	1.3	1
4	15.7	34	0.04	0.6	1
5	62.9	57	0.01	0.8	1
Total				**3.7**	**8**

2.2.5 Findings

The section presents the economic impacts of climate change on Florida's industries. With increases in population and per capita income, businesses will boom in the optimistic scenario whereas climate change will have adverse impacts under the pessimistic scenario as some industries will not operate at full capacity, and others will be forced to close their operations. Non-quantified impacts of climate change are also discussed under this section.

Tourism

This is one of Florida's largest economic sectors. On average, visitors make about 85 million trips per annum staying for an average of five days per trip. About 92% of these trips are taken by domestic US travellers and 8% are taken by international visitors. In 2006, tourism accounted for $65 billion or 9.6% of Florida's gross state product (GSP). In addition, $4 billion was collected as sales taxes on tourism purchases and $500 million from the bed taxes.

The costs of inaction are presented in Table 8. The costs will be $9 billion in 2025 and will rapidly escalate to $167 billion in 2100. This would amount to 2.4% of GSP, making the cost of inaction the highest in the tourism sector.

Table 8: Tourism costs of inaction ($ billion of 2006)

	2025	2050	2075	2100
Revenues (in billions of 2006 $)				
Rapid stabilisation	161	317	460	668
Business-as-usual	152	277	372	501
Costs of inaction	9	40	88	167
Revenues (as % of GSP)				
Rapid stabilisation	9.6	9.6	9.6	9.6
Business-as-usual	9.1	8.4	7.8	7.2
Costs of inaction	0.5	1.2	1.8	2.4
Employment (000)				
Rapid stabilisation	1,433	1,856	1,856	1,856
Business-as-usual	928	860	797	738
Costs of inaction	505	996	1,059	1,118

Mitigation measures that are considered are beach protection and nourishment and conversion of dry land areas into wetlands. The latter could, however, affect real estate and infrastructure.

Real estate

The state will continue to heavily invest in infrastructure over the next century. As populations and industries grow, there is high demand for both housing and road infrastructure. Under scenario 1, the impacts of climate change will be similar for the 21st century as for the 20th century. In the business-as-usual scenario, infrastructure will be destroyed and therefore the costs will be high, particularly as some infrastructure may not be able to provide services to residents.

As mentioned earlier, the vulnerable zone will be hit the hardest due to sea level rise. This area contains about 900 000 housing units which are currently estimated at $130 billion. In addition, other facilities such as airports, hospitals, schools, etc, will be greatly destroyed under scenario 2.

The annual increase in the value of housing units at risk of damage due to sea level rise constitutes the costs of inaction. These are outlined in Table 9. The costs are estimated at $11 billion in 2025 and will rise to $56 billion in 2100.

Table 9: Real estate cost of inaction ($ billion of 2006 $ and as %)

	2025	2050	2075	2100
Damages (in billions of 2006 $)				
Rapid stabilisation	2	4	6	10
Business-as-usual	13	27	39	66
Costs of inaction	11	23	33	56
Damages as % of GSP				
Rapid stabilisation	0.12	0.13	0.13	0.15
Business-as-usual	0.79	0.82	0.81	0.95
Costs of inaction	0.67	0.69	0.68	0.8

Mitigation measures mentioned in the study include the building of seawalls as well as elevation of houses.

Electricity

The sector covers 138 power plants thereby representing over 56 gigawatts of capacity. There is a heavy reliance on power plants that burn natural gas and coal as well as oil and nuclear power plants. High temperatures combined with population and industrial growth will increase the demand for electricity mainly to supply air conditioning. Power plants will have to be built and these will burn natural gas. Construction of new plants will require huge investments and the electricity generated will be expensive. High temperatures will also reduce the performance of current power stations and transmission lines making them less efficient. High electricity demands will also impact heavily on water resources as power generation requires the use of water.

Under both scenarios the costs of electricity generation will increase rapidly during this century; the difference in costs between the scenarios (i.e. the costs of inaction) is modest but growing. Under scenario 2, the annual cost of power will increase to $78 billion by 2100 compared to $ 60.2 billion under scenario 1. Every ^{o} F degree of warming will cost consumers an extra $3 billion per annum. The costs of inaction are presented in Table 10. The business as usual scenario will require nearly 400 more sources of electricity generation than that under scenario 1.

Table 10: Costs of climate change in the electricity sector (US$ billion)

	2025	2050	2075	2100
Rapid stabilisation	22.4	37.6	48.1	60.2
Business-as-usual	23.5	42.5	58.4	78.2
Costs of inaction	1.1	4.9	10.3	18

Effects of hurricane damage

Florida is prone to extreme weather conditions such as hurricanes. With climate changes, the damages as a result of these conditions will bear economic impacts and increased death rates. Based on the earlier discussed assumption, the costs of inaction are estimated to increase to 104 billion in 2001 as compared to $ 3.7 billion now. The damage will reach 1.5% of GSP. The number of deaths will increase in 2100 to 37 if no action is taken (Table 11).

Table 11: Hurricanes striking Florida- the costs of inaction

	2025	**2050**	**2075**	**2100**
Damages (in billions of 2006 $)				
Rapid stabilisation	12	24	37	55
Business-as-usual	18	49	90	159
Costs of inaction	6	25	53	104
Damages as % of GSP				
Rapid stabilisation	0.7	0.7	0.8	0.8
Business-as-usual	1.1	1.5	1.9	2.3
Costs of inaction	0.4	0.8	1.1	1.5
Deaths				
Rapid stabilisation	14	18	19	20
Business-as-usual	21	37	47	57
Costs of inaction	7	19	28	37

The collective costs of inaction for all the sectors mentioned are summarised in Table 12. The costs are highest in the tourism sector and in damages from hurricane strikes. Therefore, it makes sense for government to focus its coping strategies on the protection of the tourism sector and minimising hurricane damage.

Table 12: Aggregate costs of inaction (in billions of 2006 dollars)

	2025	**2050**	**2075**	**2100**
Tourism	9	40	88	167
Hurricanes	6	25	54	104
Electricity	1	5	10	18
Real Estate	11	23	33	56
Total:	27	93	185	345
As percentage of projected Florida GSP	1.6	2.8	3.9	5

Excluded costs of inaction

In some areas of Florida, agriculture is a major activity and contributes significantly to the GSP of the state. Along with fisheries and forestry, these sectors will suffer severely from the impacts of climate change. There will be a high demand for irrigation as temperatures increase and variations in the rainfall patterns occur. Freshwater resources will be scarce and salt water intrusion will become a problem for these resources. There will be a high demand for water under the severe dry and hot conditions, and the economic importance of horticultural products like oranges will diminish with time. Desalination will be costly but despite this there would be a need for more plants to be constructed.

Climate change will have severe and in some cases, irreversible impacts on ecosystems. Destruction of natural resources will be unavoidable under scenario 2 and extinction of some species will occur. The Everglades[6] will be adversely affected by changes in the climate system. Hot temperatures and rising sea levels will cause water to encroach into the low lying areas of the Everglades which may result in the total deterioration of this area. Flora and fauna will be lost to the sea and in severe cases some species will become extinct. The insurance sector will also be affected as it tries to adjust to the risky Florida state. The consumers (industries/business and people) will struggle to find affordable, efficient and reliant insurance coverage.

The insurance sector will also be affected by the increased risk of hurricanes as a result climate change. Since Florida is commonly known for the occurrence of hurricanes, property insurance takes into consideration such conditions. However, with the predicted conditions, the risks will increase and therefore insurance companies and residents will struggle to find affordable insurance coverage. Some insurance firms will pull out of the area because it will become too costly to cover hurricane damages should they occur at the predicted intensity. After the 1992 hurricane Andrew hit, premiums across Florida reached a staggering high of 82%. The government had to intervene by mainly playing the role of the market regulator so as to ensure that the industry is regulated and policy holders are not too hard hit. For instance, rate increases are subject to public hearings and require a regulatory approach so as to benefit both the business people and the clients. Sometimes the government subsidises the property insurance rates for affordability purposes. If climate change intensifies, costs will have to increase, property values will decline, some companies will exit the industry and the government will have to increase its subsidies to the sector.

Changes in the global climate system will affect different sectors of Florida's economy as well as the environment and the people living in this state. Mitigation measures may be employed to reduce the impacts but adaptation will be costly. Taking action now is the best remedial measure rather than waiting for the repercussions to surface and reacting later.

[6] World heritage site in Florida with a unique wealth of natural environment: mangrove swamps, freshwater marshes, tropical hardwood, mangrove islands, wetland tree islands, etc.

The costs of inaction in the Caribbean islands

A similar study was undertaken for the Caribbean islands in 2008. In addition, three comprehensive case studies were developed for three countries in the region (Cuba, Colombia and Puerto Rico) to assess the climate change costs of inaction in each country. Three categories were considered: hurricane damages, tourism losses and infrastructure damages. The total annual cost of inaction was predicted to be US$22 billion by 2050 and $46 billion by 2100 (Table 13).

Table 13: The Caribbean climate change cost of inaction (in billion US$)

	2025	2050	2075	2100
Storms	1.1	2.8	4.9	7.9
Tourism	1.6	3.2	4.8	6.4
Infrastructure	8	15.9	23.9	31.9
Total	10.7	21.9	33.6	46.2
% of GDP	5	10.3	15.9	21.7

2.2.6 Discussion and concluding remarks

The study evaluates the impacts of climate change on the economy of Florida highlighting three sectors under the optimistic and pessimistic scenarios. The costs incurred will be huge and significant investments will have to be put into adaptation and mitigation measures. Scenario 1 indicates that the area will be hardest hit by climate change and hence it will not be as wealthy and attractive as before resulting in a reduced number of visitors and consequently losses in tourism revenue. The tourism sector is by far one of the largest sectors in the economy of Florida. The estimated costs of inaction under this sector are $88 billion for 2050 and in 2100 they will reach $167 billion. The value of residential real estate that is at risk from sea level rise is also enormous. The Real estate costs of inaction are estimated to be $23 billion in 2050 and $56 billion in the next century. Increased cost of damages and death incidents due to hurricane intensity were also predicted. The costs of inaction in 2050 are projected to be $25 billion and $104 billion in 2100. There will be a high demand for the generation of electricity due to high temperatures particularly for air-conditioning. This will increase the number of power plants to be constructed and result in inefficient use of non-renewable energy supplies such as coal and oil. Huge and costly investments will be required in this sector in order to meet the growing demand for energy. Water resources will also be put under pressure because power plants require the use of water for cooling purposes. The costs of inaction are predicted to be $5 billion and $56 billion in 2050 and 2100 respectively. On average, the total annual costs of inaction are projected to be $92 billion by 2050 and $345 billion by 2100. The impacts on the above mentioned sectors alone will shrink Florida's GSP by 5% by the end of this century. The study concludes that these costs can be largely avoided if action is taken soon to stabilise green house gas emissions that result in climate change.

Climate change is a global issue requiring attention now. Studies show that southern Africa among other regions will be adversely affected by changes in the climate system. Botswana will be greatly affected by climate change. Despite the different conditions in Florida and Botswana, a study similar to this one can be undertaken in the country in order to assess what the consequences in economic terms would be if action against climate change is not taken soon. Most of the impacts will be on the agricultural sector, tourism, electricity and on biodiversity. Such a study could be coordinated through the Ministry of Finance and Development Planning.

Information dissemination and awareness raising efforts need to be intensified so that climate change issues are internalised. Strategies should be put in place to strengthen rural livelihoods and livelihood security and to assist families and communities to cope with climate change. For instance, instead of the labour intensive drought relief programmes which are currently being implemented, government could invest in strategies which help people to cope with droughts and climate change.

Policies and development planning have to facilitate the development and implementation of climate change strategies in order to attain the objectives of sustainable development and global environmental conventions which advocate a safe and secure environment for the current and future generations.

Observations

The methods used for deriving most of the figures are not clear from the source of the case study. This made it difficult in explaining the methodologies used for estimating the figures. Moreover, the costs of inaction in this case are the difference between the two scenarios as depicted in the study. Ideally, the costs of inaction would be the economic, social and ecological costs incurred if no action is taken to combat the impacts of climate change.

Questions for discussion

1. What would be the key sectors and/or areas to focus upon when dealing with climate change in Botswana?
2. What would be the major impacts of climate change in Botswana and what would be the costs of inaction?
3. Is a study like this useful for Botswana? How should it be conducted and where should the focus be?
4. Which policy actions would you recommend to prepare for and cope with climate change in Botswana?

3 Project evaluation and the environment

3.1 Cost benefit analysis of proposed wastewater project for Dar es Salaam, Tanzania-2001

Source: Cost-benefit analysis case studies in eastern Africa for the GPA Strategic Action Plan on sewage. Institute of Marine Sciences, Dar es Salaam and UNEP GPA Coordination Office, 2001.

3.1.1 Introduction

The case study presents the cost benefit analysis (CBA) of wastewater management options in the region of Dar es Salaam in Tanzania. This is part of the three case studies selected in eastern Africa in exploring the cost and benefits of appropriate wastewater management systems proposed in coastal cities. The other areas are Mombasa in Kenya and Beau Vallon in Seychelles. A CBA is a project appraisal tool, which estimates and evaluates the costs and benefits so as to aid the selection of the most efficient project from the alternatives. CBA is also used to assess the efficiency of a single project given the availability of information on the related costs and benefits. In environmental management, it assists in setting environmental action priorities by identifying and measuring the benefits and costs of pollution control options and natural resource management strategies.

The objectives of the case study are therefore to demonstrate the use of CBA as a project appraisal technique in waste management, to illustrate the main requirements for measuring the economic costs and benefits of proposed investment options and to aid decision makers in addressing pollution from land based community sources. Few, if any, CBA studies have been carried out in Botswana to-date but there is little doubt that there is a need to assess the efficiency of projects more frequently in future.

3.1.2 Background of Dar es Salaam

Dar es Salaam is the capital city of Tanzania in eastern Africa and a major coastal urban centre in the country (Figure 2). Administratively, Dar es Salaam is broken into three districts: Ilala, Kinondoni, and Temeke with a total area of 1393 km^2 which is equivalent to 2 % of the total country area. The city area occupies 448 km^2 while 945 km^2 is covered by rural Dar es Salaam. In 2001, the population was estimated to be 2.5 million and almost seventy percent of the population lives in forty unplanned settlements covering close to 100 km^2.

Just like most large African cities, rapid urbanisation contributes to environmental degradation. The urban growth rate is around eight percent per annum. This places heavy demands on inhabited housing areas most of which do not have proper sanitary and wastewater infrastructure systems in place. In the unplanned settlements, there is indiscriminate and uncontrolled disposal of wastewater and solid wastes which mostly affects the living conditions of the communities in these areas as well as the water sources. Disease outbreaks are common under such conditions especially during the rainy season. About 85% of the population in Dar es Salaam is not connected to any sewer infrastructure. The region has four major rivers and there is access to groundwater sources, which are often polluted. The poor

segments of the society living in unplanned settlements access water from the streams as they cannot afford to buy water commercially. Economic activities include agriculture, tourism, fishing, industry and activities in the informal sector.

Figure 2: Map of Tanzania showing the location of Dar es Salaam

Wastewater services

Pollution in the region is exacerbated by activities such as domestic use, industrial activities and tourism and this has led to pollution of seawater. By 2001, the sewerage system supporting the regions was regarded as old and degenerated as it was developed in the 1950s and unsuccessful rehabilitation efforts were undertaken in the 1980s. The system covered 130 km. of sewer line with a total of eleven networks supported by seventeen pumping stations. Due to the conditions of the system, it could not properly serve the areas connected to the system. Therefore, sewage from these areas was discharged into oxidation ponds and later into the sea untreated, with some of it pumped into the surrounding area. The people not connected to the system, mostly use on-site pit latrines and septic tanks but these tend overflow into the drainage system due to the high water table.

Regarding the industries, most of them do not have infrastructure that is environmentally compatible because they were established a long time ago. Most of these therefore discharge untreated waste directly into nearby rivers and streams, with some of the effluent reaching the ocean. The pollutants

include oil, metals, dyes, hot waste products and waste from the abattoirs. Tables 14 and 15 give an insight into the pollution of water resources by source of pollution. Pit latrines are the largest contributors to water pollution in Dar es Salaam followed by industrial waste.

Table 14: Pollution load to surface water resources (kg per day)

Type of pollution	Industrial	Pit latrines	Septic tanks	No facility	Total	Total in tons
BOD	28,330	15,282	3,275	9,897	*56,784*	57
COD	29,904	16,131	3,457	10,447	*59,939*	60
Suspended solids	47,216	25,470	5,458	16,495	*94,639*	95
Dissolved solids	83,940	45,280	9,830	29,325	*168,375*	168
Total Nitrates	4,145	2,236	479	1,448	*8,308*	8
Total Phosphorus	787	425	91	275	*1,578*	2

Table 15: Pollution load to groundwater resources (kg per day, 1991)

Type of pollution	Industrial effluent	Pit latrines	Septic tanks	No facility	Sewer domestic	Total	Total in tons
BOD	1,899	15,282	7,641	1,100	1,221	*27,143*	27
COD	11,994	16,131	8,068	1,161	1,289	*38,643*	39
Suspended solids	3,148	6,116	3,832	1,833	2,035	*16,964*	17
Dissolved solids	5,596	97,857	61,128	3,258	3,618	*171,457*	171
Total Nitrates	5,596	4,829	3,018	120	3,618	*17,181*	17
Total Phosphorus	52	915	572	23	34	*1,596*	2

3.1.3 Framework and methodology for the analysis

The analysis uses the following CBA stages:

- Description of the project;
- Choice of discount rate and time horizon;
- Identification of costs and benefits;
- Quantification and valuation of the costs and benefits;
- Assessment of efficiency through the use of the Net Present Value (NPV);
- Undertaking of sensitivity analyses.

3.1.4 The analysis

Stage 1: Description of the project

Several projects have been proposed for pollution management in Dar es Salaam and some have already been implemented. The project has not been described in sufficient detail to develop a clear understanding of the physical work to be undertaken. This is a major limitation in that there are no insights into the proposed project in terms of its coverage, the size and other descriptive characteristics.

Stage 2: Discount rate and time horizon

A ten percent discount rate has been applied and for comparison purposes, five percent was also used. Applying a lower discount rate such as 5% gives more weight to long term benefits and costs. The chosen time horizon is 25 years (2000 to 2025).

Stage 3: Identifying the costs and benefits

The costs identified are those associated with the capital and operational costs of the proposed wastewater management project. However, the true cost could not be attained from national sources and therefore the cost indicators cited in 'GPA draft recommendations for decision making on sewage, 2000' (not available for review) were used to estimate the costs. Applying these indicators, the total estimated capital costs amount to US$155.6 million. It was assumed that the operating costs are 5% of the capital costs (US$7.78 million per annum).

The benefits (Table 16) are regarded as the avoided costs of the environmental impacts resulting from environmental changes due to pollution. The assumption is that the proposed project would address these problems and thus benefit the community and the nation at large

Table 16: Classification of the benefits

Type	Indicators
Tourism	Change in tourism revenues and avoided losses
Fisheries	Change in fisheries production and revenues as well as avoided losses
Human health	Access to sewerage infrastructure, reduction in environmental related diseases thereby reducing fatalities
Property	
Recreation	Clean and unspoiled environment due to less pollution
Preservation of coastal marine, natural and cultural heritage	WTP for conserving and maintaining biodiversity

Stage 4: *Quantification and valuation of the benefits and costs.*

To estimate the cost of the project, the population size has to be taken into consideration therefore the following scenario has been used:

As mentioned earlier, 70% of the population in Dar es Salaam (1,715,700) live in unplanned settlements in the peri urban areas and 30% (735,300) live in the city. Using the GPA cost indicators, it has been assumed that the cost of sewage per person in the peri urban areas is $200 while for those living in the city, the costs are $5 per person. Based on this, the total estimated capital costs of the entire project is $155.6million.

735, 300 x $200 = $147.06 million

1,715,700 x $5 = $8.58 million

Total = $155.64 million

The annual operating costs have been estimated at 5% of the capital costs and this amount to US$ 7.78 million per annum.

For the benefits (the costs of inaction) are quantified and valued as follows.

a. Fisheries

There was insufficient data on the production of fisheries and the associated income losses. Annual production was estimated at 50 000 metric tons valued between $ 5 and $10 million and the annual losses were assumed to be 10% of the production value, i.e. between $ 0.5 and $ 1 million per annum.

b. Tourism

Dar es Salaam receives about 201 000 tourists per annum who spend on average $ 945 per person ($ 190 million) for a stay of about 10 days. $ 945 is assumed to be constant for all the years. Three scenarios are applied:

- Scenario 1 (with the project): - this assumes that tourism will grow at an annual growth rate of 5% with arrivals reaching 700 000 by 2025.
- Scenario 2 (without the project) – it assumes that tourism arrivals (and income) will remain constant at the level of 200 000. This represents the unlikely situation of no immediate and severe environmental problems.

- Scenario 3 (without the project) - This is a more realistic scenario which assumes that tourism will decline annually at an average rate of 5% due to the lack of pollution management facilities.

These scenarios are presented in Table 17 with the exception of scenario 2.

To get the net revenue, the value added co-efficient of 50% of gross revenues has been assumed by taking into consideration the cost of material input purchases (to avoid double counting). Therefore the value added is half of the estimated gross foregone benefits.

Table 17: Tourism scenarios and the present values in million US$

Year (1)	**With the project (**5% growth in arrivals per year) **(2)**	**Without the project (**5% decline in arrivals per year) **(3)**	**Net decrease in arrivals (2) minus (3)**	**Undiscounted gross forgone benefits x income per tourist ($ millions) (5)**	**Value added of benefits (5) x 0.5 (6)**	**Present value of net revenues at 10% discount rate ($ millions) (7)**
2000	200 000	200 000	0	0	0	0
2001	210 000	190 000	20 000	20,000 x 945 = 18.9	9.5	8.6
2002	220 500	180 500	40 000	40,000 x 945 = 37.8	18.9	15.6
2010	325 000	113 500	212 000	212,000 x 945 = 200.3	100	38.6
2025	677 250	52 600	624 600	624,600 x 945 = 590.2	295.1	27.2

c. Property values

There is insufficient information on the loss of value of the affected areas. However, on a general note, it is known that properties near polluted areas tend to depreciate in value. It has been assumed that since 30% of population live in planned areas, and the average household size is 6.4, the number of residential properties is 115 000 (2451 000/6.4). A third of these are located on the coast or near the coast and 25% of the units are of high value (about $50 000) and the rest have been regarded as located

where there is no environmental degradation. Applying 5% loss of value, the estimated annual cost would then be 9,825 x 50,000 x 0.05 which equals $24.6 million.

d. Health

Health problems are mostly linked to inadequate access to sewerage infrastructure. Therefore it has been assumed that 15% of the population is connected to waterborne sewers, and about 590 100 disease cases have been reported from the available medical statistics for the period 1993 to 1997. This translates to 118 000 reported cases per year. The average cost of treatment is assumed to be $13 per person thus the total cost would be $1.5 million per annum.

Loss of income from work days lost is about $1.6 million. This is based on the assumption that 50% of the population are of working age (50 900) and that the loss of earnings for 15 days is $27. This amounts to $3.1 million ($1.6 million + 1.5 million). The loss of earnings due to death is based on the cost due to loss of productive years caused by death (child mortality). The estimated loss of earnings is *$11.6* million per annum.

The indirect costs (to recreation, mangrove swamps and biodiversity) have not been quantified due to a lack of information. The total annual estimated costs are thus US$64.8 million.

Stage 5: Assessment of efficiency through the use of NPV

Table 18 presents the CBA of the proposed wastewater management infrastructure. This is explained below:

- The capital cost of $156 million has been spread over 2002 to 2004;
- Operating costs for 2003 are 5% of the capital cost of 2002 and thereafter it is 5% of the total estimated capital cost, and the total annual cost is therefore capital plus operating cost;
- The net benefits for the first four years are negative and after 2005 they are counted as positive because it is assumed that the environmental costs will be avoided;
- As mentioned earlier, the benefits have been assumed to be the costs of impacts from wastewater sources (pollution/degradation) - the costs of inaction. To calculate the benefits, the total estimated environmental costs increases annually taking into consideration the changing tourism value (Table 17 column 6). The amount increases annually and is made up of the constant $ 56 million ($ 65 million minus $ 9 million representing the tourism costs) adding back the estimated costs of tourism in column 5 of Table 17. For instance, for 2002, the benefits would be $ 56 million plus $ 18.8 million ($ 75 million).This method is applied to all the years. It

is remarkable (and is not explained in the report) that for the first four years, the benefits are negative!

- Net benefits represent total benefits minus the total costs.
- Discount factor has been calculated so as to estimate the present value. It is calculated as $1/(1+r)^t$, r being the discount rate and t is the year t from now. Present value is thus discount factor x net benefits and the summation of this gives the Net Present Value.

Table 18*:* The Cost Benefit Analysis of the proposed sewage investment (in US$ million)

Year	Cap. cost	O & M costs	Total cost	Benefits	Net benefits	NPV at 10%	NPV at 5%
2001	0	0	0	-49	-49	-45	-47
2002	70.1	0	70.1	-75	-145.1	-120	-132
2003	77.1	5	82.1	-84	-166.1	-125	-143
2004	8.4	10	18.4	-94	-112.4	-84	-70
2005		10	10	103	93	58	73
2006		10	10	116	106	60	79
2007		10	10	126	116	59	82
2008		10	10	135	125	58	85
2009		10	10	146	136	58	88
2010		10	10	156	146	56	90
2011		10	10	166.5	156.5	55	92
2012		10	10	177	167	53	93
2013		10	10	188	178	52	94
2014		10	10	199.3	189.3	51	96
2015		10	10	215.8	205.8	50	99
2016		10	10	222.8	212.8	47	97
2017		10	10	234.9	224.9	45	98
2018		10	10	247.7	237.7	43	99
2019		10	10	260.8	250.8	41	99
2020		10	10	274.35	264.35	39	99
2021		10	10	288.9	278.9	38	100
2022		10	10	306	296	36	101
2023		10	10	318.5	308.5	35	101
2024		10	10	334.6	324.6	33	101
2025		10	10	351	341	31	101
Net Present Value						***643***	**1676**

Table 18 contains the findings of the study and has not been altered. Our own calculations based on the assumptions listed in the report led to slightly different figures, particularly related to the O & M costs.

The difference could be due to unreported assumptions made in the study. It shows that CBA reports should always contain sufficient detail to check the main calculations.

Stage 6: Sensitivity analysis

Figures are expressed in million US$

Estimated Investment cost	156
Annual operating costs capitalized at 10% for 25 years	91 (10 x annuity factor 9.0)
Total estimated investment cost	247
PV of estimated benefits at 10% for 25years	998
NPV (25 years at 10%)	643
Benefit cost ratio	4
Estimated investment cost by 25% higher	247 x 1.25= 309
Estimated benefits by 25% lower	998 x 0.75 = 749
Benefit cost ratio	2.4

The sensitivity analysis presents two scenarios. Firstly, a scenario with a higher rate for the operating costs (10% of the capital costs) and secondly, a scenario with changes in investment costs and benefits. The benefit cost ratios under the two scenarios are between 4 and 2.4 respectively. This indicates that the benefits exceed the costs by this much thus indicating the viability of the project.

3.1.5 Discussions

This study calculated the economic CBA of a sewerage project in Dar es Salaam. The project has a positive estimated economic NPV of $643 million and is thus efficient given the assumptions made. Discount rates of 10% and 5% were applied in the analysis. Given the long term benefits of the project, the 5% discount rate yielded higher returns. The sensitivity analysis showed positive NPVs and benefit cost ratios were attained.

It should be realised that the benefits of pollution management requires more than just putting in place infrastructure. There should be integrated environmental management and planning for sustainable development and the attainment of the United Nations' Millennium Development Goals (MDGs) encompassing all stakeholders. This would also include the monitoring and evaluation of the proposed action to assess its effectiveness in the long run.

A CBA study requires that all relevant tangible and intangible costs and benefits be included in the analysis to capture the true NPV and thus assist in making feasible decisions. This has not been done in this particular case. Some of the environmental costs and benefits may be significant but were not included. For example, the possibility of re-using treated effluent was not considered.

In Botswana, government invests heavily in wastewater treatment plants in large villages and has set the target of 98% re-use and recycling for the year 2030 in the National Master Plan for Wastewater and Sanitation. Investments should be directed at raising awareness to promote utilisation of the wastewater resource. One of the present limitations in the rural areas is the lack of connection to the sewer line and this hinders connection to the wastewater treatment works. Moreover, some of the households do not have waterborne systems and this is a challenge. Various District Council planning units need to develop strategies for people to connect to the sewers so that wastewater treatment works could operate optimally.

This study is a desk-top study which used existing data from national sources. This did not require surveys to be undertaken therefore similar studies can be undertaken in Botswana, where few field studies have been carried out.

Questions for discussions

1. What would be the benefits of establishing sewerage networks in Botswana's major villages?
2. In Botswana, two sewerage technologies are used (i.e. vacuum and gravity)? Compare the possible economic costs and benefits of each technology.
3. How would such a CBA benefit the local and the national economy at large?

3.2 Multi Criteria Analysis

This case study is based on an article compiled by Ron Jansen (2001) published in the Journal of Multi-Criteria Decision Analysis, volume 10 entitled 'On the use of multi-criteria analysis in environmental impact assessment in the Netherlands'. It is also based on the multi-criteria analysis framework developed for the assessment of Botswana National Development Plan 10 (NDP 10), Urban Development Plan 3 (UDP 3) and District Development Plan 7 (DDP7) projects.

3.2.1 Introduction

Multi-criteria analysis (MCA) is a project appraisal tool, which evaluates projects based on different criteria; usually covering economic, social and environmental considerations. It uses weights and scores of the potential impacts of projects, ultimately aggregating the project scores and then ranking the projects. In the Netherlands, MCA is commonly used in Environmental Impact Assessment (EIA). MCA contributes to making informed choices either between projects with the aim of selecting the preferred project or choosing between alternatives such as in the case of an EIA procedure. MCA also involves the participation of different stakeholders, all of whom have different roles to play in the analysis.

In Botswana, it was not until recently that environmental concerns were systematically incorporated when appraising projects. Through the 2005 EIA Act, new and existing projects are liable to an EIA so as to assess their potential environmental and socio-economic impacts. Furthermore, an EIA requires recommending mitigation measures for addressing those impacts that may cause significant environmental damage and provides for monitoring and evaluation of the impacts during the cycle of the project. As part of the EIA report, an Environmental Management Plan (EMP) needs to be developed that guides the implementation of the mitigation measures and environmental monitoring. Formal project appraisal is not yet common in Botswana and hence the use of MCA is limited.

The objective of the case study is to demonstrate how MCA can be used in Botswana and how it can guide the selection of projects. The case study discusses the role of MCA in the EIA procedure, drawing examples from The Netherlands and shows how it can be used in appraising development projects in Botswana. The Centre for Applied Research in collaboration with the Department of Environmental Affairs have been assessing ministerial and district development projects for the National, Urban and District Development Plans using a simple MCA framework. This is illustrated in this discussion using suggested projects by the Ministry of Minerals, Energy and Water Resources (MMEWR).

3.2.2 The use of Multi-Criteria Analysis in the Netherlands (Jansen, 2001)

The Netherlands is one of the many countries that utilises MCA in EIAs. Annually, about sixty EIAs are completed; and on average one-sixth of these projects are subjected to an MCA. The EIA procedure is well established in the Netherlands as all projects in the public and private sectors with potential to cause serious environmental impacts are required to undergo an EIA. EIA is mostly undertaken for large projects such as transport infrastructures, (waste) water treatment plants and construction of dams among others. There is no legal requirement for undertaking an EIA for most small projects in the Netherlands. The projects that require an EIA can be either highly technical (for example storage facilities), or have a high profile such as those involving the development of road infrastructure. However, a common element among all projects is the large amount of information that decision makers are ultimately presented with.

EIA project reports can be cumbersome. The standard size of the report is 300 pages with five to ten background documents. In an extreme case, a report of 1 450 pages and 250 maps was received for the Betuwe railway freight line in 1996. The reports are usually summarised in large evaluation tables. From 1992 to 2000, of the EIA projects subjected to an MCA, the evaluation tables included between 14 and 100 criteria, 5 to 61 alternatives and 4 to 13 categories. Large tables make it difficult to directly evaluate the results of the EIA and therefore aggregating and structuring of the results is usually done through the use of an MCA so as to aid decision making. Examples of EIA projects subjected to an MCA are indicated in Table 19 below.

Table 19: The use of MCA in EIA in the Netherlands

Activities	Year	Problem size
Provincial sludge treatment plan: Flevoland	1992	16 criteria; 29 alternatives
Design of a freshwater reservoir in the Biesbosch	1994	5 categories; 32 criteria; 7 alternatives
Betuwe freight railway	1996	5 categories; 40 criteria and 20 alternatives
Provincial road N219 bypass	1999	5 categories; 24 criteria; 5 alternatives
River development Zandmaas	1999	10 categories; 100 criteria; 3 alternatives
Hanze rail link	2000	13 categories; 92 criteria; 7 alternatives

Source: Janssen, 2001, 102.

3.2.3 Components of an MCA

Alternatives

MCA takes into consideration alternatives of projects so as to allow for comparisons and puts forward the differences among these alternatives. Alternatives to be compared are often similar in nature, for instance, if planning to develop a new rail route, alternative rail routes are brought into the picture, rather than comparing rail and water transport. However, analysing a complete set of alternatives can be a difficult exercise. The set normally includes the alternatives relevant to the initiator of the project. An alternative can be a 'do nothing' (zero) or an alternative with negligible adjustments to the current situation. However, the environmentally friendliest alternative (EMFA), that is, an alternative with the smallest impact on the environment has to be included in the set. As already mentioned, it is difficult to attain a complete set of alternatives. This may be hindered by political influences, time pressure or bad practices and may lead to the inclusion of additional alternatives by the decision maker. Inefficient alternatives can be discarded especially if the decision maker is only interested in the best alternatives.

Criteria and weights

MCA involves participation of a diverse array of stakeholders with different objectives. These include the government, private sector as well as interested and affected parties. They determine the criteria to be used in the evaluation and hence a large number of criteria can be included so as to accommodate the objectives and interests of the stakeholders. This would then require the development of consistent and systematic evaluation tables so as to discard inefficient criteria that may have a significant influence on the final ranking. Absence of such systematic evaluation tables often leads to double counting, confusion between means and ends in the criteria, inconsistencies in the spatial scales and missing criteria. Criteria are often grouped into categories or themes to give a better insight of the impacts. Criteria within a theme thus relate to a common element and therefore are in most cases entirely linked to policy objectives. Grouping criteria into categories allows for firstly, ranking for each category and secondly, for a final ranking.

In the evaluation, the different criteria are then assigned weights based on generally available scientific knowledge or policy priorities. The former reflect the opinion of one or more experts while the latter reflect tradeoffs between policy objectives and/ or stakeholders. Experts give weights to criteria within a category while weights between the categories are endorsed by the politicians for policy priorities. Therefore the weights reflect the different interests of stakeholders as per their priorities. For a country like Botswana where unemployment is an issue, under the economic criteria, we would expect employment creation to have a high weight.

Scores

The impact scores can be qualitative or (semi-)quantitative. Qualitative are measured on a plus or minus scale; those on the plus scale would have a positive impact and those with a minus indicates negative impacts. The number of pluses and minuses reflect the size of the impacts. Scores are assigned to each criterion at temporal or spatial levels .These scores are then added under each theme and the total score would then allow for ranking of the project and comparison of the proposed alternatives. Final ranking is not based on one set of weights, say, political but rather takes into consideration the weight sets of various stakeholders.

Geographical information systems (GIS) can play a vital role in EIA. The impacts of the alternatives are geo-referenced and can be stored and later used in the MCA. GIS often results in the quantification of qualitative criteria, for instance, the visual quality of the landscape.

3.2.4 MCA methods

The most popular method used in MCA is 'weighted summation'. It uses a linear function to standardise the quantitative scores and then the overall score is calculated as the weighted average of the standardised scores. This approach is simple, transparent and easy to explain and has therefore been recommended in the MCA manual published by the Dutch Commission for EIA. It performs well in most cases where it has been used. Other methods are more complex and technical. These include the evamix, analytical hierarchy process (AHP), the regime and concordance methods amongst others (see Jansen, 2001).

It is important to perform a sensitivity analysis of the major assumptions so as to give insight into the reliability and robustness of the results of the MCA. However, in most studies, a sensitivity analysis is not performed possibly to avoid too much discussions about the reliability of the analysis, the methods used and the results.

3.2.5 Role of MCA

MCA is often used to guide the decision making process in selecting a project over other projects. It makes the decision process more transparent and the information manageable for all stakeholders. In an EIA, it is particularly important in the scoping phase. During scoping, all possible alternatives are considered and a few selected for further design. In this first round, the number of alternatives can therefore be very large and this is where the MCA can be used. In the second round, a small number of

alternatives are selected and a provision is made for the environmental impacts of these alternatives at this stage. The information is then analysed in the form of evaluation tables and aggregation may be supported by an MCA.

MCA also helps to build confidence among stakeholder in the results put forward. The MCA should be well documented and transparent in order to be more informative to the stakeholders.

3.2.6 MCA in the assessment of projects for Botswana National Development Plan 10 process

Background

The government of Botswana is committed to effective development planning in order to achieve national goals and objectives. Development planning has four main objectives: sustained development; rapid economic growth; social justice and economic independence. Planning is meant to ensure that resources (financial, manpower and natural resources) are used effectively and in accordance with the nation's priorities. As such, national, district and urban development plans are prepared periodically through a systematic and pragmatic planning approach.

To ensure mainstreaming of environmental concerns in the preparation of new National Development Plan and District Development Plans, the Department of Environmental Affairs (DEA) and Centre for Applied Research (CAR) interacted with several ministries, district and urban councils, including:

- Ministries: Ministry of Finance and Development Planning, Ministry of Minerals, Energy and Water Resources, Ministry of Agriculture, Ministry of Lands and Housing, Ministry of Trade and Industry and the Ministry of Local Government;
- Districts: Ngamiland, Kgalagadi and Central districts;
- Town/cities: Gaborone.

In interacting with these institutions, firstly, an environmental checklist was prepared based on the Sectoral Key Issue Papers (SKIPs), Local authority Key Issue Papers (LA-KIPs) and environmental auditing suggestions for NDP 9, DDP 6 and UDP 2. Following this stage, workshops were held with the afore mentioned institutions to present the results and to guide them in the mainstreaming process in the selection of projects.

A systematic two-step project review procedure was adopted. The first step entails the general assessment of the proposed projects based on the checklist as well as the outcomes of the first consultative workshops and then gaps are identified followed by recommendations. Secondly, the projects are ranked based on economic, environmental and social impacts. This focussed on non-public goods. A simple MCA framework was developed to rank and score the projects.

The adopted MCA framework

The project working group developed a MCA framework, including a set of criteria and weights. The framework entails three broad categories of sustainable development: economic, environmental and social with five criteria under each category (fifteen criteria). Criteria under each category are listed as follows:

Economic	• Contribution to GDP; • Efficiency (revenues vis-à-vis costs); • Creation of employment; • Contribution to economic diversification; • Generation of foreign exchange.
Ecological	• Net environmental impacts (project + mitigation); • Irreversible environmental impacts; • Efficiency of natural resource use; • Contribution to biodiversity maintenance; • Compliant with national environmental; management and multilateral environmental agreements.
Social	• Contribution to poverty reduction; • Improvements of the livelihoods of the vulnerable groups • Impact on HIV/AIDS; • Impact on rural social conditions and equity; • Reduced rural-urban migration.

Each of the three categories was assigned equal weights out of a hundred (one third each). The impacts are analysed at five spatial levels including, the local, and district, national, regional and international levels (Table 20). Scores range from one to three, with the latter indicative of a large impact. The scores for all criteria can be either negative, positive or zero. The weight of different spatial levels is one. The resulting overall scores of the projects are used to rank the projects to allow for comparisons and to prioritise. The analysis used the weighted summation method.

Table 20*:* MCA framework used for environmental assessment of projects

Criteria	Sign of criteria	Weight	Local	National	District	Regional	International	Total Score	Total Weighted Score
Economic	+/-								
Ecological	+/-								
Social	+/-								

The framework, criteria and weights were discussed with the Ministries and Districts, and it was explained how they could adjust the criteria and weights according to their own perspective.

The following discussion uses example projects from the Ministry of Minerals, Energy and Water Resources (MMEWR) to illustrate how the assessment was carried out.

Environmental assessment of MMWER projects

Six possible projects were evaluated, including:

- Renewable energy and power – this entails provision of modern energy sources in the rural areas, development of alternative energy sources such as biogas and bio-fuels as well as promotion of energy efficiency and conservation.

- Coal and petroleum development – it involves construction of a strategic storage reserve to ensure that supplies of controlled petroleum products are maintained. In addition, coal gasification technology will be identified and a feasibility study will be undertaken.

- Water supply and infrastructure – this includes construction of more dams, the second phase of the North South Water Carrier (NSWC) and construction of water treatment plants in the western part of the country where saline water is a problem.

- Water demand management (WDM) – this project aims to promote water conservation by addressing water losses, maintenance of water supply schemes and awareness raising. The following activities are envisaged: water loss control in government departments and schools, water supply data management, reduction of water consumption in the commercial sector and educating the public on water conservation.

- Exploration and mining – this looks at activities such as mining exploration techniques, assessment of the economic potential of minerals such as granitic and rehabilitation of mines.

- Consultancies – this entails several studies such as the implementation of the National Water Master Plan, development of small scale mining and saline water utilisation in the agricultural sector.

The resulting summary of the six projects is presented in Table 21.

Table 21*:* Summary of the proposed projects

	Economic	Ecological	Social	Total	priority rank	priority category
Renewable energy and power	102	52	53	207	3	H
Coal & petroleum development	38	10	10	58	6	L
water supply & infrastructure	102	-80	110	132	5	M
water demand management	90	106	37	233	2	H
Exploration and mining	62	43	54	159	4	M
Consultancies	124	58	99	281	1	H

Note: low: up to 100; medium: 100-200; high: above 200.

Table 21 shows that the WDM project and rehabilitation of abandoned mines have the highest scores, followed by energy development and petrol storage. While the North South Water Carrier and additional dams score high on the economic side, they may have adverse and irreversible environmental impacts. This affected their ranking. One could also argue that expansion of water supply must be combined with concerted water demand management efforts.

Sensitivity analysis was carried out to test the robustness of the above results. In the first sensitivity analysis, less weight has been given to international impacts. The results are summarised in Table 22. The results show a change in the overall scores of the projects but the ranking does not change.

Table 22: MCA Sensitivity analysis 1: less weight for international impacts

	Econ	Ecol	Soc	Total	priority rank	priority cat
Renewable energy and power	102	45	53	200	3	H
Coal & petroleum development	38	3	10	51	6	L
water supply & infrastructure	102	-87	110	125	5	M
water demand management	90	85	37	212	2	H
Exploration and mining	62	43	54	159	4	M
consultancies	124	44	99	267	1	H

Table 23 shows the results when more weight is given to the ecological impacts. This results in an increase in the scores under this category for each individual project. In this case, water supply and infrastructure projects have more negative environmental impacts, which affects their ranking; the coal and petroleum development project rank fifth.

Table 23: MCA Sensitivity analysis 2: more weight for ecology

	Econ	Ecol	Soc	Total	priority rank	priority cat
Renewable energy and power	73	80	50	203	3	H
Coal & petroleum development	27	20	7	54	5	L
water supply & infrastructure	61	-120	81	22	6	M
water demand management	67	160	20	247	2	H
Exploration and mining	43	60	44	147	4	M
consultancies	88	90	76	254	1	H

If more weight is given to the economy, the ranking of projects does not change.

From the results of the sensitivity analyses, it was concluded that the MCA results are robust and do not vary greatly with different weights. Overall scores do change but the ranking do not change. The only change to the ranking of the projects is observed under scenario two, where the fifth and sixth least priority projects inter change their positions.

3.2.7 Discussions and conclusions

MCA is an important tool that is used to appraise projects which involves aggregation and standardisation of scores so as to make an informed choice. Comparing it to the cost benefit analysis, its strength is that it takes into consideration the environmental impacts rather than focussing on economic efficiency only and uses both quantitative and qualitative data.

The Dutch case shows that MCA can be used in the EIA procedure as it aids in the selection and evaluation of alternatives and thus informs and guides the decision makers in the best activity to select. It is clear and transparent and entails several methodologies that can be employed. The most informative, transparent and less complicated method is the weighted summation method, which has been used in evaluation of NDP 10 projects by CAR and DEA as well. Even though sensitivity analysis is important, it is not commonly undertaken in most MCA studies. This exercise is necessary in that it tests the uncertainties of the results of the MCA and thereby building better confidence in the MCA.

Differences between the exercise done by DEA/CAR and the use of MCA in EIAs are noted. Firstly, in the Netherlands case, a lot of criteria and categories are used in the MCA while only three categories and fifteen criteria are used in the assessment of development projects for the Botswana development plans. Secondly, the NDP10 projects evaluation exercise involved two stakeholders being CAR and the DEA. They were responsible for developing the framework, assessing the projects and ranking them. In The Netherlands, there is participation from a variety of stakeholders including the government, scientists, private sector and other interested stakeholders which takes into consideration their different views and interests. The choice of methodology was similar for the two cases even though in the EIA, more technical methods were praised as well. The most common method adopted is the weighted summation which is less complex, easy to explain and transparent.

In Botswana, formal project appraisal using techniques such as the MCA and cost-benefit analysis is not yet common. The exercise undertaken by CAR and DEA for evaluation of NDP 10 projects is very important and can be adopted in the future for national and district project appraisal. EIA has become an important tool in addressing environmental concerns in projects. This case study has demonstrated how MCA can be used in the EIA process to make the decision making process more transparent and information more manageable for all stakeholders.

As mentioned, MCA involves a number of stakeholders who have to agree on the criteria to be used when evaluating the projects and the weights to be given to the different criteria. There is therefore need to engage stakeholders so as to incorporate their interests in the analysis and ultimately yield results that balances their interests. This tool is important and can lead to the effective prioritisation and selection of projects and consequently assist in attaining the objectives of sustainable development and the country's Vision 2016.

Questions

1. Is the MCA tool useful at the district level? In which areas and in which forms?
2. What are the strengths and limitations of the MCA?

4 Natural Resources Accounting

4.1 Botswana's water accounts

This case study is based on a number of studies conducted by the Centre for Applied Research (www.car.org.bw) and the Department of Environmental Affairs (www.envirobotswana.gov.bw).

4.1.1 Introduction

The purpose of this case study is to demonstrate how natural resources accounts can be constructed using water as an example. It illustrates the methodology, information needs, data constraints, format of the accounts and the policy implications of the findings.

Natural resources accounting (NRA) is a system that emerged in the 1970s and expands the national accounts by incorporating environmental concerns into macroeconomic planning, so providing a better measure of sustainable development. Botswana uses a standard United Nations System of National Accounts (NA) to record and monitor economic performance. However, this system has environmental shortcomings that the natural resources accounts seek to correct:

- Do not recognise natural resources as capital or development assets;
- Pay little attention to the possibilities of natural resources scarcities;
- Do not reflect the impacts of environmental degradation and natural resources depletion; and
- Add pollution abatement costs as income while it should be deducted as the cost of mitigation measures to retain welfare levels.

Natural resources accounts record the changes in stocks of natural resources as well as the annual use of these resources. The ultimate goals of NRA are therefore to develop a system of accounts that can reflect changes in the status, uses and roles of natural resources and the environment in terms of their possible effect on economic planning and sustainable development. NRA further leads to a set of aggregate indicators for monitoring changes in wealth and welfare status of an economy.

NRA can be developed for a variety of natural resources including, water, forests, wildlife, minerals and livestock amongst others. NRA has been adopted in several countries globally and in southern Africa (Table 24).

Table 24: Southern African countries that have constructed natural resources accounts

	Minerals	Fisheries	Water	Wastewater	Land/land degradation	Forests
South Africa	X	X	X			X
Namibia	X	X	X		Partial	partial
Swaziland						partial
Tanzania	X	X	X			X
Botswana	X		X	X	Partial (livestock and rangelands)	

Water accounts are increasingly being recognised as an integrated water resources management (IWRM) planning tool. This is so because the accounts recognise the economic value of water and captures the stocks, uses and efficiency the resource use. Moreover, this is a tool that can help contribute to the attainment of several global agendas such as the 2002 World Summit on Sustainable Development which recognises water as a vital resource for environmental, economic and social concerns.

This case study discusses Botswana's water accounts. Firstly, background information of the accounts and the water situation in Botswana are discussed followed by the framework and methodology of the accounts. Furthermore, the findings are presented in section six followed by regional examples and lastly the discussion of the findings and concluding remarks.

4.1.2 Background

The first set of water accounts were completed in 2001 by the Central Statistics Office in collaboration with the National Conservation Strategy Coordinating Agency (NCSA), now the Department of Environmental Affairs (DEA). The accounts were developed as a planning tool to analyse the trends in water consumption by source and economic sector and to explore the benefits thereof. The accounts were confined to groundwater and surface water sources and later on were updated with the inclusion of the wastewater resource by the Centre for Applied Research.

Botswana's water situation

Surface water resources are mostly found in the north and the perennial rivers are shared with neighbouring countries hence their utilisation and management are subject to the Southern African Development Community (SADC) Protocol on Shared Water Courses. The western part of the country does not have surface water and mostly relies upon scarce, sometimes saline, groundwater. The country's total annual runoff of surface water is about 696 million $m^{3.}$ There is high variability of runoff and the rate of evaporation is also high. There are about ninety-four reservoirs/ dams most of which are used for agricultural purposes. Five large dams are operated by the Water Utilities Corporation (WUC) and these supply urban and peri-urban areas. The storage capacity of these dams is about 354 million m^3 and account for more than 90% of the total dam storage capacity. The Department of Water Affairs

(DWA) operates one medium sized reservoir with highly variable yields and water levels. Evaporation rates are high and exceed the consumption of water and this poses a lot of problems for the sustainability of water utilisation. Information about the five major dams in the country is presented in Table 25. It becomes clear that the sustainable yields are small in comparison to the total dam capacity (around 20%).

Table 25: Botswana's major dams

Dam	Capacity Mm^3	Hydrologically sustainable yields (Mm^3) BNWMP	Sustainable Yields (Mm^3) WUC estimates	Mean annual runoff (Mm^3)
Gaborone	144.2	7	10	31
Letsibogo	104	16	20	57
Nywane	2.3	0.3	0.3	1.9
Bokaa	18.5	0.1	1.1	9
Shashe	85.3	22	40	84
Total	354.3	45.3	70.3	173.9

Sources: SMEC *et al,* 1991; WUC Annual Reports and WUC files

Groundwater resources are very limited in quantity and quality and the distribution of these resources is highly uneven. Most groundwater resources are found in eastern parts of the country and are very limited in western and northern Botswana. In the latter areas, the water is often saline. Groundwater sources supply most rural areas as well as the mining and the livestock sectors. There have been concerns about the depletion of the ground resources in mining areas and around settlements.

Wastewater resources are available but their utilisation is limited. According to the National Master Plan for Wastewater and Sanitation (NMPWWS) of 2003, there are sixty -four wastewater treatment works (WWTW) with a total capacity of 90 974m^3 /day. Five types of treatment technologies are used, including the pond system, activated sludge, trickling filter, rotating biological contractors and the wetlands system.

Wastewater is produced mainly in urban areas (Gaborone, Francistown, Selibe Phikwe, Lobatse and Jwaneng. These account for about 80% of the inflow at the WWTWs. In 2002, the inflow into and outflow from the WWTWs was about 24.5 Mm^3 and 12.3 Mm^3 respectively. Currently, only twenty percent of the outflow is being re-used mostly for irrigation purposes and a significant amount is lost in the treatment system. Even though the losses are great, the environment benefits considerably. The NMPWWS has set a target of ninety-six percent of the outflow of WWTWs being re-used or recycled in 2030. Government therefore plans to stimulate re-use for irrigation especially in the agricultural sector. Other sectors which do not require the use of potable water such as construction should also be exploited for wastewater reuse.

4.1.3 Framework

The water accounts adopt a model of the UN System of Integrated Environmental and Economic Accounting (SEEA). The SEEA has the following objectives:

- To mainstream resource issues into economic decision making;
- Evaluation of resource impacts of development on the environment; and
- Evaluation of impacts of environmental policies on the economy.

The system of SEEA accounts distinguishes stocks, flow and water quality accounts. The Botswana accounts have been developed for stocks, use and wastewater. These are expressed mostly in physical terms. The accounts cover the period 1990 to 2003.

Freshwater accounts

a. Stock accounts

These indicate the amount of water available at the beginning of the year, inflows and outflows during the year and the end stock. The accounts refer to water stored in reservoirs/dams (Environmental Asset -EA. 1311), water in lakes (EA.1312), water in rivers and streams (EA.1313) and EA 132 for groundwater resources. The accounts were constructed for the country's main reservoirs (Gaborone, Bokaa, Nnywane, Shashe and Letsibogo). A typical stock account framework is outlined as in Table 26.

Table 26: Framework of the surface water stock account

	1990	1991	1992…….
Opening volume	…..	…….	…….
Inflows(+)	……	…….	…….
Abstraction(-)	…….	…….	…….
Evaporation(-)	…….	…….	…….
Closing volume	…….	…….	…….

Incomplete sub-accounts exist for groundwater resources largely due to data limitations. The opening and closing volumes of well fields are not known nor is the amount of groundwater that can be economically abstracted. Moreover, the recharge rates are not adequately known. However, incomplete groundwater stock accounts were presented. The accounts are restricted to developed groundwater resources such as well fields and individual boreholes.

b. Water use accounts

The use or flow accounts measure the flow of water between the economy and the environment, and within the economy between water suppliers and end users. The former involves the abstraction of water from natural resources and the return of the water after use to the environment. Water use within the economy indicates the supply of water from one economic sector to the other. These are shown by institutional source of water used by each sector.

Wastewater accounts

Three types of accounts have been constructed: wastewater stock account, wastewater supply account and wastewater use account.

a. The wastewater stock account indicates the amount of wastewater stored in WWTWs. The account shows how much wastewater is stored at the beginning and the end of each year, and the inflows and outflows that have occurred.

b. The wastewater supply account indicates the sources of wastewater, that is, domestic use, business, and government. Disposal of wastewater may take place onsite, off-site or through the sewerage system. The account is restricted to wastewater treated in the WWTWs.

c. Wastewater use account shows how wastewater is being used. Four uses have been distinguished: 1. treatment losses; 2. discharge in the environment; 3. re-use and 4. recycling. Re-use is the productive or consumptive use of wastewater while recycling involves upgrading treated wastewater to potable water. Total wastewater use is equal to wastewater supply.

Monetary accounts are incomplete primarily due to data constraints. Portions of relevant economic aspects of water management are discussed and these include: water supply costs, pricing, wastewater treatment costs, allocative efficiency of water and efficiency of water use by sector as well as the benefits of reuse and recycling of treated wastewater.

4.1.4 Data sources

Water is provided and managed by a number of institutions. These include:

- Water Utilities Corporation (WUC)- provides water to six urban areas and operates the North-South Water Carrier (NSWC);
- Department of Water Affairs (DWA)-supplies seventeen major villages;
- District Councils (DCs)- supply water to more than 200 small villages and are responsible for the treatment of wastewater; and
- Self providers, who mainly provide water for themselves. Examples of self providers include mines, livestock farmers and wildlife sub-sectors.

a. WUC provided data on annual water consumption, dam capacities and actual storage, abstraction as well as evaporation rates. This comprised of data from unpublished sources on billing records for 1990 to 1998, water use and tariffs by customer type and tariff band and annual reports for 1998 to 2003. However, there were problems of inconsistencies in the data on billing records and published data for water use and the misclassification of end users. Moreover, data did not warrant the separation of natural and inter dam inflows and abstractions.

b. DWA provided data on the annual production of water, consumption, losses (termed 'unaccounted for losses') abstraction (obtained from the WELLMON database for major well fields), expenditures and revenues. Data problems included missing data on water use, expenditures and revenues, lack of information on operation and maintenance costs as well as capital costs. Moreover, abstraction figures were not consistent with the abstraction figures from other sources.

c. Information on water for small villages (from the DCs) was mostly based on estimates of per capita daily use of water. Per capita water use was derived from one month of metered water use in each village and baseline data was collected from the water monitoring project with regard to water consumption in some villages. However, there was no information on the amount of water used for different purposes, for instance, domestic, government or schools and there was lack of information on the costs and revenues. The DCs also provided data on wastewater from the WWTWs.

d. Data is derived for four categories of self providers mainly mining, livestock, irrigation and electricity production. Mining includes diamond mining, copper/nickel and coal mining. Diamond and copper/nickel mining companies meter their water consumption and report the figures to government while for coal, the figures were sourced from the National Water Master Plan. Irrigation figures were also derived from the National Water Master Plan for 1990 and assumptions applied for the rest of the years. For livestock, water use was estimated based on the number of livestock and daily water requirements for livestock.

4.1.5 Methodology

The accounts require time series data about the stocks of water resources available for consumption and how the water is being used. Data was mainly acquired from the Water Utilities Corporation (WUC), Department of Water Affairs (DWA), District Councils (DCs), self providers, the NWMP (1990and 2006) and NMPWWS (2003) as indicated in section 4.1.4 above.

4.1.5.1 Freshwater accounts

Stock accounts

Surface water stock account

WUC records the volume of water stored in dams as well as abstraction. However, the aggregate inflows are not recorded. Evaporation rates are also available for each dam.

- The annual evaporation was estimated as the evaporation rate for each dam multiplied by the (opening *+ closing volume)*.
- Inflow was estimated as *(closing volume + abstraction + evaporation – opening volume).*Ideally, inflow should be separated into natural inflow and inflow from other dams (transfers) including inflow from treated wastewater that is recycled.
- Abstraction should be divided into abstraction for treatment and distribution and transfers into other dams.

Aggregate stock accounts (simplified version) could only be compiled for the period 2001 - 2003. No data were available for earlier years. For the dams managed by DWA, a stock account was constructed for one dam for the period 1990 to 2003.

Groundwater stock accounts

The groundwater stock accounts should cover the opening stock of aquifers, add the annual recharge and subtract the annual abstraction, which leads to the closing stock at the end of the year. However, a sub account was constructed for each well field using DWA WELLMON data recharge estimates. The aggregate of all well fields was then used on the overall groundwater stock account. Estimates for the aggregate abstraction of individual borehole are also contained in the account but are also incomplete.

Use accounts

The use accounts cover the period 1990 – 2003. Data was obtained from the WUC, DWA, DCs and self providers. The accounts are constructed by institution, source and sector. Due to data insufficiencies and inconsistencies, averages and scaling up/down factors were used. For the agricultural sector, water use was estimated by multiplying the number of livestock by the daily water use of cattle, goats and sheep (45, 4.5 and 4.5 litres per day respectively). Table 27 indicates the daily water requirements per head of livestock designed by the Ministry of Local Government. It was assumed that, since the irrigation sector was fairly small, consumption was constant for the last twenty years, therefore the 1991 water consumption for irrigation provided by the National Water Master Plan of 1991 was used for the accounts' period.

Table 27: Water requirements per head of livestock

	Daily (litres)	Annual (m^3)
Cattle	50	18.25
Goats	5	1.825
Sheep	5	1.825
Donkeys	20	7.3

Source: NCSA and CSO, 2001 in Lange and Hassan, 2006

4.1.5.2 Wastewater accounts

For the stock account, only a fraction of wastewater is stored temporarily in ponds,y pending maturation and discharge. The stock is therefore negligible hence the wastewater stock account is less important than the supply account.

Wastewater supply accounts

The inflows and wastewater losses are measured from the supply accounts. It is also assumed that wastewater storage is the same at the beginning of the year and at the end of the year and this is determined by the capacity of the ponds. Capacity data was obtained from WWTWs files.

As already indicated, wastewater may be disposed on-site, off-site or through the sewerage system. Onsite wastewater disposal should not be included in the accounts (this is a recommendation of the SEEA). The account is restricted to wastewater that is returned to WWTW as these flows can be re-used or recycled and can be transferred between economic sectors. Off-site wastewater disposal should be included but, this could not be done due to a lack of data. The account is constructed for individual WWTW and then for the whole country by aggregating the individual WWTWs. The amount of wastewater received at the WWTWs is estimated based on the water consumption of the categories mentioned earlier and the effluent generation fraction (EGF) or return percentages used in the NMPWWS:

- Households: 80% of the water consumption of those connected to the sewerage system enters the sewerage system (EGF is 0.8);
- Business: 55% (0.55) enters the sewerage system; and
- Government: 65% (0.65) enters the sewerage.

Wastewater supply is estimated by multiplying the actual water consumption (derived from WUC and DWA) by the EGF indicated above.

- For *domestic use*: wastewater supply is estimated by multiplying the domestic water consumption from standpipes, yard and house connections by the EGF. It is assumed that no water from standpipes and yard connections enters the sewerage system and WWTWs. Data subdivided by these categories (consumption) is available for rural villages (DWA). For urban areas, this has been calculated as a weighted average of the population depending on the three

water sources (standpipes, yard and house connections) and their average water consumption as obtained from the NMPWWS: house connections – 165 l/d/p, yard connections – 50 l/d/p and standpipes – 35 l/d/p. Population data was derived from the population census reports for 1991 and 2001.

- For the government, wastewater supply is water consumption by government multiplied by EGF of 0.65.It is assumed that all government departments are connected to the sewerage system. .
- For industries/business, wastewater supply equals water consumption of the sector multiplied by EGF of 0.55. The assumptions are the same as for the government sector.

Wastewater use account

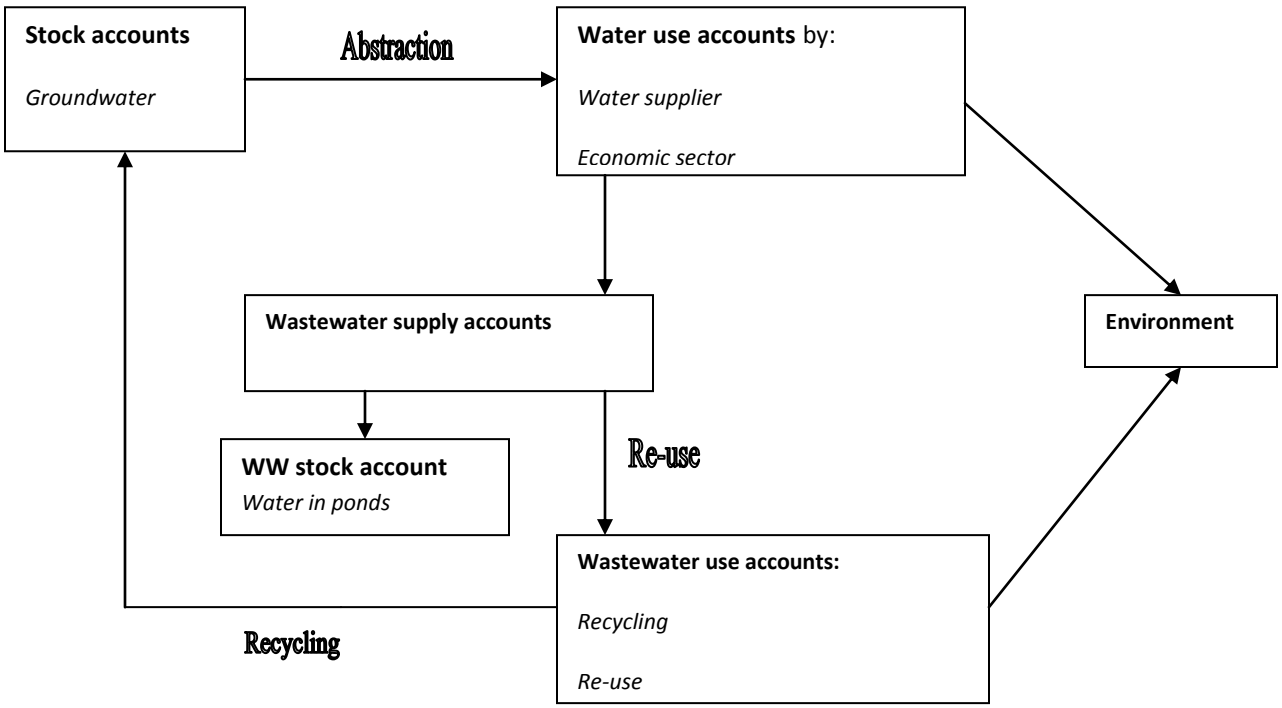
Four main destinations of wastewater are distinguished (refer to section 4.1.3). Data on inflows, outflows, quality, re-use and recycling were incomplete. Therefore, some data from the National Asset Register (NAR) has been used for 2001/02 and fieldwork was carried out at five WWTWs (Gaborone, Jwaneng, Selebi Phikwe, Francistown and Lobatse).

For the monetary aspects of the water accounts, with data available, the physical units are multiplied by monetary units to get insights into the value associated with water. Ideally, the accounts require the assessment of economic rent of water or the water supply costs. The water suppliers' data on the costs was incomplete and this prevented the development of full monetary accounts. Economic aspects of water use and management were assessed. This included water use efficiency, allocative efficiency and benefits of wastewater reuse and recycling. Two indicators are used to estimate use efficiency being value added per m^3 and employment per $m^{3.}$

4.1.6 Linkages of the accounts

The freshwater and wastewater accounts are interlinked as shown in Figure 3. Firstly, water is abstracted from the stocks and used in different sectors (use account). The water uses generate wastewater which is collected in WWTWs or discharged into the environment. Secondly, outflows from the WWTWs is reused, recycled or discharged into the environment.

Figure 3: Linkages of the accounts



4.1.7 Findings

The results of the physical and monetary accounts are discussed in this section.

4.1.7.1 Physical accounts

Stock accounts

Surface water sub account

The stock account shows that the abstraction is more than the sustainable yields for the period 2001 to 2003 (Table 28). The account indicates that the major dams are under high pressure as shown by the decrease in the amount of water stored in 2003.

Table 28: Fresh water (reservoir) stock account for the all WUC dams (Mm^3)

	2001	2002	2003
Opening volume	289	319	235
Inflows	277	142	149
Abstraction	174	159	79
Evaporation	72	66	60
Closing volume	320	236	245

Source: DEA and CAR, 2006

Groundwater sub accounts

The accounts are incomplete due to data imitations. The account is presented in table 29 for 1992, 1995 and 2001. The account indicates in most well fields, abstraction exceeds recharge rates. This gives an indication that there is a decline in the available water resources. However, without the opening volumes, it is not possible to state the lifetime of the resource. This will cause problems in future as most rural areas and the mining sector rely heavily on these resources.

Table 29: Ground water stock account (Mm^3)

		1992	1995	2001
I.	**Opening volume well fields**	Unknown	Unknown	Unknown
	Abstraction	46.3	49.8	55.7
	Recharge	15.5	15.5	15.5
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown
II.	**Opening volume individual boreholes**	Unknown	Unknown	Unknown
	Abstraction	42.1	42.6	39.7
	Recharge	Likely to exceed abstraction	Likely to exceed abstraction	Likely to exceed abstraction
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown
III.	**Opening volume total developed groundwater**	Unknown	Unknown	Unknown
	Abstraction	88.4	92.4	95.4
	Recharge	At least 57.6	At least 58.1	At least 55.2
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown

Note: I plus II equals III.

Wastewater stock account

Wastewater stocks are relatively small as only a portion is stored mostly in ponds and this makes the accounts far less important than the wastewater supply accounts. Gaborone and Lobatse ponds had a capacity of 1.5 $Mm^{3.}$ Assuming that this is the same for the other WWTWs, the total amount of stored wastewater could be around 3 Mm^3, a figure that is far less than the amount of stored surface water and groundwater resources.

Water use accounts

The general trend in the consumption of water is illustrated in Figure 4. The figure shows that aggregate water consumption has increased from 140 Mm^3 in 1990 to 170 Mm^3 in 2003. This increase is below the 1991 BNWMP demand forecasts. In the 1990s consumption had increased mainly due to the mining boom but this however levelled off in the early 2000s. By category of institutions, self providers account for the largest share in the consumption of water followed by WUC, DCs and DWA. The accounts indicate that water consumption has increased much faster in urban areas than in rural areas. Agricultural and household sectors are the largest water users accounting for 63.4 Mm^3 and 56.9 Mm^3 respectively (Table 30). The mining sector has the fastest growth in water consumption followed by households and government.

Figure 4: Trends in water consumption in Mm^3; 1990-2003

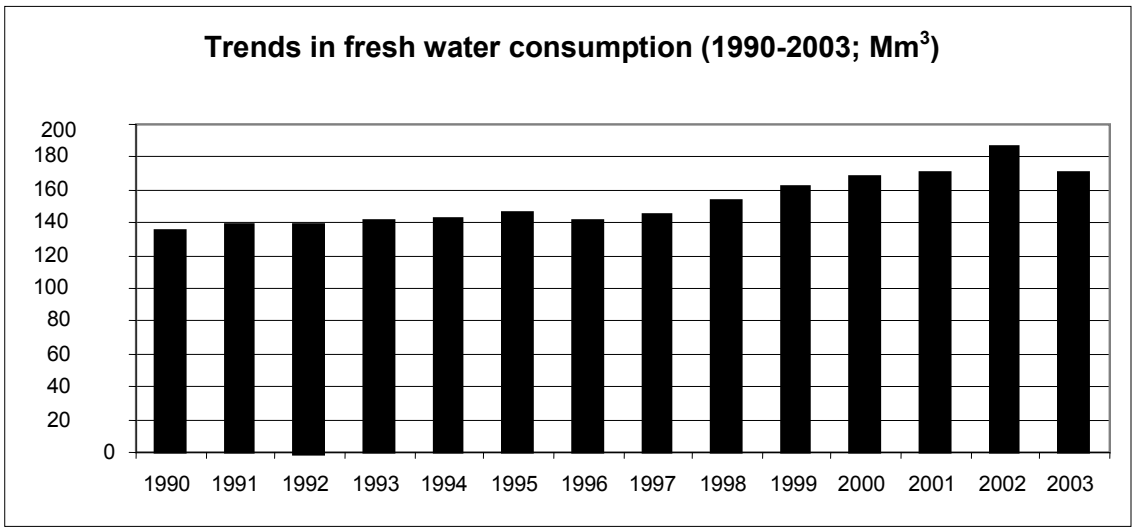


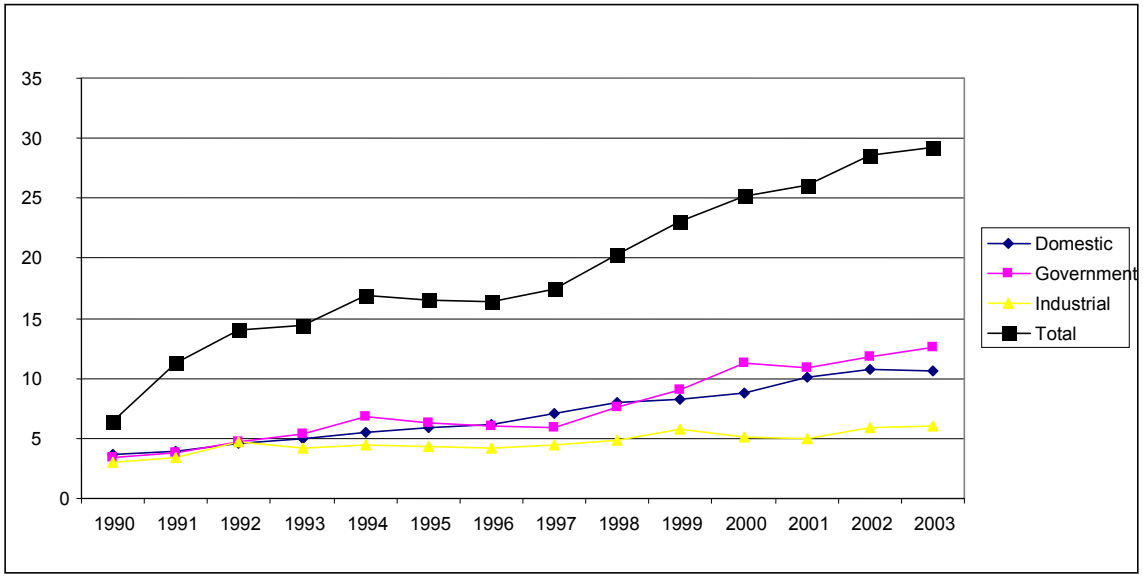
Table 30: Water use by economic sector (Mm^3) for selected years

User category	1992	1996	2000	2003
Agriculture	72.9	70.6	76	63.4
Mining	12.8	14.4	24.1	26.8
Manufacturing	3.9	2.1	4	5.1
Water + electricity	0	0.8	0.5	0.7
Construction	0	0.4	0.4	0.4
Trade	0.2	0.7	1	1.2
Hotels and restaurants	0.2	0.5	0.8	0.8
Transport and communication	0	0.2	0.2	0.3
Insurance, banking, business	0	0.5	0.7	0.8
Social and personal services	0	1.2	1.7	2.4
Government	8.7	8.8	11.1	11.5
Household use	36.1	41.1	48.1	56.9
WUC private sector	7.7	0	0	0
Total	142.5	141.3	168.6	170.3

Wastewater supply account

The estimated wastewater supply account by main category is presented in Figure 5.

Figure 5: Wastewater supply to WWTWs (1990-2003; Mm^3)



The accounts illustrate that the supply of wastewater more than doubled in the period 1990-2003. The resource is growing much faster than water consumption primarily due to improved sewerage systems.

The total amount of wastewater received in WWTWs amounted to 14.8 Mm^3 in 1992 compared to 29.2 Mm^3 in 2003. This is equivalent to inflow into WWTWs of about seventeen percent of total water consumption. Over the same period, government and households were responsible for WW supply growth with growth rates of 132.3 and 119.9% respectively. The growth rate of wastewater in the industry/business sector is only 5.7% for the whole period. This is possibly a sign of difficulties in diversification of the economy and slow pace in development of the private sector. The bulk of wastewater is generated in urban areas. Wastewater from Lobatse, Gaborone, Jwaneng, Francistown and Selebi Phikwe accounts for eighty percent all wastewater in WWTWs and Gaborone supplies more than half of the urban wastewater supply. Moreover, eight large villages also have WWTWs and thus contribute to wastewater supply.

Wastewater use account

Wastewater use covers treatment losses, re-use, recycling and environmental discharges. The use account is equal to the supply account. Table 31 shows the main wastewater destinations for 1992, 1997 and 2003. From the table, processing losses in WWTWs and discharges into the environment are most significant. These account for about 90% of wastewater supply. Discharges into the environment are important for vegetation and groundwater recharge and downstream economic activities such as agriculture. However, they may be hazardous for the environment and people's health if the discharge is of poor quality. Recycling is zero and re-use is increasing but remains low as a percentage of the outflow. Reuse grew from 0.9 Mm^3 in 1992 to 1.6 Mm^3 in 2003; an increase of 83.3% in a decade. Irrigation and landscaping are the main destinations of re-use.

Table 31: Main destination of wastewater for selected years (as % of total inflow)

Wastewater destination	**1992**	**1997**	**2003**
Processing losses	43.7	43.0	42.2
Re-use	6.5	6.4	10.8
Recycling	0.0	0.0	0.0
Environmental discharge	49.8	50.6	47.0
Total use of WW	100.0	100.0	100.0

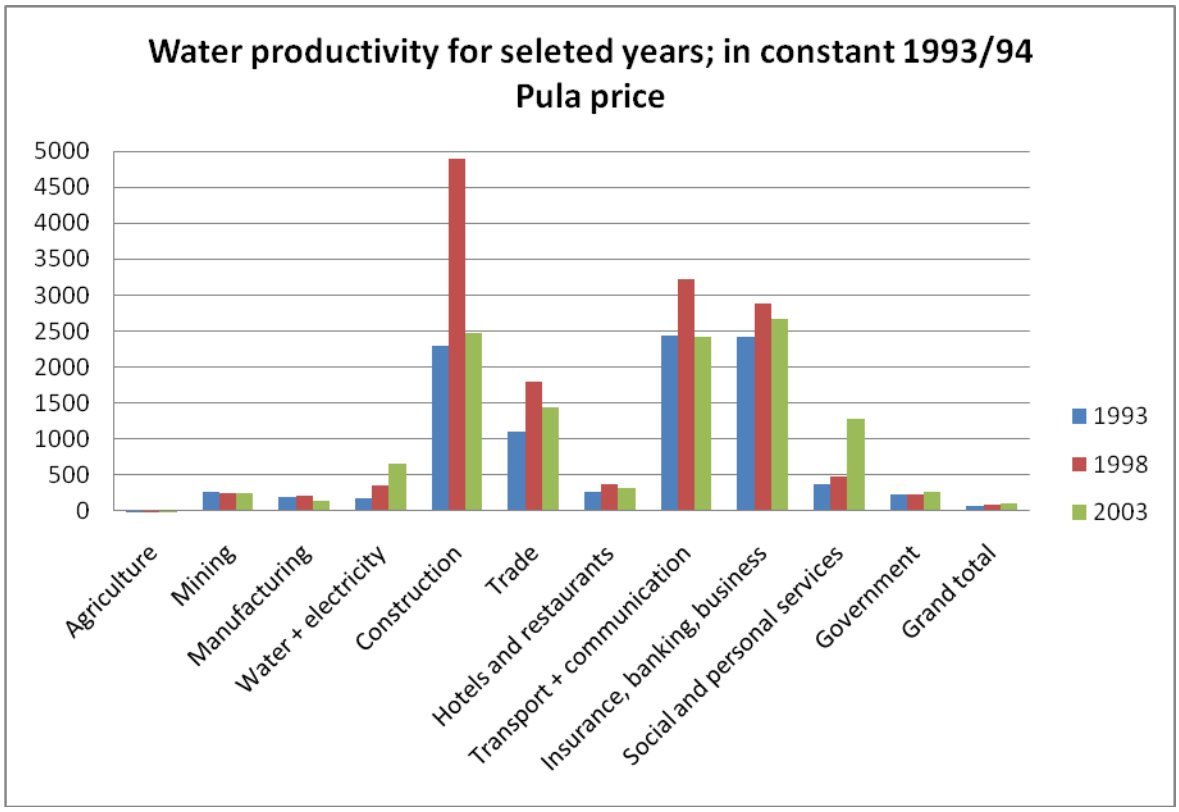
4.1.7.2 Monetary accounts

The monetary accounts could not be developed due to data inadequacies. Instead, some economic aspects of water accounts were analysed.

Water use efficiency

The estimates for value added per m^3 are presented in Figure 6. Value added per m^3 is highest in the service, construction and transport sectors (over P 1000/ m^3). It is lower in the manufacturing industry, mining and government and by far the lowest in the agricultural sectors. The estimates indicate that water use efficiency has increased in time to an average of P 106/ m^3.

Figure 6: Water productivity; in constant 1993/94 pula price.



In terms of employment, in 2003, an average of close to 2 800 paid jobs were generated for each Mm^3. The largest number of jobs are created in the service sectors (about 20 to 5 000 per Mm^3) while the public sector generates around 25 000 jobs per Mm^3. Paid employment per Mm^3 is lower in the industry, mining and agricultural sectors. The latter mostly provides jobs for self employment of farmers and informal labourers. If these were included, water efficiency would be over 1 500 jobs per Mm^3.

Benefits of wastewater re-use

Three types of potential benefits from re-use and recycling are distinguished:

- Postponement of additional supply schemes e.g. 2nd phase of NSWC- deferment by five years would lead to savings of about P 500 million over a five year period;

- Benefits derived from the use of saved water ; and
- Lower water tariffs would enhance competitiveness and savings for households e.g. in Namibia, reclamation costs are equal to bulk water supply costs from Namwater (N$ 2.40/m^3).

To derive maximum economic benefits from re-use and recycling, a combination of re-use destinations should be considered. An example is shown in Table 32. The gross benefits total P925 million per annum. Employment could be as around 40 000 paid jobs assuming the employment rate is 2 800 per Mm^3.

Table 32: Possible direct gross economic benefits of a composite re-use scenario

Destination	**Designated re-use amount Mm^3)**	**Value added / m^3 (93/94 P/m^3)**	**Directly associated value added of re-use (Million Pula 93/94 prices)**	**Possible associated paid employment**
Irrigated agriculture	8.0	20	160	50 - 500
Construction	0.2	2 468	494	7 000 - 12 000
Government	1.0	271	271	20 000- 25 000
Domestic use	5.3	0	None	
Total	14.5		925	Around 40 000

4.2 Regional water accounts for the Orange River

The Orange River is an international river basin and is shared among Lesotho, Botswana, Namibia and South Africa. Each of these countries faces water constraints and relies heavily on shared international water courses. Water accounts for this river basin were constructed in 2001 by Connigarth Economic Consultants. Data for the accounts was mostly sourced from national water accounts of each country (except Lesotho). The accounts include water supply and use as well as the ecological requirements. Furthermore, water productivity in terms of value added has been estimated. The monetary accounts for the costs of supply could not be constructed because only two out of the four countries had national water accounts encompassing monetary accounts.

Water supply has been calculated as:

Local water management area (WMA) yield which is the sum of (a*nnual runoff + storage+ groundwater yield + return flows) + transfers from other WMAs.*

Water use *= all economic uses+ water requirements for industry and households+ transfers out to other WMAs + ecological uses and losses.*

The water supply account indicates the relative contribution of each country to total supply. The results indicate that South Africa is the largest contributor at 64% of total supply, Lesotho contributes 34% and Namibia and Botswana collectively make a contribution of 2% (Table 33).

Table 33: Water supply in the Orange River basin, 2000 in Mm^3

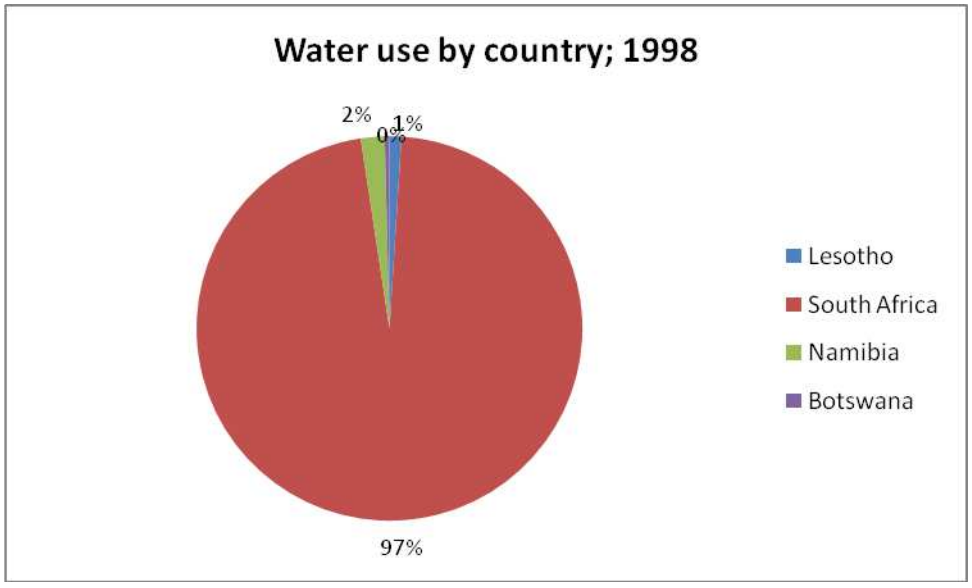
	Lesotho	**South Africa**		**Namibia**	**Botswana**	**Total**
		Upper Orange	**Lower Orange**			
Water supply=	4768	5798	3177	294	56	14,093
Net annual runoff +storage	4765	5660	1014	281	51	11,771
+Groundwater	1	65	24	13	5	108
+ Usable return flows	2	71	97	N/A	N/A	170
Sub total	4768	5796	1135	294	56	12,049
+ Transfers in from other WMA	0	2	2035	0	0	2,037
Share of total supply by country	34%	41%	23%	2%	Less than 1%	100%

Note: N/A means not available

Source: Lange *et al*, 2007.

In terms of water use, South Africa accounts for the largest amount (97%) of total water use;, Lesotho and Namibia use 1% and 2% respectively while Botswana accounts for less than 1% of total use. A comparison of the supply and consumption shows that South Africa consumes significantly more than it contributes while the opposite applies to Lesotho.

Figure 7: Water use by country



In sectoral terms, agriculture dominates water use in most countries except for Lesotho where the industrial sector and domestic uses account for the largest use of water. Transfers out of the river basin into other water management areas (WMAs) account for a significant share of total water use (56%). For South Africa, in the lower river basin, about 3,148 Mm^3 of water is transferred to other WMAs.

In terms of water productivity, the value added per m^3 of basin water was estimated at around R21 million or 2.7% of the countries' GDP. The share of each country is as follows: Botswana – 4%, Namibia – 19.3%, Lesotho – 20.3% and South Africa – 56.4%. Despite agriculture being the main recipient of water, its value added per m^3 is the lowest.

In conclusion, the accounts for the Orange River basin provide useful information on the supply and use of water by the riparian countries and water productivity. Decisions regarding the management and allocation of the resource are therefore critical and thus the accounts if further developed, will provide vital information that will aid such decision making initiatives and assist in the attainment of the SADC vision for water, MDG goals, IWRM and individual country's water objectives. Such decisions should take into consideration the economic value of the use to which the water will be put in each state. Data should also be improved to aid in the development of national water accounts which feed onto the river basin's accounts.

4.3 Discussion

The case study discusses the water accounts in Botswana and (briefly) draft accounts for the Orange River.

The Botswana surface water stock account shows that the amount of water stored in dams is highly variable and depends largely on rainfall patterns and temperatures. The total volume of water in dams

has increased due to the construction of the new Letsibogo dam. Groundwater stock account is incomplete due to data limitations. The partial accounts suggest that many well fields could be overused.

The flow accounts show the growth in water consumption in the period 1990-2003. Leading water users are agriculture and households, mining and government, and consumption has grown faster in urban centres than in rural areas. Available wastewater resources have more than doubled since 1992, much faster than water consumption. The largest suppliers are households and government. The wastewater use account illustrate that 3 Mm^3 is currently being re-used (equivalent to 20% of the outflow). Re-use is mostly confined to irrigation (agriculture and landscaping). The bulk of wastewater is discharged into the environment or evaporates during treatment.

Estimates of the value added per unit of water show that the value added per m^3 is highest in the service, construction and transport sector and very low in the agricultural sector, which uses the most water. Re-use and recycling of wastewater would lead to the deferment of construction of large water schemes, water savings and moderate water tariffs which would lead to increased savings for domestic households and also enhance Botswana's competitiveness.

Data constraints impede the expansion of the accounts especially on the monetary side and groundwater stocks. It is therefore vital that data be collected by and be availed to relevant departments to necessitate the updating of the accounts. Although this was a national exercise, the accounts can be constructed at the district level as well if the data is available.

Water accounting is a tool that can be used to enhance the resource use efficiency and reduce resource wastage, thus contributing to the achievement of IWRM objectives. The 2006 Review of the Botswana National Master Plan recognises that the nations' water resources must be monitored and accounted for, hence the need for NRA. The plan highlights that NRA can help counterbalance a number of difficulties on the path to the sustainable utilisation and management of the water resource: "The accounts monitor the levels of the resource, the value of the resource to the country, consumption and investment level and therefore could lead to an evaluation of an agreed definition of sustainability" (SMEC, 2006, p.24).

Water use efficiency is vital for sustainability in the utilisation of the water resource. All water users therefore need to treat water as an economic good and use it efficiently. The level of investments into efficient use by the private sector should be substantial given that they utilise considerable amounts of water in their operations.

As mentioned earlier NRA is applicable to most natural resources and can be used to inform policy. Capacity building of officers in the relevant departments is therefore essential as this would warrant

continuity and environmental mainstreaming in the macroeconomic planning and long-term development planning of Botswana. Several messages for policy emerge from the water accounts in Botswana (Box 1).

Box 1: Policy implication of the water accounts

- Water allocation needs to be based on allocative efficiency and optimal resource allocation;
- Water users need to use water efficiently;
- Water providers need to cut water losses;
- NMPWWS has set a target of wastewater re-use of 96% by 2030, therefore this should be encouraged to attain the objectives of policy and in turn use water efficiently and meet projected water demand;
- Re-use and recycling have several benefits including deferment of large additional water supply schemes and extra production with saved water;
- Costs of advanced treatment technologies can be earned back by re-using and recycling wastewater;
- The choice of technology used will determine the amount of outflow from the WWTWs, for instance, although the pond system is cheap, the resource is lost through evaporation. Therefore, investments should be put in better technologies.
- There is potential to use NRA for allocation of shared water such as the Okavango River.

Questions

1. Is NRA relevant to district issues and shared water courses such as the Okavango and Zambezi and how can it be applied?

2. What are the policy implications at district level and transboundary river basin level from national water accounts?

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5 Economic instruments

5.1 Ground water pricing in Thailand

Source: Abaza H. and J. Reitenberg-McCraken, 1998. Economic instruments for environmental management: a wide world compendium of case studies. United Nations Environment Programme, New York. Pages 60 to 63.

5.1.1 Introduction

This case study discusses groundwater pricing in Thailand in the late 1990s. Water pricing is an important way of improving water allocation, encouraging optimal resource use and water conservation. Pricing should however take into account that water is a basic need and a commodity with an economic value. IWRM has emerged as a planning concept that may ensure a sustainable and efficient water supply and use. IWRM takes into consideration the need to secure scarce water resources for social, environmental and economic development for current and future generations and for ecosystems. Box 2 illustrates the underlying elements of IWRM based on the Dublin's principles.

Box 2: IWRM principles

- Freshwater is a finite and vulnerable resource essential to sustain life, development and the environment;
- Water has an economic value in all its competing uses and should be recognised as an economic good;
- Water management should be based on participatory approaches involving all users, planners and decision makers at all levels; and
- Women play a central part in the provision, management and safeguarding of water management and therefore it should be gender sensitive.

Water pricing may affect efficiency of water use both at individual and the national levels. Charging for the use of groundwater is an economic tool which has been adopted for decades world wide as well as in southern Africa.

The purpose of the case study is to demonstrate the role of groundwater pricing as a tool for the sustainable use and management of groundwater resources. The case study discusses the design of the instrument in response to the observed environmental and socio economic issues. Conclusions are then drawn and compared to the Botswana situation in terms of applicability.

5.1.2 Background of Thailand

Figure 8: Geographical map of Thailand

The Kingdom of Thailand is situated in eastern Asia and covers a land area of 513,115 km^2 and is bordered by Malaysia, Myanmar, Laos People's Republic and Cambodia in the southwest. In 1999, the population was about 62 million with a growth rate of 0.3% and 19.4% of the population resided in the urban areas. The country is divided into four main geographical regions: the North, the Central Plain, the Northeast and the South. The Northeast accounts for about a third of the country's population with low income groups mostly dominating this region. This region experiences long periods of floods with

alternating droughts and the productivity of the land is generally low due to among others the salinity of the soil.

The country has twenty five river basins and high rainfall (annual average of 1700 mm). The total annual rainfall of all river basins is estimated to be 800,000 Mm^3 and 75% of this is lost through evaporation and evapo-transpiration while the remaining 25% is captured in the streams, rivers and reservoirs.

Groundwater is mainly recharged by rainfall and seepage streams and aquifers yield a huge amount throughout the country. The largest source of groundwater is found in the lower Central Plain particularly in Bangkok Metropolitan Region (BMR) and this is mainly used to meet growing water demands[7].

Groundwater is mainly used for industrial and household consumption. The resource use is regulated through the Groundwater Act of 1977 and user charges. Groundwater from privately owned wells was particularly important for household consumption especially in areas where piped water was not available. Rural households and those not served by the Provincial Waterworks Authority install water pumps so as to extract groundwater and this is comprised of mainly the poor segments of the society. However, these small users operate without permits and are uncontrolled, and as a result groundwater levels drop thereby risking resource depletion and land subsidence.

Due to low extraction costs, the industrial sector has benefited from groundwater. Moreover, government agencies also rely on groundwater extraction, especially during surface water shortages, primarily so as to meet the deficit.

In Thailand, groundwater extraction by both private and public users amounted to 1.8 Mm^3 per day covering a total of 7 595 wells. Moreover, government agencies extract about 0.4 Mm^3 per day.

There is however uncontrolled and overutilization of groundwater and this has led to major environmental problems such as land subsidence, groundwater depletion and pollution. Land subsidence is more apparent in the Bangkok Metropolitan Region. Depletion raises the possibility of salt water intrusion due to seawater contamination of the groundwater reservoirs. Excessive groundwater use beyond its natural rate would eventually deplete the groundwater stock and further exacerbate the above mentioned problems.

5.1.3 Economic instruments to promote sustainable use of groundwater

In response to excessive use of groundwater resources, the Department of Mineral Resources (DMR) adopted groundwater pricing in 1984. A user charge of 1baht (US$ 0.04) per m^3 was imposed for groundwater extraction. Moreover, the Metropolitan Waterworks Authority completely banned the

[7] Water demand doubled between 1980 and 1990 to reach an estimated daily amount of 43,000 Mm^3; the annual growth rate is 10%.

extraction of groundwater in areas where land subsidence caused problems (Class I and II areas)[8]. The user charge was later increased to US$ 0.14 per m^3 due to continued land subsidence. However, where piped water was unavailable, the user could obtain a 25% discount. It is important to understand the underlying factors in designing environmental economic instruments. In Thailand, pricing is designed to achieve optimal resource use and tackle environmental concerns such as land subsidence. The following are the key elements which are necessary when designing instruments:

- The costs of using the resource directly accruing to the user, ether private or public users;
- Affordability and acceptability – it is necessary to determine the income levels of different user groups and therefore it is important to assess their willingness to pay for the extraction of the water resource. This should also take cognisance of issues such as poverty because the poor segments of the society are in most cases unable to pay highly for the resource thus subsidies may be introduced in such cases;
- Environmental concerns – environmental externalities such as pollution should be accounted for when designing charges. This should also consider the foregone future benefits.

The above three mentioned factors reflect some components of the marginal opportunity costs (MOC). MOC consists of the user costs, external costs and forgone future benefits. In many cases, the users pay for the user costs only, but ideally all the costs should be accounted for. In principle, groundwater extraction should reach the level whereby the marginal benefits equal the marginal social costs. In attaining this, a user charge, which bridges the difference between the user costs and the MOC, should be introduced.

Through the 1977 Groundwater Act, resource use was regulated through permits (command and control). These included among others permits for drilling, extraction and discharge and these permits were transferable. However, small users managed to extract water without obtaining permits from the DMR thus attaining water free of charge. This is due to a lack of enforcement and monitoring by the implementers, resulting in environmental external costs.

5.1.4 Discussion of the results

The case study indicates that groundwater pricing can be used together with the regulatory method where a complete ban on groundwater extraction in critical areas is imposed. Extraction is regulated by the Groundwater Act of 1977, its Amendments (1992, various ministerial Regulations and Announcements of the Ministry of Industry and those of the Department of Mineral Resources (DMR). The charge imposed in 1984 was US$ 0.04 and a decade later this was increased to US$0.14. This was possibly due to continued land subsidence especially in the Bangkok area.

[8] Class I represents highly critical areas at which the rate of subsidence is as high as 10c m or more per annum and these are mostly districts in Bangkok. Class II indicates moderately critical areas where subsidence is between 5 to 10 cm per year and it occurs in about five districts of Bangkok and neighbouring provinces.

The aim of imposing the charge is to reduce groundwater extraction and raise revenue for the department. However, the department does not use meter readings to calculate the amount of water extracted. Each user reports to the department every three months on how much they have extracted and then DMR calculates using this reported volume against the allowable amount stated on each permit and the type of activity in operation. The permits were transferable and could be revoked if extraction led to damages of the reservoirs, the water stored, environment or public health and land subsidence. These could also be withdrawn if piped water was made available in certain areas.

The DMR could not control the amounts of volumes extracted due to lack of water meters at the water pumps. Moreover, small users could extract water for private use and this was beyond the control of the DMR. Due to this lack of monitoring and enforcement, correct amounts of water extracted could not be attained hence it was not easy to determine how much water was used at a particular time. This resulted in the user charge imposed not achieving the intended objectives.

Another limitation is that according to the Groundwater Act, the user charge for groundwater cannot exceed the subsidised user charge for piped water, which was then US$ 0.28 per m^3. This prevents the groundwater user charge reflecting the true marginal cost of extraction.

Willingness-to-pay studies in Botswana for livestock owners in north-western Kgatleng (Oageng, 1999) and domestic consumers in a Maun ward (Mmopelwa et al, 2005) have shown that water users are willing to pay more than the actual abstraction costs. Almost half of the cattle owners are willing to pay on average P 0.77/m^3 on top of their direct use costs for water (Oageng, 1999). In Maun, households are willing to pay a premium for a more reliable water resource (Mmopelwa et al, 2005).

Several observations are noted:

- It is easy to create environmental economic instruments but enforcement and implementation is challenging, costly and requires skills and capacity;
- Poor design of instruments is likely to hinder the achievement of the intended objectives of imposing the charges. There should be baseline information in designing a user charge otherwise it is unlikely to have an impact and the impact cannot be assessed;
- The charges are unlikely to change environmental behaviour if they are not linked to the volume of resource use. User charges are less effective for flat rates;
- Low charges may be affordable especially to the low income groups but in most cases fail to alter the behaviour of resource users. They often lead to low revenues and resource wastage;
- External costs and forgone benefits should be included in the user charge imposed on the resource users.

- Instruments are often combined (in this case regulations and charges) in order to achieve a particular objective.

Applicability and relevance to Botswana

In Botswana, groundwater resources are very important given that surface water resources are very limited. Groundwater supports most of the rural population and is particularly utilised in most the mining and livestock sectors. However, there are concerns about depletion and pollution of the resource especially around mines and large settlements. For the livestock sector, farmers pay fees for watering livestock at council boreholes and privately owned boreholes. However, these fees are low and do not necessarily reflect the economic value of the good. Charges should include the external costs (e.g. land degradation) and foregone benefits (e.g. resource depletion).

When designing instruments, a holistic approach should be adopted so as to consider the views and inputs of different stakeholders. This would ensure ownership and better understanding as to why resource users need to pay extra for the utilisation of natural resources. It is important that monitoring and evaluation of user charges be carried out so as to assess the efficiency of the instrument at hand.

Questions

1. How could water use charges be applied to the commercial livestock sector? Which improvements would it bring about and what difficulties may be encountered?

References

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5.2 Community Based Natural Resources Management- case study of Sankuyo Tshwaragano Management Trust in northern Botswana.

Sources:

Centre for Applied Research, 2007. Community-based natural resource management, rural livelihoods and environmental sustainability. Phase three Botswana country report. Prepared for IUCN-South Africa and USAID Frame.

Buzwani B., T. Setlhogile, J. Arntzen and F. Pott, 2007. Best practices in CBNRM activities in Botswana. Study carried out for the Environmental Support Programme, UNDP and GoB.

5.2.1 Introduction

This case study discusses community-based natural resources management (CBNRM) as a way of managing natural resources through property rights. Property rights may refer to rights to ownership of resource, use of resources and/or develop resources. CBNRM is an example of devolution of user rights to community organisations. It involves the sustainable utilisation and conservation of natural resources and contributes to rural development and the improvement of rural livelihoods.

CBNRM covers natural resources such as wildlife, veld products, fisheries and rangelands, but the emphasis has often been on wildlife and tourism. CBNRM evolved in Zimbabwe out of concern for the status of wildlife and the inadequacies of other wildlife management approaches. The notion behind CBNRM is the involvement and participation of local communities in managing and benefiting from natural resources utilisation. The communities would obtain legal resource user rights, form local institutions and become responsible for sustained use of these resources in exchange for the community benefits. The following components are necessary for effective CBNRM:

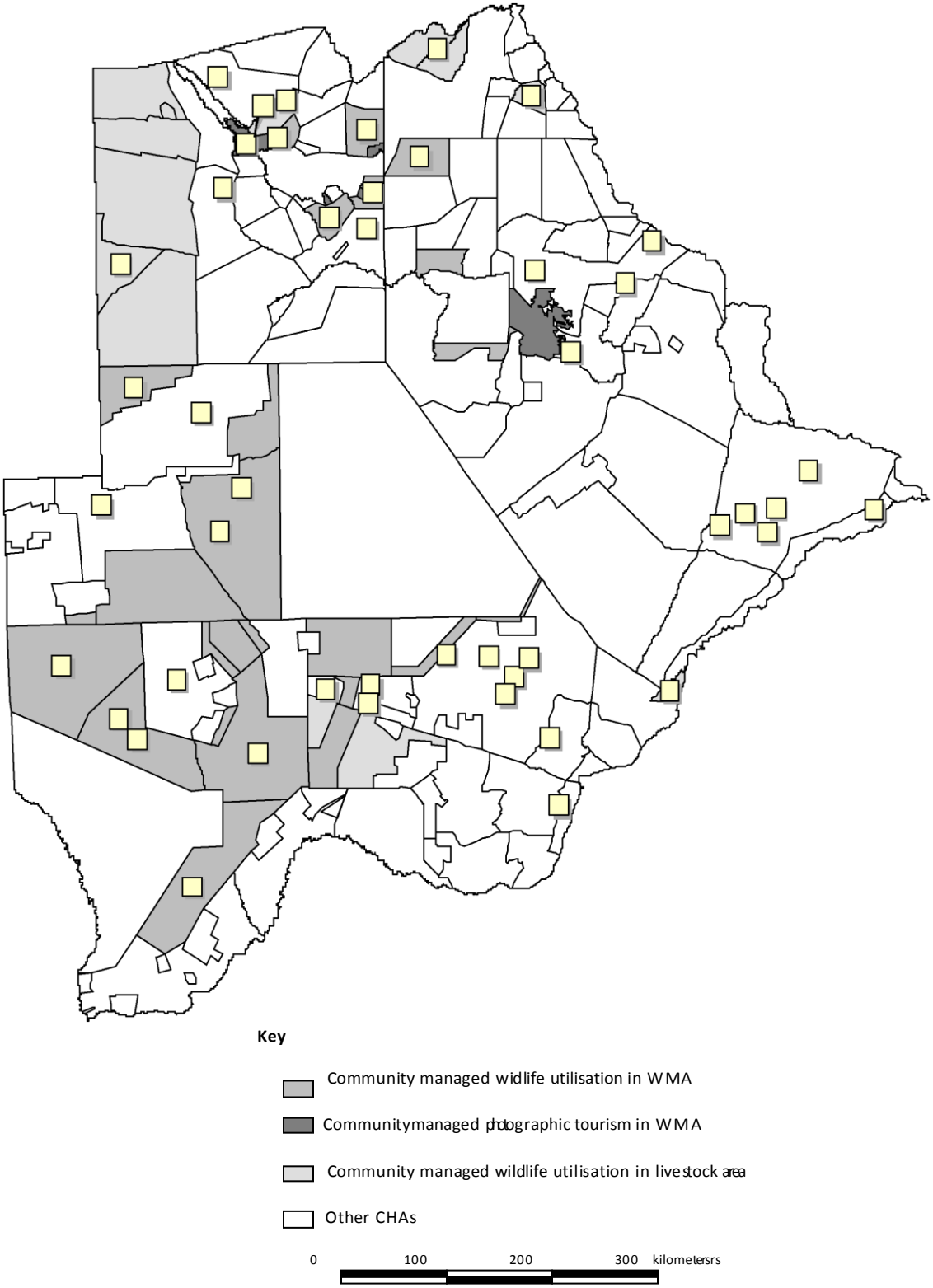
- *Proprietorship* - this entails the rights to allocate and sell resources; the rights to retain benefits; the authority to make general management decisions; and rights of exclusion and control;
- *Governance* - this is where institutional structures and organisational development must enable high levels of participation through mechanisms that are transparent, accountable, democratic and equitable. The village level face-to-face management is ideal in this case;
- *Capacity building* including knowledge and information systems. Record keeping and knowledge about the value of natural resources to give communities power to make good deals when negotiating the sale of their products.

In Botswana, CBNRM started in 1990 through the Natural Resources Management Project (NRMP) which was jointly funded by the United States Agency for International development (USAID) and the Botswana Government. The first CBNRM project (Chobe Enclave Community Trust or CECT) was established in 1993 and engaged in hunting and photographic safaris. Most of the current CBNRM projects depend on wildlife and tourism, while a few deal with veldproducts and rangelands. Over the years, CBNRM projects have mushroomed and expanded to all nine districts. Figure 9 shows the coverage of CBNRM projects in Botswana.

The study draws from the experiences of the Sankuyo Tshwaragano Management Trust (STMT) which deals with the delegation of wildlife user rights and resource management. The main objective of the case study is to demonstrate the use of user rights as a way of managing natural resources (CBNRM) and the associated benefits and constraints.

Information was sourced from different literature.

Figure 9*:* Community-Based Organisations in Botswana



5.2.2 Sankuyo Tshwaragano Management Trust (STMT)

Background

STMT is a community-based organisation (CBO) operating in Ngamiland district north of Botswana. The trust was established in 1995 following a consultative process facilitated by the Department of Wildlife and National Parks (DWNP). It is the second oldest CBO and STMT engages in the utilisation of the wildlife resource through hunting, photographic tourism and other tourism activities (e.g. camp site, lodge and a now defunct cultural village).

Sankuyo village is located in the Kwando/Okavango Wildlife Management Area adjacent to Moremi Game Reserve. This area has a high tourism potential because of abundant wildlife and forest resources, its location on the edge of the Okavango delta and its proximity to Maun where there is an international airport. The population of Sankuyo was about 400 in 2001 (CSO, 2002). Prior to the CBNRM project, the inhabitants of Sankuyo lived in poverty and engaged in some agriculture, hunting and gathering.

After the government zoned some CHAs for community management, communities could apply for a head lease from the Land Board so as to obtain exclusive rights to use and manage wildlife quotas in the respective controlled hunting areas. These areas are reserved specifically for controlled hunting and photographic tourism. This enabled the community to get involved in managing and benefiting from the wildlife resource in their area.

Upon the inception of the Trust, the community of Sankuyo was assisted by DWNP, NRMP and non-governmental organizations who offered technical assistance. Community mobilisation and consultations were undertaken and this led to drafting of a constitution which gave Sankuyo village an identity as a legal and registered entity (STMT)[9]. The villagers then developed a strategic management plan for NG34 which outlined ways in which to run the Trust, develop the CBNRM enterprise, how the area will be used and ways of conserving the natural resources in the area.

In 1995, the Tawana Land Board allocated STMT with a head lease for NG33 and NG34 for photographic tourism and hunting respectively. The community was then given a wildlife quota by DWNP for hunting purposes. The use rights could be subleased to joint venture partners depending on the Trust. Since then, hunting rights have been sub-leased to four joint venture partners.

[9] For a community to obtain a head lease and user rights, they need to form a Trust which is legally registered and has a constitution.

STMTs Joint venture agreements (JVA)

STMT's first tender for the hunting and photographic safaris was awarded in 1996 to Game Safaris (Table 34). The land rental and wildlife quota were valued at P285 000 and the lease was for one year. Through the Joint Venture Agreement, thirty Sankuyo residents were employed for the whole year in the hunting and photographic safari operations of Game Safaris. Other benefits included game meat from hunting activities of the operator; some of the meat was sold and generated trust income. Part of the meat was distributed to destitutes in the area.

The second JVA was with Crocodile camp company, which offered P 385 000 for the community area. It leased the area for three years and in the third year (1999), it earned the trust P 595 000. The trust was able to buy a vehicle and 50 jobs were created through the JVA. Moreover, community escort guides were trained so as to monitor hunting activities of the safari operator. In 1999, through a cost sharing arrangement, between STMT and Crocodile Camp, trust offices were constructed. During the same year, Crocodile Camp built the Sankuyo community hall and equipped it with a television and furniture.

Table 34: A summary of STMT's joint venture agreements

Starting date	Partner	Length of sub-lease (# of years)	Benefits (Pula)	JVP employment (# of jobs)
1996	Game safaris	1	285,000	30
1997	Crocodile camp	3	385, 000 - 595, 000	50
2000	HCH	5	1,300,000	56
2006	Johan Calitz	5	1,500,000	56

Source: Buzwani, *et, al*, 2007

The tendering process has not been without problems. In 1997, the Trust preferred to continue with Game Safaris but this company was not shortlisted for tendering. In 2000, STMT preferred another company over HCH but the trust was overruled by the technical advisory committee (TAC). Due to such controversies and conflicts, the hunting quota for 2000 was not awarded. HCH was awarded the tender and the company created 56 jobs were created for the residents of Sankuyo and P65 000 was donated to the local football team.

Activities of STMT

STMT is engaged in a number of activities guided by four very important documents including the Deed of Trust, Policies and Procedures for Trust Activities, Policies and Procedures for Enterprises and Santawani Lodge Operations Manual. The main activities of the Trust are briefly summarised in Table 35.

In addition, the Trust operates a sales and reservations office near Maun and participates in a research and monitoring camp, which is jointly run with John Calitz Hunting Safaris. Research has been undertaken on predators (wild dogs and lions) and on herbivores. Community members are expected to benefit through training and development. STMT may also benefit through improved monitoring of wildlife and other natural resources in NG 33 and 34.

Table 35: STMT's main activities

	Hunting	**Photographic safaris**
JVP	Joint venture partnership with Johan Calitz Hunting Safaris for NG34. The private company sub-leases the hunting area from the Trust and pays them quota fees for the game animals and provides contributions like the community development fund. Two hunting safari camps owned and operated by the JVP and staffed with 30 community members, 15 at each camp.	Moremi Tented Camp (MTC) operated with sublease held by Squacco Heron (Pty) Ltd. MTC is a 16-bed upmarket, tented camp that is marketed and managed by Okavango Wilderness Safaris through a contractual arrangement with Squacco Heron (Pty) Ltd. MTC employs 18 community members.
STMT		Santawani Lodge in NG 33 – is a community enterprise (owned, operated and completely staffed by 17 STMT community members). Facilities include six newly completed brick under thatch chalets. Other facilities: bar and restaurant with an outside fireplace and social area; office, storerooms, kitchen, laundry facility and staff village. Activities include game drives and night drives conducted by a licensed, community professional guide. A small artificial waterhole in front of the lodge offers sedentary game viewing and bird watching opportunities. Optional full day mokoro and powerboat excursions into the Delta can be arranged from Santawani Lodge. Kaziikini Campsite - is a community enterprise (owned, operated and completely staffed by 9 STMT community members). It has attractive, serviced campsites with water standpipes, braai stands and dustbins. Shared ablution facilities (hot and cold running water, flush toilets, and laundry basins and clothes lines). Rustic traditional huts with bedding/linen. Well-stocked bar and restaurant (destroyed by an accidental fire); a reception office and staff village.

Benefits of the Trust

STMT activities generate significant material and non-material benefits for the community of Sankuyo as well as those from outside the village. Substantial revenues have been accrued from sub-leasing of the hunting area, wildlife quota fees for game animals hunted, meat sales and ecotourism enterprises. Other sources of revenues include camping fees and vehicle hire. Total revenues and their sources for the period 2001-2005) are summarised in Table 36. Other material benefits derived from the trust activities cover employment, household dividends and game meat.

Non-material benefits are also significant and this includes capacity building and empowerment. Table 37 outlines the major benefits derived from STMT's activities. The benefits are derived at both

household and community levels and several studies have concluded that the household level benefits are mostly preferred.

Figure 10: A dining area of Santawani Lodge

Table 36: STMT revenues (2001-2005)

Year	Land Rental	Game Quota Fee	Meat Sales	Net profit from Kaziikini	Net profit from Santawani	Other Income
2000	166,833	49,090	-	-	-	80.946
2001	57,047	55,600	510	48,204	-	65,457
2002	492,000	872,550	5,929	59,897	26,623	36,329
2003	466,509	965,772	4,473	159,746	188,536	17,597
2004	562,655	1,096,377	4,641	73,479	- 13,061	11,336
2005	455,000	1,060,400	2,936	71,489	525 175	12,412

Table 37: Material and non-material benefits generated by STMT

Material benefits	Non- material benefits
1) At household level • Employment - to date about 105 jobs have been created through direct employment in STMT and joint venture partnerships. On average, 1.5 jobs accrue per household; • Cash dividends – Between 1997 and 2005, a total of P53 450 has been directly paid to households as dividends. On average, individual households received P500 in 2005. However, this is very modest given the amount of revenues generated by the trust annually; • Distribution of game meat from the hunting activities of the joint venture partner. Some of this is given to destitute, to the community at large or auctioned especially meat of the most preferred species such as impala and kudu; • Old age allowances to individuals who are sixty years of age or more; • Housing for destitutes; • Micro schemes; and • Scholarships for training.	• Creation of new institutions and organisations; • Capacity building; • Pride and ownership of community managed resources; • Empowerment - For instance, the community has gained skills and powers in negotiating business deals; • Networking – the trust takes part in several for such as the annual CBNRM forum which brings together several CBNRM stakeholders to assess the CBNRM and share ideas as well.
2) At community level • Construction of a community hall with DSTV facilities; • Trust offices; • Enviro loo toilets; and • Community trust fund	

With regard to natural resources management (NRM), the trust does not have a comprehensive management strategy in place. However, it has developed the following NRM activities:

- Community Escort Guides (CEG) accompany both hunting and photographic safaris;
- Monitoring and conservation of natural resources in NG33 and NG34; and
- Environmental research through the JVP.

The efforts seem to have results. It has been reported that poaching has declined over the years and that people's attitude towards wildlife has become more positive as they now benefit from the resource.

5.2.3 Discussion

STMT is a good example of a wildlife based CBNRM project in a high potential zone for tourism. Through subleasing the hunting area and fees generated from the wildlife quota, the Trust receives significant

amounts of revenues. The Trust is financially sustainable and has potential to reduce poverty and improve people's livelihoods. The benefits that accrue at both household and community levels are important but it is critical that benefits trickle down to the household level so as to be felt by individual community members.

In terms of natural resource management, STMT has an environmental monitoring committee in place as well as community escort guides and has started a resource monitoring system (MOMS). However, there is no comprehensive environmental management strategy as yet and no the Trust does not invest in resource enhancement (e.g. water points and game). The Trust still focuses its efforts on wildlife, and has not started to tap the development potential and conservation of other natural resources. Clearly, establishing effective local resource management is a process with many steps!

Communities receive user rights from the relevant authority to enable them to exclusively use the resources in their area. STMT sub-leases the resource rights to commercial operators in order to complement its capacity and maximise its benefits. For a community to qualify for the rights, it needs to be recognised as a legally registered entity with a constitution and have an approved resource management plan in place.

The leasing system is currently in place has raised several concerns by stakeholders. The 15 year head lease and particularly the five year sub-lease for commercial partners are too short for significant tourism investments in the concession areas. It also appears at odds with the lease period for livestock ranches (50 years). Investments in infrastructure and resource management require a longer period than 5 years.

STMT has some remarkable achievements and this has made it one of the most successful CBOs in the country. It can therefore be used as an example to guide other CBNRM initiatives in the country or to start new ones. CBNRM is diversifying to cover other natural resources. Therefore the strategies that STMT uses can be applied in other areas even though the resources that may be covered are different.

It is therefore very important that the district planners encourage CBNRM in their respective districts so as to foster rural development through the utilisation of natural resources. It is also critical that resource rights be granted to communities so that the resources are not available to everybody for utilisation. This would thus assist in achieving the Nation's long term Vision 2016 and Millennium Development Goals.

Questions

1. How feasible is CBNRM as a form of improved local natural resource management?
2. Can CBNRM be expanded to all natural resources in communal areas?
3. What could be the role for community-private sector partnerships in CBNRM and improved local natural resource management?

5.3 Indonesia's Program for Pollution Control, Evaluation and Rating (PROPER)

Sources:

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www.worldbank.org/nipr/work_paper/PROPER.

5.3.1 Introduction

Traditionally, governments employ legal and increasingly economic instruments to improve environmental management. A third category of instruments (i.e. persuasion and consultation) is less frequently used, but it appears to have good potential as an alternative or complementary instrument. This case study describes a persuasive instrument used in Indonesia. Its success has led to similar efforts in countries such as the Philippines and Colombia.

Regulations are most frequently used to influence behaviour towards improving environmental management. Compliance is however a serious problem. As regards to pollution, innovative instruments have been developed so as to get polluters and resource users to comply with environmental regulations. Such incentives use social pressure, market forces and persuasion to help drive towards improved environmental performance. A typical example of such initiatives is the Pollution Control Evaluation and Rating (PROPER) program in Indonesia which was launched in the early 1990s by the environmental authority of Indonesia with technical support from the World Bank. The objective of the programme was to promote industrial compliance with pollution control regulations. The PROPER program rates and publicly discloses factories' environmental performance.

PROPER uses a colour coded rating ranging from gold to black to indicate the company's level of environmental performance vis-à-vis water quality standards. The results are published in the printed media. Having been rated, most companies will seek to improve their performance and can get easier access to the competitive domestic and international markets. Persuasive incentives involve the participation of a variety of stakeholders including government, non-governmental organisations (NGOs), the private sector and the community at large. PROPER has contributed to such participation and more and more companies appreciate the initiative and volunteer to take part.

This case study seeks to show how PROPER has achieved improvements in environmental management through the use of persuasive incentives. It demonstrates how the programme was initiated, designed, its achievements, challenges and the lessons learnt. The implications of such a programme in Botswana are also discussed so as to assess how it can be applied in Botswana.

5.3.2 Background

Indonesia lies on the south eastern part of Asia and is comprised of 17,508 islands. It has a population of more than 200 million and is the world's fourth most populous country. The country is regarded as one of Asia's regional industrial power houses, which experienced a boom in the industrial sector two decades ago. The manufacturing industry was growing at an annual rate of 10%; between 1980 and 1991, the nation's output of iron and steel increased more than four times, processed wood products increased more than three times while others such as paper, glass and metal also experienced a growth in the output. This contributed to increases in the average real income because jobs were created, livelihoods improved significantly and poverty levels went down by more than half in the same period.

However, by the late 1980s, a negative outcome of industrialisation became more apparent and this resulted in environmental deterioration particularly air and water quality around industrial centres. Three quarters of the industrial facilities were located in the densely populated island of Java and therefore people's lives were exposed to air pollution and poor water quality. For instance in Jakarta , exposure to such conditions led to 1,263 to 2352 deaths, 26,609 to 71,033 emergency room visits, 184,453 to 541,618 asthma attacks and between 5.3 and 11.8 million people lost work days in 1989. Air emissions exceeded the recommended standards of the World Health Organisation. Rivers were increasingly contaminated by industrial effluent: the Biological Oxygen Demand (BOD) measured at water quality monitoring stations climbed from 3-6 milligrams per litre in the early 1980s to more than 10 milligrams per litre by early 1990s.

Monitoring of environmental performance of the industries was hardly undertaken or did not receive priority by the government and compliance with regulations and standards was poor. As a result, the Ministry of Population and Environment tried out different approaches to make environmental regulations more effective. In 1989, they launched a semi-voluntary programme for controlling the discharge of industrial pollution in water ways (PROKASIH programme), which was administered by the Environmental Impact Management Agency (BAPEDAL) which reported directly to the President's office. The programme was mainly focussed on water polluters. In 1995, the agency launched the PROPER program with support from the World Bank, USAEP/USAID, and Canadian and Australian development agencies. The latter programme was a response to the country's inability to handle environmental crises caused by industrialisation and the environmental agency's limited monitoring and enforcement capacity.

5.3.3 PROPER Program

The program is based on public disclosure of facilities' environmental performance and its objectives are to:

- Promote industrial compliance with pollution control regulations;
- Facilitate and enforce the adoption of activities contributing to clean technology;

- Support a better environmental management system through the use of incentives and transparency; and
- Raise awareness among the community regarding waste management regulations as well as encouraging the business community to comply with pollution control standards.

A pilot study was conducted in 1995 where 187 plants were rated- medium to large scale polluters from several river basins in Sumutra, Java, and Kalimatan. The programme initially focussed on the PROKASIH participants and later widened its scope to include air and toxic pollution. By 1998, the programme covered a total of 350 factories in more than twenty eight sectors and fourteen provinces.

The programme developed a colour-coded rating scheme based on the evaluation of environmental performance so as to grade factories against the regulatory standards. This system is based on five colours, the choice of which is culturally determined, and these correspond to the different levels of performance in-terms of pollution control. The colours are described in Box 3. Business performance rating ranges from gold (excellent) to black (very poor).

Box 3: PROPER's colour coded scheme

a. ***Gold rating (excellent)****:* this represents excellent and commendable performance ("world class") by going beyond the requirements of regulatory standards and also by showing similar excellent results in the control of air pollution and hazardous waste.
b. ***Green rating (good):*** this implies that the factories' environmental performance goes substantially beyond the expected compliance. This is for factories that utilise clean technology. A criterion for the rating is that the facility produces 10-50% of waste at the allowed quality standard.
c. ***Blue rating (adequate):*** this is given to a facility which 'just' meets the national regulatory standards.
d. ***Red rating (poor):*** this indicates that the company has some environmental management systems in place, but does not satisfy all requirements.
e. ***Black rating (very poor):*** This includes companies which are extremely dirty and cause serious risks for the environment and public health. These are companies who have not made any attempts to control pollution and contribute significantly to environmental deterioration.

The policy objective for gold and green ratings is the encouragement of a clean technology adoption while for the rest of the colours is the creation of a compelling force for compliance through public pressure and legal enforcement. The incentives associated with gold and green are public praise which would give companies a competitive edge in the market. In contrast, the disincentives for blue, red and black ratings are public pressure and legal enforcement.

The public disclosure process would help expose polluters to pressures that can make or break the company's reputation. This process includes three steps: firstly data collection and verification from

different sources at the participating facilities, secondly, data analysis and thirdly assigning ratings followed by public disclosure. The performance rating process involves the following distinct steps:

- Selection of the polluters;
- Collection of data through mail surveys;
- Verification and inspection of plants;
- Development of a pollution database;
- Analysis of data at BAPEDAL;
- Verification of data at BAPEDAL;
- Obtain rating from the advisory board;
- Obtain rating approval from the Minister of Environment;
- Report the ratings to the President of the state; and
- Release of info to the press and the public.

As indicated, the data collected undergoes a process of careful analysis before it can be released to the public.

After the first ratings in June 1995, no plant was rated gold and the 'green companies' were publicly announced. Those which were rated red and black were notified privately and given notice until December to improve their performance. By December, half of the black rated facilities and 6% of the red rated ones had made successful efforts to improve their performance. They made significant investments in pollution abatement due to the threat of public disclosure.

Selection of facilities

BAPEDAL selected mostly those facilities, which took part in PROKASIH. Questionnaires were sent to 350 facilities but only 176 had sufficient data to be rated. Some companies outside PROKASIH volunteered to take part.

5.3.4 Elements of empowerment

I. Access to information

The community was empowered by this process. By ensuring high quality and reliable information, BAPEDAL created greater community awareness about the performance of the firms and the impacts they pose on the environment. This helps stakeholders to establish strong grounds upon which to challenge polluters. It also granted facilities a wider and clear framework from which to make investment decisions. This motivated the firms to make sound investment decision and adopted cleaner and greener technologies, which enabled them to climb up the rating ladder and ensure market stability. The public disclosure process has also ensured that the data released to the public is free of

errors hence sound data analysis methodologies were adopted. This strengthened the operations of the environmental agency.

II. Stakeholder inclusion and participation

The programme has enabled the participation of a wide array of stakeholders including the general public, which has enhanced ownership of and commitment to the program. Communities were also empowered with negotiation skills and abilities in the complex area of pollution control. Moreover, the availability of information on the effects of pollution and encouragement by BAPEDAL to negotiate with the firms, have given communities a voice and made them part of the decision making process. Participation has also helped in raising awareness as regards to pollution control and compliance.

III. Accountability

The process also led to good governance practices by infusing the efforts of the community groups, NGOs, the media and BAPEDAL. This has ensured accountability on both the regulators and the regulated. Public scrutiny also ensures transparency.

IV. Capacity building

The project has improved the environmental awareness and management capacity of the stakeholders involved in the programme.

5.3.5 Results and impacts of the programme

The following are the results of the PROPER programme:

- There was an improvement in environmental performance of firms;
- Of the 187 initial firms, 65% showed non-compliance. Five were rated green while six were rated black;
- There was an increase in the number of firms that participated. By December 1995, twenty new firms registered for participation. Moreover, there was a 50% drop in the number of companies rated black within a period of one year and compliant firms grew from one third to half of the sample;
- After 18 months of full disclosure, there was a 40% reduction in pollution;
- The green and gold rated firms maintained their high standards while the low rated improved;
- In terms of the industry groups, there was a remarkable difference between factories owned by nationals, multinationals and/or the state. 70% of the factories owned by nationals were assigned black while the multinationals proved to be the best. In terms of products, those which produced paper and sugar showed more signs of compliance than rubber, textiles and palm oil firms;
- The programme provided insight into the performance status of the industries;

- The programme was cost effective because it mobilised external stakeholders for support as well as by leveraging their power to control non-environmental behaviour;
- Public recognition encouraged performance beyond the regulatory standards and allowed the firms to evaluate the costs of abatement against the benefits accrued due to compliance; and
- The programme has strengthened the capacity of BAPEDAL as an implementing authority and therefore this improved their operations.

5.3.6 Challenges and lessons

Credibility was necessary so as to gain public trust. The lack of credibility would have undermined the entire initiative of PROPER. This was addressed by evaluating the data received and subjecting it to several rounds of assessments.

Initially, uncertainty existed regarding the business community's reaction to the rating strategy. That is conversion from the environmental regulations to a colour coded system could have received mixed reactions from the stakeholders. However, BAPEDAL anticipated this and engaged technical teams from Australia, Canada and the World Bank to create transparent rating systems with a colour coded scheme.

It is important to select facilities with sufficient data. The programme initially selected 176 facilities with adequate data out of 350 surveyed firms.

The programme had strong political support, willingness of the community to participate in and building on the PROKASIH programme. This contributed greatly to its success.

Reliable data is a prerequisite for an effective pollution management initiative. Stakeholders need timely and accurate information for them to properly appraise the firms and make appropriate and just decisions.

The programme clearly shows that civil society, when empowered with access to information and capacity to utilise it, can effectively monitor the performance of polluters and can encourage good performance. Therefore, stakeholder participation in such an endeavour is very critical.

Persuasion can be a useful compliment to regulations. It provides less of the 'stick' and more of the 'carrot' in terms consultation and persuasion. The programme shows that enforcement problems can be reduced in this way.

5.3.7 Discussion

The discussion clearly demonstrates how environmental performance and pollution control can be achieved through the adoption of a holistic approach involving the participation of a diverse array of stakeholders and persuading the polluters to change their behaviour towards the environment. The benefits include: less enforcement problems for government; environmental awareness raising and capacity development of resource users and polluters; better environmental management and greater cooperation among the main stakeholders. Persuasive instruments fit well into the process of

consultation that is part of Botswana's tradition and culture. Moreover, it could be linked to environmental monitoring and audits provided for under the EIA Act as well as to the grading of tourism facilities initiated by the Botswana Tourism Board. This approach can therefore be adopted in Botswana. The regulations are in place but compliance and implementation of many of these instruments is a challenge to the authorities. Possible uses of persuasion in Botswana would include environmental ratings of large industries, mines and agricultural projects, tourism camps in the Okavango Delta and CBNRM projects.

Questions

1. What are the advantages and disadvantages of this approach for Botswana (as compared to regulatory and economic instruments?
2. What would an environmental rating system for mines look like?
3. What would an environmental rating system for Okavango tourism camps look like?

Appendix 1: Some results from Botswana water accounts

Table A1: Water use account by institution (in 000m^3; 1992-2003)

Category	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
DC	20435	20611	20791	20973	21158	21345	21536	21734	21937	22151	22369	22591
DWA	7765	7715	8703	8961	9080	9374	10356	10723	10465	10413	11326	11805
WUC	25391	26973	27692	27672	28043	30661	35435	38438	41903	44585	49170	50343
Others	86661	86476	85584	88912	83009	84178	86042	91798	94363	93182	104060	85592
Total	140252	141775	142770	146518	141290	145558	153369	162693	168668	170331	186925	170332

Table A2: Water use by economic sector (000m^3; 1992-2003)

User category	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	72913	74196	72912	75216	70592	69558	71559	74802	76048	75652	82086	63420
Mining	12840	14890	15197	16551	14418	17910	18361	20857	24098	22851	25357	26751
Manufacturing	390	2289	2291	2282	2069	2559	3108	3725	3994	4392	4910	5109
Water + electricity	1240	1306	1176	1152	768	738	960	735	510	467	475	710
Construction	0	320	246	240	364	304	193	365	386	397	423	430
Trade	159	660	651	618	749	760	747	932	956	1053	1067	1175
Hotels and restaurants	227	635	624	540	546	567	535	755	803	800	804	845
Transport + communication	0	172	161	169	167	171	185	222	235	241	260	265
Insurance, banking, business	11	488	446	457	517	529	583	657	692	706	771	782
Social and personal services	0	1272	1182	1247	1176	1148	1285	1587	1680	1727	2395	2435
Government	8689	7459	9017	8693	8847	8577	10101	10347	11096	11275	11053	11502
Household use	36090	38089	38866	39352	41078	42742	45752	47603	48093	50771	57224	56908
WUC private sector	7695	0	0	0	0	0	0	0	0	0	0	0
Grand total	140252	141775	142770	146518	141290	145562	153369	162588	168590	170331	186825	170332

Table A3: Wastewater use accounts (1990-2003; 000 m^3)

	User category	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
I.	Agriculture	320	335	332	349	334	401	417	459	480	554	531	600
II.	Mining	214	212	234	227	233	232	236	257	253	259	302	318
III.	Industry	0	0	0	0	0	0	0	0	0	0	0	0
IV.	Water/ Electricity	0	0	0	0	0	0	0	0	0	0	0	0
V.	Construction	0	0	0	0	0	0	0	0	0	0	0	0
V	Services	141	146	176	167	164	168	210	237	244	256	302	302
VI.	Government												
	Central govt	141	146	176	167	164	168	210	237	244	256	302	302
	Local govt	71	71	78	76	78	77	79	86	84	86	101	106
VI.	Domestic Use	0	0	0	0	0	0	0	0	0	0	0	0
VII.	Environment												
VII.1	Evaporation/ treatment losses	6127	6232	7301	7164	7055	7480	8714	9785	10540	10591	11724	11942
VII.2	Discharge in rivers	6880	7144	8362	8148	8060	8528	10093	11535	12466	13932	15126	15497
	Other outflow	34	38	42	51	47	54	38	51	60	67	65	72
VIII.	**Total use of WW**	**13929**	**14325**	**16700**	**16348**	**16135**	**17109**	**19995**	**22648**	**24372**	**26002**	**28453**	**29138**

Table A4: Value added per m^3 of water (1993/94 constant prices; Pula).

User category	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	6.50	6.43	6.67	6.73	7.05	6.37	5.53	6.07	5.91	5.41	3.71
Mining	274.44	262.04	252.18	313.36	269.56	256.93	252.12	260.45	264.69	257.08	260.22
Manufacturing	194.24	236.95	256.97	300.80	250.04	218.78	187.49	177.10	160.25	144.29	137.83
Water + electricity	190.07	222.61	228.33	366.90	409.44	357.19	500.91	796.56	895.79	942.17	653.86
Construction	2294.25	2999.12	3189.95	2269.05	2766.54	4889.56	2629.59	2565.12	2596.33	2395.36	2467.54
Trade	1116.19	1396.79	1653.76	1635.61	1631.08	1799.96	1522.98	1613.83	1570.70	1543.14	1444.62
Hotels and restaurants	275.65	3199.90	367.99	364.84	380.04	372.69	281.75	277.32	303.24	333.64	321.38
Transport + communication	2447.82	2758.13	2649.87	2869.92	2971.32	3220.92	2739.03	2677.95	2673.90	2441.42	2428.13
Insurance, banking, business	2421.34	2821.44	3025.64	2770.76	2901.15	2883.80	2657.51	2692.61	2807.68	2577.31	2666.16