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INTRODUCTION INTO ENVIRONMENTAL ECONOMICS

Environmental Planning Programme
Ministry of Finance and Development Planning
National Conservation Strategy Agency

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COURSE INFORMATION

Objectives:

- Demonstrate the close links between natural resources, their management and economic development;
- Familiarise participants with the main theories and tools that links environmental management and planning

Institutions:

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COURSE OUTLINE

TOPIC 1: ENVIRONMENT AND ECONOMIC DEVELOPMENT

- Concepts and theories
- Empirical evidence
- Does growth lead to sustainable development?
- Market mechanism
- Markets and the environment

TOPIC 2: RESOURCE VALUATION

- Concept of total economic value
- Direct valuation approaches
- Indirect valuation approaches

TOPIC 3: PROJECT EVALUATION AND THE ENVIRONMENT

- The discount rate
- Cost-benefit analysis
- Two case studies

TOPIC 4: NATURAL RESOURCE ACCOUNTING: INTEGRATING ENVIRONMENT AND MACRO-ECONOMIC PLANNING

- Basics of natural resource accounting NRA
- NRA and minerals in southern Africa
- NRA and water in southern Africa

TOPIC 5: ECONOMIC INCENTIVES FOR SUSTAINABLE RESOURCE MANAGEMENT

- Environmental policy principles and instruments
- Environmentally perverse subsidies
- Evaluation of environmental-economic instruments in southern Africa

SOME READINGS IN ENVIRONMENTAL-ECONOMICS

GLOSSARY OF ENVIRONMENTAL-ECONOMIC TERMS

TOPIC 1:
ECONOMIC DEVELOPMENT AND THE ENVIRONMENT

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1.1. CONCEPTS AND THEORIES

1.1.1. Introduction

Traditional economic development theories and planning neglect the environment. In response, Western environmentalists in the 1960s considered economic growth as the main cause of environmental problems. In the 1980s and 1990s, a more balanced approach towards environment and economic development emerged based on the concept of sustainable development (WCED, 1987). It was recognised that particularly in developing countries economic growth is necessary to solve environmental problems (SADC-ELMS, 1996).

Sustainable Development (SD) puts economics in a broader perspective: natural resources are seen as scarce production factors (not problems only), which may put limits to economic development. Problems:

a. finiteness of resources;
b. limited sink/ absorption function.

Sustainable development aims at balancing equity, efficiency and sustainability concerns.

1.1.2. Key concepts

Economic growth: *rate of growth in physical outputs (good and services) produced in a country*. Or: *the steady process by which the productive capacity of an economy is increased over time to bring about rising levels of national income* (Todaro, 1995)

Development: *societal transformation with the main objective of satisfying human needs and aspirations usually achieved through increasing the productive potential and equality of opportunity* (Colby, 1990). The purpose of human development is to widen the range of people's choices (UNDP). Economic development is usually associated with rising per capita income. Note that development has an environmental component: a pleasant and healthy environment is usually a human aspiration or need.

Sustainable development: '*process of change in which the exploitation of resources, the direction of investments, the orientation of technological developments, and institutional change are all in harmony and enhance both currents and future potential to meet human needs and aspirations'* (WCED, 1987)

Environment: *all external conditions and factors, living and non-living, that affect an organism or other specified ecosystem during its lifetime* (Miller, 1992). Environmental change refers to: a. depletion of resources (renewable, non-renewable); b. loss of biodiversity and/or c. pollution. Environmental change may affect environmental functions such as the production, absorption and life-support functions. Important aspects of the environment:

- Renewable and non-renewable resources;
- Biotic and abiotic resources;
- Components and eco-systems

Links between environment and economic activities can be classified as follows:

- Through environmental functions;
- Through environmental management;

Links may only become apparent after some time (time lag).

1.1.3. Theories regarding economic development and environment

The interdependence between economic growth and environment has long been neglected in theories. Two scholars will be briefly reviewed. Both are essentially optimistic, i.e. they argue that environmental problems will be solved through the process of economic growth.

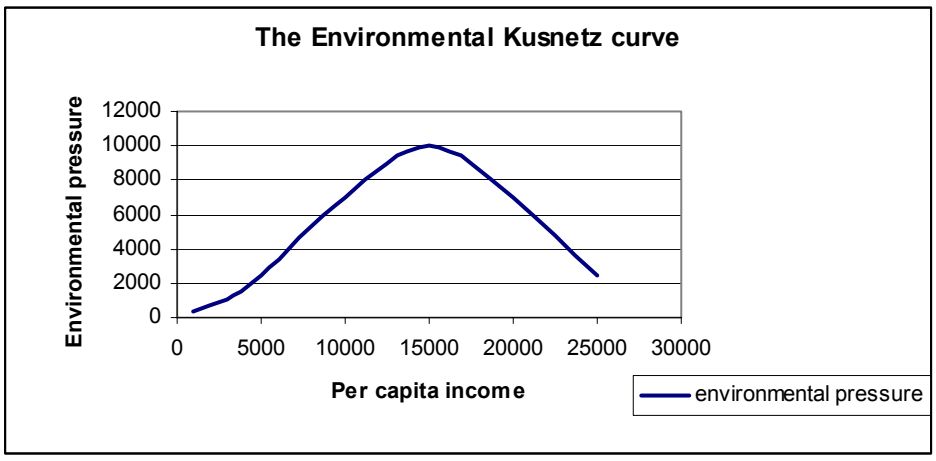
Wilkinson (1973) argued that natural imbalances are the source of development. Such imbalances may arise from natural (e.g. droughts, floods) or human causes (economic growth, population growth). If such imbalances arise, societies have four adaptive mechanisms:

- Expansion of the resource base;
- More efficient resource use;
- Switches in economic structure towards less-resource consuming sectors (economic diversification);
- Population control and restriction of consumption patterns.

Wilkinson argues that societies are able to adapt in time to avoid irreversible environmental problems. Therefore, the adaptive mechanisms generate both economic growth and development and reduce environmental pressure.

The *Environmental Kusnetz Curve (EKC)* assumes that an inverse U-shaped relationship exists between per capita income and environmental pressure. During the process of economic growth, environmental problems will initially worsen, but after some time they will become less severe. In other words, economic growth will ultimately resolve environmental problems after a trickling down process, for example, through enhanced environmental protection.

Figure 1.1



Obviously, the EKC is politically attractive as the main message is that economic growth should be stimulated (e.g. World Bank, 1992). It should be recognised, however, that it is a sweeping generalisation that has attracted a lot of 'verification' studies, based on cross-country comparisons and on time-series analysis. These studies have led to the following 'situation analysis':

1. The EKC is mostly applicable to environmental problems that have local environmental health effects, which can be solved relatively cheaply;
2. The EKZ is mostly applied to pollution problems; few applications consider resource uses;
3. Emissions of global pollutants (e.g. greenhouse gasses) do not follow the EKZ pattern;
4. There seems to a shift in environmental problems: some problems decrease with rising p.c. income; others initially increase and decrease later; yet others, continue to increase.

The main strength of the EKZ is that it directly deals with the linkages between economic growth and the environment. Of course, the key questions are when the turning point will be reached, whether countries can influence the time it takes to reach that point and the shape of the curve (e.g. reduce the peak). However, several major points of criticism may be raised towards the EKZ:

- The EKZ- curve does not consider how countries import environmental problems (relocation of industries);
- The results are subjective; they are strongly dependent on the selected indicators or variables;
- The EKZ-curve does not explain the reasons for the changes in environmental pressure;
- The EKZ curve assumes that environmental problems are reversible;
- The EKZ curve does not provide full information about the environmental impacts of economic growth.
- The EKZ curve can easily be understood as a blueprint for all countries with a uniform turning point. This does not do justice to countries' heterogeneity in national and global terms.

It is important to recognise the influence of other determinants of environmental pressure such as international trade, political power and income distribution, political strategy and system, literacy, advocacy, vigilance, and popular rights, density of economic activities, energy prices and external shocks;

In brief, theories conclude that economic growth and a healthy environment are not necessarily incompatible. Where economic growth is a necessity to reduce poverty, growth also appears to be a requirement to improve environmental conditions in developing countries.

1.2. EMPIRICAL EVIDENCE

1.2.1 Introduction

The empirical relationships between p.c. income and the environment have been measured in several ways. First, differences between the two groups of developed and developing countries are examined. Second, a large number of countries with different p.c. income levels are compared. Thirdly, specific cases of environmental damage and narrowing growth opportunities are recorded. Each of these will be briefly reviewed below.

A few observations should be made first. All countries depend on the environment, but the extent varies in time and among countries. Generally, countries reduce their

dependency on primary sectors during the development process. Some countries develop mostly through the exploitation of oil or minerals.

1.2.2. The comparison of developed and developing countries

Inhabitants of developing countries consume less resources and cause less pollution than their counterparts in developed countries. Within the group of developing countries, south Asia and sub-saharan Africa has the lowest per capita income and resource use. According to the WCED, developing countries used less than 10% of the paper, metals and commercial energy than developed countries (WCED, 1987, p.33)

The 2000/2001 World Development report shows the following inequalities:
- Higher deforestation rates in developing countries;
- Much lower energy use and CO_2 emissions in developing countries.

Table 1.1: Socioeconomic and environmental characteristics of countries by income level.

	Low-income countries	Middle-income countries	High-income countries	Sub-saharan Africa
Population (mln; 99)	2417	2667	891	642
Gross income (GNP; bln. $ 99)	988	5323	22921	321
P.c. income	410	2000	25730	500
Annual deforestation (% of area)	0.7	0.3	-0.2	0.7
Protected areas (% of total area)	5.6	5.1	10.8	6.2
Commercial energy use p.c. (kgoe)	563	1368	5369	695
CO^2 emissions p.c. (MT; 99)	1.1	3.7	12.3	0.8

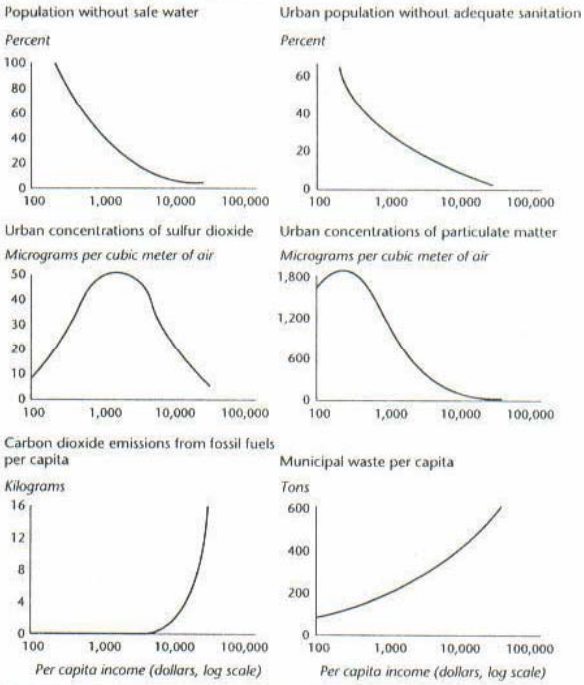
Source: World Development Report 2000/2001.

1.2.3. Cross-country comparisons based on per capita income

The 1992 World Development Report has a detailed cross-country comparison (Figure 2). The conclusions show that the EKC does not always apply. Three types of problems are identified:
- Environmental problems that decline with rising income;
- Environmental problems that initially worsen, but get better afterwards;
- Environmental problems that continue to worsen.

Another cross-country comparison led to the following results:
- Growing resource use pressure with p.c. increase: increasing p.c. use of paper, and water (countries over 550 mm); increasing p.c. use of minerals (exponential) and fossil energy (linear);
- Growing pollution wit p.c. increase: increasing greenhouse gas emissions and waste;
- decreasing urban air pollution (suspended particles)

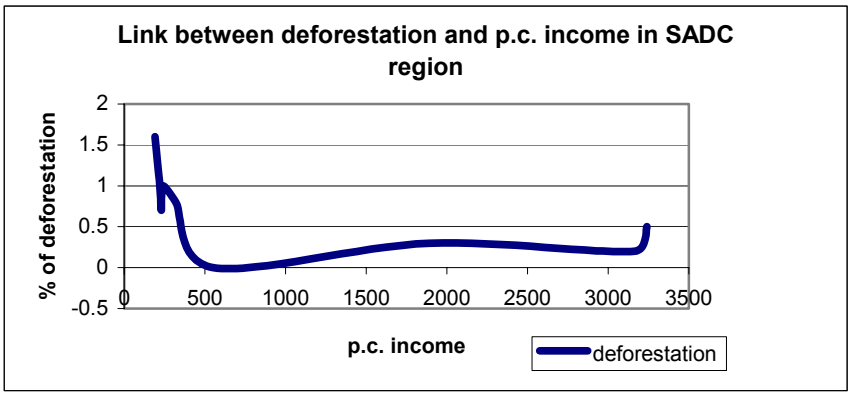
Figure 1 Environmental Indicators at Different Country Income Levels



Note: Estimates based on cross-country regression of data from the 1980s.
Source: World Bank 1992, based on Shafik and Bandyopadhyay 1992.

The conclusions depend, however, on the selection of countries and the specification of the environmental variable as the example of deforestation for SADC countries below shows.

Figure 1.3:



Pearce et al. (1989) found that within the high-income countries the willingness-to-pay for environmental protection is positively correlated to p.c. income.

1.2.4. Economic damage due to environmental degradation

The literature discusses many examples, where environmental degradation has a negative impact on the economic growth potential, either by the costs of environmental rehabilitation or reduced growth opportunities.

A few examples of costs of environmental degradation:

1. Burkina Faso experience economic losses of 4% of GNP due to soil erosion and loss of soil fertility.
2. Indonesia' economic growth adjusted for depletion of oil and wood and loss of soil fertility would be almost halved 7.1% down to 4.1 % period 71-84.
3. The cost of rangeland degradation in Africa is about 2.7% of the continent's income;
4. In Namibia, the cost of rangeland degradation are estimated to be N$ 50 mln. per annum.

Some examples of decreased growth opportunities:

- The World Bank (1990) estimated that the number of low income countries able to export tropical timber would decrease from 33 in 1990 to 10 in the year 2000.
- In The Philippines, mangrove production would drop to 10% of present levels within 30 years due to mangrove depletion;
- In Botswana, game farming and ranching is no longer viable in parts of western Botswana due to the drop in wildlife numbers

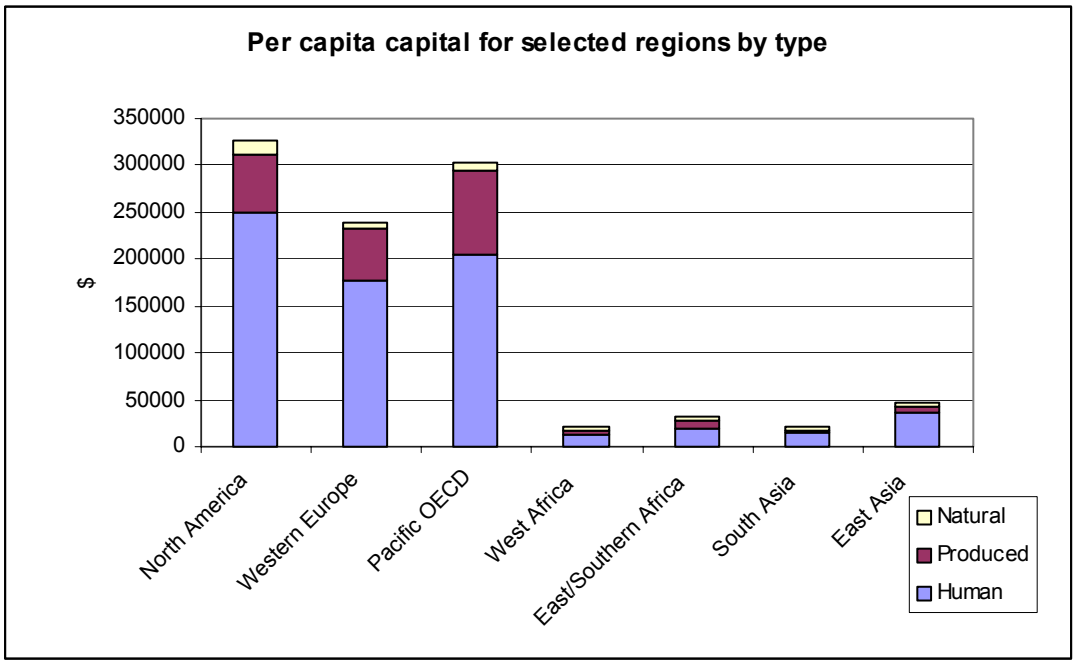
1.3 DOES ECONOMIC GROWTH LEAD TO SUSTAINABLE DEVELOPMENT?

There is no single answer to this question. In developing countries, economic growth is a pre-requisite for poverty alleviation. Economic growth is necessary to meet the outstanding needs and aspiration of the growing population. Assuming no changes in income distribution, the poorest will benefit, absolute poverty will decrease and the associated environmental problems will decrease too. Economic growth is, however, not sufficient to achieve sustainable development, and may be unsustainable in cases. This requires further elaboration.

In essence, development means meeting more needs. This can be done by increasing the environmental flows and/or by depletion the environmental stocks. An analogy may be drawn with personal savings. A person may draw a sustainable income from the interest on her savings (flow). However, if she withdraw more than the interest, the savings balance will be affected, and her future income will decrease. This is not sustainable. Therefore sustainable development requires at least a constant capital (human, physical and environmental). *Weak sustainable development* is achieved if the capital amount remains at least constant, and any decline in environmental capital is compensated by an at least least increase in human or physical capital. *Strong sustainable development* requires that in addition to the general constant capital requirement, no decline occurs in the renewable environmental capital base. This is a much more restrictive development conditionality.

Looking at the estimated per capita capital stock for selected region (figure 3), we conclude that developed regions have a much higher capital base per person than developing regions. Human capital is the driving force of development. Developed regions have considerably higher physical capital, as reflected in better infrastructure and communication facilities. Natural capital constitutes a small component of the total capital base.

Figure 1.4:



Source: adapted from the Environment Department, 1997.

Another indicator of the sustainability of economic growth is the genuine savings index. This is the savings ratio minus the depletion of natural resources and the damage caused by pollution and resource degradation. Many developing counties have a negative genuine savings rate, and therefore their modest economic growth is not sustainable (World Bank, 1997).

The following conclusions may be drawn. No unique, uniform relationship exists between per capita income and environmental pressure or the state of the environment. In this respect, uncritical application of the Environmental Kusnetz curve would be wrong. Environmental problems seem to sift. Some are being resolved by economic growth (e.g. fuelwood, sanitation and environmental health). Others become more prevalent, in particular pollution. local pollution problems can be resolved relatively easy and cheaply, and therefore tend to decline with rising per capita income (e.g. urban pollution). However, contributions to global pollution (global warming and ozone depletion) rise sharply with per capita income. This implies that developed countries are primarily responsible for global pollution, but also that global pollution will continue to rise with per capita income increases in developing countries. Another 'advantage' of developed countries is their ability to import raw material and reduce their domestic environmental pressure. It is unlikely that developing countries have this opportunity when they have reached higher per capita incomes.

The implications for Botswana include:

- It is necessary to pre-empt emerging environmental problems such as pollution and waste ;
- It is important to monitor the trends in and composition of the country's natural capital;
- Revenues from non-renewable capital should be used to build up other capital sources (human, produced and renewable natural capital);
- It is important to stimulate the switch from fuelwood to other energy sources. Poverty alleviation is an important element;
- It is important to foster other factors that reduce environmental pressure, and facilitate timely adaptations. These include poverty alleviation, technology development, empowerment of civil society and advocacy and comprehensive environmental policies.

1.4 THE MARKET MECHANISM

1.4.1. How do markets work?

Markets allocate resources through forces of demand and supply. Demand of a good is defined as the amount of an item that a buyer is willing to at possible alternative prices, other things being equal.

Determinants of demand are the following:

- Price. As the price of a good increase we expect an individual to demand less of that good but there are some exceptions. Luxury goods (snob effect)
- Individual's income. As individual's income increases the demand for goods will also increase but there are also exceptions. Inferior goods, in which case an increase in income result in a fall in demand for a good. Environmental degradation, as your income increase you will prefer clean air.
- Price of other goods. Two types of goods, substitutes and complements

  - Substitutes are goods that can be used as alternatives, if the price of a substitute increases then the demand for the first good will increases. Private cars and public transport
  - Complements are goods that are used together. If the price of a complement rises then the demand for the first good will fall
- Taste. Changes in taste either as a result of advertising or external factors will lead to a change in the demand for a good.
- Population. If the total population increases the demand for the goods also increase.

Holding other determinants constant, except the price, the demand curve can be plotted as downward slopping refer to figure 1.5.

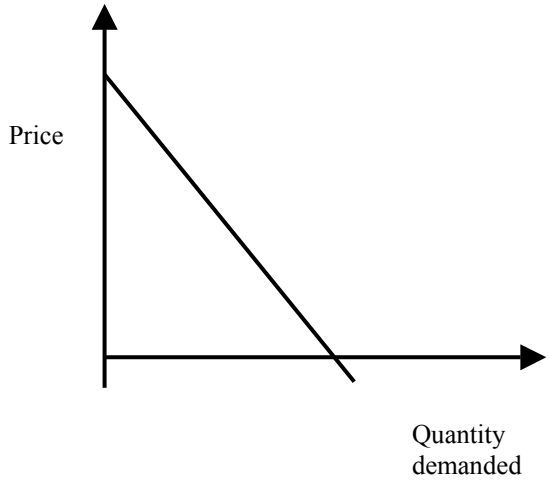


Figure 1.5

Movement along the demand curve represents a change in quantity demanded resulting from a change in price of the good, holding other things constant.

Supply of a good is defined as the various quantities of a good that suppliers are willing to seller at different prices, other things being equal.

Determinants for supply are as follows

- Price. As the price increases the quantity that suppliers wish to sell also increase
- firm's objectives. It is assumed that firms try to maximise profits so will increase supply
- prices of other goods. A fall in price of one commodity may cause a shift in the quantity supplied of another good (carrots and cabbage)
- production costs. An increase in the price of an input will cause supply of a good to fall.

Again holding other determinants constant, except for the price, the supply curve for a good can be plotted as upward sloping. Figure 1.6

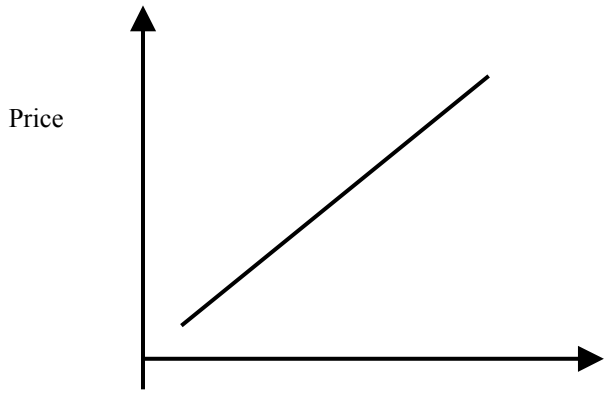


Figure 1.6:

A market is defined as a setting in which goods and services that an individual may want to acquire are available for purchase at a known price. The market setting involves buyer and sellers. Prices for goods and services are determined by markets force of demand and supply, where there is no institutional or government intervention. Through market forces of supply and demand, an equilibrium price will be reached. An equilibrium price is a price at which the demand (measuring the marginal Willingness to pay) is equated to the supply (measuring the marginal willingness to sell). At the equilibrium price, an efficient allocation is reached, (as both producers and consumes are better off). No individual is worse-off because they have reached a point where both as satisfied (figure 1.7).

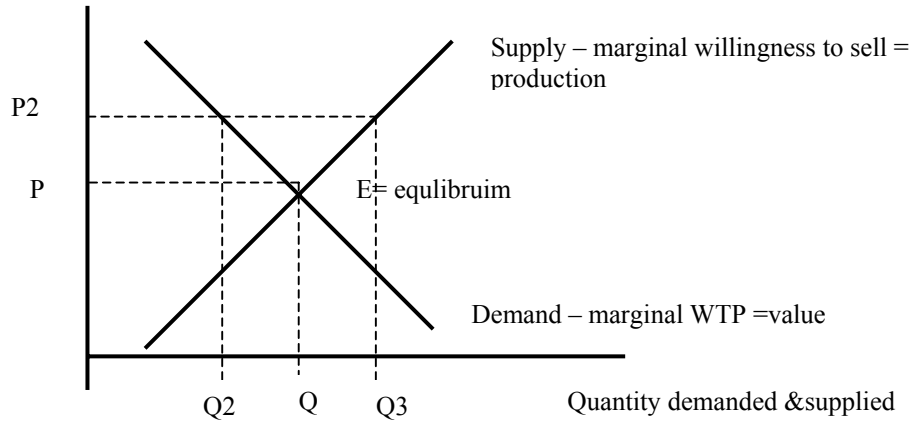


Figure 1.7

At price P2, consumers demand Q2 while the suppliers are willing to supply Q3. So there is no market equilibrium and both parties are not better off.

Again if other determinants are hold constant the relationship between price and supply is excepted to be upward sloping, refer to figure 1.5.

1.4.2. Market and allocation of resources.

It is widely believed that free markets (without government intervention) will result in optimal and efficient allocation of resources. That is an equilibrium price is reached

through market forces of demand and supply. Adam Smith (1723-1790) initiated this view in what came to be known as the "invisible hand". Markets work efficiently as price signals to consumers and producers what the cost of producing a particular product is and to producers what consumer's preferences are. This is the advantage that is pointed out by Adam Smith. Thus, prices signal the status and nature of resources in terms of scarcity. Commodities that are relative scare or whose factor inputs are relative scare will generally command higher prices relative to abundant resources and their demand will be lower relative to abundant resources. So perfect markets will lead to optimal utilisation of resources and through substitution depletion of resources is unlikely. Therefore free markets solve the problem of relative scarcity through substitution but not absolute scarcity.

The efficiency of price mechanism in allocating resources is determined by the elasticity of demand. Elasticities that are relevant are the following;

- price elasticity
- income elasticity
- supply elasticity

Price elasticity of a good measures the responsiveness of the quantity demanded of an item to a small change in its price, given its demand curve. Prices are likely to work efficient where the price elasticity is highly elastic. But for resources whose price elasticity of demand is low or inelastic, the price mechanism is not likely to be effective in regulating the use of resources. See graphic illustration below

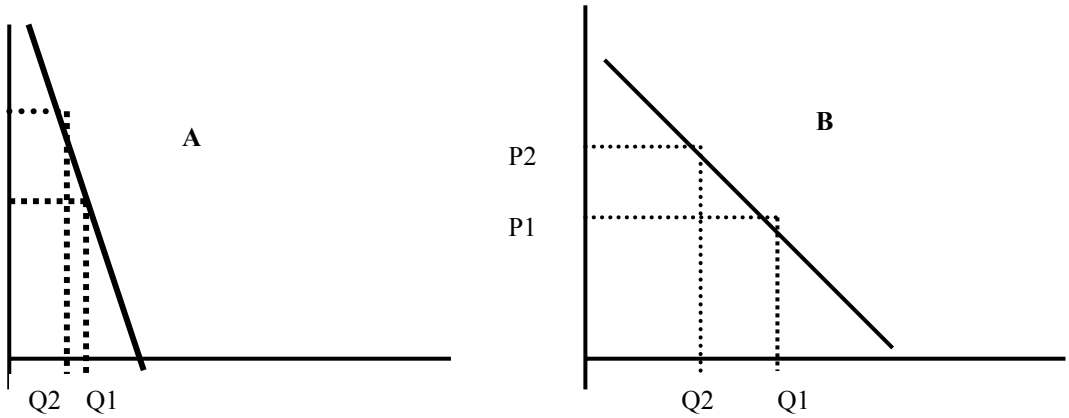


Figure 1.8. A-B

Figures 1.7.A and B show demand curves for two goods, figure A depicts a good with low elasticity. While figure B represents a good with highly elastic demand as shown by figure B. Assuming similar changes in prices for the two goods, an increase in price in figure A, from P1 to P2 results to a small decline from Q1 to Q2. While in Figure B an increase in price from P1 to P2 result in a huge fall in the demand from Q1 to Q2.

1.4.3. Efficient resource allocation

Allocation of resources is said to be efficient if it is not possible to make one or more persons better off without making at least one other person worse off. In this case so-called Pareto optimality has been achieved. Conversely, an allocation is inefficient if it is possible to improve one individual's welfare without worsening the welfare of others.

This situation is called Pareto improvement. An efficient allocation can be illustrated more conveniently by the Edgeworth box (Figure 1.9).

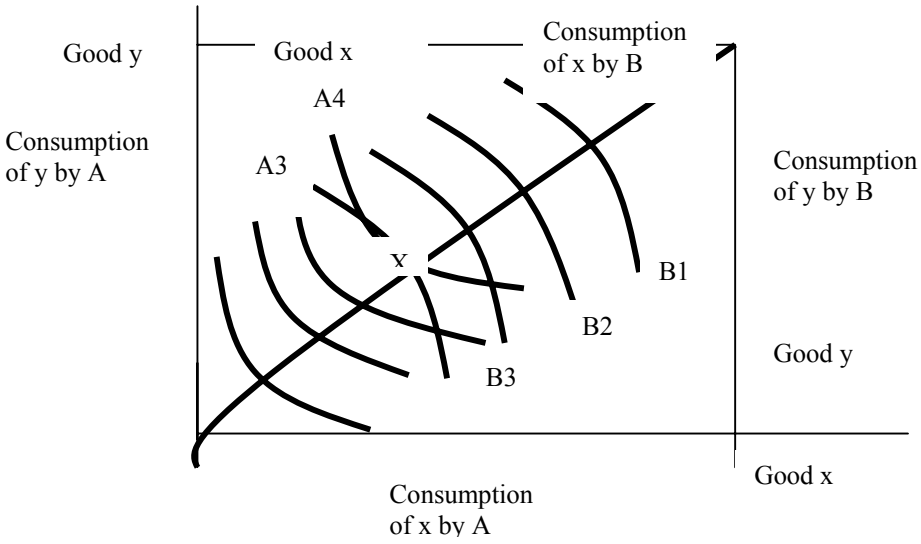


Figure 1.9

Assume two consumers denoted as consumer A and B, consuming goods X and Y (figure 1.9). Consumer A's indifference curve are A1-A4 while consumer B's indifference curves are B1-B4. A Pareto optimal allocation is where the highest indifference curves of the two consumers are tangential to each other, point X. any movement from X will result in one consumer being better-off and another worse off.

Some of the institutional arrangements that are required for the market to optimally and efficiently allocate resources (goods and services) are the following:

- markets must exist for all goods and services ;
- perfect competition must prevail for all goods and services ;
- no externalities exist;
- all goods and services that are exchanged must be private goods, there should be no public goods ;
- property rights for goods and services must be well defined .

1.5 MARKETS AND ENVIRONMENTAL RESOURCES

Two seemingly contradictory problems occur with the relationship between markets and the environment. First, environmental problems may emerge because there is no market. In this case, market creation could help to solve or prevent environmental problems. Second, existing markets do not treat the environment adequately, and as a result environmental problems are caused. Some examples: pollution, resource wastage. Below, both aspects of the markets are discussed in more detail.

1.5.1 Absence of markets and environmental degradation

Most of environmental goods and services are not traded in any formal market, e.g fresh air, river quality, Where markets exist for these resources, the markets are incomplete and not competitive in one way or the other. The absence of markets for these goods and services means that their market prices are zero. But these resources command a price as can be reflected in the household production function. For instance fuelwood may not command a market price but efforts by household in

collecting reflect it price. The problem is that there are no balances between demand and supply. Thus markets cannot allocate them properly, a s markets work efficiently through balances between supply and demand. Because their prices are not reflected in normal markets therefore no market price, the resources are likely to be over-used and in the process degraded.

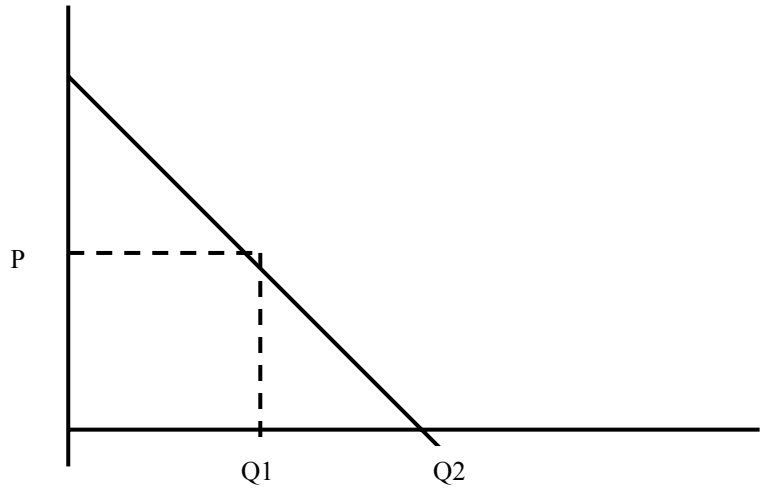


Figure 1.10.

As prices restrict or limit consumption of goods (law of demand), no market prices for natural resources encourages over-consumption. In figure 1.6, assume the entrance into a lake is P, the demand to visit the lake will be Q1. But when the price/ entrance fee is zero the demand to visit the lake will be Q2. At Q2 the lake is being over-used as there is no limiting factor, price. So we can conclude that where there are no balance between demand and supply through prices there will be market failures. Market failure arises when the market is incapable of allocating scarce resources efficiently.

The most important factor that contributes to market failure for many environmental resources is the fact that the environmental resources are either public goods or possess some characteristics of public goods. Public goods have the characteristic of non-excludability and non-rivalry. There are non-excludable in the sense that no one can be excluded from consumption of these goods. For example no one can be excluded from consumption of fresh air, or from enjoying/benefiting from the functions of ozone layer. Non-excludability arises where the marginal costs of excluding are extremely high or if a resource is find everywhere.

Non-rivalry arises where ones' consumption does not diminish another individual's consumption of the same resource. For instance your consumption of fresh air will not diminish my consumption or utility derived from consuming the same good, unless you polluted it. These two characteristics make it very difficult for the creation of markets for environmental goods. The public goods nature of many environmental resources poses particular difficulties in designing and administering measures that seek to reduce the problems associated with market failure.

Another factor that makes it difficult for the creation of markets for public goods is the provision of public goods for more than one individual. Unlike with private goods where the demand for the good is summation of the demand of the two individuals, aggregate demand for public good is derived by summing vertically that is summing the prices of the two consumers at demands of the two individuals

So it is the case that markets cannot work efficiently in provision of public goods. For a public good, provision will be under-provided e.g clean water (river or air) but a public bad will be over-provided e.g. pollution is a public bad and therefore will also be over-provided, e.g the case of air pollution is Selebi-Phikwe.

Due to the public nature of environmental goods and services, is the property rights. Because environmental goods and services have non-excludability characteristics, property rights for many environmental resources are not clearly or ill-defined. In most cases, these resources are open access. For instance property rights for clean air are not defined and property rights for ozone layer(atmosphere) are non-existence. This makes it difficult for markets to be created and also to work efficiently.

1.5.2. Environmental inadequacies of markets

Where markets exist for environmental resources, there are in most cases incomplete, e.g water provision, timber extraction, diamond mining leads to groundwater depletion in the Orapa/ Lethakane area. Markets are incomplete where there are externalities. An externality occurs when production or consumption decisions of one agent affect the economic activity(utility) of another agent and the affected party is not compensation in any way. With externalities, there is a divergence between the social costs and the private costs. When making economic decisions, an economic agent will only take into account private costs and externalises the external costs; this leads to over-use of resources or pollution. When external costs are externalised, the price charged will be lower and the demand for the good will be higher, leading to over-production and consumption of resources, refer figure 1.11.

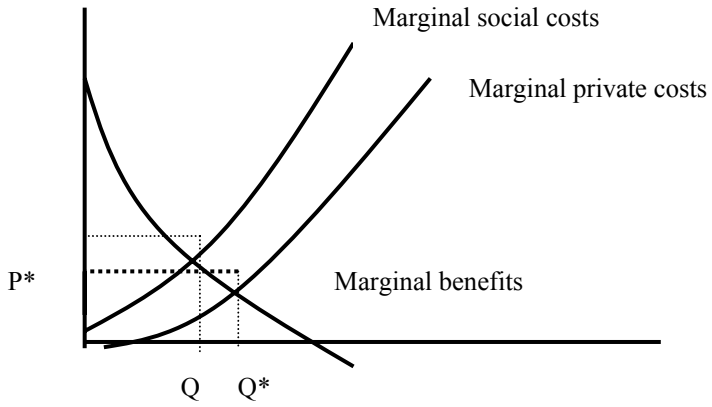


Figure 1.11:

If markets are incomplete due to externalities, the producer will only incorporate the private costs in his decision making and externalise the external costs. So the producer will produce at a point where the marginal private costs are equated to the marginal benefits and charge at P*. This is not an optimal allocation as one party is better off and another party is worse-off. But if the producer is made to internalise externalities, he will produce at Q and charge a higher price P**. This is an optimal allocation as both parties are better-off. An example is a situation where there is a cement manufacturing plant and a plantation for oranges. Cement manufacturing plant externalises its external costs, which affect the production of oranges. If the cement plant can internalise the external costs then production will be reduced and the orange plantation will not be affected

1.6 DISCUSSION QUESTIONS

1. In Botswana, which environmental problems have been alleviated by economic growth and which ones have become more serious?
2. In your view, which other factors have caused environmental problems? Confine the discussion to at most three main determinants?

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TOPIC 2: RESOURCE VALUATION

CONTENTS

- **Concept of total economic value**
- **Direct valuation approaches**
- **Indirect valuation approaches**
- **Discussion questions**
- **Readings**

2.1 INTRODUCTION

Resource valuation is putting a monetary value to environmental resources. Resource valuation is measuring people's preference for an environmental good against an environmental bad. Valuation of environmental goods and services is fundamental to sustainable development as it ensures that environmentally values are included into economic decision making.

Reasons for valuing the environment:

- Absence of monetary value in environmental goods may signal over-use of these resources e.g. environment as waste sink may be over-used as we do not know its value and its status. Zero prices signal no scarcity so the tendency is to over-use that particular resource. Refer figure 1.5.
- It will to some extent reflect the strength of feeling for the environmental asset in question.
- Assuming that a monetary value assigned for a resource is high, this will offer a supportive argument for environmental resource. E.g. Rhino is in danger of extinction from some development; the argument will be baseless unless value of rhino and its importance are presented. The support of monetary expression makes the case stronger than any other argument.
- It permits comparison with other monetary benefits arising from alternative uses. Suppose we want to preserve a wetland which has an opportunity cost in terms of agricultural output. If the benefits of wetland can be monetarised then we can compare them with the agricultural benefits and analyse whether it is worthwhile undertaking wetland preservation using appraisal technique such as Cost Benefit Analysis.

2.2. TOTAL ECONOMIC VALUE

Environmental resources have different functions and uses. For instance some of the functions and uses of tropical rain-forests are regulate world and local climates by absorbing atmospheric carbon, source of timber and fuelwood, and habitat for various species. Environmental functions and uses can be divided into direct uses and indirect uses. Direct uses are the actual uses of functions and products of natural resources. Indirect uses are other uses not linked with actual uses at present moment.

As natural resources have different uses and values, then their total value can be presented as follows.

Total economic value = direct use value + indirect use value + option value + existence value

Direct use value is the value derived from actual consumption of a resource. Indirect use value is the value that corresponds to the ecologist's concept of 'ecological functions'. For instance we may not use the tropical forests but use species benefits from the forests, thus indirectly using the forests.

Option values are the value of the environment as a potential future benefit as oppose to actual present use value. It is expressed a WTP for preservation of the environment against some probability that the individual will use the resource at a later stage. It is a risk aversion premium and will be positive where the future

availability of a natural resource is uncertain. But for a risk taker the option value will be negative/zero.

Existence value is the value aspect that is not at all related to use. An individual may derive satisfaction from knowing that certain species exist irrespective of the fact whether she uses it or not. Individual having existence value values may not demand to use these resources in any way. Existence value can also be defined as value for the sympathy and respect for the rights of non-human beings.

There are two broad types of valuation techniques:
- direct approaches
- indirect approaches

Each will be discussed in more detail below.

2.3. DIRECT VALUATION APPROACHES

Direct valuation methods that attempt to estimate/elicit the values (preferences) of resources directly by use of surveys and other experiments. People are asked directly their willingness to pay or accept for a proposed environmental change. Examples include the Contingent Valuation methods (CVM) and Contingent Ranking methods.

The contingent valuation method CVM is used to estimate values for environmental amenities and other non-marketed goods and services. Questionnaires are used to ask respondents their WTP or WTA for non-marketed goods contingent upon the creation of a market or other means of payments. Questionnaires used are of two types
- eliciting ranking
- eliciting values

There are three basic parts to most CV surveys

Firstly, respondents are given information about the nature and status of the resource that they are going to value, how they are expected to pay (/accept) for the change upon a creation of a market.

The second part is to do with valuation of the resource. The respondent is then ask to reveal how much she is willing to pay for the change in the service or quality or how much he is to accept for a deterioration in the service upon a creation of a market or payment form.

Lastly, socio-economic and demographic characteristics of the respondents are also sort.

Aggregate WTP or WTA is the value of the environment, or value of a change of environmental resource.

Assessing the validity of the results is achieved by the following tasks. Firstly, by inspection of the frequency distribution of the willingness to pay. Normal distribution shows there is no bias in the results given by the respondents. While, binomial clustering at either low extreme values or extreme high value suggests the presence of bias in the willingness to pay. Clustering at low values suggests a problem of free rider and at higher values suggests strategic behaviour.

Secondly, validity of the results is assessed by analysing the determinants of WTP and investigates whether they conform to economic theory. Therefore, consistence is used as a measure of validity.

Convergent validity is achieved by comparing the results with results obtained from other valuation methods such as hedonic pricing.

CVM has several biases, including the following ones:

- Hypothetical bias. This bias arises when respondents are asked to state the WTP for changes which are hypothetical than real. Therefore responses are likely to be unreliable, as respondents know they will not affect the outcomes. To avoid hypothetical bias, CVM studies must be close to reality as possible;
- Information bias. This bias arises from the structure of information represented to the respondent. They may be given information, which is biased.
- Payment vehicle bias. Bids are sensitive to the form o payment. Case of Selebi-Phikwe. Direct form of payment and indirect form of payment (through) salary an individual will forgo to move to a similar job outside Phikwe that pays less.
- Strategic bias. This arises from the respondent objectives to influence the outcome of the study to his/her favour. For instance, the respondent may indicate higher WTP just to influence the result to his/her favour.

2.4. INDIRECT VALUATION APPROACHES

Use actual and observed markets based values to estimate individual's preferences for environmental goods and services. Values expressed in terms of preferences are revealed indirectly when individual purchases marketed goods with is related to an environmental goods or quality. Houses and air/noise quality, boats and river quality, costs incurred in trips to the river and river quality. Examples of indirect \approaches include the Hedonic Pricing Method, Travel Cost Method and Replacement costs.

2.4.1 Travel cost method

- Based on extension of theory of consumer demand
- Attention paid on the observed travel costs and value of time spent travelling to the site
- Knowledge of costs incurred in terms of time and transport can be used to infer the value placed by users on environmental goods
- Only applied to recreational facilities and cultural sites, water and wood collection.

Time costs are included because time has an opportunity costs, you could work instead of travelling.

Steps in Travel Cost Methods.

- Identify and a site to be valued and zone the area of interest into different zones
- Obtain the average costs of travel from each zone to the area of interest.
- Obtain the visiting rate from each zone and plot-visiting rate from each zone against the cost involved from each zone.

Visiting rate = visits from each zone/population in that zone

- Derive an aggregate demand curve for the site

Assume that there is an admission fee to the park and that admission fee has the same effect as the travel cost (reduce number of trips). Assume that a fee of P1 is charged and the effect is to reduce visitation rate by 1 visits per year then new visits can be calculated. To find the new visitation rate use the curve for visits rate against time. Plotting gate fees +travel cost against total visitation derives an aggregate demand curve.

Area under the curve is the value of the site.

Assume an improvement in environmental quality and this lead to increase in visits. They will be a shift in demand curve, the extent of the shift of the demand curve measure the value for an improvement in environmental quality.

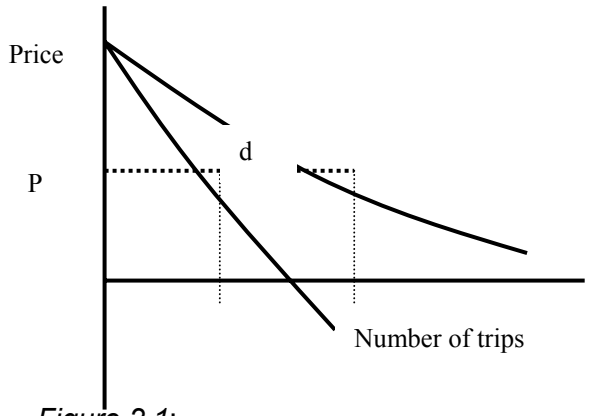

Figure 2.1:

Assume an outward shift in the demand curve for visits to the river. Area d will be the value of an improvement.

Limitations

- only capable of measuring resources for which people are WTP (through travelling to the site) its use is limited o recreational facilities and historic sites, only measures the user values not option and existence values
- there is also question of visitor visiting different sites at the same time how do we desegregate the costs amongst sites
- visits are not a function of costs only but of income level, social class and taste
- what value should be assigned to the time costs of travel can use some proportion of average wage but this is open to criticisms
- model assumes that there is negative utility in travelling to a site but this is questionable

2.4.2 Hedonic pricing method

The method infers the value of environmental goods and services by establishing the link between prices of marketed goods and services and environmental resources. Suppose that an environmental resource that you wish to value is not traded but can be defined in terms of attribute(s) or service that affects a market price of a marketed

good. The identification of a property price effect due to a difference in environmental quality is usually done by means of a multiple linear regression. Data are taken from either on a small number of similar residential properties over a period of time or on a large number of different properties at a point in time (cross sectional). Though air quality is not marketed, its value can be inferred from the value of house. For instance value of the house is made up of the following parameters.

$H_p = F(S, B, P_{CBD}, N, A, Q_A)$

H_p = house price

S = Size
B = Number of bedroom
P_{CBD} = Proximity to CBD
N = Neighbourhood
A= Age
Q_A= Air quality

The coefficient of air quality is expected to be negative and it is the marginal implicit price of the attribute. It is defined as the additional amount of money an individual is willing to pay if the air quality improves by a certain standard.

- Major problems of Hedonic pricing method are the statistical problems especially multicollinearity.
- Another problem is that the method will only work well where consumers are given information
- Where consumers have a choice of where to buy a house.
- Only limited to user values and no option and existence values

2.4.3 Replacement costs

Replacement cost techniques infers to the value of environmental resources by looking at the cost of replacing or restoring a damage property to its original state. The costs incurred will therefore be the Willingness to pay for improved environmental quality or benefit of restoration. Mostly applicable in valuing air pollution, for instance, the case of air pollution in Selebi-Phikwe and the amount of costs incurred in repairing houses and other properties.

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TOPIC 3:
PROJECT EVALUATION AND THE ENVIRONMENT

CONTENTS

3.1. INTRODUCTION

Project appraisal can be defined as assessment of returns from a project. Appraisal purely involves comparison of costs and benefits of an investment. The main objective of project appraisal is to maximise welfare (benefits). Generally, this is achieved by implementing a project with positive return or selecting a project from alternatives with high returns relative to alternative projects. Projects can be differentiated into two groups, private and social projects. Social projects are assessed/ appraised according to the society goals and objective. A private project is assessed on the bases of shareholders objective, which in most cases profitability of the project.

Project appraisal is an important component of sustainable development for the following reasons

- integrating environmental values in decision making we are effectively reducing environmental impacts as projects with less cost (economic and environmental) are likely to be implemented
- secondly, as resources as limited and wanted are not limited, it means with project appraisal, scarce resources will be invested where there are most productive (hence sustainable development)

3.2. DISCOUNTING

Discounting is a procedure of finding the present value of future costs and benefits. In an project costs and benefits occur at different stages of the project. For instance in afforestration project costs are incurred now and benefits are realised at a later stage of the project. Fixed/overhead costs such as seedlings are incurred now while variable costs will be incurred as soon as the project becomes operational. So to appraise a project there is a need to use a common unit. Therefore, in project appraisal, discounting is to compare costs and benefits occurring at different stages. It is not realistic to compare P5 occurring now with P5 occurring after 3 years.

Discounting is the opposite of compounding, where you want to find the future benefits of an investment. In the case of discounting you want to estimate the present value of an anticipated future costs and benefits.

Assume that we anticipate that a project would have earned 15 millions pula in 15 year.

To find the present value of the future 15 million Pula we discount. The rate at which we discount is called the discount rate. Observe that if we invest the present value of 15 million at an interest rate that we have discounted we will end up with 15 million pula.

General formula for discounting is as follows:

$$\frac{Bt - ct}{(1 + r)^t}$$

where Bt = benefits in time t

Ct = costs in time t
r = discount rate
t = timer horizon

The reasons for discounting include the following.

1.Time preference or the social time preference rate of discount.

- Impatience: people discount the future benefits because they simply prefer their benefits now to later. They are impatient.
- Risk of death
- Risk of uncertainty.
- Declining marginal utility.

The argument is that future generations will be richer than the current generation, so a certain amount today will yield lower utility in future compared to today.

2. Opportunity cost of capital.

Besides the time preference reason, an individual would prefer the money now than later so that s/he can invest to an interest.

Discount rate and factor and its environmental impacts .

The higher the discount rate means that the discount factor will be lower. Now this has implication for the weight given to future costs and benefits. Discount factor is the value that is used to determine present value of future costs and benefits. With discount rates less weight is given to long term costs and benefits. Long term serious environmental costs are not given much attention with high discount rate. Therefore, this may lead to decision that harm the environment.

Higher discount rates discriminate against future generations and also neglect long term impacts. Project with social costs(include environmental) that occur well in the future and net social benefits that occur in the near term will likely pass the standard cost benefit test, with higher discount rate. This is because high discount rate reduce significant costs to insignificant values. Deforestation has benefits now and huge cost in the future, if we discount using higher rate, these costs were be reduced such that benefits(occuring now) will out-weight them.

While projects with benefits that occur in the future and costs that occur now are less likely pass the standard cost benefit analysis test, e.g. afforestation due to long gestation period have benefits well in the future and these benefits will be lowered by discounting.

Therefore catastrophic impacts not fairly appraised with positive discount rates. Example, assume project involves significant environmental impacts in a hundred year's times, costs estimated at P100 m using today's prices. Assume the probability of occurrence of impacts is 0.5. In hundred years expected costs = P50m

Discounted at 10% present value = P3629
Discounted at 5%, = P380227
2% = 690 1653

The importance of costs and benefits becomes less with discounting.

Second implication of discounting is that, as higher discount rate signals uncertainty and impatience about the future, it therefore means that higher discount rate leads to faster depletion of the resources in the earlier years and shorter will be the interval before which the resource is exhausted.

- a lower value is placed on future consumption relative to present consumption.
- Undermines savings

With renewable resources, discount rate can determines the rate of harvesting. Higher discount leads to intense harvesting effort. If the discount rate rises above the maximum biological growth rate of the stock, then renewable resource may be driven to extinction (under certain conditions, e.g price and costs of harvest).

- also leads to rapid development of exhaustible resources and shorter rotation periods and smaller stocks of renewable resources.

on the other hand, it is argued that If discounting is allowed to determined the level of investment, it will slow down the general pace of development through the depression effect on investment. Since natural resources are required for investment the demand for natural resource will general be less with high discount rates.

Conclude:

Total environmental impact not very clear.

Two school of thought:

- lower discount for environmental sensitive area
- keep constant but include sustainable criteria.

Critiques of Discounting

Pure time Preference

- economists argue that individual impatience is not necessarily
- consistence with maximising an individual's lifetime welfare
- maximisation
- impatience discounting is irrational
- the risk of death argument ignores the view that society is immortal in contrast to the individual mortality, mortality of the individual, personal problem
- uncertainty about presence or scale of benefits and costs may be unrelated to time. Risk and uncertainty should not be handled be adjusting the discount rates, it should be incorporated in net benefits through probability of occurrence

Declining/diminishing marginal utility

- Assumes constantly increasing wealth, compare European countries and African countries. Assumption may be too simplistic;
- Economists dispute whether there is any meaningful to measure the value of e, elasticity of the marginal utility of consumption function. The comparing utility of different generations not an easy task.

Special issues

When discounting special attention should be given to irreversibility and Sustainability issues.

3.3. COST BENEFITS ANALYSIS (CBA)

Economic theory is based on the notion of a rational individual, an individual makes decision on the bases of comparing costs and benefits and will always try to maximise utility. Cost benefits analysis, especially, social Cost benefit analysis extend the individual rational decision making to the government decision making.

Therefore CBA is defined as an appraisal technique that uses costs and benefits to select the most efficient project from the alternatives. The efficiency effect of a project is the difference between benefits and costs. The main aim is select a project that to maximise net benefits. All costs and benefits (tangible and intangibles) are converted into monetary values. Costs benefit analysis uses money is a yardstick. CBA can be applied at both the social and private level. Social CBA is concerned wit societal issues such as equity, distribution. Private CBA on the other hand is only concerned with financial returns (profitability of the project).

Stages of CBA

1. Description of the project(s), such as location of the project and size. This stage is important for identification and extrapolation of impacts.
2. Identification of costs and benefits in time. If you cannot identify costs and benefits then you cannot value them.
3. Quantification of costs and benefits over time in different units
4. Valuation of costs and benefits in time (monetary value)uses monetary value as a yard stick.
5. Discounting of costs and benefits occurring at different stages of the project for comparison
6. Assessment based on Internal Rate of Return(IRR), Net Present Value (NPV) or cost benefit ratio.

Evaluation criteria

1) Net Present value (NPV)

$$\text{NPV} = \sum_{t=1}^{t=n} \frac{(B-C)}{(1+R)^t}$$

NPV> 0 accept the project
NPV< reject the project
Or select the project with the highest NPV

2) Benefit Cost Ratio

$$\text{BCR} = \frac{\left[\sum_{t=1}^{t=n} B_t^{-(1+R)^t}\right]}{\sum_{t=1}^{t=n} C_t^{-(1+R)^t}}$$

If BCR >1 accept the project
BCR< 1 reject the project
Select project with the highest BCR

3. Internal Rate of Return.

$$\text{IRR}= \frac{\sum_{t=1}^{t=n} B}{(1+R)^t} = \frac{\sum_{t=1}^{t=n} C}{(1+R)^t}$$

If IRR > present rate or discount rate, then accept the project
Choose project with highest IRR

7. Risk and uncertainty analysis

As we are dealing with potential costs and benefits, test of risk and uncertainty must be carried out. This is normally done by changing price of output, time horizon, changing discount rate, to test how Net Present Value will be affected.

Cost benefits analysis has to important advantages. Firstly CBA is easier to apply and it gives clear and concise information for decision-makers. The information it gives is clear and concise in the sense that decision-maker are given only one value, the Net Present value. Secondly, it well into mainstream development planning as it aims at maximising the net returns from any investment.

3.4. CASE STUDIES

3.4.1. Cost benefits analysis: soil conservation

Case study : Benefit-Cost Analysis of Soil Conservation in Maphutseng, Lesotho.

Soil erosion has been a problem since the last century in Lesotho and this has been a major concern to both locals and foreign visitors. For instance, large scale conservation programme was launched by the British colonial administration in the 1930s. But as soon as the foreign support was withdrawn, the project failed. In 1981 Farm Improvement with Soil Conservation (FISC), Project was initiated by Swedish International Development Authority (SIDA). The project was launched in 1985. The main aim of the project was to combat soil conservation. Emphasise was on labour intensive and simple technical methods. Farmers were given incentives in the form of fertilisers and seeds to work on their farms. While people working communal land were given cash payments.

The land use in Maphutseng village is dominated by grazing taking 56% of the total area. For cultivated land maize and sorghum take up together almost all of the actively cropped land (20 and 10 % respectively).

Identification of costs and benefits from the project

Benefits identified from the project were both tangible and intangible. Tangible benefits were as follows

- increased yields from maize and sorghum (major crops)
- fodder benefits
- afforestation benefits
- fruit trees and vegetables

While intangibles benefits were

- local communities will receive training
- lifetime of the water bodies (small dams) in the area will be prolonged
- benefits from other areas not directly linked to the Maphutseng.

Costs identified were labour costs, inputs such as fertilisers, seeds, seedlings and capital

Quantification of benefits and costs

Increased maize and sorghum yields

Two scenarios were used to estimate the yields "with-project" and "without-project"
"with-project" Scenario a constant yield above the historical average is assumed. A 1.81 relative increase was used to estimate the future yields. This value was applied to an average yield of 694. While "without-project" scenario yields are expected to decline gradually due to erosion, poor management. it is assumed that there will be a 2% annual decline of the yields with the with-out project scenario. Refer figure 1

Fodder benefits

Fodder production in 1986 was limited 6 ha. but it was assumed that this area will expand by 3 ha/year, reaching 24 ha in 1994. The avrage yield Is estimated to be 2 t/ha.

Valuation of costs and benefits in economic prices

In CBA market prices are not used, this is because they are not true reflection of social value. so international price or shadow prices are used.

Labour costs; wages range from M2.5 per day to M2.5 per task.

Material inputs costs price for maize and sorghum seeds were M2.40/20kg and M2.25/8kg respectively

Output prices, are normally calculated as the import cost saved

Price for maize per tonne was calculated at M370 with a 2 % annual decline

Fodder price M= 4.50/ 20kg

Discounting

In Lesotho, there is no national discount rate for consistency. Different projects used different discount rate. e.g Lesotho Highlands Water Project used 6%. Other discount rates used for different projects ranged from 5 – 10%.

So a 5% discount rate was used in this projects.

Time horizon 20 year time horizon was chosen.

Assessment of the project

The project had a NPV of Minus M125,000 which correspond to a internal rate of return of 1%. Therefore reject the project.

Uncertainty and sensitivity analysis

Major uncertainties of the project include the following

- FISC project impact
- Yield pattern over time
- Price trend over time
- Suitable discount rate
- Appropriate time horizon

Sensitivity test for yield pattern

With-out project it was assumed that an annual decline of 2 % will occur
This was changed to 0.5 % and 5% declines

Decline %	IRR	NPV @ 5%
0.5	-3.2	-225,811
2.0	1.2	-124,615
5	4.5	-18,454

Sensitivity of FISC project impact

Initially it was assumed that 50% of the use of fertilisers and seed is a direct result of the project. Assumption was changed to 0% and 100%

Impact factor	IRR	NPV @5%
0	-4.2	-282,374
50	1.2	-124,615
100	3.1	-56,696

Sensitivity for price trends

Initially, it was assumed that maize and sorghum price will continue to decline by 2 % annually. This was changed to increase by 2% annually and 0 % decline annually.

Price change %	IRR	NPV @ 5%
-2	1.2	-124,615
0	3.6	-53,151
+2	5.9	36,025

Sensitivity to discount rates

A 5% discount rate was used and this was changed % and 10 % discount rates

Rate (%)	NPV(M)
0	58,665
5	-124,615
10	-200,858

Conclusion

From a social point of view the project was not efficient as it did not maximum benefits. This may be due to the fact that other intangible benefits were not included in calculating the benefits
But from a financial perspective, the project had a positive net present value. this is because other social costs were not taken into account. Moreover, prices that were used, were those received by the farmers(market prices) which were higher than those used in social appraisal.

3.4.1. Total economic value of forests

Total economic value of the Mexican forests

Forests resources provide a stream of goods and service including timber and non-timber products, recreation, climate regulation, carbon sequestration, existence value. The total economic value of forest can be defined as the amount of resources, expressed in common units of money that society would be worse-off if the forest were lost.

Mexico's forest sector

Mexico's forest cover more than 50 million ha and its contribution to Mexican GDP ranges from 1.8% to 2% in the last decade. Approximately, one quarter of Mexican population live in forests areas, often subsisting in extreme poverty.

Direct use value of forest

Conventional (hotel-beach based) tourism is an important economic activity in Mexico. Forests play an important role in ecotourism. Using Travel Cost Technique, It is estimated that direct use value of forests through tourism and recreation range from USD 30.6 to USD 33.6 million per year

Use value of non-timber forest products

Enthnobotanical studies indicate that over 2000 plants species are utilised from Mexico's forests. Some of the products that are internationally traded include the following resins, terpentine and pitch from Pine forests. Estimating, the use values of these resources are a complex one as there are no market price for them.

Functional values

Two functional values for the Mexico forests that were the value of forests in their role in the global carbon cycle and the value of the functions in the hydrological cycle. The role of carbon sequestration was estimated in two parts. The first part is estimating the capacity of the forest to store carbon. Second stage was to place a monetary value on this forest function in terms of global warming damage avoided. Value of hydrological function is estimated by valuing the sedimentation costs and infrastructural damage arising from erosion as a result of deforestation.

Option value of pharmaceuticals

The methodology used to estimate this value was
$Vp(L) = (N. P.r.a.V/n)/H\ yr^{-1}$

$Vp(L)$ = the pharmaceutical value of 1 ha of forest (USD ha^{-1})

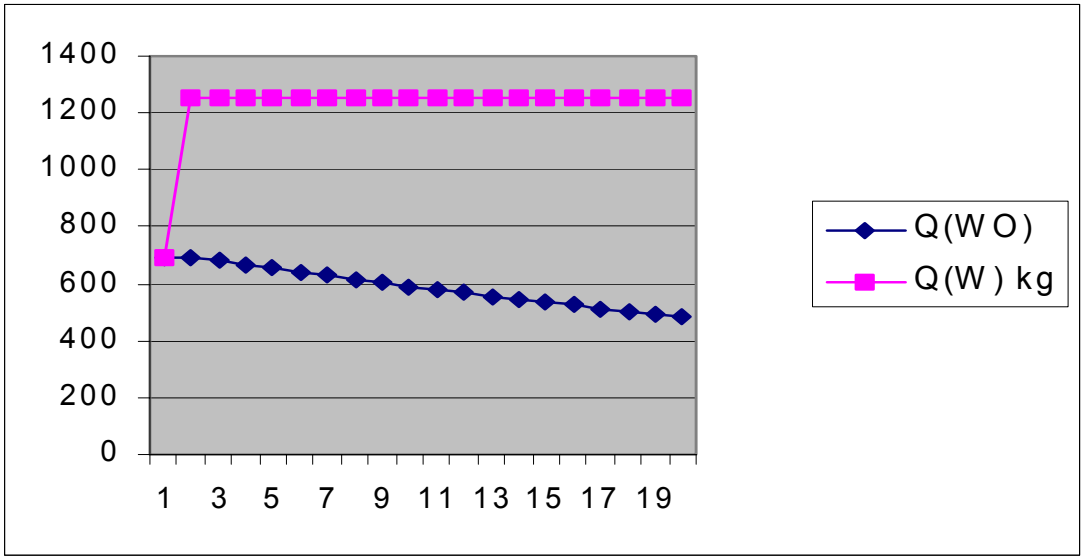
N= the number of plant species in forests
P = the probability of a hit
R = the royalty rate
A= rent capture
V/n = average value of drugs developed
H = the area of forests (ha)

Total economic value of the forests

	Area(h)	Tourism	NTFPA	Carbon	Watershed protection	Option value	Existence
Tropical evergreen	9.7		330 ha	100 ha		6.4 ha	
Trop. Deciduos	16.1			56 ha			
Temp. coniferous	16.9			103 ha			
Temp. deciduos	8.8		330 ha	20 ha			
Total	**51.5**	**32.1mil**	**N/a**	**3788.3 mil**	**2.3 mil**	**331.7**	**60.2 mil**

The total economic value of the forests was estimated to be in the range of 4 billon. Only a small portion of the TEV is captured in Mexico, much of the benefits are outside Mexico. As most of TEV is not captured in the country, forests have been used in an unsustainable manner.

Figure 1



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TOPIC 4
NATURAL RESOURCE ACCOUNTING: THE ENVIRONMENT AND MACRO-ECONOMIC PERFORMANCE

CONTENTS

4.1. THE BASICS OF NATURAL RESOURCE ACCOUNTING

4.1.1. Introduction

Most countries adopt a uniform, globally recognised system of *National Accounts* that records and monitors their economic performance. This 'national book keeping system' provides countries insights in their national income, economic growth, capital accumulation and the performance by macro-economic sector. The best known result is the per capita income figure, taken as a measure of welfare increase.

Natural resource accounting (NRA) is an approach that expands the National Accounts, and makes up for the major environmental shortcomings. These include:

- Natural resources are capital stocks or development assets and therefore need to be accounted for. This does not happen in the traditional Nat. Accounts;
- Costs of natural capital depletion should be deducted as they are not a source of income;
- Pollution abatement costs should not be included as 'income' but rather be seen as a mitigation measure to retain welfare levels.

Correction of the estimated income for capital depletion and pollution abatement costs would lead to a better measure of sustainable income. This is often called the *green national income.* The overall objective of NRA is to integrate environmental aspects into macroeconomic planning and performance measurement. Specific objectives of NRA include:

1. To provide a better insight in current and potential welfare levels;
2. To monitor trends in environmental stocks and flows;
3. To analyse the economic benefits of different resource uses, and to maximise the macro-economic benefits;
4. To analyse what happens with the resource rent;
5. To identify emerging environmental issues, and to take timely action (early warning);

By adopting *Natural Resource Accounting*, countries facilitate the comparison of the economic-environment performance among countries. This may provide additional policy insights. Another spin-off is that NRA assists in focusing data collection, generates additional research interests and fosters interministerial cooperation.

4.1.2. Natural Resource Accounting

The NRA are a set of formal, structured accounts, which record the stocks, changes in stocks and the annual resource use. The NRA are linked to the NA and use a similar type of classification of economic activities. They may be compiled in physical and in monetary units (physical and monetary accounts).

Examples of stock and flow accounts are given in Tables 1 and 2. Table 1 shows a resource decline in a particular year (1991). If this decline would continue, resource depletion threatens and remedial actions need to be taken. Table 2 shows an example of a use or flow account. The account shows the relative importance of each economic activity. Some accounts make a reservation for 'environmental use'. This is often difficult to assess and subjective.

Table 4.1: Example of a stock account

	1991	*1992*	*1993*	*1994*	*1995*	*1996*
Opening stock	*1100*	*1000*				
Additions such as natural growth, new discoveries	*200*	*Etc.*				
Deduction such as use and losses	*300*	*Etc.*				
Closing stock	*1000*	*Etc.*				

Table 4.2: *Example of a use or flow account*

	Resource sub-type a	*Resource sub-type b*	*Total resource use*
Agriculture			
Mining			
Manufacturing			
Transport etc.			
Services			
Government			
Urban households			
Rural households			
Environmental use/ needs			
Total consumption			

Both accounts are first constructed in physical units (e.g. M^3 for water and tons for minerals and wood). Ideally, both accounts are also calculated in monetary values using standard resource valuation methods. If this happens, the national income can be corrected with the monetary value of resource depletion and the costs of environmental rehabilitation.

NRA become more valuable when they cover a longer period as it then provides better insights in the long term resource trends.

To fully exploit the usefulness of NRA, most countries adopt a pragmatic approach that is focused on the most important issues or resources and policy needs and takes into account the available means and expertise.

Strengths of NRA include:
- Integration of environmental and economic planning;
- Improves an existing system of National Accounts.

Current weaknesses include:
- No uniform approach;
- No comprehensive applications;
- Difficult to compare results among countries.

4.2. NRA AND MINERALS IN SOUTHERN AFRICA[1]

4.2.1. Introduction

Minerals are an important economic resource for Botswana and Namibia. Namibia produces more than 30 minerals. The most important minerals are diamonds, uranium, copper, gold, lead, zinc, and silver. Diamonds and uranium alone accounted for nearly 80% of both value-added and exports generated by mining in recent years. The easily accessible reserves of Namibia's most important mineral, diamonds, are rapidly being depleted. Botswana produces relies mostly on diamond, but also produces copper, nickel, coal, and various minor minerals. Minerals contribute around a third of GDP, around 40% of government revenues and around 80% of exports.

The NRA is done stepwise. Firstly, stock and flow accounts have to be prepared. Secondly, monetary accounts were prepared based on the estimated mineral value.

4.2.2 Physical stock and flow accounts

Ideally, stock accounts are constructed for all major minerals. This is not always possible due to missing data and data confidentiality. Table 4.3 gives the example of the physical stock accounts for diamonds in Botswana. It is a combination of stock and flow accounts. The extraction column indicates the flows or use. Since there is virtually no domestic processing or use of diamonds, the assumption is that all diamonds are exported (one flow).

No information exists about new discoveries. At the current rate of extraction, the current stock would last around 40 years.

[1] This section is heavily based on results of the on-going Southern African NRA-project, co-ordinated by the University of Pretoria. This text draws heavily from two reports: Lange and Motinga, 1997; CSO/NCSA, 2001.

Table 4.3: Physical asset accounts for diamonds (1980-1999; mln. carats)

	Opening Stocks	Extraction	New Discoveries	Other volume changes	Closing stocks
1980	1,053	5.1	Na	Na	1,048
1981	1,048	5.0	Na	Na	1,043
1982	1,043	7.8	Na	Na	1,035
1983	1,035	10.7	Na	Na	1,024
1984	1,024	12.9	Na	Na	1,012
1985	1,012	12.6	Na	Na	999
1986	999	13.1	Na	Na	986
1987	986	13.2	Na	Na	973
1988	973	15.2	Na	Na	957
1989	957	15.3	Na	Na	942
1990	942	17.4	Na	Na	925
1991	925	16.5	Na	Na	908
1992	908	15.9	Na	Na	892
1993	892	14.7	Na	Na	878
1994	878	15.6	Na	Na	862
1995	862	16.8	Na	Na	845
1996	845	17.7	Na	Na	828
1997	828	20.1	Na	Na	807
1998	807	19.8	Na	Na	788
1999	788	20.7	Na	Na	767

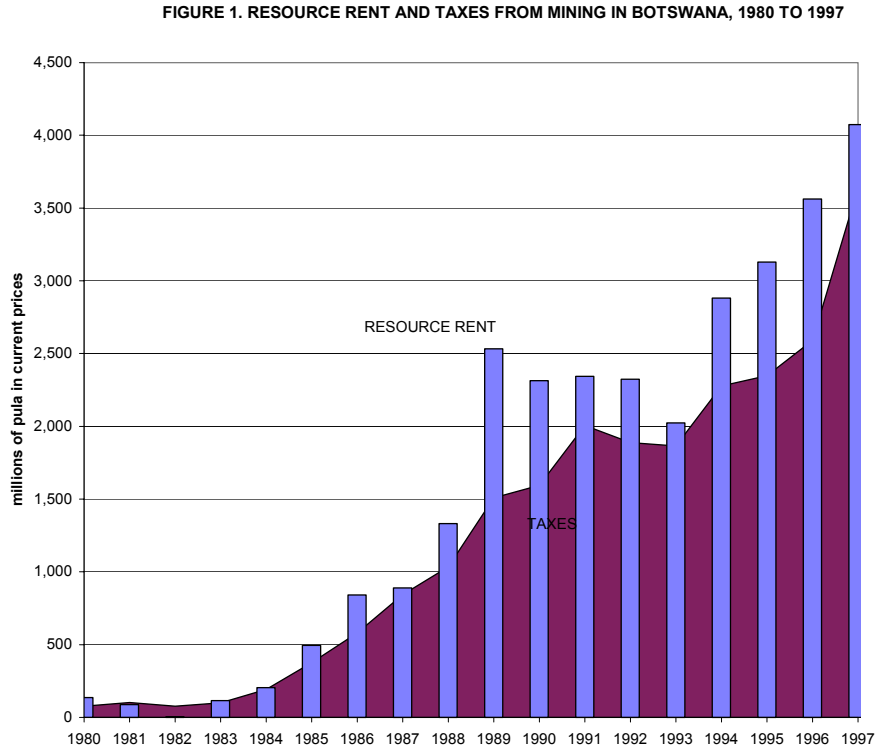
Na: not available. Source: CSO/NCSA, 2001.

Table 4:.4 **Monetary asset account for diamonds (1980-87; (mln. Pula in current prices).**

	Opening stock	Extraction	New discoveries	Other volume changes	Revaluation	Closing stock
1980/81	1,350	137	na	na	154	1,367
1981/82	1,367	114	na	na	-116	1,137
1982/83	1,137	190	na	na	949	1,897
1983/84	1,897	272	na	na	1,093	2,719
1984/85	2,719	355	na	na	1,185	3,548
1985/86	3,548	468	na	na	1,601	4,681
1986/87	4,681	644	na	na	2,401	6,437
1987/88	6,437	832	na	na	2,709	8,314
1988/89	8,314	1,308	na	na	6,039	13,045
1989/90	13,045	1,609	na	na	4,608	16,045
1990/91	16,045	2,067	na	na	6,561	20,539
1991/92	20,539	2,194	na	na	3,474	21,820
1992/93	21,820	2,272	na	na	3,060	22,608
1993/94	22,608	2,280	na	na	2,394	22,722
1994/95	22,722	2,566	na	na	5,378	25,534
1995/96	25,534	3,017	na	na	7,398	29,916
1996/97	29,916	3,635	na	na	9,645	35,926
1997/98	35,926	4,752	na	na	15,306	46,481

Source: CSO/NCSA, 2001.

Figure 4.1:



Source: Lange and Hassan, 1999

4.2.3. Monetary accounts

Mineral extraction has been valued using the economic rent of minerals using the following standard formula (CSO/ NCSA, 2001):

$$VC_t = UR_t * Qde_t * \frac{(1+r)^N - 1}{r*(1+r)^N}$$

$$N_t = QC_t / Qde_t$$

Where

VC is the value of the mineral stock at the close of the period
UR is the unit rent, total rent divided by extraction
Qde is the volume of depletion
QC is the volume of the mineral stock at the close of the period
r is the discount rate
N is the number of years depletion can take place at the current rate.

A number of assumptions are required for implementing this formula: a) future rates of extraction, b) expected future per unit rent, and c) the discount rate. This information was not available . Therefore, the assumptions are made that the volume of extraction and the per unit rent remain constant over time. A discount rate of 10% was used. After calculation of the economic rent per physical unit of mineral (carat, ton), monetary accounts were calculated for each mineral. Table 4.4 shows the example of diamonds.

Interestingly, while the stock decline in physical units, it increases in monetary value due to an increase in the resource value. This does not apply to Botswana's other minerals, which show a very low economic rent.

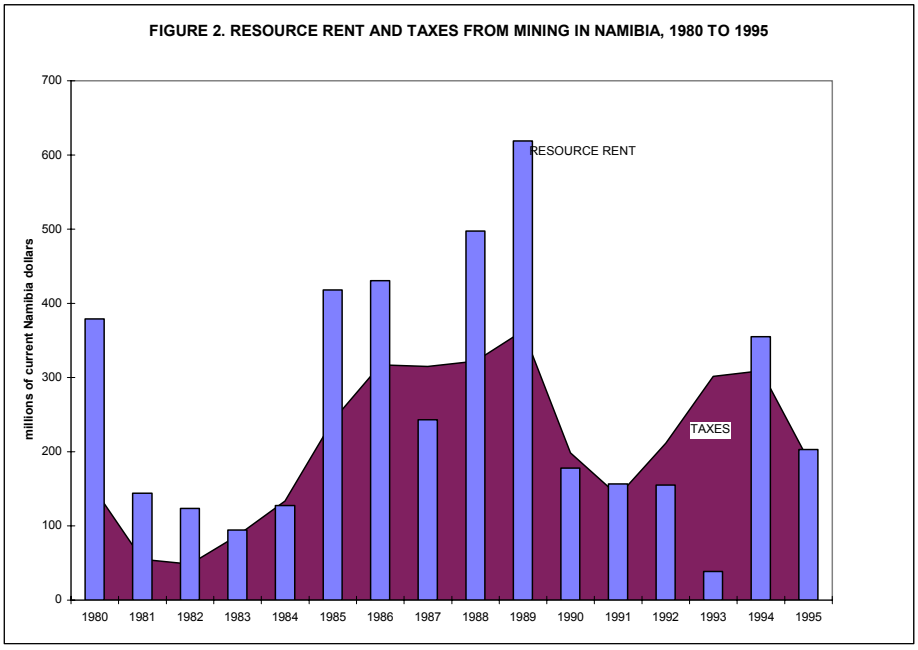
4.2.4. Policy issues

4.2.4.1. Rent recovery

Rent recovery is important as it implies that governments have more resources available to boost development. Both Botswana and Namibia have been fairly successful at recovering the rent generated by mining in that taxes levied by the governments have been roughly equal to the rents generated (Figures 4.1 and 4.2). However, it is not possible to determine whether the depletion of mineral assets is being offset by the accumulation of other economically-productive assets because the revenue obtained through taxes has gone into general government revenues and is not earmarked for a specific purpose, such as a resource depletion fund.

The rent recovery from fisheries in Namibia is much poorer; quota levies are considerably lower as a share of rents than that obtained in the mining sector, averaging only 30% of resource rent since 1990 when quota levies were first introduced. This is partly due to the fact that the government sacrifices some of the rent in order to promote a greater domestic stake in the fishing industry.

Figure 4.2:



Source: Lange and Hassan, 1999.

4.2.4.2. Use of mineral revenues

The government in Botswana has adopted the principle that mineral revenues should be invested in productive activities, i.e. human and produced capital. This is measured by the sustainable budget index (SBI). The SBI is the ratio of non-

investment recurrent expenditures to recurrent revenues (that is, revenues except for mineral revenues and grants). Non-investment recurrent expenditure is measured as the recurrent expenditures minus spending for health and education. Health and education are considered an investment in human capital, which is more appropriately considered part of the development and capital budget. Through the early 1990's, the SBI has, in fact, been less than 1 (Figure 6). However, in recent years, the ratio has increased, reaching 1.02 in 1998.

The SBI is sometimes considered too restrictive. El Serafy (1989) developed the alternative "user-cost" method (CSO/NCSA, 2001). This method divides the resource rent into two components:

- the amount of resource rent that needs to be reinvested in order to maintain a constant stream of income (the "national pension fund" or rent);
- the residual amount can be consumed as current income or income content.

Using this method, Botswana need not invest all its diamond revenues in order to ensure a permanent stream of income. If a long-term real return on investment of 10% were obtained, Botswana need invest only 2% of the rents from diamonds by 1997. At a 1% return, 66% of mineral revenues would have to be reinvested by 1997.

In Namibia, where mineral revenues contribute a much smaller share of government revenue, it is more difficult to assess the use of these revenues. However, the government of Namibia is investing a great deal in the development of human capital, i.e. nearly 35% of its budget is for education and health expenditures in 1997.

Some example of policy issues that emerge from the mineral accounts:

- In Botswana, mining of copper, nickel and coal generates very little direct benefits, and their role should therefore be carefully monitored;
- The Botswana and Namibian governments are generally successful in extracting revenues from the mining sector. The prevailing instruments appear effective;
- Namibia's mineral revenues are volatile, and have not shown the steady increase that Botswana has experienced. This is probably due to the uniqueness of the diamond market.

4.3 NRA AND WATER RESOURCES IN SOUTHERN AFRICA[2]

4.3.1. Introduction

Water is a more complicated resource than minerals, and this make the construction of comprehensive water account more difficult. Water has the following characteristics:

- Water is partly renewable and partly non-renewable (fossil ground water);
- Water occurs as ground water, perennial as well as seasonal surface water;
- Annual water availability fluctuates strongly with rainfall;
- Water is supplied by a variety of public sector institutions as well as by self providers;
- Water may be polluted, rendering certain uses undesirable.

[2] This section is based on the following reports: Lange, 1997 and Lange et al., 2001.

Ideally, all characteristics should be incorporated into water account. In practice, some are and many are not yet. In Southern Africa, Botswana, Namibia and South Africa have prepared water accounts. In addition, transboundary water accounts have been prepared for the Orange river catchment (Lesotho, South Africa, Namibia). We use Namibia as an example below.

4.3.2. Physical accounts

Table 4.5 gives an estimate of the water stocks for the period 1980-1993. Knowledge about groundwater (stock and recharge) is very limited. This is worrying as groundwater accounts for around half the water use, and concern exists about ground water depletion. The annual amount of surface water fluctuates considerably due to rainfall variations. Ideally, the stock accounts should distinguish between shared and domestic water sources as use of the former is subject to international treaties.

*Table 4.5. :*Stocks of water (1980-1993; millions of cubic metres)

		Perennial Surface Water Annual Runoff of Major Rivers					**Ephemeral Surface Water**	
	Ground Water	Orange	Zambezi	Kwando	Okavango	Kunene	Annual Runoff	Annual Dam Storage
1980	na	3,583	41,633	1,732	5,035	1,561	64	241
1981	na	3,308	23,686	923	5,105	1,980	73	164
1982	na	1,125	23,157	837	3,907	2,868	86	105
1983	na	1,592	25,595	869	9,408	11,156	437	157
1984	na	932	28,555	880	5,375	6,594	481	277
1985	na	2,200	28,996	913	4,629	7,238	367	417
1986	na	2,731	31,916	929	4,239	4,165	215	378
1987	na	21,885	28,988	787	5,393	4,191	775	471
1988	na	10,897	49,953	1,026	5,820	5,085	755	461
1989	na	2,415	19,887	1,064	4,370	4,582	161	335
1990	na	3,534	31,483	795	3,882	3,863	275	303
1991	na	2,800	17,613	661	6,607	7,404	58	184
1992	938	600	34,941	785	3,228	1,840	222	252
1993	na	1,298	24,011	844	2,998	2,516	286	293

na: not available

Notes: Annual runoff of perennial surface is reported for recording stations. These cannot be summed since some rivers feed into others. Data about groundwater available only for selected aquifers in the Central Area of Namibia in 1992; these figures are fairly representative of the groundwater stocks in that area in earlier years.
Ephemeral surface water estimates are based on data from the major rivers, but not all rivers.

Source: Lange, 1997

Table 4.6. Distribution of Water Use by Natural Source, institutional Source, and Using Sector in 1993 (in percent)

		Natural Source			Institutional Source	
	Total	**Ground**	**Perennial**	**Ephemeral**	**Bulk**	**Rural**
Communal Agriculture	17%	16%	34%	0%	9%	24%
Commercial Agriculture	43	28	54	65	32	52
Mining	11	20	2	1	5	15
Manufacturing	2	3	0	3	6	0
Services	3	4	0	3	6	0
Rural Households	5	6	6	2	0	9
Urban Households	17	22	3	24	40	0
Government	1	1	0	2	3	0
Total	100	100	100	100	100	100
Percent of Total	**100**	**51**	**27**	**22**	**43**	**57**

Source: Lange and Motinga, 1997.

The use accounts distinguish the same economic activities as the national accounts. In addition, they differentiate between type of water and the institutional source. Table 4.6 (a summary of the 1993 user account) shows that agriculture is by far the largest water consumer followed at a distance by urban households and communal agriculture. Note that this use account does not consider 'environmental use', i.e. the water requirements of existing ecosystems. Such needs are usually high, and would substantially increase water consumption.

4.3.3. Water allocation efficiency

Botswana nor Namibia have prepared monetary water accounts. The reasons include missing data, especially on the costs of water provision, and the diverse water pricing policies. In stead, the water accounts have concentrated on the efficiency of water allocation. This has been measured by estimating the value added per M^3 by various users. Other measures of allocative efficiency (e.g. employment creation) have not yet been calculated.

Table 4.7 provides the example of economic contributions made by each water use. The table shows that the value added by agriculture is very low. From a value added perspective, it would be much wiser to increase the water allocation to industries and services.

A comparison of Botswana, Namibia and South Africa shows that Botswana achieves the highest valued added per M^3 and South Africa the lowest. These results are interesting, but need further analysis before policy recommendations may be made.

Table 4.7: *Economic contribution of water by sector in Namibia (1993)*

Sector	Output (10^6 N$)	Value-Added (10^6 N$)	N$ of Output per m^3 of water input	N$ of Value-added per m^3 of water input
Agriculture	**793**	**561**	**6.5**	**4.6**
Commercial agriculture[a]	617	405	7.1	4.7
Livestock	580	na	26.2	
Crops	14	na	0.2	
Communal agriculture[b]	176	156	5.0	4.5
Mining	**1,880**	**862**	**86.6**	**40.0**
Diamond mining	1,137	609	83.6	44.7
Other mining	743	253	91.7	32.0
Manufacturing	**2,006**	**656**	**403.6**	**132.0**
Fish processing	530	316	757.1	451.4
Other manufacturing	1,476	340	345.7	79.6
Services	**5,311**	**2,807**	**1,018.6**	**538.3**
Hotels/Restaurants (Tourism)	296	129	258.7	112.7
Transportation	680	245	871.8	314.1
Other services	4,335	2,433	1,317.7	739.6
Non-Agricultural Sectors	**14,419**	**7,013**	**375.0**	**182.4**
All Producing Sectors		**7,574**	**95.1**	**47.3**
Gross Domestic Product		**8,860**		**44.3**

[a] The subsectors Livestock and Crops do not sum to the total because of a small amount of own-account construction included in this sector.

[b] Communal agriculture cannot be disaggregated at this time.

na: not available. The national accounts do not disaggregate agricultural value-added between livestock and crop production.

Note: Blanks indicate that the figure cannot be calculated. Electricity and construction are included in services. The value of government and household use of water cannot be calculated in this way.

Source: Lange and Motinga, 1997.

Some policy issues that emerge from the water accounts:

- Water allocations should be re-examined in view of expected mounting water shortages in future;
- Water use efficiency in agriculture has to increase (high value crops, technology); in addition food security is a more realistic policy goal than food self sufficiency)

- Stronger incentives are needed to reduce water consumption. This requires higher water charges.
- Water subsidies need to be reviewed;
- Need for a regional analysis of the differences in water efficiency among countries.

4.3.5. Regional water accounts for the Orange river catchment area

The Orange river is an international river basin, whose water resources –according to SADC treaty on shared river courses- should be distributed fairly and equitably among the countries involved after taking into account the environmental needs. To boost regional development, water should also be used efficiently. Conningarth Economic Consultants in association with 'Urban-Econ and Agromodel' carried out this case study.
Three categories of water supply are recognised: perennial rivers, ephemeral rivers and ground water. The following demand categories are distinguished: domestic demand (urban and rural) by income category, industries, electricity generation, irrigation (crops, fodder, orchards), mining, livestock farming, game farming, eco-tourism and recreation, ecology and transfer-out of the system (note: the substantial transfer out of the system through the Lesotho Highland Water Scheme was effected after the period covered by the study 1991-1998). Three types of farmers were distinguished: commercial farmers, small farmers and communal farmers.

It proved difficult to acquire the necessary data. The study relied heavily on data for South Africa, in particular data from the Orange River Replanning Study and from the Water Situation Assessment Model. Data from Lesotho, Botswana and Namibia proved more difficult to obtain and were often imputed from the South African situation. Inevitably in such a study, assumptions have to fill data gaps. Visits to all countries are planned to up-date the data used and to verify the 'best practical assumptions' made to complete the accounts.

Figure 4.3: Water use by country.

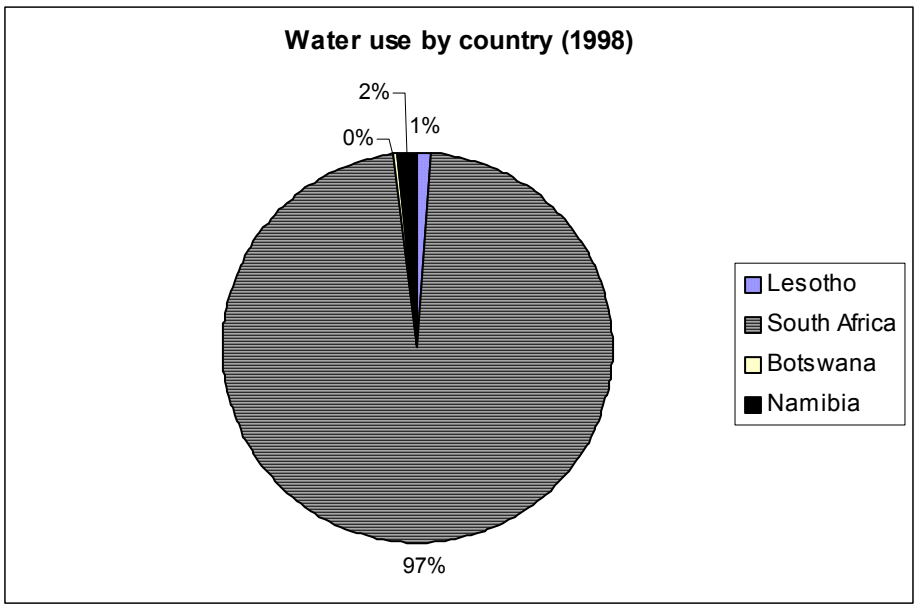
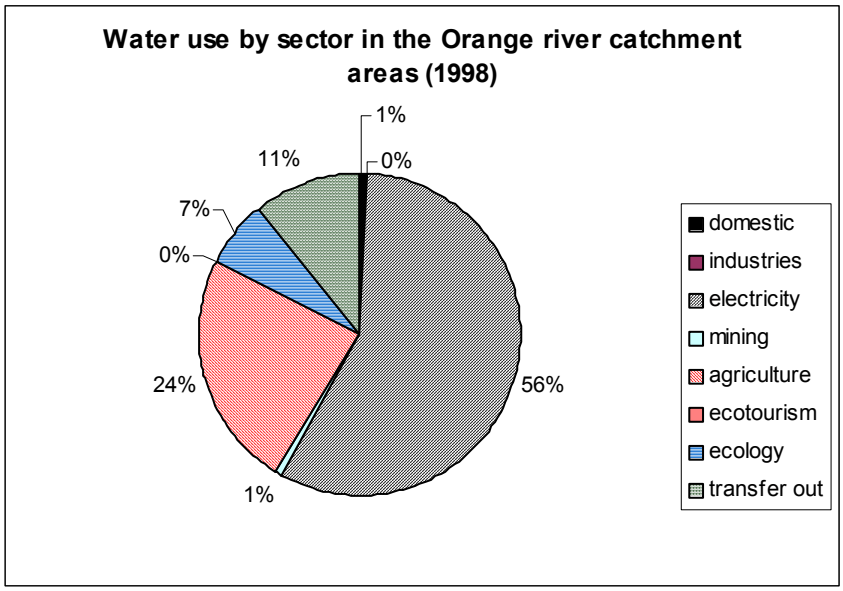


Figure 4.4: Water use by economic activity (1998)



The findings proved extremely interesting, and will be discussed in more detail below. The utilisation level of the water is high and has increased from 57.5% in 1991 to 64.4% in 1998. If we add the extractions for the Lesotho Highlands Water Scheme, it probably means that the present utilisation rate of water is 70 to 80%. This is high and should be an incentive to the governments to careful review the benefits of current uses. South Africa consumes the lion's share of water (Figure 4.3).

Botswana and especially South Africa extract more water than they supply. Lesotho, on the other hand, extracts little water and yet contributes a lot to the supply. From this perspective, it has been a wise move from Lesotho to sell water to South Africa instead of letting it flow for free into South Africa. The main water users are agriculture and electricity. Agriculture accounted for 56% of the use in 1998 (even 83% in the lower Orange river catchment); electricity for 24%. (Figure 4.4).

Out transfers have become major water uses. In the upper Orange, out transfers are even most important (63% of use). Such transfers could have major environmental impacts if 'local' uses increase further. The value added by water from the Orange river catchment area is around R21 bln. or 2.7% of the countries' national product. The break-down by country is as follows: South Africa (56.4%), Lesotho (20.3%), Namibia (19.3%) and Botswana (4%). The lower Orange river catchment accounts for almost 80% of the value added and for over 60% of the employment. The value added and employment generation is highest for perennial water as compared to groundwater and ephemeral rivers. The value added and employment creation per m^3 of water is low for agriculture, i.e. the main recipient of water. Taking into account that domestic and industrial use are expected to grow significantly in future, it is clear that agriculture will have to face water reforms in future.

4.6 DISCUSSION QUESTIONS

1. How would NRA benefit development planning in Botswana in genEral and your work in particular?
2. Assess the feasibility of NRA in Botswana and Southern Africa at large? What are the major constraints and opportunities?

4.7 READINGS

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TOPIC 5

ECONOMIC INCENTIVES FOR SUSTAINABLE RESOURCE MANAGEMENT

SUBJECTS

5.1. Environmental policy principles and instruments
5.2. Environmentally perverse subsidies
5.3. Evaluation of environmental-economic instruments in southern Africa

CONTENTS:

- **Arntzen,J., 2001. Economic instruments and natural resource management. RANESA Policy Brief April 2001 (draft). University of Pretoria.**
- **World Bank, 1997. Persuasion and incentives; new ways to achieve a cleaner world. Environment Matter, winter/spring, pp.6-9.**
- **Discussion questions**

ECONOMIC INSTRUMENTS AND NATURAL RESOURCE MANAGEMENT3

(RANESA POLICY BRIEF April 2001, prepared by Jaap Arntzen)

1. Introduction

Governments in Southern Africa are showing growing interest in the application of environmental economic instruments in improving the state of the environment. This interest is brought about by several factors, including:

- Frustration with the limited success of regulations. Regulations are easy to make, but sometimes difficult to implement and often difficult to enforce;
- The need to raise government revenues. Governments often have no other ways to finance natural resource management;
- The growing diversity and complexity of environmental issues requires additional instruments;
- A global trend in favour of the use of environmental-economic instruments.

It is the purpose of this policy brief to explain what environmental-economic instruments are and how they can be successfully used to improve natural resource management and to enhance economic growth. In addition, the brief aims to demonstrate the environmental problems and costs associated with traditional economic instruments that fail to take inmate account environmental impacts.

2. Environmental-economic instruments

In general, environmental policies have three types of instruments at their disposal:

- legislative or regulatory instruments;
- environmental-economic instruments; and
- Consultative instruments.

Each type has its strengths and weaknesses and therefore environmental policies tend to use a mixture of legislative, economic and consultative instruments. Historically however, country worldwide have mostly relied on environmental legislation and, to a lesser extent, on non-binding consultative instruments. Southern Africa is no exception. As a consequence of this instrument bias, the potential of the other instruments remained under-utilised at the expense of natural resource management. Fortunately, this bias is now gradually being removed.

A classification of the main types of instruments is given in Table 1 below.

3 This policy brief is based on a regional research project on Environmental Impacts of Economic Instruments in Southern Africa, funded by the Dutch Ministry for Foreign Affairs (DGIS). Fore more details, see Arntzen, 1999.

Table 5.1: Classification of instruments

MAIN TYPES	SUB-TYPES	INSTRUMENTS
Regulations		Standard, norm, ban, license, quota
Economic instruments (MBI)	Revenue-generating instrument (financial instruments)	User or pollution charge
	Non-revenue generating instruments	Property rights, subsidies, deposit-refund
Consultative instruments	Non-binding consultative instrument	Education, awareness raising,
	Binding consultative instruments	Covenants

Regulations aim at *directly* influencing the behaviour of resource users and polluters by issuing orders, prohibitions, restrictions or obligations. Environmental standards are also part of the regulatory instruments. These instruments are also labelled command-and-control instruments as they prescribe resource behaviour.

In contrast, *consultative instruments* seek voluntary, environmentally friendly, adaptations of individuals or groups. Such instruments can be *non-binding* and b*inding.* Examples of non-binding instruments include education, awareness raising and consultation. Government hopes that these instruments improve resource attitudes and behaviour, but there is no guarantee that this happens. Non-binding consultative instruments have long been used with mixed success. During drought and other natural hazards, they have proven to be effective. However, in many cases environmental behaviour does not change voluntary. During the last two decades, binding consultative instruments have been pioneered. The covenant offers the best example. A covenant is a binding environmental plan agreed upon after discussions between the resource user and government. A covenant has clear environmental targets and spells out the responsibilities of the resource user(s) and government. In addition, it has an agreed time frame for its implementation and sanctions for non-compliance. No examples are known of covenants in Southern Africa. The management plans, which communities prepare prior to receiving wildlife user rights, are close to covenants, but most do no have all the characteristics described here.

Environmental-economic offer financial gains for environmentally friendly behaviour and imposes financial costs on environmentally damaging behaviour. In this way, they aim at indirectly influencing the behaviour of resource users and polluters. The second aim of environmental-economic instruments is to raise revenues for government's efforts in natural resource management. Not surprisingly, revenue raising often becomes the major result of these instruments. The advantage of environmental-economic instruments is that polluters and resource users have a choice, i.e. to reduce pollution and resource use or to pay more. They will choose the solution, which is cheapest to them, and thus minimise their costs. This makes environmental-economic instruments efficient. The roots of environmental-economic instruments lie in the polluter-pays-principle and in the user-pays-principle, which stipulate that polluters and resource users should pay for the damage and use respectively. A growing number of Southern African countries has adopted these principles, and thus have a legal/political base for environmental economic instruments. Usually, the instruments are sub-divided into *revenue raising* and *non-revenue raising* instruments. The former generate revenues (e.g. charges), whilst the latter do not or may even costs money (e.g. subsidies). Charges are the most common instrument worldwide. In Southern Africa, property-rights are also commonly used.

With respect to the application of environmental-economic instruments, two concerns require special attention in Southern Africa. First, the interests of the majority of low-income groups need to be considered carefully. The majority of the region's population lives in poverty, and their interest should be considered in the design and implementation of instruments. The affordability should be considered together with opportunities for cross-subsidisation (for example: high-income resource users subsidise low-income groups). Second, inflation is high in the region (by global standards), and this requires that most financial instruments be regularly adjusted to remain 'constant' in real terms.

Which instrument(s) should be applied and when?
Each type of instrument has its strengths and weaknesses. Therefore, instruments should be chosen carefully. In many cases, a mixture of instruments is most suitable. Based on the strengths and weaknesses of each type of instrument, *indications* and *counter-indications* have been developed to guide the choice of instruments. These are summarised in Table 5.2. While this is not a blueprint for uncritical instrument application, it helps to select a few suitable instruments for each environmental issue, and make the final choice after additional analysis/ deliberations.

Table 5.2: Indications and counter-indications for environmental instruments

	INDICATIONS	**COUNTER-INDICATIONS**
ECONOMIC INSTRUMENTS	Emerging informal economic instruments Perfect competition Small government capacity Commercialisation Growing size of market economy	Market imperfections Non-linearity of environmental problems Large non-market sector Lack of expertise and data
Revenue-raising instruments (e.g. charges)	Government deficit Rising marginal supply costs Polluter-pays-principle User-pays-principle	Poverty-low incomes
Non-revenue raising instruments	High price elasticity	Lack of alternatives Para-statals and governments
Property rights	Traditional property rights Enclosure resources (land, water, minerals)	Dual resource rights Off-site environmental effects Mobile natural resources
Tradable rights	Resource area approach (e.g. catchment area) Resource scarcity	No user exclusivity
Tax measures	Efficient and broad-based tax system VAT tax system	Limited scope Collection problems
Deposit-refund	Poverty-unemployment	Small market; high costs
REGULATIONS	Environmental emergencies Serious pollution Strength of legal system Large government sector Customary regulations Large public sector	Colonial association with orders Informal sector Many and scattered targets Small government capacity
CONSULTATIVE INSTRUMENTS	Culture of consultation Small, organised economy-target group Growing civil society with interest groups Government policy in favour of decentralisation Small government capacity	Scattered, unorganised group/sector Conflicts within groups/ sector

Sources: Kuik et al., 1997; Panayotou, 1994; Arntzen, 1999.

THE EXAMPLE OF LAND RESOURCES

In Southern Africa, three issues have captured the attention of policy makers:

1. land redistribution and reforms;
2. unproductive land use; and
3. land degradation.

To-date, environmental- economic instrument do not play a major role in resolving these issues. The most important gap in the use of environmental-economic instruments is the allocation of land resources. Land allocation is primarily based on land-use planning, and does not pay adequate attention to economic factors. For example, economic factors should play a role in the decision as to whether land should be used for livestock or for wildlife.

Land degradation is often the by-product of subsidies that failed to incorporate environmental concerns. In most cases, these subsidies benefit the agricultural sectors such as livestock, irrigation and forestry. Agricultural subsidies have led to agricultural expansion into marginal areas, at the expense of other sectors such as wildlife. For example, removal of livestock subsidies made Namibian farmers switch to wildlife and derive more income from this sector (a rise from N$ 31 mln. in 1972 to N$ 56 mln. in 1992; Dima and Katjiua, 1999). Clearly, government need to conducts an environmental review all subsidy programmes.

Three environmental-economic instruments are used to address these issues:

- Land charges;
- Property rights; and
- Community-based natural resource management.

Land charges for leasehold ranches are for example found in Botswana. The charges are very low (currently subject to review), and consequently they proved ineffective in improving land management and land productivity (Figure 1). Clearly, low charges do not work. Namibia is planning to introduce a land tax for freehold land in order to stimulate its productive use and to re-distribute under-utilised land. This instrument is a fairer, more transparent and effective instrument of land redistribution than land expropriation.

Figure 5.1: The impact of low charges on resource use

Examples of low resource charges:
- *Leasehold land (Botswana)*
- *Fishing (Namibia)*
- *Wildlife hunting (Botswana)*
- *Blend water price (Zimbabwe)*
- *Irrigation water (South Africa, Namibia)*

Effects of low charges:
- *In combination with private property rights, it discourages sustainable resource management (resource speculation and marginal use);no development incentive*
- *Requires strict enforcement of quotas to prevent over-utilisation (fish, wildlife)*

Property rights have been used in three ways: 1. de-privatisation of private land to rectify historical injustices, achieve a fairer land distribution or to increase the utilisation of land; 2. Privatisation of communal land, either de-facto through fencing or de-jure through conversion into leasehold land; 3. Assignment of exclusive user rights in communal areas to communities. Privatisation does not lead to higher land productivity as long as other production constraints persist. Such constraints include lack of capital, access to credit, skills and absentee management. Privatisation displaces people and thus has negative social impacts. Land privatisation should therefore only be considered if farm management constraints and the social problems are resolved. Land de-privatisation may be socially beneficial, but should be accompanied by strong government support programmes for small farmers and environmental policies. Otherwise, the instrument may be economically and environmentally unsustainable. The community-based natural resource management instrument appears to be a promising land management instrument. It balances efficiency, equity and sustainability, and reduces the land management burden of government. Obviously, community conflicts may arise (e.g. related to the destination of revenues). Some government control is necessary to monitor natural resource trends (e.g. through quotas). CBNRM appears to work well when communities enter into a smart partnership is sought with commercial companies for e.g. wildlife utilisation. Tendering of community resource rights has significantly increased their revenues.

Several lessons emerge:

- Land charges or taxes should be sufficiently high to cover government costs, to stimulate higher land productivity and better land management;
- Economic factors should be incorporated in allocations of land to sectors. This can be done through tendering of land rights or by calculating the net benefits/ha for each sector.
- Community-based resource management appears a promising 'African' instrument that deserves support until it can be conclusively evaluated;
- Land privatisation and de-privatisation can only succeed if other land management constraints are resolved at the same time.

THE EXAMPLE OF WATER RESOURCES

Policy makers are increasingly concerned about the rapidly growing demand for water, escalating supply costs, growing competition for water coupled with the risk of conflicts and pressure to start using shared river resources and water needed to maintain the ecosystem. In general the following concerns exist:

- Water shortages, locally, nationally and regionally;
- Rapid rise in marginal supply costs due to transfer schemes, desalination plants etc.
- Inefficiencies in water allocation that may inhibit future economic growth;
- Water pollution by industries, inadequate sanitation facilities, fertilisers and pesticides.

Water policies in the region are rapidly evolving in most countries. New Acts are approved (South Africa), new strategies are being devised (Zimbabwe) or existing plans are being up-dated (Botswana). Policy efforts appear to have a number of characteristics in common:

- Greater emphasis on water tariffs and costs recovery (all countries). Cost recovery targets and tariffs however differ;
- Greater emphasis on water demand management (all countries);
- Adoption of a catchment area approach to overcome institutional fragmentation and to improve water allocations (South Africa and Zimbabwe);
- Recognition of environmental water rights, i.e. water needed to maintain these systems (South Africa and SADC treaty on shared river courses);
- Prioritisation of water needs. For example, South Africa gives absolute priority to basic human water needs and environmental water needs;
- Restriction/abolishment of riparian rights, which entitled farms along rivers to extract unlimited water resources (Zimbabwe);
- Growing use of environmental-economic instruments.

Most countries apply a wide range of instruments for water management. The most important regulations cover licenses required for water abstraction, drought contingency regulations, and water quality and effluent standards. Water-saving awareness raising campaigns are common during droughts. The common environmental-economic instruments are:

- User charges;
- User rights. Individuals or groups are granted water abstraction rights; and
- Development rights. Individuals or companies are granted the right to develop water sources such as boreholes;

South Africa's 1998 Water Act permits the establishment of water markets for productive use in so-called water management areas. In water markets, productive sectors would compete for the water sources left after the environmental and basic human needs (the so-called *water reserve*) have been met. Theoretically, each sector should be allocated as much water so as to sustain a production level where the marginal net benefits of each sector are equal. In practical terms, current allocations could be reviewed based on the development benefits of each activity (in terms of value added or employment creation impact). This would solve the paradox that sectors with low development benefits receive the highest water subsidies.

User charges
User charges are common for institutional suppliers. Charges are *financing charges* as they primarily aim at recovering part of the production costs. The charging principles differ among countries. For example, until recently Zimbabwe had a countrywide blend price for water based on the average historical supply costs. Botswana aims at full recovery of the marginal production costs in urban areas, while rural charges aim to recover the recurrent costs only. It is assumed that the rural population cannot afford to repay the high investment costs of rural reticulation system. In most countries water charges vary spatially reflecting difference in supply costs. Spatial price differences offer, *other things being equal*, an incentive for high-water use activities to be located in water abundant areas. Most countries have progressive rates with a low rate for the low use band (also called the *lifeline* or *social* band) and increasing charges for higher user bands. The results of staggered charges are twofold:

- The large users, presumably richer households, companies and the public sector, subsidise water consumption in the social band, i.e. upon which the low income groups depend;
- They offer an incentive to safe water as high use is 'punished' with extra high charges.

Charges are an indispensable element in sustainable water resource management. They raise revenues to support water management, sometimes through surcharges for specific areas such as water demand management (Namibia) and water research (South Africa). Without charges, domestic use would be much higher. For example, in Selebi-Phikwe, Botswana, households whose bill was paid by the employer used three times as much water as similar households, who paid themselves. Higher charges will normally lead to water-savings in irrigation and for luxury household use (gardens, swimming pools etc.). However, there are several factors that may restrict the water-saving impact of water charges. These include:

- For domestic use, most households use water for sanitation, and have little room to save water irrespective of charges;
- For most industries, water constitutes a small portion of the production costs. It is therefore not a business priority to save water;
- For the public sector, the bill may be centrally paid through the Ministry of Finance. In that event, individual ministries and departments probably do not know their consumption, and will not respond to an increase in charges.

As water is a basic needs, water management cannot be based on environmental and economic factors only. Governments aim to provide universal and affordable access to water by providing free water from standpipes in villages and townships, and/or by offering 'cheap' water for the basic needs of households with individual water connections. The price of water is calculated such that the water bill does not exceed a certain percentage of people's income (usually 2 or 5%). In this way, governments have been reasonably successful in achieving equitable access to water. However, the provision of 'social water' is costly to governments and water wastage is common due to lack of control. Three methods may be used to establish management around 'standpipes' and reduce the economic and social costs:

- Make communities responsible for their management (Namibia). Social control will reduce wastage;
- Restrict access and give local residents a water quota in the form of water cards. Trials in Botswana have shown that this system yields significant water-saving potential;
- Replace standpipes with individual connections. This has adverse equity impacts unless governments subsidise the connections and a limited amount of water consumption each month.

Property rights

While governments usually own the water resources, they delegate development and user rights to institutional water suppliers or self-providers. The latter are farmers and companies that have to secure their own water supply, mostly in rural areas.

Development rights have generally been successful in improving access to water. However, maintenance of the systems proves difficult in countries with macro-economic problems. Illegal connections, leakages and inadequate maintenance may seriously disrupt the water supply.

Institutional water suppliers usually enjoy a monopoly in their area of jurisdiction. Monopolies do not encourage cost minimisation. Therefore, most governments have retained the prerogative to approve price changes. This has the disadvantage that political motives may become an important price determinant. Another measure to improve efficiency is the integration of the institutional responsibilities of water supply

and wastewater treatment. This would offer an 'in-house' incentive to make optimal use of treated effluent.

Several lessons emerge:

- Environmental-economic instruments are necessary elements of integrated water management, but they are not sufficient. They need to be supplemented by regulations and consultative instruments (e.g. building regulations and water-saving covenants);
- the current environmental-economic instruments can be strengthened (higher charges, product charges, two-tier VAT system).
- economic instruments do not sufficiently determine the allocation of water resources. The high water use of agriculture combined with the relatively low development benefits is not optimal and can probably not be sustained

A GENERAL REVIEW OF ENVIRONMENTAL-ECONOMIC INSTRUMENTS IN SOUTHERN AFRICA

We will discuss each type of environmental-economic instruments before we conclude with a brief discussion of contextual factors that need to be taken into account for the choice and design of environmental-economic instruments.

User charges

Charges are frequently used in Southern Africa. Charges are payment for resource use or pollution. Resource use charges are often low, mostly for three reasons. First, charges are not regularly adjusted, and therefore their 'real' value is eroded. Second, low charges are often applied for economic empowerment of citizens (e.g. livestock, fisheries). Low charges are affordable, and will thus promote the interest of emerging citizen entrepreneurs. Thirdly, the base or principle underlying charges is often not clear. As a result, charges are set haphazardly and are not transparent. Charges should be clearly grounded in policy principles such as UPP and PPP and be based on transparent pricing concepts and methods such as the marginal opportunity costs.

It is well known from the literature that low charges do not alter the behavioural patterns of resource users. Moreover, it reduces government revenues. However, low charges also discourage growth and economic development. It is therefore better for governments to have proper charges together with targeted, temporary subsidies to assist citizen entrepreneurs.

Charges are unlikely to change environmental behaviour if:

- the price elasticity of demand is minimal;
- they are not linked to the volume of resource use (e.g. flat rates);
- they are linked to the wrong resource. For example, charges for irrigation farmers are linked to the irrigated area rather than the amount of water consumed.
- Dual resource supply systems exist: one free of charge and one at costs. The former erodes the effectiveness of the latter;

Furthermore, in order for charges to succeed, it is important that revenues are ploughed back into improving resource management and are not treated as general tax revenues.

Property rights
This instrument is widely used in the region in the form of privatisation, de-privatisation and community-based resource management. They include ownership rights (e.g. land), development rights (e.g. land and water) and user rights (e.g. water, fish and wildlife). The idea is that through property rights resource users themselves will experience environmental externalities such as land degradation or wildlife depletion and consequently look better after the natural resources. Moreover, property rights would also improve resource security and warrant investments.

The performance of property rights has been mixed. Private land rights may have saved some resources from the perils of open access, but they have generally been unsuccessful in improving land management, economically, socially and environmentally. Factors that negatively influenced their performance include:

- Persistence of other management constraints;
- Continued access to communal areas (dual grazing rights);
- Failure to enforce resource management conditions; and
- Institutional fragmentation and imperfect markets.

However, private rights have been instrumental in developing water resources outside villages and urban areas. They need, however, to be coupled with sustainability conditions.

The results of community-based property rights are promising, but it is too early to reach definite conclusions. With respect to wildlife, CBNRM contributes to sustainability and equity. Tendering proved to be useful in promoting efficiency and equity. The programmes are now diversifying into other resources (e.g. veldproducts in Botswana and water in Namibia). Increased benefits to local population lead to a more positive attitude towards natural resources. Constraints include:

- Community conflicts and cohesiveness;
- External resource threats beyond the control of local communities;
- Illiteracy, limited community skills and experience.

Tradable water rights could be linked to the catchment area approach that is now pursued in the wetter (parts of) countries (South Africa, Zimbabwe, and Zambia).

While property rights are useful to shift resource management responsibilities from government to civil society, governments need to ensure that market failures and institutional failures (CBNRM) are minimised. This requires that conditions are attached to property rights and that monitoring takes place.

Tax measures
Tax measures are currently hardly used to improve resource management. This is undoubtedly due to the limited scope of the tax system and inadequate collection mechanisms. Tax measures tend to be efficient as they use existing mechanisms. There is scope for the use of a two-tier VAT system, where environmentally benign products would fall in the lower VAT rate. In addition, tax concessions could be offered to commercial companies for investments in environmentally friendly technologies.

Environmental subsidies
These conflicts with the PPP and UPP, but may be utilised to encourage environmentally friendly technologies and behaviour. They may be justified for

activities with net benefits to society but are not taken up by because the net benefits to individuals or companies are negative. Examples may include solar power, water harvesting and re-cycling. Such subsidies should not become permanent.

Deposit-and-refund schemes

Deposit-and-refund schemes mostly address litter and waste management. The purposes of the instrument are to reduce littering and encourage recycling and re-use. In Southern Africa, these schemes are restricted to bottles and cans. The region does not yet expand the scope of these schemes to, for example, PET bottles and durable consumer goods. Interestingly, two factors were found to encourage recycling and re-use in the region. Firstly, high unemployment offers opportunities for informal recycling/ collection schemes. (e.g. aluminium cans). Such schemes run without government involvement. Secondly, shortage of foreign exchange offers a strong incentive for recycling and re-use.

Contextual factors for the application of economic instruments

Several factors need to be considered in the choice and design of environmental-economic instruments.

Firstly, poverty is endemic in the region. Poverty reduces people's willingness to pay for resource use and for substitutes of scarce resources and certain technologies. On the other hand, poverty reduces resource wastage and provides an incentive for labour-intensive recycling and re-use of waste.

Secondly, it is often stated that economic instruments are incompatible with the African culture. This generalisation is misleading, as culture is dynamic and adaptive. There is evidence that when resource scarcity reaches critical levels, people start to charge for resource use even if no formal policies are in place. Such charges are often based on a mixture of economic and social arguments. It is, however, important to recognise that the traditional culture had a strong element of consultation and inclusiveness that could be well exploited through a combination of economic and consultative instruments. The promising results of community-based natural resource management, i.e. and African blend of the property rights instrument with a covenant between communities and government serves as a good example.

Thirdly, the history of countries influences the attitudes towards and feasibility of economic instruments. In the region, historical injustices such as appropriation of land and user quota by minority groups (e.g. fisheries) need to be incorporated in the design of new economic instruments.

Fourthly, political motives play an important role in the choice and implementation of instruments. Reasons include citizen empowerment, social equity concerns, and interest protection. In many cases, political interference has compromised resource sustainability and economic efficiency, and the equity impacts have been mixed. It is important to be transparent about the motives, and to seek the best way of achieving the goals.

Fifthly, The capacity of governments is limited. This requires greater involvement of other stakeholders in society, including in the area of natural resource management. This is currently done through two instruments. Firstly, devolution of development rights to self-providers of water outside urban areas. Second, granting of user rights to communities, which reduces the implementation, monitoring and enforcement burden of government.

Finally, the Southern African economies depend on primary production sectors. Consequently, sustainable resource management should be considered a priority to sustain economic growth. Moreover, a substantial, but diminishing part of the

economy is subsistence-oriented. Financial incentives may be hard to introduce in this sector, and are unlikely to have the same effect as in the market sector.

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DISCUSSION QUESTIONS

1. Discuss the desirability and feasibility of the introduction of transferable livestock grazing fees in communal areas? What alternatives would you recommend to control grazing pressure?
2. Discuss the feasibility and desirability of the introduction of a borehole market in communal areas in Botswana?
3. Analyse the impacts of subsidies for livestock (Botswana/ Namibia) and irrigation (Namibia, South Africa, Zimbabwe) on the environment and countries' development?

SOME READINGS ON ENVIRONMENTAL ECONOMICS

1. General introductory texts

Munasinghe,M., 1993. The Economist's Approach to Sustainable Development. Finance and Development, December 1993, pp. 16-19.

> This brief article contains an analytical framework linking environment and economic development. It shows how economists view sustainable development, and concludes that economists have to understand and incorporate the views of sociologists and ecologists too, to achieve sustainable development.

Pearce,D.W., A.Markandya and E.Barbier, 1989. Blueprint for a green Economy. Earthscan, London.

> This book give an easy-to-read review of the economic meaning of sustainable development, different valuation methods, natural resource accounting, project appraisal, discount rate, and price and the incentives for environmental management.

Pearce,D.W. and R.K.Turner, 1990. Economics of Natural Resource Management. Harvester/Weatshaft.

> *This book contains technical discussions of a wide range of topics: the circular and sustainable economy, optimal levels of pollution and resource use, discussions of instruments such as taxes, subsidies and marketable permits, valuation methods, total economic value, discounting, biodiversity/ resource extinction. The last part deals with environment and development issues, and includes a case study of wetlands.*

Turner,R.K.. Environmental Economics and Management. Chapter 2 in O'Riordan (ed.). 1995. Environmental Science for Environmental Management. Longman

> This chapter briefly reviews resource scarcity, ecological limits on the economy, sustainable economic development, valuation and pollution control policy.

2. General text on selected topics

Bateman,I., Environmental and Economic Appraisal. Chapter 3 in; O'Riordan (ed.). 1995. Environmental Science for Environmental Management. Longman

This chapter briefly discusses the range of valuation methods and cost-benefit analysis.

Dixon,J., D.E.James and P.B.Sherman, 1989. The Economics of Dryland Management. Earthscan, London.

This book contains a detailed economic assessment of drylands, particularly CBA. It covers valuation methods, financial and social costs-benefit analysis, treatment of off-site and on-site effects, risks and uncertainties. The chapter covers a detailed CBA of a soil conservation project in Lesotho.

3. Applications

Abaza,H. and J. Rietbergen-Mc.Cracken, 1998. Economic instruments for Environmental Management: a world-wide compendium of case studies. UNEP Environmental Economics Series No. 25, New York and Geneva.

The report contains case studies of (environmental) economic instruments from Africa, Asia, eastern and central Europe and South America. The African case studies cover property rights |(Botswana), forest management (Botswana), water management (Botswana), wildlife user right (Zimbabwe) and waste management (various countries).

Abaza,H. and J. Rietbergen-Mc.Cracken, 1998. Economic *Valuation* for Environmental Management*; a world-wide compendium of case studies*. UNEP Environmental Economics Series No. 25, New York and Geneva.

The report contains valuation case studies from Africa, Asia, eastern and central Europe and South America. The African case studies cover valuing time to collect water (Kenya), the value of viewing wildlife (Kenya), the value of land (Ghana) and the costs of rainforest conservation (Cameroon).

Amusa,L.. 2000. The economic value of Communal Rangelands in Botswana: a Case study of the Kgalagadi north sub-district. M.Sc dissertation, dep. of Environmental Science, University of Botswana.

The dissertation discusses the findings of two valuation methods, i.e. a direct use value estimate derived from secondary data, and value estimates derived from a contingent valuation survey in two villages. Both communities attach the highest WTP to retaining their current land uses. Expansion of communal grazing into wildlife management areas is not feasible as the WTP of beneficiaries is lower than the WTA of the losers. The WTA for fencing of communal grazing areas is high. This implies that losers expect compensation for lost resources access.

Arntzen, J.W., and N.H.Fidzani, 1998. Incentives for Sustainable Natural resource Management and Economic Diversification in Botswana. Final Report to the NCS Co-ordinating Agency.

The report evaluates the operation of current economic instruments in Botswana using the concept of marginal opportunity costs. Furthermore, it recommends ways of strengthening the environmental (economic) instruments, and explores resource-based opportunities for economic diversification. The report constitutes

the foundation of the environmental-economics component of the NCS Environmental Action Plan.

Barde,J.P., and D.W.Pearce, 1991. Valuing the Environment. Earthscan, London.

This book contains 6 case studies of mostly CBAs related to pollution control. The case studies are restricted to European countries and the USA.

Barnes, J. , 1995. Economic Analysis of Community-Based Wildlife Utilisation Initiatives in Botswana. *Development Southern Africa, 12, 6, 783-803*.

This article reviews the feasibility of wildlife utilisation in communal rangelands in western Botswana. It demonstrates that a declining wildlife resource reduces the financial and economic feasibility of wildlife-based projects.

F.J.Convery, 1995. Applying Environmental-Economics to Africa. World Bank, Technical Paper No. 277, Washington DC.

This report aims to assist planning officers to integrate environmental economics in national Environmental Action Plans (similar to Botswana's NCS). The report covers a bit of the theory of environmental economics and a wide range of relevant topics such as : price and non-price incentives, property rights and tenure, estimating and comparing costs and benefits and institutional/cultural development. The report contains many practical examples.

Dixon,J., D.E.James and P.B.Sherman, 1990. The Economics of Dryland Management. Earthscane, London.

This is the second volume with case studies on the use of environmental-economic techniques on land improvements, farm practices, rangeland management, damage assessments and resource management.

M.Munasinghe, Environmental Economics and Sustainable Development. WB-Environmental paper No. 3, Washington DC.

Part 1 of this report discusses analytical issues such as sustsinable development, linking environment and economics and environmental-economic appraisal methods (CBA and MCA). Part 2 covers brief and more detailed case studies of environmental valuation. The detailed cases are the valuation of biophysical resources in Madagascar and a multicriteria analysis aimed at including environmental externalities in energy planning in Sri Lanka. Short cases studies include the value of viewing elephants in Kenya.

Oageng,M., 1999. Economic Instruments and Sustainable Water Use in the Communal Livestock Sector; the case of north-western Kgatleng. . M.Sc dissertation, dep. of Environmental Science, University of Botswana.

The dissertation is based on a willingness-to-pay survey among livestock owners in northern Kgatleng. In addition, the study examined the impacts of property rights. Many livestock owners are WTP for water from the NSWC, but only the average and not the marginal costs. This is therefore not a realistic option.

Pearce,D.,W. 1993. Blueprint for a Green Economy 3. CSERGE and Earthscan, London.

The book focuses on ‘simple’ ways of measuring sustainable development at the national level, using the UK as an example. Part 1 defines sustainable development, and explores possible measurements. Part 2 measures the achievements for various types of pollution and resource uses. Part 3 introduces with the political dimension.