ROLE AND PROCEDURES OF NATURAL RESOURCESS ACCOUNTING (NRA):

AN NRA FRAMEWORK FOR BOTSWANA

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ABSTRACT

Internationally, it is increasingly argued that a healthy environment and continuing economic growth are linked, a view that has led to the literature on sustainable development. This concept suggests that economic development cannot last long if environmental depletion is not fully accounted for. However, the state of the environment is rarely measured or monitored and it is often compromised to achieve short run economic growth and growth objectives. To minimise the risk that such behaviours are generated by lack of information, and to operationalise sustainable development, aspects of sustainability have to be incorporated into the System of National Accounts (SNA) through the use of Natural Resource Accounts (NRA).

This paper aims to show the role that NRA can play in environmental and economic accounting, and the procedures that need to be followed when carrying out natural resources accounting. The paper first reviews the SNA and its shortcomings regarding the treatment of the environment and natural capital. This is done by looking at the SNA classification of assets and examining how far environmental attributes are accounted for.

Then the paper proposes the use of NRA to correct the deficiencies of the SNA. Satellite accounts are suggested for resource based sectors in the Botswana economy, in order to augment national accounts. It is stressed that economic growth is only correctly reflected if the accounting prices used reflect full opportunity costs i.e. correct for externalities.

The sectors addressed are minerals, water, energy, livestock and wildlife. Available data has been used where possible and proposed data sources have been given for future development of these accounts.

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CHAPTER 1:System of National Accounts (SNA)

1.1 Introduction

The foundations of the current approach to national accounting were laid about half a century ago. The aim of the SNA was to trace the activities related to the production and disposition of goods and services, and the associated income flows. The qualitative effects of these activities on natural resources and the environment was less of an issue at the time, and it is understandable that better treatment of natural resources and the environment in the SNA was not a major concern. Yet, some of the early literature that provided the intellectual underpinning of the SNA anticipated the importance of natural capital and helped to define the concept of "true" income which is the focus of the current approach to sustainable accounting.

Hicks defined the concept of income when he argued that: "The purpose of income calculation in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves" (Hicks, 1946, p174). The same basic idea holds at the national level. True income is a practical guide to the maximum amount a nation can consume without depleting its stock of assets in the future. This means that allowance has to be made for the depreciation of capital (or productive assets), broadly defined. Clearly, neither GDP nor even NNP or National Income as computed under the existing SNA, are consistent with the spirit of Hicks's definition, hence the need to re-evaluate the SNA.

The current SNA assumes that the contribution of the physical environment to the economy operating within it, will continue undiminished. That is, agricultural products will continue to grow as before, land will be available for larger populations, water will continue to be available for households and industry, and clean air to exist. It is also assumed that mineral resources and fuel will continue to be available (Harrison 1993). Some substitution may take place, for example, as people and industries change from using wood for fuel to using coal and then to using oil, or from iron and steel to aluminum in the case of metals. But no fundamental resource scarcity is foreseen.

There are at least seven reasons why GDP is not a good measure of welfare (Harrison, 1993, p28):

(a) activities are valued at cost rather than worth
(b) several important goods and services are not included in the accounts because a zero valuation is put on them
(c) the concept of maintenance of capital applies only to man-made assets, and thus no allowance is made for non-produced assets such as land
(d) no allowance is made for holding gains and losses on assets that are brought about by changing prices
(e) human or institutional capital is not taken into account
(f) the contribution of the environment to economic activity is given limited attention
(g) the impact of the economy on the environment is also given limited attention.

1.2 Brief review of the SNA (1968) guidelines on the treatment of man-made capital.

Two types of transactions associated with man-made capital occur on a year by year basis. One of these is consumption of fixed capital (depreciation); thus an allowance is needed to permit the replacement of a capital asset at the end of its useful life. Over the economy as a whole the value of the consumption of fixed capital in a year is the value of all man-made assets used up in that year and which will need to be replaced if the level of man-made capital stock at the start of the year is to be kept intact. A second is current expenditure on repair and maintenance of capital stock. The SNA distinguishes between current and capital repairs as follows:
"Expenditures on the current repair and maintenance make good breakages in fixed assets and keep them in proper working order", while "Outlays on capital repair and alteration lengthen the expected normal lifetime of use of fixed assets or increase the productivity of these goods significantly (United Nations,1968., p3)." This distinction may be blurred in practice. Although current maintenance may not directly extend the life of an asset, the lack of maintenance may shorten it and in practice estimates of life length of assets are based on the presumption that regular maintenance takes place. Thus, there is a relationship between the level of current maintenance and of capital consumption. The SNA also states that: "It may be considered that expenditure on repairs and maintenance are sufficient to maintain the asset in its original condition" as justification for not making provision for consumption of these fixed assets. Experts in the SNA revision process questioned this provision and a suggestion was made to change it in the next SNA Manual. In a number of poorer developing countries, for example, the retrenchment of government expenditure has led to the neglect of road maintenance and in time new capital projects have been undertaken to replace existing roads; capital expenditures that would not have occurred if adequate current maintenance had taken place. Thus it is suggested that if maintenance is insufficient to keep assets in their original condition then estimates of the capital expenditure needed to replace these assets should be made.

1.3 SNA and Environmental issues

Over the last two decades public reaction to environmental issues has broadened from concerns for endangered wildlife and for preserving aesthetically pleasing landscapes, to the realization that the whole process of economic development is dependent on the utilization of natural resources. In extreme cases, such as in sub-Saharan Africa, physical and economic survival frequently depends on the management of land and water resources, both in quantity and quality.

Environmental economists find a number of deficiencies in national income accounting using the present System of National Accounts (SNA). The problems are both of omission and commission. Many activities undertaken in less developed countries, for example collecting firewood for fuel, are excluded from the present measures of Gross Domestic Product (GDP). On the other hand, major projects to rehabilitate polluted rivers or otherwise restore environmental resources degraded in previous periods are included in GDP and if these projects are initiated without matching cutbacks in other programmes, increases in this type of activity lead to increases in GDP (Harrison, 1989).

Various specialised statistical systems have been or are being developed to address questions in specific areas and the environment is no exception. Physical resource accounts are being developed to show, in volume terms, inputs and outputs of physical processes including natural resources and manufacturing products. The United Nations' "Framework for Development and Environmental Statistics" (United Nations, 1984), for example, attempts to put environmental, economic and social statistics in context to show their interaction with one another. Various proposals have been and are being examined to develop an aggregate that includes the "desirables" omitted from the SNA and excludes the "undesirables' that are included in the SNA. It is intended that such statistical systems will form satellite accounts to be used in conjunction with the revised SNA. To the extent that these systems are concerned with the greater elaboration of specific details, the re-arrangement of existing items and the inclusion of others, no conflicts should arise.

However, given the claim of the SNA to provide a comprehensive framework under which all such satellite accounts can be developed, it is important that the process of reviewing the SNA ensures that appropriate interface to environmental matters is established. Furthermore, there is one issue on which environmentalists and the present SNA take very different views.

Environmentalists argue that neither non-renewable resources such as mineral deposits, nor resources such as land and water should be treated as free gifts of nature. While land and water may seem at first sight to be free, we are increasingly conscious that these resources are not automatically self-renewing. Man may have limited power to renew resources, but he has much greater power to destroy them. Economic activity necessarily interacts with nature and provision must be made for programmes which will maintain and husband these permanent resources. Lack of such programmes will lead to the destruction of the resources. The presence or absence of such programmes is therefore an economic decision that directly affects the potential economic activity in subsequent periods, just as decisions on the rate of depletion of non-renewable resources do. In both cases therefore there is a strict parallel between the decisions to create and to maintain man-made capital and it is argued that the SNA should record these resources as alternative forms of capital. The question therefore is how the treatment of these resources as natural capital would change the present practice of the SNA.

Much of the discussion by environmentalists in the past concerned treatment of non-renewable resources such as mineral deposits. Within the production accounts of the SNA, when an exploitable resource, such as diamond, is extracted and sold, only the direct costs associated with its extraction, including labour, are deducted from its market value and the whole of the difference is treated as gross operating surplus. Net operating surplus differs from this in that consumption of fixed man-made capital occurs. Although the process of diamond extraction is treated as production, resource depletion is not corrected for. As a counterpart to this, neither the value of new reserves discovered, nor changes in the value of reserves because of changes in world prices, are treated as income. This currently results in an anomaly when presenting information on stocks. The value of the unexploited diamonds at the start of the year appears in a balance sheet for the industry and the nation, as do the start of the year values of man-made capital assets, but since all changes to the value of the exploitable resource between the start and end of the year are explained in the reconciliation account this occurrence in the balance sheet is in effect a "memorandum" item. If exploitable resources were treated as natural capital, part of what is now treated as gross operating surplus in the production account would appear as consumption of natural capital, and the net operating surplus would be decreased by this amount. A matching entry would then appear in the balance sheet of natural capital assets.

1.4 How does the current SNA classify assets; are "natural" assets adequately covered?

At present, the SNA recognises only certain forms of assets. Environmentalists argue that these assets should include environmental attributes. The assets referred to in the SNA derive from one of three sources:

(a) they may be the result of current production, for example, inventories or fixed capital;

(b) they may represent the use of savings, for example, financial assets;

(c) they may exist naturally, for example, as mineral deposits or other environmental assets, but be drawn into the production sphere and hence become economic assets in the SNA sense.

The following are the characteristics of assets in the SNA:

Inventories

These are recorded as capital resulting from production. They share all the attributes of fixed capital assets, except that they do not generate future income and therefore cannot be valued in the same manner as fixed assets.

Fixed assets

Assets that come from fixed capital formation are works of construction, land improvements, transport and other equipment, and cultivated agricultural assets such as the breeding stock of domestic animals and plantations. All these assets can be given a value related to past production and all could conceptually be given a value related to the future income to be generated by the assets.

Valuables

A new type of capital formation was introduced in the 1993 SNA, known as "valuables". These are assets which were produced at some time within the production boundary of the SNA, neither consumed nor used in production, but representing a store of value to the owner that can be realized at a future time, because their prices are expected to rise, or at least not fall, in the foreseeable future. Examples include antiques, precious stones and works of art.

Non-financial tangible Non-produced Assets

These share many, but not all, of the characteristics of fixed capital. They can be given a monetary value, they generate future income, and they can be transferred from one institutional unit to the another. These assets include land, subsoil assets, timber tracts and fisheries. They were not produced within the production boundary of the

SNA, however, and may not yet have been the subject of an SNA transaction, although by being drawn into the economic sphere they are expected to be the subject of an SNA transaction in the future.

Non-financial Non-produced Intangible Assets

These cover transferable leases, patented entities, copyrights, and purchased goodwill. They represent future income but not production. Because a monetary valuation is difficult to establish for the majority of those that do not come to the market, the SNA accounts record only those which have been the subject of a transaction and for which a market value exists.

Financial assets

Financial assets are not produced in an SNA sense and are always matched by liabilities, except in the case of gold and special drawing rights. All financial assets have a monetary value; they have been and will be the subject of transactions in the accounts and are separable. Those matched by liabilities represent future income and could be valued in terms of this income.

From the above classification of assets by the SNA, Harrison (1993) defines an asset as "a stock of wealth over which ownership can be established and that may be the subject of an SNA transaction in future." She adds, however, that, " given the uncertainty that may exist in some circumstances over what does or does not constitute an SNA transaction, an economic asset may be defined more generally…."(p29). Harrison (1993) looked at the application of this definition to environmental assets. She distinguishes four basic attributes, (land, water, biota and air) which would determine the valuation of natural amenities and resources as assets.

Land

Land is involved in production in a number of ways, in some instances only marginally. The first category to be considered is land that exists as space underlying buildings and structures such as roads and dams. Under this category land is essentially inert. It is involved in production insofar as it yields rent, although in practice it may be difficult to distinguish how much rent should be attributed to the land itself and how much to the building or structure on top of it.

A second category of land consists of ground and associated soil used in agriculture for production of crops, including forests, and to provide for animals. Land in this category also gives rise to rent, but its involvement in production is more extensive because it sustains the biota existing upon it. Agricultural land may change in quality due to inappropriate use and overuse causing the land to deteriorate, but recovery can occur either through rehabilitation or natural regeneration.

The third category is open land designated as parks/reserves and gardens, or any other land that is either unused completely or only marginally utilised. This has many of the same attributes as agricultural land, although the amount of rent involved is nominal, usually consisting only of access fees. Controlled regeneration of open land does not typically take place, although this practice may change as environmental consciousness grows.

In principle all land can be given an absolute value, although a value may be much easier to establish for land under buildings and agricultural land than for parks and wild lands. It is possible to establish ownership over land, even if it is the default ownership by government of land to which no other economic agent has laid claim. Mineral deposits may be regarded as a special type of land. Like the land under buildings, such deposits are relatively inert and do not interact with living biota. They do, however, yield considerable rental values when access to these deposits is granted, and once it is granted they contribute inputs to the production process in the form of minerals. Once payment for access to the deposits has been made, often referred to as royalties, then the deposits are available to the developer at only the extraction cost.

Water

Water can be divided into two categories. The first category, which is controlled water, consists of water connected with dams, irrigation systems, and other waterways that are strictly controlled by human intervention. The second category consists of natural waterways, such as rivers, lakes, and coastal waters. These two categories have the same attributes as agricultural and open land, respectively.

Biota

No rent is produced from living plants and animals, but they yield both renewable products (such as grain, milk and wool) and nonrenewable products on their destruction (such as wool and meat). All biota experience natural growth, which may be regarded as either controlled or natural regeneration. On the basis of the above, biota can be divided into those under direct human control and intervention and those that take place in the wild.

Biota do not constitute a sink for pollution, but the quality of the plants and animals themselves and their products used by man may deteriorate owing to the effects of pollution, for example, because the soil has been degraded due to deforestation or leaching.

Air

Like sunlight and rainfall, air is necessary to the survival of all forms of life, including human beings, and it is therefore implicitly used in production. The stock of air is difficult to define or value, although it is possible, at least in principle, to estimate changes in the quality of air brought about by its use as a pollution sink, and to measure both controlled and natural regeneration.

All environmental attributes can be classified as economic assets in accordance with the definition presented earlier for the assets already included in the SNA. The present SNA asset boundary includes all of these categories of environmental attributes but not all aspects of those attributes.

1.5 How far are environmental attributes accounted for in the present SNA?

Land

All types of land are recorded in opening and closing stocks. The effects of degradation of land are not separately identified in the SNA accounts, but the effect of the price of agricultural land may represent the effects of degradation rather than a falling demand for land. The depletion of mineral resources is also shown as part of other changes in assets account. Thus all changes in the environmental attributes of land and subsoil deposits are in principle taken into account in the present SNA and are indeed treated as assets there, although the way in which depletion and degradation are captured may be unsatisfactory from an environmental point of view.

Biota

Cultivated biota also appear in opening and closing stocks. The consequences of natural growth and off-take are shown in the balance sheets, usually net, either as changes in inventories or as additions to fixed capital. Again, no effects of degradation are shown explicitly, but if drought reduces the value of livestock, the effects will show up in the change in prices to be recorded.

The current SNA subdivides biota into those that yield economic products and those that do not. The first group appears in the balance sheet as non-produced assets. Natural growth and off-take will be recorded as economic appearance of depletion of assets in the other changes in assets account, an inadequate solution from the environmental point of view but satisfactory in accounting terms. Wild biota that do not yield economic products are not treated as economic assets, and no entries appear in the SNA balance sheets.

Water and Air

Water, whether controlled or uncontrolled, and air create problems for any accounting system because of the difficulty of measuring and valuing a stock variable. In principle, the 1968 SNA includes inland waters under the heading of land, and in practice any valuation put on recreational land and other open land is likely to include the value of associated surface water. The 1993 SNA recognizes this joint valuation and continues to include such water with the corresponding category of land. The SNA also allows for some bodies of water that are used as economic resources (such as aquifers) to be included as a further class of non-produced assets.

Neither water nor air undergoes natural growth, off-take, or depletion in the normal sense. Water may become scarce because of geographic dispersion from aquifers to the sea or may be subject to chemical transformation, but tracking this is more difficult than measuring the off-take of wild biota or the depletion of mineral deposits. The SNA does not propose to record such an effect. The SNA does not make any direct allowance for the degradation of water or air.

In a discussion of the SNA, past and present, Lutz and Munasinghe (1991) point out three weaknesses in the SNA's treatment of the environment:

1. National accounts may not represent welfare accurately, because the balance sheets do not fully include environmental and natural resources, and therefore important. changes in the status of such resources are neglected.

2. The true costs of using natural resources in human activity are not recorded in conventional national accounts, the depletion or degradation of natural capital (such as the stock of water, soil, air, minerals, and wilderness areas), which occurs in the course of productive activity, is not included in terms of current costs or depreciation of natural wealth. Thus, resource-based goods are under-priced in the market -the lower the value added, the more underpriced the final product (Dasgupta and Maler 1991). It follows that countries that export primary products do so by subsidising them, often with disproportionately large adverse impacts on the poorest members of society (who are less able to protect themselves)-the small cultivator, the forest dweller, the landless peasant, and so on. Currently, there are no estimates of such hidden costs or "subsidies', but if there were, the GDP of many countries could well be significantly lower. In addition, natural resource depletion raises intergenerational equity issues to the extent that the productive assets available to future generations are unfairly diminished.

3. Abatement or cleanup activities (for example, those that result in expenditures incurred to restore the environment) often serve to inflate national income, but the offsetting costs of environmental damage are not included. In the case of private firms, defensive environmental expenditures (that is, measures to reduce or avoid environmental damage) are deducted from final value added. However, if the Government or households undertake such cleanup costs, they are added to national output. The resulting GDP estimate is incorrect because; (a) harmful outputs like pollution are ignored; and (b) beneficial inputs related to environmental needs are implicitly undervalued.

With the weaknesses of the SNA outlined above, the question arises, to what extent can the SNA be used as a tool for sustained macroeconomic policy decision making? This is discussed in the next chapter, which looks at the role of Natural Resources Accounting and its relationship with the concept of Sustainability.

CHAPTER 2: Natural Resources Accounting (NRA)

2.1 Origins of the Natural Resources Accounting and the concept of Sustainability

Mankind's relationship with the environment has gone through several stages, starting with primitive times, in which human beings lived in a state of symbiosis with nature. This was followed by a period of increasing mastery over nature up to the industrial age, culminating in the rapid material-intensive growth pattern of the twentieth century which adversely affected natural resources in many ways (Munasinghe 1993, p1). This raised a lot of concern about the sustainable use of natural resources, which led to different schools of thought on the definition of sustainability. There are three approaches to the concept of sustainability:

- The economic approach to sustainability is based on the Hicks-Lindahl concept of the maximum flow of income that could be generated while at least maintaining intact the stock of assets (or capital) that is yielding these benefits (Solow 1986, Maler1990). There is an underlying concept of optimality and efficiency that is applied to the use of natural resources. Problems of interpretation arise in identifying the kinds of capital to be maintained (e.g., manufactured, natural, and human capital) and their substitutability, as well as in valuing these assets, particularly ecological resources. The maintenance of constant capital stocks has been regarded as the condition for sustaining social welfare (Pearce et al., 1996).

-The ecological view focuses on the stability of biological and physical systems. Of particular importance is the viability of subsystems that are critical to the global stability of the overall ecosystem (Perrings 1991). Protection of biodiversity is a key concept. The emphasis is on preserving the resilience and dynamic ability of natural systems to adapt to change, rather than the conservation of some "ideal' static state (Munasinghe 1993).

-The socio-cultural concept of sustainability seeks to maintain the stability of social and cultural systems, including the reduction of destructive conflicts (UNEP, et al. 1991). Both intragenerational equity (especially elimination of poverty), and intergenerational equity (involving the rights of future generations) are important aspects of this approach. Preservation of cultural diversity across the globe, and the better use of knowledge concerning sustainable practices embedded in less dominant cultures, are pursued.

In NRA terms, using the first approach would mean that net receipts from the sale of a non-renewable asset (with finite stock) contain an element of capital consumption that needs to be set aside (or reinvested) to compensate for the depletion in the stock of the asset (a general statement of the "Hartwick rule" for sustainability). The said consumption allowance (user cost), which represents depreciation in the stock of an exhaustible natural resource, must then be deducted from the SNA measure of NNP to derive the true indicator of sustainable income and consumption (El Serafy, 1989; Hartwick, 1990). Hartwick & Hageman (1993). The conceptual roots of this approach are not new, user cost was a term used by Keynes in his General Theory (1936) to describe the treatment of depreciation of equipment. In a natural resource context the idea can be taken back to Hotelling's (1925) royalty on the extraction of finite resource stock.

User costs on depletable natural assets were also recognised in the mining economic literature, long before Hick's definition of sustainable income as a charge for reducing the value of a mine through extraction (Marshall, 1936). The same rule was shown to apply to depreciation of stocks of renewable resources (Hartwick, 1994; Vincent & Hartwick, 1997; Vincent, 1997 and Hamilton, 1997). Similar arguments and results were derived for the case of depletion of environmental quality stocks through pollution, and for adding direct and indirect non-market benefits of natural assets and environmental services to income and GDP (Vincent & Hartwick, 1997).

Unlike the Ricardian rent from the "indestructible powers of the soil" (Ricardo, 1821 p379-386), which represents true income and requires no allowance for asset depletion, receipts from the sale of finite asset stocks need to be adjusted for resource depreciation (user costs) to arrive at a correct measure of sustainable income. A debate has emerged as to the point in the accounting process where this correction should take place. El Serafy (1989) suggests a deduction of user costs at the GDP level, while more recent theoretical work on the treatment of discoveries, natural growth, and augmentation of environmental quality has argued that it is appropriate for such additions or appreciation in value, as well as exploration and enhancement costs, to be added to NNP (Dasgupta et al., 1997; Hartwick & Hageman, 1993). The various methods proposed for calculating and adjusting the SNA for depreciation (negative and positive) of natural assets and environmental quality stocks, and hence the flow of their market and non-market services, are reviewed in Hartwick & Hageman (1993) and Vincent and Hartwick (1997).

Based on the imperatives of carrying capacity (assimilative powers and resilience of ecosystems) that determine ecological limits to growth, a parallel approach to sustainability emerged from within the natural sciences. Although the underlying principle of ecological limits is synonymous with the concept of constant capital in economics, the two concepts yield different conditions for sustainability. The ecological economic conditions for sustainability are more stringent and represent a strong sustainability paradigm (Pearce et al., 1996). The roles of technological progress and substitution between natural manufactured and human capital are, in general, insignificant in the ecological economic paradigm. On the other hand, these are central to the neoclassical economic notion which is frequently termed weak sustainability.

While both the economic and ecological approaches require a non-declining assets' base for sustainability of income and well-being, the conditions set by each for attaining this goal vary greatly. In the neoclassical view, since substitution between the various forms of capital is allowed, weak sustainability requires that the total stock of assets, not that of its individual components, remains intact (e.g. growth in one component can compensate for a decline in others). Conversely, strong sustainability requires that certain components of the capital stock, particularly vulnerable natural resources, remain within critical ecological limits of resilience and assimilative capacity. In other words, strong sustainability precludes extinction of species and the exceeding of critical ambient limits even if there is overall growth in the capital asset portfolio. This is based on the notion if there are no perfect substitutes for certain natural assets, their loss implies irreversible ecological damage

The third approach requires that conditions necessary for equal access to the resource base should be put in place and must be met for each generation (Pearce, 1987). This calls for a pattern of social and structural economic transformations (i.e. development) which optimises the economic and societal benefits available in the present, without jeopardising the likely potential for similar benefits in the future. A primary goal of such social and structural economic transformations is to achieve a reasonable (however defined) and equitably distributed level of economic well-being that can be improved for many generations (Goodland and Ledec, 1987)

However, this approach leaves many questions unanswered. Society will still need to determine an appropriate level at which to set discount rates on its consumption of natural resources. Another bone of contention is the policy connection between intergenerational and intragenerational equity. Do policies to redistribute wealth within a society necessarily have any connection with sustainability? At the level of a developing country, any policy meant to help the poor must take into account their environmental tendencies. It is argued that property rights should be effectively given to the poor, which will lead to an increase in their wealth, and therefore the demands they make on the environment. Some reconciliation between cross sectional and inter-temporal equities is obvious where environmental services are normal goods. The affluent portion of society will have an interest in paying the poor not to destroy the environment, simultaneously improving the environment for current and future generations, and redistributing income.

Ideally NRA would contribute the information needed to construct indicators for the conditions of sustainability paradigms. However, indicators for monitoring progress towards weak sustainability targets are much less demanding than those needed for strong sustainability targets and can be more adequately provided within the NRA framework. This is mainly due to the complexity of defining ecological limits for carrying capacity and resilience, and to the limited knowledge and high uncertainty about the functioning of ecosystems, biophysical thresholds, and futures valuation of nature by humankind (Pearce et al., 1996).

2.2 Application procedures of NRA framework

NRA permits the adjusting of the conventional SNA for its errors of commission and omission in its treatment of environmental values. The use of NRA has increased during the past two decades to span a wide range of applications. Various approaches have been followed, especially in industrialised countries, to correct the omissions related to environmental assets and services and to improve measures of income and well-being generated by the current SNA. The approaches and procedures adopted have ranged from minor adjustments of certain aspects of existing accounting frameworks, to the construction of separate satellite NRA, to the major restructuring of conventional economic accounts[1]. There are two approaches used to compile NRA, namely physical resource accounts and monetary accounts, these are discussed in turn. [1]

2.3 Physical Resource Accounts

Physical Resource accounts represent the earliest attempt to account for the extraction and use of natural resources and the generation of waste and environmental externalities in physical terms. The physical resource accounts were initiated as a simple extension of the national balance sheet accounts to record changes in the stocks of key natural resources, and in pollution and energy flows. These accounts were put to several uses related to integrated economic and environmental management. The most common application is their compilation in separate inter-industry input-output (I-O) tables, which are then linked to the economic activities of the SNA through fixed coefficients of resource use and waste generation. The leading pilot applications in this category include the models of Ayerse and Kneese (1969) and Leontief (1970) which addressed air and water pollution. However, these early attempts only considered the flow of polluting materials without necessarily converting such flows into negative or positive environmental impacts, or measuring the extent of pollution damage on sectoral activities or the environment.

The materials balance approach was then extended in terms of energy flows, from primary energy-generating sectors, through conversion processes, to final energy consumption. Energy played the role of money as a physical numeraire in these models, converting different units of measurement of resource requirements and waste output (e.g. minerals, water, etc.) into a currency of energy units. A parallel effort by the UN statistical office led to the development of materials/energy balances (MEB) guidelines as an extended system of environmental statistics (UN, 1976). This approach was further extended to lead to more developed physical resource accounts, monitoring sectoral resource use and the depletion or increase of stocks as well as the generation and disposition of pollutants. Both stock and flow accounts were developed as satellite accounts, separate from SNA. Norway and France adopted this approach for selected resource sectors (Peskin & Lutz, 1993 and Bartelmus et al., 1991). The initial focus on commercially exploited resources such as minerals was

[1] For more information on construction and use of environmental accounts by industrialised countries, see Peskin and Lutz (1993), Bartelmus (1989) and Hamilton & Lutz (1996)

extended to the harvesting of timber and fish resources as well as non-market assets (uncultivated biological resources).

Because monetary values are not assigned to the physical material flows, the depletion of resources, and waste generation, the contribution of these approaches to correcting measures of economic welfare for depreciation of natural capital, non-market values of environmental goods and services, and pollution damage remained limited. Nevertheless, the physical resource accounts can be, and have been, used to address many important questions through integrating resource use and waste generation with economic activity models. Examples of such uses include:

a. Analysing the extent of resource use and the rate of extraction of key resources by various economic activities. This provides powerful information to resource managers, policy makers and development planners about the trade-off between economic expansion and resource depletion. The relative contributions of various economic sectors to current growth versus future decline in assets' stocks and, consequently, well-being can therefore be evaluated to guide priorities in development planning and resource management policies.

b. Similarly, physical resource accounts contribute to pollution management by establishing the link between waste generation and economic activity to evaluate trade-offs between growth and the state of environmental quality. This will enhance the ability to prioritise the relative importance of environmental problems, and assess economic performance against expected environmental damage.

c. By linking economic activity with emission levels, and constructing accounts to monitor change in the absorptive capacity of recipient resource stocks/media (e.g. carbon stock in forests), physical resource accounts allow the evaluation of alternative strategies of pollution management within one integrated framework. This involves assessing the efficacy of targeting source sectors versus, for instance, expanding sink stocks to balance the carbon budget.

d. Physical resource accounts also provide the required information to construct indicators for monitoring resource scarcity (depletion) and distance from ecological limits (e.g. the degree of erosion of biological resources and the levels of environmental damage and contamination). These are critical for evaluating progress towards strong sustainability conditions.

e. The information generated by physical resources accounts on the links between economic activity and the environment provides the basis for evaluating the impacts of alternative development strategies, trade policies, and structural change on the state of the environment and the natural resource base. Similarly, this enables an assessment of the implications of environmental policy and resource management strategies for economic activity and growth.

   Physical resource accounts are generally more useful when constructing strong sustainability indicators, as they contain valuable information on ecological assets and processes.

2.4 Monetary Accounts

Monetary accounts move us from physical resource accounting to the measurement of income and wealth needed to monitor sustainability. Monetary accounting for the environment uses a wide range of applications and procedures. The following are examples of some steps commonly followed towards full environmental accounting.

a. *Treatment of environmental expenditures.* Common to most industrialised economies, this method reflects the prime concern about pollution and environmental quality in these countries. This approach works within the existing structure of the SNA, leading to minor modifications, particularly in the definition and classification of income and expenditure entries (El Serafy & Lutz, 1989 and Daly, 1989). For example, in France and Japan expenditures on pollution abatement are separated from final demand and subtracted from GDP as intermediate inputs. Similarly, environmental defensive outlays by consumers are removed from consumption and added to intermediate expenditure, i.e. excluded from value added (Daly, 1989: Harrison, 1989 and Peskin, 1989).

b. *Treatment of natural asset depreciation.* This is another partial treatment within the present accounting SNA frame. So far this approach has mainly been adopted on marketed natural resources such as subsoil assets, timber and fisheries. However, some attempts have been made at assessing the depreciation of other non-marketed renewable resources and environmental assets (e.g. topsoils, carbon stock, biological diversity, air and water quality) (World Bank, 1997; Young, 1993; Vincent, 1997 and Hoffren, 1996). The cited studies used a wide range of methods to calculate depreciation of natural asset stocks. While there are some important variations in the methods followed to calculate changes in physical stocks, the major source of disparity was the different valuation methods adopted. The net-price and capitalised value methods were those most commonly used (Vincent & Hartwick, 1997).

   The most useful of these corrections are related to adjusted saving measures, which provide improved indicators of macroeconomic performance (Pearce & Atkinson, 1993). An important member of this group is the "real saving" index, a heuristic device which measures depletion of natural assets and accumulation of pollutants from net saving[2] (Hamilton, 1994). The direct policy relevance of these measures is the fact that persistent deterioration in genuine savings implies a constant decline in welfare (Pezzey, 1993 and Hamilton & Atkinson, 1995).

   2

[2] Net saving is derived by subtracting depreciation of produced assets from gross saving

Adjusted saving measures also provide a useful decomposition of the portfolio of capital assets and sources of change in their levels. This generates valuable information for investment policy analysis and economic expansion strategies. For instance, it provides the basis for evaluating the correlation between various measures of growth and macroeconomic performance and movements in the levels of the different components of the assets portfolio (e.g. produced, human and natural). This allows a better understanding of the determinants of economic expansion and environmental degradation and conveys useful information on the trade-offs between growth and sustainability in macroeconomic and environmental management.

c. *Full environmental accounting.* This represents attempts to accommodate all entries of the more comprehensive physical resources accounts into the current SNA, with money values assigned. The Dutch system provides one example where environmental damage is estimated and subtracted from GDP, and where efforts are being made to adjust for resource depreciation. The Netherlands has embarked on a multi-stage programme to move gradually towards full environmental accounting. The UN Statistical Division (UNSTAT) suggested a system of integrated environmental and economic accounting (SEEA), which attempts to combine elements of physical resource accounts, MEB, and monetary valuation in a satellite account supplementing the SNA (UN, 1993). The SEEA addresses many of the deficiencies of the SNA, in terms of adjusting conventional measures of income for natural asset depreciation and environmental degradation. However, a number of limitations remain in the SEEA, mainly in the areas of the valuation of environmental damage, the treatment of ancillary protective expenditures (intra-industry), and the valuation of non-market environmental assets and functions (Bartelmus et al., 1991). The treatment of the depreciation of natural assets as a subsidy from nature to producers, and hence reduced from value added, is also considered unsatisfactory (Harrison, 1993).

   Another example of full environmental accounting was developed by Peskin (1989a). The Peskin approach treats nature as a supplier of intermediate products to processing industries and final consumption goods and services to consumers, in a neo-classical economic sense. It therefore fits the I-O structure of the income and product account of the current SNA. In this framework, valuation of non-market environmental values was based on the benefit side measures of willingness to pay rather than cost-benefit estimates (Peskin & Lutz, 1993).

Information generated by the monetary accounts approach is mainly used to construct improved aggregate indicators of economic performance. Adjustments are made to both the product (GDP) and assets accounts. Examples include what is termed the environmentally adjusted domestic product (EDP) or green national income and savings. These indicators provide a more accurate measure of a country's income, wealth, and welfare changes. They do not themselves produce direct policy advice and prescription, but rather provide information for policy makers and planners to use for planning towards sustainability. Monetary indices offer an evaluation of the relative significance and priority of various environmental problems, as comparisons become feasible with a common currency measure. Increased awareness of, and sensitivity to, environmental degradation and resource depletion issues are an important indirect benefit obtained from these improved measures. Useful information for saving and investment policy is revealed with the improved measures by indicating where depletion is occurring at alarming rates or whether the country is living off its capital stocks. This improves the country's capacity to evaluate the trade-off between current versus future consumption (e.g. higher saving and investment rates). Moreover, valuable sectoral information and indicators are also generated on the rate of recovery of economic rents and how those have been spent (e.g. wasted in current consumption or invested to compensate for depreciation in the exploited natural assets.) Like the physical resource accounts indicators for strong sustainability, monetary accounts provide the basis for evaluating progress towards attaining weak sustainability conditions.

CHAPTER 3

3.1 Application of NRA and experiences in Africa

None of the African countries have started publishing the NRA on a regular basis as an augmentation of the National Income Accounting practice. Only a few cases of research efforts to construct a NRA have taken place or are in progress. There are also efforts underway to expand capacity in this area and to institutionalise NRA. The following is a brief review of experiences in Africa:

3.1.1 Botswana

The first attempt to construct NRA in Africa started in Botswana (Perrings et al., and Gilbert, 1989). Mixed units (physical and monetary) of resource user and stock accounts were compiled for selected resources (livestock, forestry and water) in Botswana for the 1979-86 period (Perrings et al., 1989). The following preliminary estimates of the use and change in the stocks of these resources were not used to adjust measures of income and wealth. However, they did reveal important patterns in the rates of change in the resource stocks, with major policy implications. The information generated was used to provide preliminary analysis of crucial resource extraction issues in the sectors studied. Of particular interest is the correlation between stocking rates and the decline in the livestock and veldt vegetative resources over the study period. This effort, however, did not continue and is currently being revived under a new regional initiative on NRA in Southern Africa, involving Namibia, South Africa, Botswana and Zimbabwe. Institutions including USAID are involved in funding this new initiative, largely via the regional coordinating body,RANESA (Resources Accounting Network for East and Southern Africa) . Currently mineral and water accounts are being compiled for Botswana under the auspices of this regional body. At the time of writing, these accounts are still in draft form Being incomplete they cannot be reviewed here but it will be interesting to compare the framework recommemded in this paper with the one being to be adopted officially.

3.1.2 Tanzania

Peskin (1996b) estimated an inputted value of the net depletion of forest resources in Tanzania, due to fuelwood extraction alone, to be 5% of the total GDP in 1980. This estimate was based on valuing the average time spent in firewood collection and estimating the proportion of harvesting in excess of regeneration.

3.1.3 Zimbabwe

A number of attempts were also made in Zimbabwe to construct environmental statistics and to derive from them improved indicators of income and wealth. The Central Statistics Office (CSO) has compiled and published a set of environmental statistics, including land, soil degradation, forests and woodlands, fuelwood consumption, wildlife, mineral reserves, energy use, and selected pollution figures (waste, air and water quality in Harare) (CSO 1994). The data generated mainly consists of physical units, such as land areas, and numbers and levels of substance and resources. The published booklet containing the statistics suggests that further issues of the publication will be produced regularly. Two studies have produced estimates of resource use and values for selected sectors. Crowards (1994) derived monetary estimates of annual rents and losses attributable to forests and woodlands, soil erosion and gold extraction in Zimbabwe for the period 1980-89. The figures were used to adjust measures of national income (product accounts) for the value of resource depletion, and to analyse various aspects of resource extraction and management in the resource sectors studied. The total value of resource depletion unaccounted for in the conventional SNA wasmore than ZM$200 million (in 1989 values) approximately 2% of GDP during the study period.

Another study by Adger (1993) estimated the net reduction in wood stocks in Zimbabwe, as a result of the extraction of fuelwood in excess of the natural supply, to be 2,7 million tonnes in 1987. This estimate compares well with Crowards' (1996) estimate of 1,9 million tonnes for the same year. However, the two studies calculated very different values for the depletion of forest resources, ranging from 0.23% (Crowards, 1996) to 1.2% (Adger, 1993) of the total GDP in 1987. The main reason for the difference was the large variation in stumpage values for the resource. Similarly, a much higher estimate of the value of the resource depletion in forestry, soils, and minerals was generated by Adger (1993), amounting to more than 7% of total GDP, compared to Crowards (1996) estimate of 2%. A separate study generated estimates of the missing values of fuelwood harvested from forests and woodland resources to be about 0.5% of GDP (Mbugu, 1998). While most of the attempts have remained within the research community, government interest in integrating the construction of environmental accounts into regular functions of national income statistics has been growing. A new initiative by the national planning agency and statistics department, supported by the regional NRA project in Southern Africa, is currently pursuing the task.

3.1.4 Namibia

In 1995 the Ministry of Environment and Tourism for Namibia began a pilot project to construct NRAs for the evaluation of the current natural resource policy, to assist in designing ecologically sound development policies. The pilot project was completed in January 1997 and a new phase of work to institutionalise NRA followed. Namibian NRA generally follows the UN's SEEA, though strongly influenced by the Norwegian system (Alfsen et al., 1987) in its emphasis on constructing detailed physical resource accounts and the integration of the NRA with economic models for policy analysis (Lange, 1997a). Accounts were constructed for water, fisheries, minerals, land degradation, and livestock sectors in Namibia. In most cases, both stock and use accounts were constructed. Plans are in place to extend these accounts to cover forestry, energy, and pollution. Details of the constructed accounts are found in Lange (1997a). The information generated by these accounts was utilised for the following purposes:

a. To bring environmental considerations into economic management and planning in order to address specific macroeconomic policy issues at the national level;

b. To analyse various aspects of resource management within an integrated framework, adopting a system-based approach that captures interdependence and trade-offs between economic activity and the environment. This approach was also placed in dialogue with the making of proactive rather than reactive policy;

c. To provide a concrete basis of objective communication between line ministries on potential impacts, trade-offs and priorities of multi-sectoral development strategies and resource management policies.

The following are examples of the applications of the NRA in Namibia for policy analysis:

1. An analysis of the rate of recovery of resource rents from commercially exploited mineral and fishery resources was made. Results of the analysis show that the Namibian Government has been relatively successful at recovering the rent generated by mining over the past 15 years. However, the rent obtained through taxes goes into a general government revenue pool and is not earmarked for a specific purpose, such as the resource depletion fund. It was therefore not possible to determine whether recovered rents were properly invested in other forms of economically productive assets in order to compensate for the depletion of mineral resources.

Nevertheless, about 40% of the Namibian Government budget was invested in the development of human capital. This sizeable share of current receipts is considered significant in building alternative opportunities and sources of employment and income that can substitute for the expected future loss of economic benefits from mineral resources owing to the depreciation in the stock of assets (Lange & Motinga, 1997).

On the other hand, recovery of resource rents from fisheries has been less successful. Quota levies averaged only 30% of resource rents over the 15-year period since 1980 (Lange & Motinga, 1997). Selling quotas at such low rates provides a weak incentive structure for planners who determine harvesting levels and may lead to over-fishing. An important policy message can be obtained from this analysis, indicating the need for improved measures to discourage over-exploitation and eventual exhaustion of fish resources in Namibia. The annual sale of tradeable quotas is recommended for a better recovery of resource rents and the elimination of windfall profits to fishing companies. In addition to contributing to the optimal exploitation and more sustainable management of fish resources, the collection of adequate rents provides economic resources for investment to compensate for the consumption of natural assets.

2. The Namibian NRA was also used to address many critical aspects of water resource policy, and livestock management and associated land degradation. The current state of water use and allocation, its economic contribution and the extent of water subsidies, as well as the economic optimality of current patterns of water use and infrastructure development, were analysed (Lange, 1997b). Aspects related to the social costs of land degradation as a result of overstocking, and the implications for long-term carrying capacity and lost productivity of rangelands, especially in the context of global warming, were addressed using the constructed NRA (Lange et al., 1997).

Important insights into macroeconomic planning and resource policy design for sustainable management and use of the resources studied were gained from these applications. An important extension of the use of the NRA constructed for Namibia is ongoing work to evaluate the impact of the development strategies in Namibia's first national Development Plan on a natural resources base, through the integration of the NRA with the Input-Output model (Lange, 1997a).

3.1.5 South Africa

After a number of independent and collaborative research projects in this area, stronger commitment from specialised government agencies in South Africa has been gained in terms of budgetary allocations, recruitment of specialised personnel and integration into the agencies' work plans and policies. A pilot initiative was taken by the Development Bank of Southern Africa (DBSA) in collaboration with the World Bank and other local agencies, in the form of a workshop on NRA in 1994. This was followed by a pilot research project which produced the South African Economic and Environmental Policy (SANEEP) model (DBSA, 1997). An attempt was made through the SANEEP model to construct physical resource accounts for water use and the generation of pollutants (e.g. liquid effluents, solid waste and gaseous emissions). The constructed accounts were linked to the 1998 input-output economic model for South Africa to conduct an evaluation of the environmental impacts of various policy and development scenarios (DBSA, 1997). Parallel efforts have taken place at the CSIR during 1996-98 to construct and use NRA in models for sustainable management of forest resources (Hassan et al., 1997 and Beukman et al., 1998). Aspects related to the trade-offs between wood and other sources of energy in terms of economic and environmental (pollution) values were addressed using the constructed models.

The University of Pretoria, in collaboration with other national institutions and withfinancial support from the Environmental Economics Network for Eastern and Southern Africa (EE-NESA), completed a project in 1997/98, where monetary and physical resource accounts were constructed for cultivated forests, natural forests, woodlands and fynbos vegetation (Hassan, 1998a, and Hassan et al., 1998). The studies established very high values for woody resources that are missing from conventional national accounts. Two aspects of forestry addressed were the changing forest stock and the environmental imacts of afforestation (on water tables and on air quality -especially absortion of carbon dioxide). The stock of cultivated forest resources was found to be accumulating at a positive net average annual rate equivalent to more than 2% of the Net National Product (NNP) and 31% of the total GDP of agriculture, forestry, and fishery combined over the 1980-1996 period (Hassan, 1998a). The value of the positive carbon sink externality was, on average during the study period, more than offsetting the negative externality value of water abstraction of cultivated forests. Nevertheless, the contribution of cultivated forests to the total carbon budget in South Africa was found to be marginal. Coupled with the limited options for further reforestation owing to the lack of suitable area and the rising competition for increasingly scarce water supply sources, this indicates a low potential for cultivated plantations to provide an effective instrument for lowering carbon balances in South Africa. The implication for environmental policy on pollution management in South Africa is that measures to reduce carbon dioxide emissions at their source are superior (Hassan, 1998b).

On the other hand, a fall in asset stocks was registered for natural forests, woodlands and fynbos vegetation, indicating unsustainable exploitation rates. This fact calls for better resource management and economic development strategies to reverse the severe rates of degradation and depletion of these resources.

This is particularly important given the rich biological resources that this vegetation supports. These resources contribute a combined direct use value equivalent to more than 5% of the total value- to the national income added in 1998, yet which is unaccounted for in the SNA. (Hassan 1998a)

Continued collaboration with the World Bank has led to the production of a draft working document outlining a proposed framework and plan for the implementation of NRA in South Africa (Blignaut, 1998). The proposed framework and plan have been endorsed and adopted by the CSO, Department of Environmental Affairs (DEAT) and a forum of numerous government agencies, research and non-governmental organisations at a national workshop held in July 1998. One of the comparative advantages that South Africa has over other countries in the region is the strong capacity for and experience in the construction of national accounts in general, in addition to the official commitment of resources, such as the recruitment of specialised personnel (environmental economists) to devote full-time work to the compilation of NRA in the two key agencies which play the main role in the construction and use of NRA (DEAT and CSS).

From the above, it is clear that Southern Africa is taking the lead in NRA efforts, compared to other parts of the continent. While it is perhaps the only region in Africa where attempts have been made in this direction, these attempts remain pilot initiatives of individual academic research interests or are donor-driven. They are yet to be institutionalised for an effective contribution to integrated environmental and economic management and development planning. However, a positive trend is emerging in the region in terms of increasing attention and commitment, from national agencies that generate economic and environmental statistics, to the importance of adjusting measures of national income and economic well-being for environmental degradation and natural resources depletion. Namibia and South Africa are good examples in this regard. New opportunities continue to emerge in the region in support of capacity creation, institutionalisation and research work in NRA. The USAID-funded regional project on NRA in Southern Africa that was recently launched is a good example of regional initiatives involving Namibia, South Africa, Botswana, Swaziland and Zimbabwe. Under this new project a number of NRA activities are planned, including the construction of regional resource accounts for water and other regionally significant and scarce resource sectors.

PART 2

ANALYSIS OF SELECTED NATURAL RESOURCE-BASED SECTORS IN BOTSWANA

CHAPTER 4: The Mineral Resources Sector

4.0 Background

Botswana depends heavily on its natural resource base, mainly on mining. Botswana has a broad range of minerals, including diamonds, copper/nickel, coal, and soda ash, but diamonds dominate economically, accounting for most of the value-added, employment, and government revenues generated by mining. A large number of other minerals are known to exist in Botswana. Those identified so far include: agates, fluorite, kyanite, silver, antimony, glass sand, lead, altered serpentine, asbestos, graphite, limestone, talc, gypsum, manganese, uranium, chromite, iron, platinum, zinc, feldspar and kaolin.

Government policy regarding mining has supported large-scale commercial exploitation of mineral resources to maximise economic rent, which is then appropriated by the government for use on behalf of society. Commercial exploitation of some of the above minerals has been constrained by a number of factors, such as insufficient reserves, unfavourable metallurgical properties and remote locations without the necessary infrastructure. Development is in some cases also constrained by the weak and often volatile markets for some of these minerals. Asbestos, talc, kyanite and manganese have been exploited in the past, but are no longer in commercial production.

Although the geology of eastern Botswana is well mapped, the rest of the country, which is covered by Kalahari sands, remains largely unknown. With the development of new exploration techniques, there has been growing interest by the private sector in exploring the mineral potential of these areas.

Since the economy is dominated by diamonds, it can be quite vulnerable to fluctuations in price and demand for them on the world market. Mining's share of GDP peaked at 51% in 1988 and has since declined to about 33%, as Botswana has sought to diversify its economy and to lessen its vulnerability to changing market conditions for diamonds. Mining's contribution to exports has been even more significant, averaging 81% over the period since 1980.

Clearly, mining is a critical sector of the economy and Botswana's mineral assets form a major source of its wealth. However, Botswana's current national accounts give a distorted picture of the country's economic health because they report the contribution of mining to GDP but not the simultaneous loss of mineral wealth. This is problematic, as minerals are non-renewable resources that are being depleted, even though the economic life of minerals can be extended by new discoveries or new extraction technologies. Mining generates income, but at the same time depletes national wealth by using up the limited supply of mineral assets. Current income is being generated by using up natural capital, which is not revealed under the current national accounting convention.

Natural Resources Accounts seeks to correct this omission, by providing a more accurate picture of the extent to which the economy relies on mineral wealth and the economic implications of the rate at which this wealth is being depleted. The economic value of the mineral resource itself is measured by the resource rent. The resource rent is an extra economic return above the costs of extracting the mineral, i.e. intermediate input costs, labour costs, and the opportunity cost of capital invested in the business (sometimes thought of as an "average" rate of profit in an economy). This resource rent, which occurs because resources are scarce, accrues as "windfall" profits to mining companies unless there are government policies to recover it. Botswana is doing well in recovering this resource rent through appropriate taxes, which are used to benefit all citizens.

Non-renewable resources like minerals will eventually be depleted, and the employment and incomes generated by this activity will come to an end. It is especially important that the resource rents from minerals be invested in other kinds of economic activity, which can replace the employment from, and incomes of, mineral-based industries once they are exhausted. In this way, exploitation of minerals can be economically sustainable, because it creates a permanent source of income, even though non-renewable resources are, by definition, not biologically sustainable.

4.1 Management of Mineral Revenues in Botswana

Diamond mining generates significant resource rent and is of considerable economic value, whereas copper/nickel and coal are only marginally valuable from an economic perspective. As mentioned earlier, sustainable management of mineral resources requires that the resource rent be recovered by government and reinvested in other activities which will generate income after the mineral is exhausted (Hartwick's Rule).

There are two approaches to measure whether the mineral revenues are being used in a sustainable manner. One, which was developed for use by the Ministry of Finance and Development Planning, measures sustainability from a fiscal point of view, the Sustainable Budget Index (SBI). The other, which represents Hartwick's Rule and measures sustainability from the point of view of economic sustainability, is the user cost approach. The latter has not been measured in Botswana because it requires information about diamond reserves. This information is not published in Botswana, and is considered confidential.

4.2 The use of Sustainable Budget Index (SBI)

Botswana has demonstrated considerable fiscal discipline over the years in its use of its diamond revenues. In order to better monitor the purposes for which the mineral revenues are used, Botswana has constructed a Sustainable Budget Index (SBI). The SBI indicates the extent to which annual consumption by the public sector is financed out of mineral revenues, which are considered non-recurrent revenues. The SBI is the ratio of non-investment recurrent expenditures to recurrent revenues (revenues except for mineral revenues). 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 (Ministry of Finance and Development planning, 1996; Wright, 1997). An SBI value of 1 or less means that current government consumption is sustainable because it is financed entirely out of revenues other then minerals, so that all the revenue from minerals is used for public investment. An SBI value greater than 1 means that consumption relies in part on the mineral revenues, which is fiscally unsustainable. Through the early 1990's, the SBI has been less than 1. However, it has increased in recent years, reaching 1 in 1998. The SBI is a useful indicator of the uses of mineral revenues. One of the problems with the Index is its distinction between investment and consumption expenditures; not all public investments are productive and are therefore unlikely to replace mineral revenues once they are exhausted. Capital projects typically occur over a number of years while mineral revenues can fluctuate a great deal from year to year owing to causes beyond the control of the Government. It would be counter-productive to curtail existing capital projects, or to postpone new ones deemed necessary, because of short-term fluctuations in mineral revenues.

4.3 Applying Hartwick's Rule to Mineral Resources Management in Botswana

Hartwick's Rule does not differ much from the SBI, but looks at resource management from the perspective of economically sustainable resource management, rather than fiscal management. For economies such as that of Botswana, which rely heavily on non-renewable resources, it is expected that there should be considerable overlap between the two approaches. Economic sustainability means ensuring a permanent stream of income in the future, equivalent to the stream of rent currently generated by minerals. It tackles the question of how much has to be saved to maintain the income currently received once there are no more diamond revenues. While the simplest interpretation of Hartwick's Rule would be that all resource rent should be reinvested, it may not be necessary to reinvest the entire rent in order to guarantee economic sustainability. In fact if the entire rent is reinvested, there may be an unnecessary sacrifice of consumption by the present generation for the future.

It can be argued that poverty alleviation is a precondition for sustainability since the poor place substantial demands on natural environments. If this is accepted then Botswana could reasonably invest only a smaller amount of its mineral revenues in order to ensure an optimal permanent stream of income. Botswana is currently investing a great deal more than is necessary to attain economic sustainability. Close to 100% of mineral revenues are used for investment by Government on capital budget and human capital development. Investment of more than 50% of mineral revenues imposes an unwarranted hardship on the current generation. It is possible to use more of the rent to fund programmes that are not strictly defined as investment, such as poverty alleviation, without endangering the livelihood of future generations. Because of the close relationship between poverty and unsustainable resource use, future generations may find themselves better off if poverty is alleviated in the current generation.

4.4 NRA Concerns

While total resource rent from mining can be estimated, proper physical accounts for minerals need to be constructed, as this is currently hampered by concerns about confidentiality. Economic accounts for the monetary value of mineral wealth and the depletion of stock cannot be calculated because much of the data needed to calculate economic value is confidential.

For proper accounting to be possible the following will have to be made available:

a. information about reserves of diamonds, copper/nickel and soda ash;
b. information from the national accounts about detailed economic activity disaggregated for each mineral, i.e., value-added and capital stock information for diamonds, copper/nickel and soda ash. Information about the mining industry as a whole is currently available, but is not disaggregated by mineral.

For NRA to be constructed for Botswana, confidential data would need to be made accessible in order to calculate the economic value of mineral assets and the value of depletion of mineral assets.

4.5 Proposed Physical Accounts Frame for Minerals

There will be entries for the estimated reserves, or stock, at the beginning of the year, for any changes due to extraction or new discoveries during the year, and for the reserves at the end of the year. All entries will be reported in physical units, such as tons or carats. Confidential information on diamond reserves cannot be reflected in the mineral NRA, but it should be made accessible for the preparation of the NRA.

Physical data Requirements

a. volume of annual extraction in carats and tons
b. volume of proved reserves in carats and tons

Data Sources

a. Department of Mines (volume of annual extraction)
b. Department of Geological Surveys (for proved reserves)

Table 1. Coal in million of tons

Years	Opening Stock	Extraction	Additions	Other Changes	Closing Stock
1980	7188	0.3	0	0	7187.7
1981	7187.7	0.4	0	0	7187.3
1982	7187.3	0.4	0	0	7187
1983	7187	0.4	0	0	7186.6
1984	7186.6	0.4	0	0	7186.2
1985	7186.2	0.4	0	0	7185.8
1986	7185.8	0.4	0	0	7185.4
1987	7185.4	0.6	0	0	7184.8
1988	7184.8	0.6	0	0	7184.2
1989	7184.2	0.5	0	0	7183.7
1990	7183.7	0.8	0	0	7182.9
1991	7182.9	0.8	0	0	7182.1
1992	7182.1	0.9	0	0	7181.2
1993	7181.2	0.9	0	0	7180.3
1994	7180.3	0.9	0	0	7179.4
1995	7179.4	0.9	0	0	7178.5
1996	7178.5	0.7	0	0	7177.8
1997	7177.8	0.8	0	0	7177

Source:- Central Statistics Office

Table 2. Copper/Nickel in millions of tons

Years	Opening Stock	Extraction	Additions	Other Changes	Closing stock
1980	40.4	2.5	0	0	37.9
1981	37.9	2.5	0	0	35.4
1982	35.4	2.5	0	0	32.9
1983	32.9	2.8	0	0	30.1
1984	30.1	3.1	0	0	27
1985	27	3.3	0	0	23.7
1986	23.7	3.3	0	0	20.4
1987	20.4	3.2	0	0	17.2
1988	17.2	3.3	0	0	13.9
1989	13.9	3.4	0	1	11.5
1990	11.5	3.4	0	3.3	11.4
1991	11.4	3.5	0	0	7.9
1992	7.9	3.6	0	0	4.3
1993	4.3	3.5	0	93.7	94.5
1994	94.5	3.6	0	0	90.9
1995	90.9	3.4	0	35	122.5
1996	122.5	3.6	0	0	118.9
1997	118.9	3.5	0	0	115.4

Source:- Central Statistics Office

Table 3. Diamonds in million of carats

Years	Opening Stock	Extraction	Additions	Other Changes	Closing stock
1980	Information is	5,101	can't be	can't be	can't be
1981	not publicly	4,960	Publicly	publicly	publicly
1982	Reported	7,768	Reported	reported	reported
1983		10,731			
1984		12,882			
1985		12,634			
1986		13,100			
1987		13,225			
1988		15,229			
1989		15,252			
1990		17,351			
1991		16,506			
1992		15,946			
1993		14,730			
1994		15,550			
1995		16,802			
1996		17,707			
1997		20,111			
1998					
1999					

Botswana's base and precious metals potential remains largely under-explored, but more international companies are involved mining exploration in Botswana. The discovery of minerals through new exploration will lead to an increase in the size of mineral reserves (proven), and this can be recorded under "other changes" and reflected under "closing stocks".

4.6 Resource Rent from the Mineral Resources Sector

Table 4. Resource Rent from Coal

Year	Value of Sales	Extraction Costs	Capital Stock	Profits at 10%	Resource Rent	Rent per Unit
1980	un	Un	un	un	un	un
1981	un	Un	un	un	un	un
1982	4	3	22	2.2	-1.2	-3.9
1983	4	0.6	23	2.3	1.1	2.9
1984	4	0.6	24	2.4	1	2.3
1985	5	1.2	31	3.1	0.7	1.8
1986	6	1.7	34	3.4	0.9	2.4
1987	6	1.8	34	3.4	0.8	1.8
1988	8	2.1	48	4.8	1.1	2.1
1989	11	5.6	85	8.5	-3.1	-5.3
1990	13	5.8	69	6.9	0.3	0.6
1991	-	-	-	-	-	-
1992	24	10.7	155	15.5	-2.2	-3.6
1993	25	12.2	161	16.1	-3.3	-8.0
1994	26	15.6	176	17.6	-7.2	-1.0
1995	25	16	99	9.9	-0.9	-2.7

Table 5. Resource Rent from Copper/Nickel

Year	Value of Sales	Extraction Costs	Capital Stock	Profits at 10%	Resource Rent	Rent per Unit
1980	83	43	549	54.9	-14.9	-6.1
1981	79	55	618	61.8	-38.8	-15.8
1982	60	74	233	23.3	-37.3	-13.1
1983	61	66	292	29.2	-34.2	-11
1984	72	28.8	301	30.1	13.1	4
1985	131	115.1	324	32.4	-16.1	-4.9
1986	111	96.5	329	32.9	-18.4	-5.6
1987	382	107	346	34.6	240.7	72.1
1988	472	98.4	367	36.7	336.9	99.1
1989	378	85.6	459	45.9	246.5	71.9
1990	299	256.6	466	46.6	-14.2	-4.1
1991	393	427	484	48.4	-82.4	-23.2
1992	359	419.7	557	55.7	-68.9	-19.7
1993	338	237	533	53.3	47.7	13.6
1994	444	440.6	1,003	100.3	-96.9	-28.4
1995	558	464.5	1,344	134.4	-40.9	-37.1

Source:- Central Statistics Office and author's own calculations

Table 6. Resource Rent from Diamonds

Year	Value of Sales	Extraction Costs	Capital Stock	Profits at 10%	Resource Rent	Rent per Unit
1980	132	13	152	15	104	21
1981	108	28	344	34	46	5.9
1982	233	35	451	45	153	14.2
1983	324	36	509	51	237	18.4
1984	612	34	959	96	482	38.1
1985	970	38	737	74	858	65.5
1986	1,040	50	831	83	907	68.5
1987	1,258	76	915	92	1,090	71.6
1988	2,415	98	1,191	119	2,198	144.1
1989	2,327	109	1,488	149	2,069	119.2
1990	2,659	122	1,784	178	2,359	142.9
1991	2,781	161	2,123	212	2,408	151
1992	2,516	183	2,369	237	2,096	142.3
1993	3,321	214	2,661	266	2,841	182.7
1994	3,771	247	2,957	296	3,228	192.1
1995	4,170	254	3,133	313	3,603	203.5

Source:-the value of sales is estimated by CSO under the assumption that profits for the mining sector are declining. Resource rent was calculated as the difference between the value of sales and the sum of extraction cost and profits. Profit was calculated as 10% return on capital. Rent per unit is calculated as the total resource rent divided by the amount extracted in a given year.

4.7 Proposed Monetary Accounts Frame for Minerals

Table 7. Coal, Copper/Nickel and diamonds
(in millions of Pula at current prices). This is an outline table showing a proposed format. Data is collected, but is not made available to the public.

Years	Opening Stock	Extraction	Other changes	Revaluation	Closing Stock
1980					
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					

Source:-
Separate tables will have to be constructed for each mineral type.

Data Source

1. Central Statistics Office

The economic value of minerals is calculated as a per unit rent for each mineral times the quantity of the estimated reserves of each mineral. The reserves of a given mineral must be valued with its own rent because each mineral earns a very different per-unit rent. For example, the value of diamond reserves must be estimated with the resource rent per carat of diamonds, which would be different to that of coal (see Appendix A for methods of estimating resource Rent).

Monetary Accounts are not constructed owing to the unavailability of data for diamonds, and inadequate data for copper/nickel and coal.

CHAPTER 5: Water Resources Sector

5.1 Background

Water is a scarce resource affecting many aspects of Botswana's development and natural environment. It is a key resource in any plan for implementing a sustainable approach to development. Over most of Botswana rainfall is low, varying from 250mm a year in the far southwest to 650mm in the extreme north; the national average is only 450mm. Most of the rainfall, surface water and water in the soil is lost through evaporation; open water evaporating at a rate of about 2000mm per year. Recurring periods of drought exacerbate water scarcity.

Eighty percent of Botswana is covered by the sands of the Kalahari Desert, which has no effective drainage system apart from dry valleys, which hardly carry any water, even after intense rainfall. Shallow depressions (pans) retain water briefly before it evaporates. The thickness of the Kalahari sand beds inhibits groundwater recharge through rainfall in most areas. Groundwater found beneath these sand beds is generally at great depths and with low yields that can only support a small number of people and livestock. Water is found in areas of calcrete, silcrete and ferricrete formations; consequently drilling and well sinking may be expensive. Away from the Kalahari, groundwater occurs closer to the surface (30-100 metres in eastern Botswana), and is recharged from rainfall.

Surface water resources are concentrated in the thinly populated Ngamiland and Chobe Districts, where the only perennial sources of water, the Okavango and Kwando/Chobe/Linyanti rivers are found. These two systems represent 95% of Botswana's surface water resources. There are a number of ephemeral rivers in eastern Botswana, flowing only during periods of heavy rain, and draining towards Limpopo and Marico rivers, which form the border with South Africa. A number of these rivers are able to store water in the underlying sand, thus providing a source of water for rural users, including water for livestock and small scale irrigation during periods with no flow. Other minor sources of include the pans and dry river valleys in the Kalahari which carry or hold water temporarily after rains. (NDP 7, 1991-1997)

A broad assessment of the total potential surface water resources, *excluding* the Okavango and Kwand/Chobe/Linyanti rivers, gives a potential of just over 200 million cubic metres per year. With only four major dams in operation (Bokaa, Gaborone, Letsibogo and Shashe), about 20% of this potential yield has actually been harnessed. There is, therefore, substantial scope for surface water development, particularly in the northeast of the country. However, a number of factors (such as the flat topography, low dam efficiency, unpredictability and variability of inflow into dams) require that reliable dams have comparatively large storage capacities, which makes the development of surface water resources costly.

Groundwater plays an important role in water supply for domestic, industrial, mining and livestock needs, and becomes even more important during droughts as surface sources dry up. Currently there are more than 14 000 registered boreholes, from which about 60% of Botswana's total water demands are met. The role of ground water as backup to surface water will increase as the economy demands more water.

5.2 Water Use in Botswana

Botswana's total annual water demand is expected to be 193,4 million cubic metres per annum, starting this calendar year, with the agricultural sector, mainly livestock and limited irrigation, consuming about 48% of this. The remainder is shared among domestic, commercial, construction, energy, wildlife and scattered settlements. The largest water users are urban areas (24%), 23% is used by livestock, 18% by mining and energy, 15% by irrigation and forestry, 11% goes to major villages, 5% is for rural villages, 3% for wildlife and 1% for other settlements.

With continued growth in population and other development activities, national demand for water should continue to rise. Since water is a finite resource, which also happens to be very scarce in Botswana, there is urgent need for water demand management and or/conservation projects to raise the nation's awareness of the need to use the minimum amount of water possible in every task.

Water use in the 17 gazetted major villages accounts for 22% of settlement consumption and is growing rapidly as a result of population increase and a shift towards the use of private connections. In some major villages, the average annual growth rate of water demand in the past two decades has exceeded 15%. Per capita consumption for public standpipe users is about 15 litres per day, while consumption rates for yard and house connections are currently about 60 and 120 litres per day, respectively, in these major villages.

The water use in more than 460 rural villages with potable water supply accounts for about 10% of settlement consumption. Consumption per capita per day in these villages is still low, about 34 litres, and almost all the water is supplied through public standpipes.
Other minor settlements use small amounts of water, usually from local sources, such as pans, sand rivers, hand-dug wells and boreholes. Although rural villages and lands areas contain more than 50% of the population, they account for less than 20% of the settlement consumption of water. Overall they have a per capita consumption of less than 20 litres per day.

In the past, there was little or no competition between the different types of water use, since each could be supplied independently. As demands for water increased, however, competition between different water users has emerged, particularly among towns, mining, irrigated agriculture, rural and major villages. This competition is expected to increase, once the Agriculture Master Plan is finalised. This is expected to recommend a move towards irrigated agriculture to achieve food self-sufficiency. If sustainability is an objective, a comprehensive approach to planning in the sector, with possible revision of the National Water Master Plan, is therefore essential. In addition, regional water supply schemes, using both groundwater and surface supplies to serve clustered demand centres, are becoming increasingly appropriate.

While the National Water Master Plan provides a great deal of detailed information about water use, it cannot provide a systematic and comprehensive assessment of sectoral comparative advantages in water use. This is because its classification of end-users is not the same as the classification of economic activities used for the

National Accounts. In addition it does not provide a permanent process for monitoring trends in this economic aspect of water use over time.

Highly detailed information about water use, water tariffs and the cost of delivering water is required so that Natural Resources Accounts can be constructed for a classification of end-users that is comparable to the classification of economic activities used in the National Accounts. The National Water Master Plan can be used as a reference document, but more detailed information will be required to compile the water NRA.

5.3 Physical Accounts for Water from 1980-1995

Table 8. Water Accounts (in cubic metres)

		Perennial Surface Water Annual runoff of Major Rivers		Ephemeral Surface Water	
Year	Ground Water	Okavango	Kwando/Chobe/Linyanti	Annual Runoff	Annual Dam Storage
1980	Un	5,046	1,823	77	463
1981	Un	5,135	1,003	78	456
1982	Un	3,907	739	89	348
1983	Un	9,408	896	194	416
1984	Un	5,375	889	236	564
1985	Un	4,629	1,026	388	336
1986	Un	4,239	1,030	479	312
1987	Un	5,393	877	415	300
1988	Un	5,820	1,026	116	256
1989	Un	4,370	1,064	123	465
1990	Un	3,882	975	335	566
1991	Un	6,607	767	456	601
1992	Un	3,228	878	214	758
1993	Un	2,998	844	224	894
1994	Un	3,883	933	303	841
1995	Un	5,669	1,765	367	780

Source:- Water Utilities Corporation and Department of Water Affairs

There are three natural sources of water supply, which vary in terms of location, renewability, quality and reliability:
- groundwater which is found throughout the country, varying in quality
- perennial surface water supplied by the rivers that occur along Botswana's boundaries
- dams that capture seasonal surface water from rainfall, which is unpredictable in location, timing and quantity.

Data Sources

1. Water Utilities Corporation (WUC) (for volume of water supplied to urban areas and mining)
2. Department of Water Affairs (DWA) (for volume of water supplied to major villages)
3. District Councils (for volume of water supplied to rural villages)

Estimates of groundwater reserves, of groundwater depletion and groundwater pollution will have to be made. Many countries have incomplete information about groundwater stocks, as it is not easy to compile this information. But without information on groundwater stocks, it will be difficult to assess groundwater depletion. However, the depth of the water table can be used as a proxy indicator of depletion. For example, depletion can be indicated by boreholes whose water tables fall continuously over a certain specified period and do not recover during periods of rainfall. This information can be used to supplement the water stock accounts by recording the amount of water provided by boreholes experiencing depletion.
It should be noted, however, that not only the severity, but also the implications of groundwater depletion are not easy to determine, especially in countries like Botswana with highly variable rainfall. The rechargeability of aquifers from heavy rainfall may be affected by economy induced changes in the environment, e.g. roads and housing which increase runoff and raise the amplitude of river flows, siltation of riverbeds. More information is required to determine the cycle for Botswana's underground streams and aquifers.

Some of the groundwater found in Botswana is saline (e.g. water found in Chokwe and Robelela) and some has been polluted by nitrates from pit latrines (e.g. water in Ramotswa). Until this water is purified, for example through desalination, then it will be harmful to the agricultural sector as it can destroy crops.

5.4 Water Use by Sector

Table 9. water use by economic activity and source in 1995 (millions of cubic metres)

	Ground Water	Perennial Surface Water	Ephemeral Surface Water
Agriculture	**249,5**	**150,6**	**104,3**
Livestock	54,6	45,3	33,9
Irrigation	87,5	49,1	42,6
Freehold farms	107,4	56,2	27,8
Mining	**29,9**	**0**	**0**
Coal	5,6	0	0
Copper/nickel	6.2	0	0
Diamonds	18,1	0	0
Manufacturing	**11,9**	**1,3**	**9,2**
Meat Processing	0,1	0	0,1
Other Agric, Proc.	2,2	1,3	0,8
Beverages	4,6	0	3,6
Other Manufacturing	5,0	0	4,7
Utilities & Services	**5,2**	**0**	**4,1**
Utilites	0,5	0	0,1
Construction	1,2	0	2,7
Trade, Hotels & Rest	1,8	0	0,7
Transportation	0,6	0	0,1
Communications	0,2	0	0
Banking & Insurance	0,1	0	0,2
Self-owned housing	0	0	0
Social services	0,9	0	0,3
Households	**79,3**	**0,3**	**13,5**
Urban	31,7	0	12,8
Major villages	34,9	0.2	0,7
Rural villages	12,7	0.1	0

Source:- Water Utilities Corporation, Department of Water Affairs

Data Sources

1. Official records from WUC, DWA and District Councils
2. Informal sources (estimates based on rough assumptions, such as average daily water use per person.

5.5 Monetary Accounts Frame for Water in 1995

Table 10. Use of water by economic activity (in millions of Pula)

	Total amount of water used	Cost of Delivery	User Charge	Value-added	Water Pollution
Agriculture	**504,4**	un	un	un	un
Livestock	133.8	un	un	Un	un
irrigation	179.2	un	un	un	un
Freehold farms	191.4	un	un	un	un
Mining	**29,9**	un	un	un	un
Coal	5,6	un	un	un	un
Copper/Nickel	6,2	un	un	un	un
Diamonds	18,1	un	un	un	un
Manufacturing	**11,9**	un	un	un	un
Meat processing	0,1	un	un	un	un
Other Agric.Proc.	2,2	un	un	un	un
Beverages	4,6	un	un	un	un
Other Manufacturing	5,0	un	un	un	un
Utilities & Services	**9,3**	un	un	un	un
Utilities	0,6	un	un	un	un
Construction	3,9	un	un	un	un
Trade,Hotels & Rest.	2,5	un	un	un	un
Transportaion	0,7	un	un	un	un
Communications	0,2	un	un	un	un
Banking & Insurance	0,3	un	un	un	un
Self-owned housing	0	un	un	un	un
Social services	1,2	un	un	un	Un
Households	**93,1**	un	un	un	un
Urban	44,5	un	un	un	un
Major villages	35.8	un	un	un	un
Rural villages	12,8	un	un	un	un

un : unavailable
Note: Data is not available in disaggregated form from the various sources.

Data Sources

1. Accounting Sections of WUC and DWA
2. Treasury Department of District Councils

Water has been supplied to many users at less than the recovery cost. With increasing demand for water, pricing policy has come under review and the principle of cost recovery has been adopted for most users. (See principles of water valuation, Appendix B)

CHAPTER 6: Energy Resources Sector

6.1 Background

The favourable economic conditions that occurred over the past two decades have allowed Botswana to meet its basic energy requirements. The country has abundant coal, which supplies 99% of domestic requirements and produces 93% of domestically generated electricity. However, many households still consume large amounts of fuelwood, which puts pressure on the resource, especially around the main population centres. The country has not yet made significant use of solar energy.

Botswana's energy profile is dominated by fuelwood, which contributes 58% to the total primary energy supplied. This is followed by coal at 23%, petroleum at 18,5%, electricity at 0,5% and solar energy, which contributes negligibly, compared to other sources. If energy used in production is excluded (referred to as "net energy supply"), fuelwood and petroleum products account for 69,4%, and 19,2%, respectively. Coal accounts for only 5,6%, as most of it has been used in generating electricity, and electricity stands at 5,85%. Solar energy remains comparatively insignificant at 0,01%.

The energy pattern reflects the economic and social structure of the country. Fuelwood is mainly consumed in the residential sector, especially in the rural areas where the majority of the population resides, and the degree of commercialization is very low. It is also consumed in the small to medium scale commercial enterprises and in Government institutions like primary schools. Medium- and high-income households use mostly liquefied petroleum gas and electricity. Liquefied petroleum gas is gradually making inroads in low-income houses, either because of the convenience this fuel offers, and/or because fuelwood is becoming scarce in some areas. Petroleum products, which are all imported, are mainly consumed in the transport sector. Diesel demand, which follows petrol, has been gradually going down as some of the institutions that use diesel generators are now replacing these with grid connections. Coal and electricity are mainly used in the industrial sector, especially in mining. Coal is gradually beginning to be used in manufacturing, Government institutions and, to a minimum extent, households. Solar energy is generally used by Government institutions, particularly schools, clinics and some private homes.

6.2 Energy resources management

Petroleum

The monitoring and coordination of petroleum products is done by Government. This entails the procurement of petroleum products, the maintenance of government strategic reserves, and price regulation for paraffin, petrol and diesel. Purchasing and physical distribution of petroleum are left to the oil companies. Almost all the petrol is used for transport. Diesel fuel, apart from transport, is also used for water pumping as a source of energy, isolated power generation and standby power generators. Illuminating paraffin is widely used by low-income households for cooking and lighting purposes.

All petroleum products are imported from South Africa. In order to diversify sources of supply in case of interruptions, as well as to meet ever-increasing demands, alternative sources have been sought unsuccessfully by Government. A review of strategic reserves, four years ago, showed that existing storage capacity would not meet the 60 days supply cover required in case of emergency. Government is working on increasing underground storage capacity.

Fuelwood

The availability of fuelwood as a primary source of energy for most of the rural population has now reached a critical level in certain areas in South-Eastern Botswana. The people most vulnerable to shortages are generally those in the lower income bracket, who are unable to purchase fuelwood and do not have the means to collect fuelwood from areas beyond walking distance. There is close cooperation among institutions, which deal with fuelwood, with the Ministry of Agriculture taking the lead responsibility in forestry management. The Ministry has set up management schemes in fuelwood collection zones in Eastern Botswana. These ensure adequate supplies of fuelwood and promote afforestation activities to meet community needs for wood products. The schemes also monitor and control the use of fuelwood by Government institutions and promote the use of other fuels like coal. The National Institute of Research takes responsibility for carrying out research on the productivity and regeneration of indigenous wood species in order to make improved policy contributions on their sustainable use and management.

Coal

Botswana has large coal resources, though these are only of average quality owing to, among other things, high ash and sulphur content. Coal production is undertaken by the private sector. Major consumers of this resource are the Botswana Power Corporation and the various mines. Other coal consumers are government institutions, manufacturing (mainly BMC), industries and households.

Under the Expanded Coal Utilization Project (ECUP), through its technical and extension efforts, there has been increased consumption of coal in industrial, commercial and Government institutions. ECUP has created a market that is in the region of just over 30 000 tonnes. The Morupule Colliery also markets coal to some small consumers, and has built a coal grading plant at the request of ECUP. Investigations into improving the quality of Botswana coal are continuing, and, if proved viable, a coal beneficiation plant will be constructed in cooperation with Morupule Colliery. Coal imports in the region of 10 000 tonnes per annum are required to meet the higher quality needs of some industries.

Electricity

The major supplier of electricity in Botswana is the Botswana Power Corporation (BPC), operating a national grid from Morupule Power Station. The power station has done very well so far, reaching performance levels of over 90%. Transmission and distribution lines have been constructed over many parts of the country now, with the south-eastern part of the country having a high percentage of electricity coverage. The major consumers of electricity are industry (55%), commerce (25%), households (13%) and Government (7%). Consumption or uptake of electricity by households is still at low levels, despite its subsidization by Government through the Rural Electrification Scheme. Low incomes in the rural and low urban areas limit the ability of people to take advantage of high quality electricity supplies on a cost recovery basis.

Purchase of cheaper electricity from neighbouring countries, especially South Africa, has also been facilitated through the Southern African Power Pool (SAPP). Another power substation is planned, and should supply the country's load requirements until at least the year 2007.

6.3 Environmental Concerns

Environmental problems related to the energy resources sector are not yet serious in Botswana. However, fuelwood collection has increased over the years due to population growth in the rural areas. This suggests that, over time, unsustainable harvesting of fuelwood resources will occur. This can only be countered by an increase in formal employment and associated incomes, which will enable people to switch to other fuels that are more convenient. The use of wood for fencing and shelter may also decline in favour of other building materials. It must be noted, however, that this "energy ladder" theory may not apply, as evidence shows that households typically employ a combination of energy forms depending on cost and application. Households also behave rationally. If electricity is expensive, they will turn to liquefied petroleum gas or wood for energy intensive applications such as cooking.

Although it can be assumed that fuel combustion is not currently producing a dangerous concentration of toxins and pollutants on a national scale, hazardous levels may potentially occur in some densely populated areas with increased energy consumption. It is important, then, that utilization of fuels that show low emission levels be encouraged and that those with high emission levels be discouraged. Emissions levels can be reduced by improving combustion technologies and by improving the quality of fuels like coal. Most importantly, the capacity should be built or improved to monitor energy related pollution. To overcome long-term environmental problems, environmental impact assessments are required to determine the potential ecological impact of energy developments and projects well in advance of implementation. The only sector with high emission levels is mining (in particular Morupule coal mine and Selibe-Phikwe copper/nickel mine), but at neither have emission levels exceeded the maximum limits set by Government. The abatement costs incurred in keeping these emissions within required levels, are not reflected in the national accounts. Botswana is quickly getting industrialised, hence there is a need to start accounting for all the pollution that currently occurs.

Table 11 Proposed Physical Accounts Frame for Energy

	Petroleum Products							
Years	Petrol	Diesel	Paraffin	Others	Coal	Electricity	Fuel wood	Other fuels
1980								
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989								
1990								
1991								
1992								
1993								
1994								
1995								
1996								
1997								
1998								
1999								

Data sources

1. Botswana Power Corporation
2. Morupule Colliery
3. Department of Energy Affairs

6.4 Energy Use by Sector

Table 12. Use of energy fuels by economic activity

	Petroleum Products				Coal	Electricity	Fuel wood	Other fuels
	Petrol	Diesel	Paraffin	Others				
Agriculture								
Livestock								
Irrigation								
Freehold farms								
Mining								
Coal								
Copper/nickel								
Diamonds								
Manufacturing								
Meat processing								
Other agric. Proc								
Beverages								
Other Manufacturing								
Utilities & Services								
Utilities								
Construction								
Trade, Hotels & Rest								
Transportation								
Communications								
Banking & Insurance								
Self-owned housing								
Social services								
Other								
Households								
Urban								
Major villages								
Rural villages								

Data Sources

1. Botswana Power Corporation
2. Department of Energy Affairs
3. Central Statistics Office

6.5 Proposed Monetary Accounts Frame for Energy

Table 13. Use of energy by economic activity (in Pula)

	Total amount of fuel used, e.g. coal	Cost of delivery	User charge	value-added
Agriculture				
Livestock				
Irrigation				
Freehold farms				
Mining				
Coal				
Copper/nickel				
Diamonds				
Manufacturing				
Meat processing				
Other Agric. Proc.				
Beverages				
Other Manufacturing				
Utilities & Services				
Utilities				
Construction				
Trade, Hotels & Rest				
Transportation				
Communications				
Banking & Insurance				
Self-owned housing				
Social services				
Other				
Households				
Urban				
Major villages				
Rural villages				

Data Sources

1. Botswana Power Corporation
2. Central Statistics Office

The pricing of energy products remains the central tool of energy policy. An economically efficient price should reflect the true cost of supplying energy; that is, price is equal to the marginal social cost (MSC). However, MSC is equal to the marginal private cost (MPC) plus the marginal external cost (MEC). The problem is that MEC is not just a function of the energy resource, but also of its end user. The same emission constitutes a far lower value emission in rural Botswana than it does in Gaborone.

Properly set energy prices will encourage additional production and exploration for minerals like coal and natural gas, and discourage inefficiency or wasteful consumption. If there are constant returns to scale, long-run marginal cost pricing is suitable as it contains contributions to future investment needs (basic microeconomics shows that with increasing returns to scale there is always a need for a subsidy, which is a potential source of distortion). Although most energy prices in Botswana tend to reflect true cost, further efforts are required to improve the efficiency of the energy market. The pricing will be reflected in the conventional national accounts, and one would like the accounts to reflect the full social rather than the private costs of all resources.

CHAPTER 7: Livestock Resources Sector

7.1 Background

This sub-sector is dominated by the cattle industry of 1,8 million head. This is a decline from the 2,7 million head recorded 10 years ago. More than 80% of the cattle are in the traditional sector. The decline in cattle numbers is mainly attributed to drought, poor management, mainly by absentee farmers, and the cattle lung disease, which relatively required the eradication of 300 000 cattle.

The small stock population is around 2,1 million, with 1,8 million goats and 0,3 million sheep. The number of small stock has increased over the years, as these species have been less affected by the recurring drought. The goat population has increased at a higher rate than that of sheep over the years. This increase might be attributed to the utilization of Financial Assistance Policy funds which subsidise purchases of small stock, often from outside the country.. However, growth in production is constrained by high mortality rates as a result of poor management, weak extension service, and inadequate technical support.

Poultry production has increased by over 150% over the past decade, leading to a 40% reduction in poultry imports. However, the country still depends on imports for day-old chicks. The country is almost self-sufficient in egg production.

7.2 Livestock management

The on-farm Artificial Insemination Pilot Programme and range resource conservation have played an important role in improving the value of the national herd. More than 50 farmers from two pilot areas (Northern and Southern regions) carried out artificial insemination on their own farms. Awareness of the need to fence grazing areas has also been created in the Tribal Grazing Land Policy (TGLP) ranches. More than sixty percent of the TGLP ranches are now perimeter fenced with a minimum of four paddocks. Farmer participation in fodder production has also increased tremendously over the past 10 years.

The Ministry of Agriculture has been focusing on the prevention and control of diseases of economic importance. Botswana has maintained Foot and Mouth Disease free status since 1980. An outbreak of Lumpy Skin Disease (LSD) was controlled through an effective vaccination programme. There was an outbreak of the Cattle Lung Disease in the North-west region of the Country in 1995. The Government adopted a disease eradication policy and over 300 000 cattle were destroyed; about 35% of the cattle destroyed were replaced subsequently within the area.

Botswana's beef is exported to two lucrative markets, the European Union (EU) and South Africa, through quota arrangements. The EU prices are estimated to be more than 20% above non-EU world prices, and 5% above South African prices. The lucrativeness of these markets has led Botswana to concentrate on these two markets only. However, this has not been without cost to the livestock industry. Even though the EU market is profitable, it has the most stringent rules against livestock diseases. This makes it a highly volatile market. An isolated case of a single animal with a disease, such as Foot and Mouth Disease, automatically leads to an instant complete embargo on beef from that particular area. It is for this reason that Botswana's beef export to the EU was almost zero in 1980 (Fidzani et al., 1998).

The lucrative and volatile EU market has led to the heavy investment by the Ministry of Agriculture in both infrastructure and disease control. The country has had to be divided into regional camps, through the use of cordon fences, to limit and control cattle movements. This makes it possible for some areas to remain open for the EU market even when there is an outbreak of disease in another region. These investments have proven to be very expensive, both financially and ecologically, especially since Botswana has not been able to meet its full EU quota. This means that Botswana has not been able to maximize the potential benefits this sector could have provided.

7.3 Environmental Concerns

The expansion or most probably the over-expansion of the livestock resources sector, due to borehole technology and substantial Government support through subsidies, has penetrated into marginal areas with high risks of resource degradation. This may be at the expense of sectors like wildlife, the returns on which are consequently reduced. The Government has traditionally supported the livestock sector as it was considered more suitable in most parts of the country than cultivation. Most livestock policies aim to increase livestock production through the development of both the commercial (freehold/leasehold land) and the traditional livestock resources sector (communal land). Although the focus of livestock support has been on increased production, depletion of renewable resources is a growing concern to the Ministry of Agriculture. The lack of incentives for sustainable resource management has been recently identified as one of the four factors contributing to land degradation (together with poverty, population growth and lack of management capacity, MOA, 1996).

The increase in livestock production has led to overstocking or overgrazing, the end result of which is rangeland degradation. This in turn led to the loss of some valuable forage and reduced rangelands' resilience and ability to withstand drought. All these factors reduce both the sustainability of the rangelands in the long run and the economic viability of the livestock sector.

As the livestock sector is dominated by cattle, Botswana may need to diversify its beef markets. The country's dependence on the EU market will have to be reduced, as the European consumers might in future come up with other reasons to put an embargo on imported beef. The opening up of the EU market, because of the World Trade Agreement, will require the EU to reduce subsidies on its livestock sector and this will naturally reduce the beef price. This will also increase competition for access to the EU market from other beef producers. Other beef producers might also end up competing for the South African beef market with Botswana. It is therefore imperative that Botswana identifies other beef markets, even if they pay less than the EU or South Africa.

Botswana can also trade cattle on the hoof for breeding purposes. This might encourage farmers to sell cattle at an early age in South Africa (which is a bigger market), which would save forage. Farmers will thus be encouraged to concentrate on the quality of the breed rather than the number of animals bred. This will reduce pressure on rangelands, as less land is needed for this purpose.

Table 14 Proposed Physical Accounts Frame for Livestock

	Communal Areas	Freehold Farms	Stateland Farms
Agricultural District	Various species	Various species	Various species
Bamalete/Tlokweng			
Kweneng South			
Kgatleng			
Kweneng North			
Kweneng West			
Borolong			
Ngwaketse North			
Ngwaketse South			
Ngwaketse Central			
Ngwaketse West			
Serowe			
Mahalapye			
Palapye			
Bobonong			
Selibe-Phikwe			
Machaneng			
Letlhakane			
Masunga			
Tutume			
Tonota			
Gumare			
Okavango			
Maun			
Chobe			
Hukuntsi			
Tsabong			
Gantsi			

Note: Various species means cattle, goats, sheep, horses, donkeys and other domestic species.

Physical Accounts will need to be developed each year for the various Agricultural Districts. These will be important in the sense that decisions will have to be made on whether some districts should continue to be Agricultural Districts. For example, the Bamalete/Tlokweng District is the smallest in the country, where arable land has already been lost to residential use. This has reduced the livestock carrying capacity of land and the relevant Land Board cannot allocate land for pastoral farming anymore. The data are currently published in aggregate form, however they are collected at a district level, it is proposed that they should be kept in this dis-aggregated form. This would mean that the impact of livestock in wildlife-rich districts could be assessed.

Data Sources

1. Ministry of Agriculture (Animal Production Department)
2. Central Statistics Office

Table 15. Proposed Monetary Accounts Frame for Livestock

	Cattle					Sheep				Goats			
Years	Off Take	Total value	Value of beef sold	Value of meat prod.	Value of by-prod.	Off Take	Total value	Value of mutton	Value of by-prod.	Off take	Total value	Value of mutton	Value of by-prod.
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	219	53,820	104,991	94,371	17,253	3,4	129	226		4,1	154	153	
1984	222	54,724	106,990	92,875	16,748	7,9	348	321		8,2	341	379	
1985	192	50,980	111,732	99,181	20,746	10	456	502		16,8	728	786	
1986	174	50,594	169,187	129,944	21,683	10,1	521,7	518		22,8	1,058	1,133	
1987	118	38,569	91,825	82,770	22,000	11,8	681	533		29,5	1,479	1,552	
1988	185	65,811	113,565	88,933	26,033	9,6	511,4	516		23	1,200	1,491	
1989	211	134,314	349,001	290,220	38,793	7	540	555		13	633	743	
1990	197	66,745	117,809	96,776	26,875	5,6	355	381		11	567	588	
1991	163	99,148	263,104	241,433	28,564	8,2	520	480		13,9	669	711	
1992	205	106,742	389,233	211,121	34,123	5,7	349	355		6,4	346	341	
1993	197	125,250	461,700	355,600	39,623	4,2	288	293		4,8	260	288	
1994	150	94,949	251,923	203,426	48,497	3	197	192		2,6	153	164	
1995	177	140,422	273,929	216,864	57,142	3,1	283	277		2,6	194	201	
1996	142	115,811	464,435	379,397	85,039	4,2	430	485		3,1	262	272	
1997	140	131,481	300,663	213,585	87,079	2,8	306	366		2,1	188	183	
1998													
1999													
	('000)	(P'000)	(P'000)	(P'000)	(P'000)	'000	(P'000)	(P'000)	(P'000)	('000)	(P'000)	P'000)	
	(P'000)												

The above table proposes monetary accounts for selected livestock that appear on the production accounts of Botswana's National Accounts. It will be very important to include, in future, other livestock, such as poultry, whose production has been increasing over the years. Separate monetary accounts for cattle may be necessary, in order to reflect Government subsidies used to support the cattle industry, which are not taxed. The increase of subsidies for and lack of tax on the cattle industry has led to an increased number of players in the industry, and consequently also to range degradation.

Data Sources

1. Botswana Meat Commission
2. Municipal abattoirs
3. Central Statistics Office

CHAPTER 8: Wildlife Resources Sector

8.1 Background

The wildlife resources of Botswana are some of the most significant in Africa, if not in the world. There are populations of a wide variety of free-ranging ungulates and associated predators. National Parks and Game Reserves currently cover 17% of Botswana. Surrounding these protected areas are Wildlife Management Areas (WMAs) which occupy a further 20% of Botswana. These protected areas are the main strongholds of wildlife.

An aerial monitoring programme, carried out on a yearly basis, has made it possible to estimate the number of main game species. Studies have been conducted, in which aerial count data, collected by the Department of Wildlife and National Parks (DWNP), are compared with those of previous surveys. These studies suggest that, in certain areas, wildlife numbers have declined over the years, mainly as a result of drought. Wildebeest and hartebeest are the more severely affected species, whereas densities for more drought resistant species, such as Gemsbok and Springbok, seem to have been affected much less. In the north of Botswana, where the largest and most valuable wildlife populations occur, the presence of permanent water and floodplain conditions appears to have reduced the effects of the drought on animal densities. In the Okavango delta, for example, game biomass appears to have remained stable for the past 10 years. Away from the permanent water sources of the north, evidence suggests that there has been a general decline in biomass similar to that recorded in the Kalahari region. Apart from drought, wildlife species have been heavily affected by cordon fences, which impacted negatively on their normal summer migration to Zimbabwe.

Wildlife has been frequently identified as an under-utilized natural resource. This refers to the fact that commercial wildlife utilization did not contribute sufficiently to national and local development. During the current plan period, the Government has identified tourism as one of its engines of growth, and wildlife happens to be dominating the tourism sector. The reduction in wildlife resources represents considerable capital loss, particularly in rural areas (Arntzen et al., for Boteti area). This has an adverse impact on rural livelihoods (e.g. less game meat) and on future development opportunities through wildlife utilization. Currently, wildlife utilization takes place in the areas of safari-hunting tourism, game-viewing tourism, subsistence and licensed hunting, commercial wildlife production (farming, ranching etc.) and secondary trade and processing of wildlife products.

8.2 Wildlife Resources Management

The government of Botswana has developed a number of policies, after recognizing the development potential and threats to wildlife resources. These policies are aimed at promoting sustainable wildlife utilization based on resource use and conservation. National Parks and Game Reserves, occupying 17% of total land in Botswana and managed by government, have been set aside primarily for wildlife preservation. No hunting is allowed and no natural resource can be removed from these areas. Wildlife management Areas (WMAs) have been established in areas thought to yield higher returns from wildlife utilization than traditional forms of agriculture and other non-wildlife uses. WMAs also act as buffer zones around Parks/Reserves or as protection for migratory routes. The country has also been fully divided into Controlled Hunting Areas (CHAs), for each of which annual quotas are determined following aerial counts of wildlife. Most of the CHAs and photographic areas in northern Botswana are now leased to the private sector in order to realize optimum utilization of these areas.

An ostrich management plan to promote ostrich conservation and utilization was developed. This enabled a number of people to venture into ostrich farming projects. Management plans for elephants and crocodiles are also in place. Community-based wildlife management projects are also being carried out throughout the country under management or conservation trusts. Despite the implementation of these projects a number of constraints have become apparent. Some communities do not know the boundaries of their areas. Others lack support from local administrations and do not understand the opportunities that the programmes afford them. There has been insufficient staff to guide and assist communities in this respect.

8.3 Environmental concerns

Apart from the destruction of habitat by elephants, most of the wildlife resources do little damage to the environment. A lot of environmental degradation seems to come from outside this sector. The wildlife resources sector is facing increasing competition for rangeland from the livestock sector. The expansion of the livestock sector into marginal areas, owing to the poor location of boreholes and to veterinary cordon fences being put up, has reduced the size of land designated as WMAs. Apart from interfering with the migratory routes of wildlife, range degradation reduces the resilience of wildlife during drought, which is a recurring phenomenon in Botswana. Population growth has led to a number of settlements cropping up in the WMAs, interfering with migratory patterns of wildlife. All these impact negatively on the tourism sector, which is predominantly wildlife based. The Government's tourism strategy of high cost, low volume tourism, aimed at conserving Botswana's wilderness, will be defeated if the policy on livestock production is not reviewed.

Botswana has been estimating wildlife by aerial count since 1977 and continues to do so on an annual basis. Only about 20 large species of mammals, including ostrich and crocodile, are currently being estimated. The physical accounts may not be presented as per the proposed frame, because of the large number of species that will have to be accounted for, hence separate accounts for individual National Parks, Game Reserves etc. may be a necessity and only aggregated at a later stage.

Table 16. Physical Accounts for Wildlife in 1995

Species	National Parks	Game Reserves	Wildlife Management Areas	Private Game Farms
Buffalo	5,300	13,100	0	
Crocodile	303	394	0	Data is not yet available
Duiker	18,200	19,100	6,100	
Eland	5,700	14,800	2,100	
Elephant	31,000	37,400	11,100	
Gemsbok	141,400	9,600	13,000	
Giraffe	7,100	4,200	700	
Hartebeest	600	38,900	1,500	
Impala	76,000	20,000	0	
Kudu	5,800	18,800	3,400	
Lechwe	57,200	0	0	
Ostrich	8,000	53,700	10,300	
Reedbuck	2,100	0	0	
Roan	1,100	500	0	
Sable	2,600	300	0	
Sitatunga	1,700	0	400	
Springbuck	4,300	91,700	14,000	
Steenbuck	23,200	45,400	2,400	
Tsessebe	10,500	0	0	
Waterbuck	1,300	0	0	
Wildebeest	11,200	43,500	5,600	
Zebra	51,200	2,800	0	

Data Sources

1. Department of Wildlife and National Parks
2. Private Game Farms
3. Non-Governmental Organizations (e.g. Kalahari Conservation Society)

Wildlife populations are bound to change upwards or downwards each year, mainly owing to seasonal migration to and from Botswana. The other reason for this is that the aerial count methodology gives precise estimates for conspicuous and widely distributed species.

Disaggregation of wildlife, by the proposed categories, will enable analysis of wildlife per square kilometre, and this will be compared with the number of livestock, especially cattle, in, or in the vicinity of, wildlife management areas.

Table 17. Proposed Monetary Accounts Frame for Wildlife

Years	User Charges for hunting	User Charges Parks/Reserves	Royalties from concession areas	Value of live animals sold	Sale of Ivory & trophies
1980					
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					

Data Sources

1. Department of Wildlife and National Parks
2. Department of Tourism

Annual aerial counts determine the annual hunting quota for each controlled hunting area or CHA. There is no clear principle underlying the determination of hunting fees. Administrative and enforcement costs are probably the determinant of hunting fees at present. These fees are generally low and have been constant since 1988, but are currently under review, with a substantial increase being considered. Hunting fees are low because of the lack of a wildlife market in Botswana, owing to the constraints imposed by veterinary laws. Until these veterinary laws are reviewed, it will be difficult to determine the value of venison.

Botswana, together with two other Southern African countries (Namibia and Zimbabwe), has been allowed to trade again in ivory. The purpose of this is twofold: first it will enable Botswana to clear its many tons of stored ivory, and secondly it will enable the country to continue managing the ever-increasing number of elephants through culling, as there will be an available market for the resulting ivory.

9.0 CONCLUSION

The conventional System of National Accounting, which measures the macroeconomic performance of an economy, does not reflect the true state of the environment, and hence is considered inappropriate when evaluating growth strategies that will influence the welfare of future generations. The resulting omissions may lead to flawed policies which in turn lead to sub-optimal allocations and the unsustainable extraction and use of natural resources.

There are trade-offs that occur between economic growth and environmental degradation, and NRA adjusts the conventional measures of this economic growth for the omitted environmental values. It establishes the link between economic activities and their use of natural resources and impacts on the environment. This enhances the ability of policy makers to evaluate properly the trade-offs between economic growth and resource depletion. Alternative development strategies can then be evaluated in terms of their environmental impacts.

An economy like that of Botswana, that is focusing on dynamic optimization of its policies and programmes will be able to calculate "green Net National Product (NNP)", through the use of properly constructed natural resources accounts. This can only happen if in calculating NNP, deductions made from Gross National Product include the depletion or depreciation of natural capital and social costs that are incurred due to increases in the stock of environmental pollution. The optimal growth path of an economy can be seen as the present value hamiltonian of a nationwide dynamic optimization problem. The Hamiltonian in this case will equal in present value terms the utility on an optimal path, that is a weighted average of future utilities where the weights are discount factors. This value corresponds to the properly calculated NNP. It must be noted however, that the measurement of NNP will thus depend on the choice of discount rate, and that thus even monetary policy (which determines interest rates) may be seen to influence the level of sustainable national income.

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APPENDIX A. Methods of Estimating Resource Rent

There are three alternative approaches or methods for calculating or estimating resource rent, as defined for the United Nations' system of environmental accounting for calculating rent. These are discussed in turn as follows:

Present discounted value

This requires forecasting of the net revenue in each year in which a resource is used and discounting it to the present time. The drawback of this method is that it requires the making of projections about several highly unpredictable factors: the future price of a resource, future resource availability and rates of extraction, and future costs of extraction (which are determined by future technological innovations and the future prices of inputs to extraction). The extremely high degree of uncertainty surrounding each of these factors makes this method difficult and unreliable to use. In addition, the choice of discount rate is always controversial. This method, then, is rather unreliable, except over relatively short periods and for individual extraction sites rather than for the entire industry (Lange & Motinga, 1997).

User-cost allowance method

This is a special case of Present discount value method, which applies to the depletion of exhaustible resources. This requires fewer projections because it makes two rather unrealistic simplifying assumptions:

1. that the net annual returns are constant over the lifetime of the resources;
2. that the rate of extraction is constant.

Consequently only the discount rate and the life span of the resource are determined. The contribution of the User-cost allowance method is that it splits the value into two components: the part that must be reinvested in order to maintain a constant stream of income as a resource is depleted, and the part that is consumed.

Net-price or net-rent method

This is based on Hotelling's theoretical work, that in a competitive market equilibrium, the net price of the marginal unit of a non- renewable mineral extracted, will equal the nominal interest rate. While this condition may be true in the long run, there are likely to be extended periods of disequilibrium when this is not true. Despite the problems associated with this assumption, this has been the method of choice by many countries. Using this method, total rent can be estimated with data from the national income accounts in the following manner:

Total Rent = Value Output minus
Intermediate consumption
Compensation of employees
Taxes (or minus subsidies)
Consumption of fixed capital
"Normal" profit on invested capital stock

Per unit rent = Total Rent/Quantity of output
Value of resource stock = Per unit rent x quantity of proved reserves
Depletion cost = per unit rent x annual output

APENDIX B. Methods of Valuation of Water

There are several methods of or approaches to, valuing and pricing water. These are discussed in turn:

Average Cost Price

This price is calculated as the average cost, including both operating and capital costs, of providing water from an existing water supply infrastructure. The method does not distinguish existing from new infrastructure; hence it does not include a provision for the rising costs of meeting future water demand.

Marginal Cost Price

This is also based on the principle of cost recovery. The method calculates price as the cost of providing an additional unit of water from the newest infrastructure. This approach is based on the recognition that as the demand for water increases, the cost of supplying water is likely to increase. Cost will increase because, as nearby, relatively inexpensive sources reach their limits, water will have to be transported from greater distances or deeper boreholes, new infrastructure such as dams will have to be constructed, or more expensive sources like desalination will be required. Marginal cost pricing better reflects the scarcity value of water, creates incentive for water conservation (since the price rises as usage increases), and, by creating a stepped pricing structure, introduces a means to generate surpluses (charges to marginal users) to finance subsidies to essential water use.

Opportunity Cost Price

This approach to pricing is based on the concept that, except for essential use, water should go to the most economically productive users. Many users may be able to afford to pay the financial costs of delivering water, whether average or marginal cost, but, for example, use of water for irrigated production of maize may generate a much lower net contribution to the GDP than the use for livestock watering, mining or industry. Opportunity cost can be assessed as the sectoral value-added generated per unit of water input. Even if this method is not used to set prices and other methods are used to allocate water, this analysis still provides indispensable economic information for prioritising water allocation because it shows the sectoral comparative advantage of water use. This is particularly important when planning for future infrastructure and economic development strategies.

APPENDIX C: Research Methodology

The NRA framework for Botswana described in this paper covers water, minerals, energy, livestock, and wildlife. Both Asset and Resource Use Accounts are constructed where appropriate and data are available (see Figure 1). Asset Accounts record the amount of the natural resource asset at the beginning of the period, changes to the amount that occur during that year, and the amount of the resource at the end of the year. Changes during the year, for example for minerals, can result from extraction of minerals, new discoveries, or changes in the certified reserves due to changes in technology or world mineral prices. The Resource Use Accounts record the use of resources (such as water) by each economic activity during the year, and any change in the quality of resources (such as land degradation or water pollution) resulting from economic activity during the year. Institutional characteristics are important for the classification of water, land, livestock, and wildlife.

The NRA consist of both physical resource accounts and, where possible, monetary accounts. Often the importance of physical resource accounts is overlooked in the discussions about NRA. However, reliable physical resource accounts and analysis of them must underlie any monetary accounts. Also, from a policy perspective, the detailed physical resource accounts themselves can provide a great deal of useful policy information when linked to the national economic accounts, for example, in the comparative advantage of water allocation among different industries.

In addition, physical resource accounts provide the basis for dialogue and collaboration between economists and natural scientists by presenting information in units that can be understood by natural scientists. This collaboration is necessary to develop a better understanding of the interaction between economic systems and natural systems, which will provide a sound basis for policy-making in government.

Figure 1. Natural Resource Accounts: Asset Accounts and Resource Use Accounts

A. ASSET ACCOUNTS

	Amount in physical units or monetary value
Opening assets at beginning of the year	
Changes in assets	
- Extraction/Depletion	
+ Additions/Growth	
+/- Other Changes	
Closing assets at end of the year	

B. RESOURCE USE ACCOUNTS

ECONOMIC ACTIVITIES

	WATER	LAND	LIVESTOCK	ENERGY	WILDLIFE	FORESTRY	FISHERIES
AGRICULTURE							
Trad. Agric - Cattle							
Trad. Agric – Other							
Freehold farms							
Hunting, Forestry, Fishing & Veldt Gathering							
MINING							
Diamond – Mining							
Other Mining							
MANUFACTURING							
Meat Processing							
Other Manufacturing							
UTILITIES & SERVICES							
Water and Electricity							
Construction							
W & R trade, Hotels & Rest.							
Transport							
Communications							
Banking & Insurance, Business Services							
Government							
Other Services							
HOUSEHOLDS							
Urban							
Towns							
Rural							

The estimation of monetary values for natural resources often presents a considerable challenge because many environmental assets, like wildlife are not valued in economic markets and do not have market prices. The compilation of monetary accounts may be hampered by the absence of necessary physical or economic data, the confidentiality of certain information, or the lack of sound economic tools for valuation.

A brief discussion of the resource variables and some of the issues considered in constructing the NRA framework is given below under the following categories: (A) water and Water-based resources, (B) Land and Land-based resources and (C) Air. Several questions about the appropriate classification are raised. The classifications for the proposed accounts in physical and monetary terms are shown in tables. These tables list the resources and describe the units of measurement for the physical accounts and the methods of valuation for the monetary accounts. The method of linking the NRA with the national economic accounts is to use the same classification of economic activities for the NRA as is used for the economic accounts..

Water and Water-Based Resources

Water

As in much of Southern Africa, water is the most critical limiting resource in Botswana. From the perspective of monitoring the use and supply of water for economic activities, it is necessary to consider both natural and institutional sources of water and the institutional arrangements for providing water to end-users. Stock accounts were compiled for each of the natural sources of water; and Resource Use Accounts must in future be compiled for both natural sources and institutional sources.

There are three natural sources of water supply, which vary in location, renewability, quality, and reliability:

- groundwater which is found throughout the country, though varying in quality;
- perennial surface water supplied by the rivers which occur along Botswana's boundaries;
- dams that capture seasonal surface water from rainfall, which is unpredictable in location, timing, and quantity.

[Note: in future, **re-use** of water could be a major source, and this could be included as one of the sources of water in the NRA]

In addition, a number of different institutions provide water. Some of these institutions rely on relatively large-scale, technologically sophisticated, infrastructure for collection and long-distance water distribution networks, while others rely mostly on local small-scale infrastructure such as local boreholes, small dams and haffirs. The former generally serves urban areas and the important mining, industrial and commercial activities whereas the latter generally serves the needs of the rural population. The institutions include:

- The Water Utilities Corporation (WUC) which provides water to urban areas;
- The Department of Water Affairs which provides water to large villages;
- The District Councils which provide water to small villages;
- Other forms of water supply in which users, mainly individuals and livestock owners, provide their own water at their own expense.

Consequently, in order to represent both natural and socio-economic characteristics, the Resource Use Accounts for water are disaggregated by both natural source (3 types).

Land and Land-Based Resources

Land

There are many ways in which to classify land, and a great deal of work has been done in Botswana to analyse land characteristics. Because of the focus of the NRA on the economic use of resources, the primary economic use of land – range lands for extensive cattle ranching – should be the guiding principle for the classification of land. The other major use of land is for wildlife; relatively little land is used or is suitable for crop production. It has been argued that wildlife, as the basis for tourism, might even be economically more important than livestock. Yet it is difficult to determine this with certainty since tourism has not been evaluated as a unique economic activity in the national accounts and all estimates of the size of the tourism industry are guesses at best. Livestock provides the basis of livelihood for much more of the rural population than does wildlife. In addition, both wildlife and livestock may co-exist on rangelands and, in fact, compete for land. Other classifications of land can be added, if it is found useful to do so to assist policy planning. For example, it may be desirable to carry out a valuation of wetlands, especially of the Okavango wetlands since the area is under intense pressure.

Since the economic importance of land is primarily its livestock carrying capacity, this measure (the number of hectares required to support one Livestock Unit (LSU)) should be used to classify the stock of land according to the following ten ranges of long-term carrying capacity:

Ranges of Potential Carrying Capacity

1. From 2 – 4 ha/LSU
2. From 5 – 8 ha/LSU
3. From 9 – 12 ha/LSU
4. From 13 – 16 ha/LSU
5. From 17 – 20 ha/LSU
6. From 21 – 26 ha/LSU
7. From 27 34 ha/LSU
8. From 35 – 46 ha/LSU
9. From 47 – 100 ha/LSU
10. More than 100 ha/LSU

It is admissible that carrying capacity, per se, is not always well defined, particularly in regions like Southern Africa with low and erratic rainfall. Since carrying capacity in a given year is determined primarily by rainfall, significant changes in year to year carrying capacity will occur as a result of annual variation in rainfall. Data about annual rainfall may be compiled in order to lay the groundwork to analyse the relationship between rainfall and annual carrying capacity. Carrying capacity is also affected by human actions.

There is some evidence of rangeland degradation, but comprehensive measurements of degradation do not exist and the issue remains controversial. Land degradation is defined as a continuous (without recovery) decline in production per hectare of land.

Whether annual variation in vegetation cover actually represents degradation rather than natural cycles of vegetation, and what the source of this degradation might be, are not well understood. It is especially difficult to measure whether degradation – a decline in output per hectare – is occurring on communal lands because livestock are raised for a variety of purposes, some of which are difficult to measure. Also, the various products are not always sold in formal markets, making quantity and price estimates difficult. Three potentially serious kinds of degradation have been noted, namely soil erosion, bush encroachment (the replacement of edible species of vegetation by inedible, woody species), and bush/veld fires.

Because of the critical role of property rights in land management, the stock accounts for land distinguish three kinds of land tenure: state land (about 25% of the country), tribal land (over 70%, communal and leasehold), and freehold land (less than 5%). It may become useful for policy analysis to disaggregate tribal land, treating communal land and TGLP leasehold land (1975) separately. In addition, land accounts should be disaggregated by Agricultural Districts.

Livestock

As a major (natural) capital asset for many people in Botswana, accounts should be established for the major types of livestock: cattle, goats, sheep, horses, and donkeys. Livestock are measured in two ways: numbers of animals and animal biomass measured in Livestock Unit (LSU) equivalents. By definition, 1 Livestock Unit is equivalent to 450kg (MoA, 1989). Livestock Accounts should be compiled for the different systems of land tenure and disaggregated by Agricultural Districts. Accounts should be constructed for stock (herds) and for annual offtake. For the non-commercial sector, accounts should be compiled for additional livestock products that are often not marketed but are important for households. These products include milk, ploughing power, transportation, manure, and hides.

Wildlife

Wildlife is economically important both for tourism and for its contribution to rural livelihoods. Wildlife tourism includes both game-viewing and hunting. In terms of eco-tourism potential, both the mix of wildlife and the density are important factors. In Botswana, stock accounts of the numbers of key animal species are compiled by the Department of Wildlife and National Parks (DWNP) annually in order to set hunting quotas. The species to be included in the NRA should be determined by the available data. The NRA should distinguish wildlife by Agricultural District and by type of land tenure. Resource Use Accounts should record the offtake of wildlife for three kinds of economic activities: trophy hunting, subsistence use, and estimates of poaching, where available.

Minerals

Diamonds dominate Botswana's mining industry, but copper, nickel, and soda ash are also economically significant. Because copper and nickel are produced jointly from a single source, they should be treated as a single resource in the NRA. Annual production of these minerals can be reported but stock accounts for diamonds cannot be reported for reasons of confidentiality. Because there is no domestic use of these minerals, their production should be incorporated in the Stock Accounts.

Energy

Stock Accounts consist entirely of coal. Resource Use Accounts should include the use of all major fuels, electricity, wood fuel, and other renewable energy components. The methodology proposed in the compilation of Energy Accounts was prepared.