Environmental & Resource Economics **29:** 257–283, 2004.

Wealth, Natural Capital, and Sustainable Development: Contrasting Examples from Botswana and Namibia

GLENN-MARIE LANGE
Center for Economy, Environment and Society, The Earth Institute at Columbia University, 2910 Broadway, Hogan Hall B-16, New York 10027, USA (e-mail: GL2134@ columbia.edu)

Accepted 20 February 2004

Abstract. Theoretical work has demonstrated that sustainable development requires non-declining per capita wealth, where wealth is defined to include produced, natural, human and social capital. Several studies have attempted to measure total national wealth or changes in wealth, but have been seriously hampered by a lack of data, especially for natural and human capital. To address this problem, the UN and other international statistical agencies developed a standardized framework for environmental accounts, the System of integrated Environmental and Economic Accounts (SEEA). Using the newly available asset accounts for natural capital, national wealth accounts are constructed and used to assess the contrasting development paths of Botswana and Namibia. Botswana, with an explicit policy of reinvestment of resource rents, has roughly tripled per capita wealth and national income over the past two decades. Namibia, with no explicit policy to use natural capita to build wealth, has seen per capita wealth and income decline.

Key words: Botswana, environmental accounting, Namibia, natural capital, sustainable development, wealth

JEL classification: Q0, Q2, O1

1. Introduction

Theoretical work (e.g., Kunte et al. 1998; Dasgupta and Mäler 2000, 2001; Heal and Kristrom 2001; Arrow et al. 2003) has demonstrated that sustainable development requires non-declining per capita wealth, where wealth is defined in the broadest sense to include produced, natural, and human (including social) capital. This implies a shift in focus from economic development as GNP growth to economic development as a process of 'portfolio management' that seeks to optimize the management of each asset and the distribution of wealth among different kinds of assets (Dasgupta 2002; Hamilton 2002; World Bank 2002). The particular challenge for resource-rich economies is to transform natural capital into other forms of

productive wealth, a process that requires policies to promote efficient resource extraction that maximizes resource rent, and reinvestment of that rent.

For a number of reasons that cannot be reviewed in this short paper, many resource-rich countries have not been successful in this transformation of natural capital. Indeed, as a group, their economic performance has lagged behind that of other developing countries, a phenomenon known as the 'resource curse' (Auty 1993; Gylfason 1999; Sachs and Warner 2001; Sala-i-Martin and Subramaniam 2003). Clearly, the ability to monitor total per capita wealth and analyze changes in this indicator is central to economic development.

The challenge of this wealth-based approach to sustainable development is the lack of data, particularly for natural and human capital. There have been several attempts to measure total national wealth or changes in national wealth, notably, Dasgupta (2001, 2002), Hamilton and Clemmens (1999) and the World Bank (1997). However, these studies do not include all natural capital, and are based on rather crude data and assumptions that may not reflect economic values for natural capital in a given country. Most provide estimates only for a single year, which may not accurately reflect the trend over time. The most widely applied measure, Genuine or Comprehensive Saving, attempts to overcome the lack of data about wealth by measuring changes in assets from national saving adjusted for some environmental factors and expenditures on education. But this method does not measure several factors that influence the value of natural capital: new discoveries of natural capital, changes in resource management or production technology that affect the value of natural capital, and holding gains/losses.

Decomposition of natural capital asset values over time has indicated that these factors are quite important and often outweigh the effect of depletion on asset value (Ryan et al. 2003; United Nations et al. 2003). While these efforts represent a useful first step in operationalizing an important concept in development, they are not a substitute for direct measures of national wealth based on data for each country.

In the late 1980s, the United Nations Statistics Division, European Union, OECD, World Bank, and country statistical offices initiated a coordinated effort to address a major part of this problem, the omission of natural capital from the asset accounts. This effort resulted in a standardized framework and methodologies for constructing environmental accounts, called the System of Integrated Environmental and Economic Accounts, or SEEA (United Nations et al. 2003). The SEEA extends the asset boundary of the System of National Accounts to include all natural resources, recording asset value, depletion and improvements in the stock of natural capital. With the implementation of the SEEA, information about the value of natural capital

is now available for some countries and a more meaningful time series of national wealth can be constructed.

Among the developed countries, Australia, Canada and the United Kingdom have implemented the SEEA and are publishing total national wealth including at least some components of natural capital[1] (Australian Bureau of Statistics 2001; Office of National Statistics 2003; Ryan et al. 2003; Smith and Simard 2001). This paper represents the first attempt, for developing countries, to construct such accounts of total national wealth based on the asset accounts for natural capital constructed according to the SEEA. Botswana and Namibia, resource-rich countries in southern Africa, recently began constructing environmental accounts. In this paper, total wealth accounts are constructed and used to assess the contrasting development paths of these two countries, similar in some respects – size, population, geography and climate – but quite different with regard to management of natural resources.

Botswana's economy is highly dependent on minerals, notably diamonds, which account for roughly 35% of GDP, 75% of exports and 50% of government revenues (Bank of Botswana 2001a). Botswana provides an example of economically sustainable management of a non-renewable resource; it developed an explicit policy of reinvestment of all resource rent and an indicator to monitor this policy, the Sustainable Budget Index, that loosely follows the Hartwick-Solow rule (Solow 1974, 1986; Hartwick 1977). Namibia's economy is highly dependent on minerals and fisheries, which together account for roughly 20% of GDP, 85% of exports, and about 10% of government revenues (Central Bureau of Statistics 2001). Governed as part of South Africa until its independence in 1990, Namibia has had no explicit reinvestment policy for revenues from natural capital; economic growth has been based, in part, on depletion of natural resources.

By including measures of natural capital in national wealth, this implementation of the SEEA is a significant step forward in improving macroeconomic measures of sustainability. However, the value of human capital is still not included because there is no agreement about how to measure it. The potential bias in the measure of national wealth that results from the omission of human capital and the impact of HIV/AIDS, which is an especially important factor in development in Southern Africa, is discussed in the concluding section.

The organization of the paper is as follows. The next section discusses the methodology and data used for the estimation of total wealth. Section 3 presents trends in per capita total wealth for Botswana and Namibia over the past 20 years and uses this to assess the economic sustainability of the development paths chosen by each country. Trends in per capita economic growth over the same period are also reviewed. Concluding remarks are provided in the final section.

2. Methodology and data sources

2.1. WEALTH AND SUSTAINABILITY

A commonly accepted definition of sustainable economic development is a time path where per capita well-being does not decline at any point (Pezzey 1992). Solow (1974, 1986) and Hartwick (1977) derived the conditions necessary for economic sustainability in an economy dependent on a non-renewable resource, which came to be known as the Solow–Hartwick rule. The rule requires non-declining total wealth, which is achieved by reinvesting some portion of the rents from the non-renewable resource in other forms of capital (assuming, among other things, that resources are priced efficiently). The relationship between sustainable well-being and non-declining wealth was further developed by, among others Mäler (1991), Pearce and Atkinson (1993), Dasgupta (2001), Dasgupta and Mäler (2000, 2001) and Hamilton and Clemmens (1999).

The theoretical literature has defined wealth as consisting of produced capital, natural capital and human (including social) capital. Drawing on Hamilton and Clemmens, a highly simplified version of this formalization defines a closed economy producing a composite good that can be consumed or invested in either produced capital or human capital, $F(S_P, Q, S_H) = C + \Delta S_P + m$, where S_i are stocks of produced (S_P), natural (S_N) and human capital (S_H); Q is use of a non-renewable resource; C is consumption; ΔS_P is investment in produced capital; and m is investment in human capital. The change in the stock of human capital is a function of investment, $\Delta S_H = q(m)$, and the depletion of natural capital is equal to extraction, $\Delta S_N = -Q$. Well-being, V, at time t is then defined as the discounted sum of all future utility, $V_t = \sum_{\tau=t}^{\infty} \frac{U(C_t)}{(1+r)^{\tau-t}}$. For this economy, a change in well-being is proportional to the change in the value of assets:

$$\Delta V_t = U_{t,c} \cdot \sum p_{t,i} \Delta S_{t,i} \tag{1}$$

where U_c is the marginal utility of consumption, p_i are the shadow or accounting prices of produced (p_p), natural (p_N) and human capital (p_H).[2] It is relatively straightforward to expand this model for renewable resources, pollution and environmental degradation, as well as for other specifications of the utility functions, including for example utility derived from environmental quality (Dasgupta and Mäler 2000; Dasgupta 2001). Dasgupta (2001) also considered various ways in which demographic change could be incorporated into the index of sustainable development; much depends on the extent to which well-being, V, is a function of population size, P. The simplest rule derived by Dasgupta is that "... *social well-being increases if and only if wealth per head accumulates*" (Dasgupta 2001, p. 258).[3] In the format of Equation (1), this rule for sustainability can be expressed as:

$$k_{t+1} \geq k_t \tag{2}$$

where k is the value of per capita total wealth (K/P), the sum of the products of the per capita stocks of assets (S/P) and their shadow prices $k_t = \sum k_{t,i} = \sum p_{t,i} s_{t,i}$. To implement this indicator of sustainability for open economies, such as Botswana and Namibia, the concept of wealth must take into account claims on foreign stocks of capital, which are represented by net holdings of foreign financial assets.[4] Total per capita wealth, k, is thus defined to include $k_{t,f}$, net foreign financial assets as well as produced, natural, and human capital,

$$k_t = \sum (k_{t,P} + k_{t,N} + k_{t,H} + k_{t,F}) \tag{3}$$

In using Equations (2) and (3) to monitor sustainability over time, it is essential that all assets be included. Human capital is not readily measurable at this time; however, measures for the other three components of wealth can be estimated. The following modification of Equation (3) is implemented for Botswana and Namibia:

$$k_t = \sum (k_{t,P} + k_{t,N} + k_{t,F}) \tag{4}$$

Methods and data sources for each component of national wealth are described in the next two sections.

2.2. MEASURING NATIONAL WEALTH

Implementation of Equation (4) requires information about produced capital, natural capital, net foreign financial assets and population. For produced capital and net foreign financial assets, data are readily available and observed market prices can be taken as reasonable approximations of their accounting prices. For natural capital, market prices of the assets *in situ* are usually not available. Accounting prices can be reasonably derived for the major natural resources using methods developed for the SEEA, which are described in this section. Prices cannot be estimated for all natural capital at this time, an issue taken up in section 2.3.

2.2.1. *Produced capital*

The stock of produced capital includes all manufactured structures and equipment. The standard method for measuring produced capital, which has been recommended by the System of National Accounts 1993 (United Nations et al. 1993) and implemented by most statistical offices around the world, is the perpetual inventory method (PIM). PIM at any given time is simply cumulative gross investment in fixed capital minus depreciation of

existing stock. Depreciation is based on an assessment of the lifetime of fixed capital in each industry and capital stock is revalued each year so that it represents replacement value rather than historical value. Both Botswana and Namibia provide estimates of manufactured capital stock based on the PIM.

2.2.2. *Foreign financial capital*

Foreign financial assets represent claims by domestic agents – government agencies, enterprises and private individuals – on assets held in foreign countries. For small countries with relatively limited opportunities for profitable domestic investment, these assets can represent an important alternative investment of resource rents. In most countries, the foreign assets of government agencies and enterprises are reported regularly to the central bank. Information about these assets was obtained for Botswana and Namibia from (Bank of Botswana 2001a, b; Bank of Namibia 1995, 2001; International Monetary Fund 2001). For Botswana, net foreign asset accounts were constructed for the entire two decades. For Namibia, it was only possible to construct accounts from 1989 onward. Until 1990, Namibia was administered by South Africa and its finances were largely intertwined with those of South Africa. For several years after independence there were disputes with South Africa about Namibia's financial obligations, which were eventually settled by negotiation (World Bank 1995). The lack of data prior to 1989 is not a serious omission because, as we will see, the volume of Namibia's net foreign financial assets is quite small relative to other forms of wealth.

Information about holdings of foreign assets by individuals is not regularly reported in most countries and is often obtained only through special surveys. There is no published information for Botswana and Namibia. In Botswana, holdings by individuals are estimated to be a relatively small share of the total (M. Wright, Bank of Botswana, personal communication). Namibia has more unequal income and wealth distribution than Botswana and, because of its colonial past, a minority population with ties to other countries. So it is likely that foreign assets of Namibia's private citizens are more significant than in Botswana, but they are still probably small.

2.2.3. *Natural capital*

The major natural resources for Botswana and Namibia include minerals, water, land and wildlife; Namibia has, in addition, significant marine fisheries.[5] At this time, information sufficient to construct monetary accounts is only available for part of the natural capital, albeit a major part: minerals in Botswana, and minerals and fisheries in Namibia. Physical accounts, but not monetary accounts were constructed for land, water and wildlife. The issue of the missing natural capital is taken up in the following section.

Physical accounts for natural capital. Each country mines a wide range of minerals, but a few minerals account for virtually all of the economic value. Mineral accounts have been constructed for Botswana's three major minerals, which account for 99% of Mining GDP: diamonds, (roughly 97% of mining GDP), copper/nickel (mined jointly) and coal. In Namibia, mineral accounts include diamonds, uranium and gold, which provide more than 95% of mining GDP; as in Botswana, diamonds are by far the most important mineral, accounting for roughly 85% of mining GDP. For both countries, other minerals have not been included at this time because they were not economically important, but may be included in future work.

Debswana, a joint partnership between DeBeers and the government of Botswana, is the only company that mines diamonds in Botswana. In the past, information about reserves was confidential, but in recent years a new climate of transparency has prevailed and DeBeers' has published in their annual reports information about reserves classified as probable, indicated and inferred reserves. All three categories of reserves are included in Botswana's mineral accounts because the geological characteristics of its mines make the probability of economically feasible mining very high. Accounts for other minerals generally include only the first two categories (known in the terminology of the SEEA as proven and probable reserves).

Information about annual extraction of diamonds, and the reserves and extraction of copper/nickel was obtained from the annual reports of Botswana's Department of Mines. Coal reserves, obtained from (Central Statistics Office 2000), have been measured for only two of Botswana's eleven coalfields and will last thousands of years at current rates of extraction. The quality of the coal is low, so it is only used domestically, mainly for power production.

In Namibia, information about minerals comes from two sources. Extraction of minerals is published in the annual reports of the Ministry of Mines and Energy. Information about mineral reserves was obtained from a survey of the four companies that mine Namibia's three major minerals.

Namibia's fisheries accounts include the three commercially most important fisheries: hake (*Merluccius capensis* and *Merluccius paradoxus*), horse mackerel (*Trachurus capensis*) and pilchard (*Sardinops ocellatus*), which account for more than 80% of the value of fish production. Other aquatic resources will be included in the future, starting with those that are subject to controls by the Ministry of Fisheries and Marine Resources.

Fisheries only became part of Namibia's national wealth at independence from South Africa in 1990. Prior to that time, Namibia was unable to exert control over its 200-mile Exclusive Economic Zone, which contained the most lucrative fisheries, because no country would recognize South Africa's jurisdiction over the area. Namibia's fisheries were exploited, largely by foreign operators, under virtually an open-access regime, a practice that

severely depleted the fish stocks and was halted after 1990. There is little reliable information about fisheries prior to 1990 but since 1990 Namibia's Ministry of Fisheries and Marine Resources has provided information about fish stocks and annual catch.

Monetary accounts for natural capital. Asset valuation is ideally based on market prices, but there are no markets for minerals and fisheries resources in Botswana and Namibia. In an optimizing economy, the price of an asset would be equal to the present value of the stream of net income an asset is expected to earn over its lifetime. Where market prices for assets are missing, the SEEA recommends estimating the present value of the future stream of income (resource rent) directly, a method that involves two steps: (i) calculating resource rent in a given year and (ii) calculating the likely future stream of rent over the lifetime of the resource.

The resource rent, p_j, represents the accounting price of natural resource j and is calculated as the residual between product price (unit revenue), rev_j, and the unit marginal production costs, mc_j:

$$p_{t,j} = rev_{t,j} - mc_{t,j} \tag{5}$$

where production costs include intermediate consumption, labor costs, and the costs of fixed capital (depreciation and the opportunity cost of capital). Having calculated the value of rent in a given year, the asset value is the sum of rent generated each year over the remaining lifespan of the resource, T:

$$K_{t,j} = \sum_{\tau=t}^{T} \frac{p_{t,j}Q_{t,j}}{(1+r)^t} \tag{6}$$

$$T = \frac{S_{t,j}}{Q_{t,j}} \tag{7}$$

where variables are defined as above and in section 2.1.

For renewable biological resources like fisheries or forests, the net present value approach to asset valuation may take a slightly different form. If the resource is being 'mined,' that is, harvested at an unsustainable rate, then the lifespan of the resource is finite and the asset value is determined using Equations (6) and (7). However, resources managed sustainably have an infinite lifespan and Equation (6) collapses into the following form, where the asset value of resource j is simply the total resource rent, pQ, divided by the discount rate:

$$K_{t,j} = \frac{p_{t,j}Q_{t,j}}{r} \tag{8}$$

Implementation of these relatively simple models of asset valuation poses a number of challenges. Regarding the calculation of resource rent, data about

marginal costs are not generally available so average cost is commonly used, which may introduce an upward bias into the measure of rent and asset value. In Botswana and Namibia, national statistical offices provided unpublished economic data from the annual mining company surveys that are used to compile the national accounts. These surveys provide reasonably accurate information for the calculation of accounting prices for minerals. For fisheries, the statistical office provides data about each of the major fisheries based in part on observed data (for fish catch, fish prices, fuel costs) and partly on a model of fishing costs for each fishery. This model is being revised on the basis of a recently introduced annual survey of fishing companies, which should improve estimates in future. Approximately, 50 companies exploit the three major fisheries. The data are less accurate for fisheries than for minerals, but probably provide a reasonable picture of fisheries value over the long term.

From these data, a modified version of Equation (5) was used, based on total rather than unit revenue and costs: total rent, R, was calculated for each resource, j, as gross revenue, GR, minus total production costs: intermediate consumption, IC, compensation of employees. CE, consumption of fixed capital, CFC, and 'normal profit,' NP, the opportunity cost of produced capital invested in resource exploitation:

$$R_{t,j} = \mathrm{GR}_{t,j} - \mathrm{IC}_{t,j} - \mathrm{CE}_{t,j} - \mathrm{CFC}_{t,j} - \mathrm{NP}_{t,j} \tag{8}$$

Normal profit is the rate of return (i) to produced capital used for production of resource j:

$$NP_{t,j} = iK^{j}_{t,P} \tag{9}$$

From Equation (8), the unit rent is calculated as total rent divided by the quantity of resource extracted or harvested $p_{t,j} = \frac{R_{t,j}}{Q_{t,j}}$.

All figures except normal profit are obtained from observed data. For minerals, normal profit for mining was calculated with a 10% rate of return on fixed capital in line with guidelines of government planning agencies. For fisheries, a 20% return was recommended by the Ministry of Fisheries and Marine Resources to reflect the higher degree of risk in that industry.[6]

These accounting prices can then be implemented in Equation 6 to obtain asset value. Asset valuation should be based on expected future extraction paths, production costs, and market prices. However, in many instances this information is lacking so the SEEA recommends an assumption that both the future volume of extraction and the per unit rent remain constant over time. This assumption is not unreasonable for fully established mines that expect to operate for the estimated lifespan; under these circumstances, mining companies themselves often assume a constant level of extraction for long-term assessments.

Compilation of fisheries asset accounts presents greater challenges than other resources because of a combination of characteristics unique to fisheries: fish stocks cannot be directly observed, some fish species are highly mobile and may migrate out of territorial waters, fisheries are affected by complex predator–prey interactions, and stocks are often subject to large, unpredictable, inter-annual variations. The present value of each fish stock depends on future fish prices, fishing technology and costs of production, and fish stock levels and exploitation.

As with minerals, in the absence of alternative information, common practice has been to assume that the current year's prices, technology, and production costs remain constant in the future. There is a high degree of uncertainty about future stock levels because the dynamics of many fish populations and of large marine ecosystems like Namibia's Benguela Ecosystem are poorly understood. While Namibia's Ministry of Fisheries has set a goal of restoring fish stock to the high levels seen decades again, only hake has seen some improvement over the past decade; other fisheries have remained more or less the same, subject to considerable inter-annual fluctuations.[7] For the purpose of asset valuation, a conservative approach was taken that assumes fish stocks have stabilized at current levels and will generate the same rent in the future. This is not an entirely satisfactory assumption, but it is used for lack of any other information at this time.

2.2.4. *Population*

Population has increased by over 80% in both countries from 1980 through 2001, the latest census year (Table I), but population growth has been slowing considerably over this time, especially during the 1990s as HIV/AIDS began to impact the population. Over the same period, adult illiteracy fell by half in both countries, indicating a sharp increase in human capital. However, much of the gain in human capital will be lost to HIV/AIDS. Population growth is projected to become negative in Botswana by 2005, resulting in a declining population, and will fall to 0.8% in Namibia. It is well known that HIV/AIDS disproportionately affects adults in their most productive working years, and coping with HIV/AIDS further reduces productivity. There are no accepted methods for estimating the value of human capital at this time; the possible implications for national wealth and the measurement of well-being and sustainability will be taken up in Section 3 and the conclusions.

2.3. MISSING NATURAL CAPITAL

Due to a lack of data, the environmental accounts do not, at this time, include the value of three important, inter-related assets: land, water, and wildlife. This section describes the problems valuing missing resources, and

Table I. Population in Botswana and Namibia, 1980–2001

	Botswana	Namibia
Population, thousands		
1980	907	1003
1991	1327	1410
2001	1681	1827
Average annual population growth rate		
1980–1991	3.5%	3.1%
1991–2001	2.4%	2.6%
Estimated 2005–2010	−0.4%	0.8%
Adult illiteracy rate		
1980	43%	34%
1991	31%	24%
2001	22%	17%

Source: Population: Central Statistics Office (2003), Central Bureau of Statistics (2003). Estimated future growth rate: United Nations Population Fund (2003). Adult illiteracy rate: World Bank (2003).

the implications for measures of national wealth and sustainability. Given the constraints of this paper, the discussion of missing natural capital will focus on land because the value of these other resources is often captured in land values.

In developed countries, where most land is privately owned, land value is readily measured based on the large number of market transactions. However, in Botswana and Namibia no market prices exist for the very large portions of the land where sales or long term leasing is not allowed. In Botswana, more than 96% of land is held either by the state (42%) or under traditional tenure (54%) of which only a very small share can be leased for commercial agriculture. Only 4% is privately owned and there is no active market in land outside urban areas.

In Namibia, roughly 44 % of land is privately held, 15% is state owned and 41% is held under traditional tenure. There is an active market in private farmland, but prices in recent years have been driven in part by speculation and uncertainty regarding future land reform policy, making them less useful for assessing the social value of land (Sherbourne 2003). As a further complication, there is insufficient information from land sales to distinguish land value from the value of investments on the land. Even the agricultural bank, which could provide rough 'rules of thumb' for land value has not yet taken into account the growth of mixed agro-tourism operations. Namibia's recently appointed Permanent Technical Team

(PTT) on Land Reform has been tasked to investigate the relation between land prices and long-term productivity of the land; when this study becomes available, it may be possible to estimate the value of private agricultural land.

When market prices are not available, alternative methods may be used: the value assessed for tax purposes or the productive value of land. Neither country has a land tax but the possibility of deriving land value from productive use is more promising. The two major uses of non-urban land are for agriculture and land set aside for its natural beauty, biodiversity conservation and tourism. In both countries, most land is used for agriculture, primarily extensive livestock grazing.

In Botswana, agriculture contributes about 3% to GDP and evidence suggests that the value of agricultural land is very low under current use. Despite heavy investments in traditional agriculture through the 1980s and 1990s, there has been little if any improvement in livestock productivity, and in some years the subsidies to crop production have exceeded the total value of output (Arntzen 2002).

In Namibia, the picture is less clear. Agriculture contributes around 10% of GDP, but a recent study showed that many private, commercial farms cannot operate profitably under current economic conditions unless land is provided free (Sherbourne 2003). However, there may be unmeasured tourism value to land as many farmers are turning increasingly to mixed agro-tourism operations. At the same time, there is evidence that relatively well off professionals are purchasing private farms primarily as vacation homes with part-time agricultural operations. There is very little information about livestock agriculture in land under traditional tenure. It is expected that the land reform process in Namibia will provide information about the economic value of agricultural land, under both private and traditional tenure, in the future.

Regarding non-agricultural land, both countries have set aside vast areas as national parks and other protected areas, such as Namibia's Etosha National Park or Botswana's Okavango Delta, which is a World Heritage site. These lands and the flora and fauna they support provide benefits to local communities for subsistence, international tourism, and provide significant global non-use values. There have been numerous micro-level case studies, but most cover only part of the benefits and often use different methods and assumptions (e.g., Barnes 1999, 2001; Barnes et al. 2001). An appropriate method for scaling up site-specific values to national values has not been established. Namibia's Ministry of Environment and Tourism has initiated a program to develop monetary accounts for this land, but it will be several years before the results are available (Barnes and Lindeque, 2003). At this time, there is no comparable effort in Botswana.

2.3.1. *Effect of omission on measures of national wealth*

For assessing sustainable development, what is important is how per capita national wealth has changed over time. Per capita asset value depends on both the physical volume of an asset and its economic value. Land does not change in volume, so population growth, all else equal, will result in a decline in per capita land value. However, the value of land depends on how it is used. Regarding land used primarily for agriculture in Botswana, there is no evidence of serious land degradation, but at the same time productivity of agriculture has not increased over time. With a growing population, the per capita value of agricultural land has most likely declined.

In Namibia, there has been serious degradation of commercial grazing land, but productivity improvements have largely compensated for degradation (Lange et al. 1998). The cessation of hostilities in northern Namibia after independence allowed more productive use of agricultural land under traditional tenure. While the value of agricultural land has probably increased, it is not clear whether it has increased sufficiently to compensate for population growth.

Regarding unique landscapes set aside for tourism and biodiversity conservation, although there are no reliable figures on tourism values, the number of tourists has risen in both countries over the past two decades. It is likely that the value of natural areas has grown a great deal, at least keeping pace with population growth. The impact of missing natural capital on the measure of wealth and sustainability will be discussed further in section 3 and the conclusions.

3. National Wealth in Botswana and Namibia

This section reviews the level and composition of per capita wealth in Botswana and Namibia over the past 20 years to determine whether the two countries are using their natural capital in a manner that promotes sustainability, i.e., whether per capita wealth is non-decreasing, and whether depletion of natural capital is compensated for by an increase in other forms of wealth. Discussion begins with a review of the physical and monetary accounts for natural capital. The trends in per capita wealth are compared to trends in per capita GDP over the period.

3.1. PHYSICAL AND MONETARY ACCOUNTS FOR NATURAL CAPITAL

Physical indices of mineral reserves for Botswana show a steady depletion of reserves over the past 20 years (Figure 1). Nearly 25% of known diamond reserves have been extracted. The extraction of copper/nickel has been partly

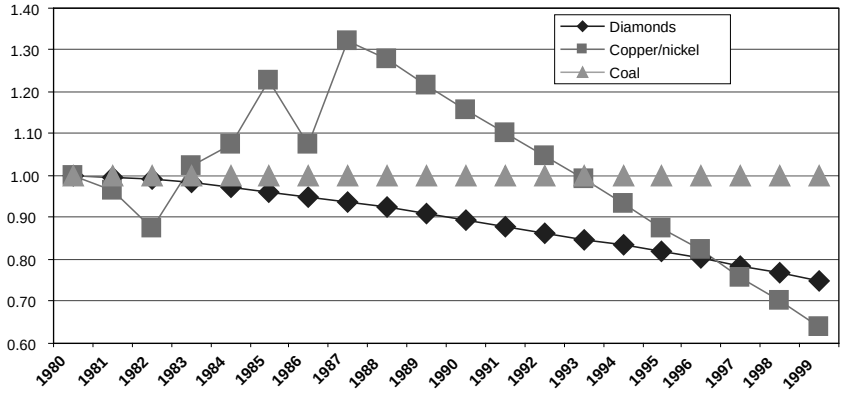

Figure 1. Index of mineral reserves in Botswana, 1980–2000.

offset by new discoveries and reclassification of reserves, but by 1998, about 30% of copper/nickel reserves had been extracted. Less than 1% of the known coal reserves have been extracted. For confidentiality reasons, Namibian mineral reserves cannot be shown, but physical depletion has occurred there as well.

Namibia's fisheries represent a classic case of open access resource exploitation, resulting in depletion of fish stocks (Figure 2, see more extensive discussion of Namibian fisheries in Lange (2003a, b). The combined fishable biomass of the three major species fell from 14 million tons in the late 1960s to around 2 million tons in the 1990s; only stocks of horse mackerel – the lowest value fish – increased. Of most importance to Namibia is the state of the fisheries since 1990, when a new sustainable fishing policy was introduced.

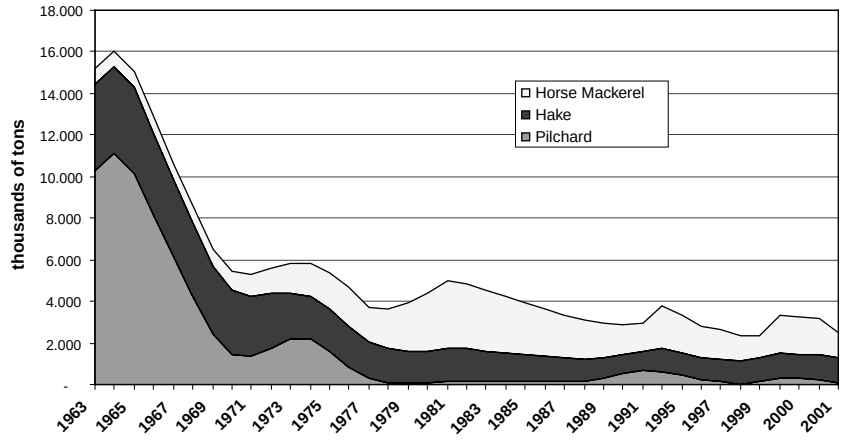

Figure 2. Biomass of major fish species in Namibia, 1963–2000 (thousands of tons).

The government hoped to restore fish stocks to previous levels, but this has not occurred: stocks of pilchard and horse mackerel ended the decade somewhat lower than in 1990, although hake stocks increased somewhat.

The monetary accounts (Table II) indicate that physical depletion does not always result in loss of asset value. Botswana's total mineral wealth, in constant prices, increased nearly five-fold from Pula 5.9 billion in 1980 to Pula 32.7 billion in 1997 (US$2.4 billion and US$13.4 billion, respectively). Although physical reserves of Botswana's most important mineral, dia-

Table II. Value of natural capital in Botswana and Namibia, 1980–1998 (million pula in 1993 constant prices)

	Botswana				Namibia		
	Diamonds	Copper–nickel	Coal	All Minerals	Minerals	Fish	Total natural capital
1980	5572	272	29	5872	6862	–	6862
1981	4805	–	35	4839	5137	–	5137
1982	7267	–	30	7296	4080	–	4080
1983	9668	–	28	9696	3508	–	3508
1984	10,317	–	19	10336	2972	–	2972
1985	11,044	–	13	11057	3138	–	3138
1986	14,179	–	7	14186	3987	–	3987
1987	15,650	87	6	15744	4122	–	4122
1988	19,479	1072	4	20,555	3976	–	3976
1989	22,575	1559	16	24,150	3748	–	3748
1990	27,177	1474	59	28,710	3203	1407	4610
1991	27,701	1469	101	29,271	2828	1101	3929
1992	26,309	1085	111	27,505	2313	1540	3853
1993	22,722	414	99	23,236	1581	2263	3844
1994	23,735	224	78	24,037	1254	2847	4101
1995	25,336	443	43	25,822	1025	2692	3717
1996	25,727	800	9	26,535	1280	1297	2577
1997	31,649	1,073	10	32,732	1510	2001	3511
1998	Na	Na	Na	Na	1181	4004	5185

'–' indicates a zero value; Na: not available.

Notes: Exchange rate of Namibia dollars for Botswana pula in 1993 was P0.74.
The Botswana pula was worth US$0.41.

Source: Author's calculations based on data in (Lange et al. 2003) and Central Bureau of Statistics (2001, unpublished data), and Central Statistics Office (1997, 1998).

monds, have declined, its value in constant prices has been increasing over time. This is due entirely to the increasing volume of extraction of diamonds over time, and, hence, less discounting of future rents, which increases present value. Botswana's diamond industry was still quite new in 1980. Both production capacity and world market conditions delayed expansion of production until late in the 1980s.

By contrast, Namibia's natural capital declined by 25% in constant prices from Pula 6.9 billion in 1980 to Pula 5.2 billion in 1998 (US$2.8 billion and US$2.1 billion, respectively). However, the story is different for minerals and fisheries. In 1980, minerals accounted for all of Namibia's natural capital, because most of its fisheries were not under Namibian control or exploitation. By 1998, this situation had reversed: fisheries accounted for 77% of natural capital. Without fisheries, Namibia's natural capital would have declined much more precipitously.

Namibia's total mineral wealth has fallen by more than 80% from Pula 6.9 billion in 1980 to Pula 1.2 billion in 1998. The decline in value reflects depletion of physical reserves, declining extraction levels, and declining resource rent per unit of mineral for diamonds and uranium, the two most important minerals. Namibia is a mature mineral economy, which has already depleted its most valuable mineral resources (Auty and Mikesell 1998). Diamonds, the most valuable mineral, have been mined since the beginning of the 20th century. Initially, the reserves consisted of relatively high quality gem and near-gem stones, which could be mined relatively cheaply. But by the end of the 1980s Namibia had largely exhausted its most profitable diamond reserves and moved to offshore diamond mining. The offshore reserves are much more expensive to mine and are not as high quality. The global market for uranium has not been good for some time, so that although the reserves have not yet been exhausted, there is not a strong market for uranium. Gold extraction began in 1993, but is still a very small component of Namibia's mineral wealth.

Fish became a part of Namibia's wealth only after independence in 1990 when it gained internationally recognized control over its EEZ. As Namibia implemented its new fisheries policy, aimed at sustainable management, the real value of fish stocks more than doubled, from Pula 1407 million in 1990 to Pula 4004 million in 1998. This increase in value is attributable to the increase in the stock of hake, the most valuable fish, as well as management and economic factors that have improved the rent generating capacity of fish. Virtually all of the fish are sold in international markets, where the price has been rising fast.

Although fish provide a bright spot in the Namibian economy, the asset value has fluctuated rather wildly over the past decade due to unpredictable environmental events that affect fish stocks. Despite government's goal to restore fisheries to high levels of stocks last seen in the 1960s, there has been little

or no stock growth in the 12 years since independence (Lange 2003a). At such a depleted level, Namibia's fisheries are less easy to manage and even more vulnerable to shocks and overexploitation. It seems unlikely that the fish stocks will recover to earlier levels. At the same time, there is increasing pressure from the fishing industry for higher levels of exploitation. Dependence on a volatile asset increases the vulnerability of the economy to external shocks.

3.2. TOTAL PER CAPITA NATIONAL WEALTH IN BOTSWANA AND NAMIBIA

The previous section has shown that the value of natural capital of Botswana has increased, while that of Namibia has decreased over the past two decades. An assessment of total wealth – produced capital, natural capital, and foreign financial assets – will show whether the depletion of natural capital has been used for building wealth or for consumption.

In 1980, Namibia's real per capita wealth was 75% greater than Botswana's (Table III). However, over the last two decades Botswana used its natural capital to build national wealth, while Namibia did not. Real wealth in Botswana grew from Pula 13,483 per person to Pula 47,090 per person between 1980 and 1997. All forms of wealth increased, but especially net foreign financial assets, which accounted for 18% of national wealth by 1997. Moreover, total wealth grew steadily except for the period 1992 to 1993. During that period, the value of minerals declined due to a world recession that reduced demand for minerals, and foreign financial assets also declined slightly, in part, liquidated to maintain levels of national spending. The recovery of world markets after 1993 restored the previous trend in per capita wealth.

The growth of national wealth is consistent with Botswana's development policy, which set a goal of improving living standards and reducing poverty based on prudent investment of mineral revenues. Physical depletion of mineral assets was offset by management changes to increase the value of minerals, and by investing all resource rent in other assets (on this last point, see Lange and Wright 2004). Although both public and private capital has grown faster than population, wealth creation has been dominated by the public sector: public sector capital (produced assets plus net foreign financial assets) grew at an average annual rate of 15%, while private sector (produced) capital grew only 7.7% annually. Furthermore, the economy is still dominated by mining and the declining share of private capital reflects slow progress in achieving government's objective of economic diversification.

By contrast, Namibia's real per capita wealth has declined 28% between 1980 and 1998 from Pula 23,575 per person to Pula 17,082 per person. All forms of wealth have declined except for fish. Net foreign financial assets form an insignificant, and often negative, share of national wealth. Prior to independence in 1990, Namibia's resources were exploited by an occupying

Table III. Total per capita wealth of Botswana and Namibia, 1980–1998 (pula per person in 1993 prices)

	Botswana					Namibia					
	Produced capital		Minerals	Net foreign financial assets	Total	Produced capital		Natural Capital		Net foreign financial assets	Total
	Public	Private				Public	Private	Minerals	Fisheries		
1980	2063	4695	6472	253	13,483	7483	9253	6839	–	Na	23,575
1981	2233	4953	5143	406	12,735	8687	10,289	4972	–	Na	23,948
1982	2369	4972	7477	439	15,257	8796	10,149	3830	–	Na	22,776
1983	2461	4996	9583	789	17,830	9170	10,239	3195	–	Na	22,604
1984	2652	5257	9851	987	18,747	8753	9386	2625	–	Na	20,765
1985	2809	5253	10,164	2680	20,906	7843	8211	2688	–	Na	18,742
1986	3068	5304	12,577	3442	24,392	8215	8502	3313	–	Na	20,030
1987	3632	5466	13,465	4177	26,741	8429	8410	3322	–	Na	20,161
1988	4071	6184	16,962	4472	31,689	7878	7694	3108	–	Na	18,680
1989	4333	7191	19,232	5038	35,794	7715	7624	2841	–	−655	17,526
1990	4726	7891	22,068	5539	40,224	8188	8072	2355	1035	−500	19,150
1991	5122	8424	22,058	6449	42,054	8565	8319	2020	786	−299	19,391
1992	5531	8761	20,239	6392	40,924	8357	8182	1606	1070	−305	18,910
1993	5988	8885	16,704	6643	38,221	7950	8011	1061	1519	188	18,729
1994	6253	9122	16,868	6903	39,145	7158	7474	820	1861	160	17,471
1995	6633	9251	17,698	6855	40,437	7093	7720	648	1703	3	17,167
1996	7083	9348	17,738	8274	42,442	6682	7622	784	795	−85	15,798
1997	7559	9659	21,346	8526	47,090	6543	7634	895	1187	256	16,515
1998	Na	Na	Na	Na	Na	6203	7657	678	2298	246	17,082

Notes: Exchange rate of Namibia dollars for Botswana pula in 1993 was P0.74.The Botswana pula was worth US$0.41.
Source: Table II, and author's calculations based on Bank of Botswana (2001a, b), Bank of Namibia (2001, 1995), Central Bureau of Statistics (2001, unpublished data), and Central Statistics Office (1997, 1998).

country, South Africa, with relatively little concern for Namibia's own national development. There was no policy of reinvestment of revenues from natural capital and by the time Namibia had achieved independence its natural resources were vastly depleted.

The post-independence period from 1990 onward is particularly significant because it represented an opportunity for new resource management and development policies. Per capita wealth in 1990 was Pula 19,150 per person; it has since continued to fall at roughly the same rate as the 1980s. The decade prior to independence was marked by civil conflict and extreme political uncertainty, factors that increase transactions costs, discourage investment and drain resources from productive activities. The end of hostilities brought about a reduction in these costs, but this did not result in an increase in net investment. After a slight rise in 1990 and 1991, per capita stocks of both public and private sector capital continued to decline.

In the last two years, 1997 and 1998, Namibia's per capita wealth increased slightly. This increase is almost entirely due to the rising value of fish stock, which, as discussed earlier, is highly volatile; it is unlikely that this trend will continue.

3.3. NATIONAL WEALTH AND WELL BEING

Theory shows that economic well-being depends on wealth. Therefore, one would expect trends in indicators of well-being to reflect the respective trends in per capita wealth. National income, despite its widely acknowledged weaknesses, is the most commonly used indicator of well-being (Dasgupta 2002). Preliminary work by Dasgupta (2001, 2002) for several countries showed, however, that over the period 1970 to 1993, trends in per capita national wealth diverged from trends in per capita national income.[8] Similar results were obtained by Hamilton (2002) in cross-sectional estimates of changes in wealth for 83 countries in 1999. This is due, in part, to the failure of national accounts to capture fully the contribution of natural capital, as well as human and social capital.

Figure 3 provides an index of growth of real per capita wealth and real per capita GDP for Botswana and Namibia from 1980 to 1997. For Botswana, per capita GDP rose with increasing wealth, but, as expected from the work by Dasgupta and Hamilton, per capita GDP did not appear to grow as quickly as wealth.

The Namibian case is somewhat more complex because of its political and social history. From 1980 to 1990, when Namibia was still in a state of civil war, both per capita GDP and per capita wealth declined. However, after independence in 1990, wealth continued to decline but GDP did not; GDP increased from 1990 to 1994, then stayed constant. While there is not yet

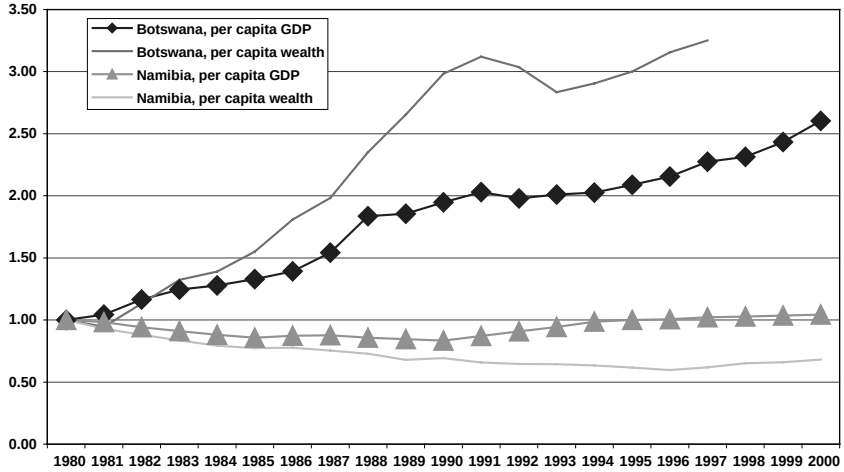

Figure 3. Index of change in real per capita wealth and per capita GDP in Botswana and Namibia, 1980–1997 (1980 = 1.00).

enough information to determine the reasons for this divergence, it is likely that the end of hostilities in 1990 brought a better climate for business and tourism, which increased the value of unmeasured natural capital and human, including social, capital. Tourism increased, raising the value of land used for tourism, and many skilled workers who had gone into exile returned after 1990, increasing human capital. In addition, the government of Namibia began to invest heavily in education and health care (Bank of Namibia 2001); adult illiteracy rate dropped from 34% in 1991 to 17% in 2001.

Whatever the role of unmeasured increases in natural and human capital (discussed below), it is clear that Namibia is liquidating its produced and natural capital. Produced capital is declining; some fisheries have recently been closed or severely restricted (pilchards and orange roughy); new mines may replace depleted mineral resources but these mines have a limited time horizon. In the absence of a policy to maintain national wealth, Namibia is undermining its basis for economic development.

3.4. WEALTH, UNMEASURED CAPITAL AND HIV/AIDS

The measure of national wealth presented here omitted some important assets, as discussed in Section 2. This measure of sustainability is still reasonably accurate as long as these omissions are small relative to measured assets, or where the omitted assets are changing at a rate similar to measured assets; such may be the case for land in Botswana and Namibia. Efforts are underway to improve estimates of land values in Namibia so this assumption can be verified in the future. While no comparable effort is underway in

Botswana, it is likely that estimates of the value of land set aside for tourism and biodiversity in Namibia will indicate at least the magnitude of similar assets in Botswana, and, hence, the effect of omitting these assets. But in Botswana and Namibia, the serious omission results from the effect of HIV/AIDS on human capital.

In both countries, life expectancy has dropped by more than 20 years. The initial impact of increased mortality rates is to reduce the years of experience, and hence the productivity, of the average worker. In addition to these direct losses, increased absences due to illness, time devoted to care of sick family members and funerals further reduce labor productivity. There is evidence that increased expenditure on health care and the loss of household income earners have already reduced investment in agriculture and family enterprises, decreased land under cultivation, and lowered agricultural productivity (Food and Agricultural Organization (FAO) 2002).

The Food and Agricultural Organization (2002) has projected that Namibia will lose 26% of its agricultural labor force and Botswana 23% between 1985 and 2020. Both countries, but especially Namibia, already have a shortage of skilled workers, which will be exacerbated by the AIDS epidemic. More disturbing and difficult to quantify is the impact of the lost capacity to transmit human and social capital across generations, as large numbers of teachers and, more importantly, parents are lost to AIDS. The very large number of young orphans is overwhelming traditional systems of orphan care provided by extended families (Haacker 2002; Bell et al. 2003).

While it is beyond the scope of this paper to explore all the possible ramifications of the HIV/AIDS epidemic, some comments on human capital and national wealth can be provided. Surprisingly, despite the large numbers of deaths and productivity losses, most studies of HIV/AIDS have found relatively small impacts on macroeconomic growth in Botswana and Namibia over the next few decades (BIDPA 2000; World Bank 2001; Green et al. 2002; Haacker 2002; Bell et al. 2003). A large portion of Botswana's national wealth, diamonds and net foreign financial assets, will not be significantly affected by AIDS. Mining requires very little labor and Debswana started providing HIV/AIDS treatment for its workers relatively early on.

To reduce the impact of HIV/AIDS, the government of Botswana has begun to provide anti-retroviral treatment to its infected population free of charge in a program funded jointly by the government and external donors. The wealth created by reinvestment of mineral rents is in part responsible for the capacity of the government to respond to the epidemic, underlining the importance of proper management of resource rents and measuring wealth. Namibia has endorsed a similar AIDS policy but does not have the domestic resources to develop a program as extensive as Botswana's; it will depend more heavily on donor funding. Namibia's wealth is more vulnerable to HIV/AIDS than Botswana's wealth: minerals and fisheries are a much smaller

share of national wealth, and these industries are somewhat more labor intensive than Botswana's mining industry. Namibia has virtually no net foreign financial assets.

4. Concluding Remarks

The pioneering conceptual work on total national wealth by researchers such as Dasgupta, Hamilton and Clemmens, and others has shown that wealth and changes in wealth may provide a better indicator of sustainable economic development than GDP and growth in GDP. Their work indicates the need to shift the focus of economic development from one that emphasizes GDP growth to one that views development as a process of 'portfolio management' that optimizes the management of each asset and the distribution of wealth among different kinds of assets.

This work represents an improvement over the empirical estimates of Dasgupta, Hamilton and Clemmens, who did not have the data for measuring wealth in developing countries and were forced to rely on incomplete indicators of change in wealth (net savings). Their estimates omitted major components of change in natural capital, which can only be measured when full asset accounts are compiled, as was done for Botswana and Namibia in this paper.

Sustainable development requires non-declining levels of per capita wealth. In resource-rich economies, this requires that natural capital be transformed into other forms of capital to build wealth. Botswana developed an explicit policy to reinvest rents form its mineral wealth in other types of assets, resulting in a remarkable growth in per capita wealth and national income. Botswana was one of the world's poorest countries at independence in 1966, but joined the World Bank's category of Upper-middle-income countries in the 1990s. Namibia, on the other hand, did not adopt such policies, either under the pre-independence government based in South Africa or under the post-independence government established in 1990. In 1980 Namibia's per capita wealth was 75% greater than Botswana's, but Namibia followed a policy of liquidating its capital, even after independence. While Botswana's per capita wealth grew, Namibia's declined; by the end of the 1990's Namibia's per capita wealth had fallen to only one-third the wealth of Botswana.

Wealth as an indicator of sustainable development requires that all forms of capital are included and that they are properly measured. The measure of national wealth for Botswana and Namibia omitted some important assets, as discussed in Section 2. The measure of sustainability – changes in per capita wealth over time – is still reasonably accurate as long as these omissions are small relative to measured assets, or where the omitted assets are

changing at a rate similar to measured assets. A case was made – to be ascertained by ongoing work – that these omissions bias the estimated level but not the trends in national wealth.

This extended measure of national wealth, although incomplete with regard to natural capital, is an improvement over earlier conventional measures. Countries begin constructing asset accounts for natural capital by first adding those for which credible asset values can be estimated, most often subsoil assets. Australia and Canada now include subsoil assets, forests and land; the UK has started only with asset accounts for petroleum and natural gas.

Human capital continues to present a major challenge and the urgency of including human capital in an assessment of sustainable development is particularly high for countries hit hard by HIV/AIDS. However, there is no agreed upon methodology for valuing human capital, and the economic impact of HIV/AIDS is rather uncertain. Proper management of national wealth – those components that can be measured – is even more serious in light of the HIV/AIDS epidemic. Botswana's policy of reinvesting mineral rents has given it, in part, the resources to address the epidemic; Namibia's policy failure has made it much more difficult to deal with HIV/AIDS. The measure of national wealth presented here for Botswana and Namibia is not complete but it is an important step toward a comprehensive measure of wealth.

Acknowledgements

I would like to thank many of my colleagues with the Natural Resource Accounting Programme of East and Southern Africa, especially Prof. Rashid Hassan (Centre for Environmental Economics and Policy in Africa, University of Pretoria) and Jonathan Barnes (Directorate of Environmental Affairs, Namibian Ministry of Environment and Tourism). I would also like to thank two anonymous reviewers. Any remaining errors are, of course, my responsibility.

Notes

1. There is not yet an agreed-upon method for including human capital.
2. The accounting price is the social worth of a good, which is not always reflected by its market price; indeed, some goods, notably environmental goods, do not have market prices at all. Thus, implementation of this index of sustainability requires estimation of accounting prices for at least some forms of capital, a subject taken up in the next section.
3. The most simple form is used because there is insufficient information at this time to estimate how well-being changes with population size. Population growth can, for example, have negative impacts due to increased congestion. Of greater concern in Southern Africa is the potential impact of population decline or the skewed age distribution due to HIV/AIDS. The impact of HIV/AIDS on human capital and productivity is directly accounted

for by the stocks of human capital; the additional impact on well-being is not known at this time.

4. Claims on domestic and foreign assets are not explicitly differentiated in theoretical models, but empirical work on wealth has recognized that net foreign financial assets are an important component of wealth for open economies, e.g., Australian Bureau of Statistics (2000). Further theoretical work might make this distinction explicit in order to examine the impact of international trade and finance on the wealth and sustainability of open economies.
5. For a detailed technical description of methodology and data sources, see (Lange et al. 2003).
6. In more detailed reports (Lange et al. 2003), a sensitivity analysis for the return to capital was performed.
7. See Lange (2003a, b) for more detailed discussion of how fish stocks are estimated, confidence intervals for stock estimates and sensitivity analysis of assumptions used in calculating asset value.
8. Dasgupta shows that trends in per capita wealth also differ, for most countries in his study, from another widely used indicator of well-being, the Human Development Index.

References

Arntzen, J. (2002), 'Review of Agricultural Subsidies', report to Ministry of Agriculture: Gaborone, Botswana.

Arrow, K.J., P. Dasgupta and K.-G. Mäler (2003), 'Evaluating Projects and Assessing Sustainable Development in Imperfect Economies'. *Environmental and Resource Economics* **26**, 647–685.

Australian Bureau of Statistics (2001), Australian System of National Accounts. Consolidated Balance Sheet. Canberra: ABS.

Auty, R. M. (1993), *Sustaining Development in Mineral Economies*: *The Resource Curse Thesis*. London: Routledge.

Auty, R. M. and R. Mikesell (1998), *Sustainable Development in Mineral Economies*. Oxford: Clarendon Press.

Bank of Botswana (2001a), Annual Report 2000. Gaborone, Botswana.

Bank of Botswana (2001b), Unpublished Time Series of Net Foreign Financial Assets. Gaborone, Botswana.

Bank of Namibia (1995), Annual Report 1994. Windhoek, Namibia: Bank of Namibia.

Bank of Namibia (2001), Annual Report 2000. Windhoek, Namibia: Bank of Namibia.

Barnes, J.I. (1999), 'Economic Potential for Biodiversity Use in Southern Africa: Empirical Evidence'. *Environment and Development Economics* **4**, 215–220.

Barnes, J.I. (2001), 'Economic Returns and Allocation of Resources in the Wildlife Sector of Botswana'. *South African Journal of Wildlife Research* **31**, 141–153.

Barnes, J.I., J. Cannon and K. Morrison (2001), 'Economic Returns to Selected Land Uses in Ngamiland, Botswana', Report to Conservation International, Washington, DC.

Barnes, J. and P. Lindeque (2003), 'A Study to Value the Natural Asset Portfolio of the Ministry of Environment and Tourism (MET): Wildlife Stocks, Tourism Land, and Forests', unpublished report to the Directorate of Environmental Affairs, Ministry of Tourism and Environment. Windhoek, Namibia.

Bell, C., S. Devarajan and H. Gersbach (2003), 'The Long-Run Economic Impact of AIDS: Theory and an Application to South Africa'. World Bank paper (unpublished). Washington, DC: World Bank.

BIDPA (Botswana Institute for Development Policy Analysis) (2000), 'Macroeconomic Impacts of the HIV/AIDS Epidemic in Botswana'. Gaborone, Botswana: BIDPA.
Central Bureau of Statistics (1999), National Accounts 1998. Windhoek, Namibia: National Planning Commission.
Central Bureau of Statistics (2001), National Accounts 2000. Windhoek, Namibia: National Planning Commission.
Central Bureau of Statistics (2003), Population Census 2001. Windhoek, Namibia: National Planning Commission.
Central Statistics Office (1998), 'National Accounts Statistics – Capital Stock.' Stats Brief No. 98/7, June, Gaborone, Botswana: CSO.
Central Statistics Office (2000), Environment Statistics. Gaborone, Botswana: CSO.
Central Statistics Office (2003), Population Census 2001, Gaborone, Botswana: CSO.
Central Statistics Office (annual), Statistical Bulletin. Gaborone, Botswana: CSO.
Dasgupta, P. (2001). *Human Well-Being and the Natural Environment*. Oxford: Oxford University Press.
Dasgupta, P. (2002), 'Economic Development, Environmental Degradation and the Persistence of Deprivation in Poor Countries'. Paper presented at the World Bank, May.
Dasgupta, P. and K. Mäler (2000), 'Net National Product, Wealth, and Social Well-Being'. *Environment and Development Economics* **5**, 69–94.
Dasgupta, P. and K. Mäler (2001), 'Wealth as a Criterion for Sustainable Development'. Beijer Institute Discussion Paper Series No. 140.
Department of Mines (annual), Annual Report. Gaborone, Botswana: Ministry of Mines, Energy and Water Resources.
Food and Agriculture Organization (2002), 'AIDS – a Threat to Rural Africa: Fact Sheet'. Rome: FAO.
Green, J., P. Akatu, M. Mfunwa, T. Poddar and S. Ding (2002), 'Botswana: Selected Issues and Statistical Appendix'. IMF Country Report No. 02/243
Gylfason, T. (1999), 'Exports, Inflation and Growth'. *World Development* **27**(6), 1031–1057.
Haacker, M. (2002), 'The Economic Consequences of HIV/AIDS in Southern Africa'. IMF Working Paper, African Department WP/02/38.
Hamilton, K. (2002), 'Sustainable per Capita Welfare with Growing Population: Theory and Measurement'. Paper presented at the Second World Congress of Environmental and Resource Economists, Monterey, California, 23–27 June.
Hamilton, K. and M. Clemmens (1999), 'Genuine Savings Rates in Developing Countries'. *World Bank Economic Review* **13**(2), 336–356.
Hartwick, J. (1977), 'Intergenerational Equity and the Investing of Rents from Exhaustible Resources'. *American Economic Review* **67**(5), 972–974.
Heal, G. and B. Kristrom (2001) 'National Income and the Environment,' draft of a chapter forthcoming in T. Tietenberg and H. Folmer, eds., International Yearbook of Environmental and Resource Economics. Cheltenham, UK: Edward Elgar.
International Monetary Fund (2001), *International Financial Statistics Yearbook*. Washington, DC: IMF.
Kunte, A., K. Hamilton, J. Dixon and M. Clemens (1998), 'Estimating National Wealth: Methodology and Results'. Environment Department Papers, Environmental Economics Series No. 57, Washington, DC: World Bank.
Lange, G. (2001), 'The Contribution of Minerals to Sustainable Development in Botswana: Natural Resource Accounts for Minerals.' Final Report to the Botswana Natural Resource Accounting Programme. Gaborone, Botswana.

Lange, G. (2002) 'Alternative Measures of the Value of Natural Capital in Constant Prices'. Paper presented at the workshop, Putting Theory to Work: The Measurement of Genuine Wealth, 25–26 May 2002, Stanford University.

Lange, G. (2003a), 'Fisheries Accounts: Managing a Recovering Fishery', in G. Lange, R. Hassan and K. Hamilton, eds., Environmental Accounting in Action: Case Studies from Southern Africa. Cheltenham, UK: Edward Elgar Publishers.

Lange, G. (2003b) 'The Value of Namibia's Commercial Fisheries.' Research Discussion Paper Number 55. Ministry of Environment and Tourism, Directorate of Environmental Affairs, Windhoek, Namibia, February 2003.

Lange, G., J.I. Barnes and J. Motinga (1998), 'Cattle Numbers, Herd Productivity, and Land Degradation in Namibia.' Development Southern Africa **15**(4), 555–572.

Lange, G., R. Hassan and K. Hamilton (2003), Environmental Accounting in Action: Case Studies from Southern Africa. Cheltenham, UK: Edward Elgar Publishers.

Lange, G. and M. Wright (2004), 'Sustainable Development in Mineral Economies: The Example of Botswana.' *Environment and Development Economics* **9**(4), 485–505.

Mäler, K. (1991), 'National Accounts and Environmental Resources'. *Environmental and Resource Economics* **1**(1), 1–15.

Marine Research and Information Centre (2001), Unpublished Database of Fish Stocks, Catch and TAC, MRIC, Swakopmund, Namibia.

Office of National Statistics (2003) 'Asset Value of Petroleum and Natural Gas Reserves', available from website of the UK's ONS: www.statistics.gov.uk.

Pearce, D. and G. Atkinson (1993), 'Capital Theory and the Measurement of Sustainable Development: An Indicator of Weak Sustainability'. *Ecological Economics* **8**, 103–108.

Pezzey, J. (1992), 'Sustainable Development Concepts: An Economic Analysis'. World Bank Environment Paper No. 2.

Ryan, L., R. Thomson and A. Sincock (2003), 'Accounting for Subsoil Assets in the National Accounts.' Paper presented at the London Group Meeting, Rome, 5–7 November.

Sachs, J. and A. Warner (2001), 'The Curse of Natural Resources'. *European Economic Review* **45**, 827–838.

Sala-i-Martin, X. and A. Subramaniam (2003), 'Addressing the Natural Resource Curse: An Illustration from Nigeria.' IMF Working Paper No 03/139. Washington, DC: IMF.

Sherbourne, R. (2003), 'A Rich Man's Hobby,' Institute for Public Policy Research Opinion Paper Number 11. Windhoek, Namibia: IPPR.

Smith, R. and C. Simard (2001), 'A Proposed Approach to Sustainable Development Indicators Based on Capital.' Paper presented by Statistics Canada at the National Conference of Sustainable Development Indicators, March 27, Ottawa, Canada.

Solow, R. (1974), 'Intergenerational Equity and Exhaustible Resources'. *Review of Economic Studies* **41**, 29–45.

Solow, R. (1986), 'On the Intergenerational Allocation of Natural Resources'. *Scandinavian Journal of Economics* **88**, 141–149.

Solow, R. (2003) 'Population Estimates and Projections: Data Online'. Retrieved from http://www.un.org/esa/population/unpop.htm in January 2004.

United Nations, European Commission, International Monetary Fund, Organization for Economic Cooperation and Development, and World Bank (1993) *System of National Accounts*. New York: UN.

United Nations, European Commission, International Monetary Fund, Organization for Economic Cooperation and Development, and World Bank (2003) Integrated Environmental and Economic Accounting 2003. New York: UN. Available on the UN website: www.un.org

World Bank (1995), Namibia Public Expenditure Review. Washington, DC: World Bank.

World Bank (1997), 'Expanding the Measure of Wealth: Indicators of Sustainable Development'. ESD Studies and Monographs Series No. 17, Washington, DC: World Bank.
World Bank (2001), Namibia: Selected Development Impact of HIV/AIDS. Washington, DC: World Bank.
World Bank (2002), World Development Report. Washington, DC: World Bank.
World Bank (2003), World Development Indicators. EdStat online database available at www.worldbank.org