Natural Resources, Environment, and Sustainable Growth in Mozambique

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Acknowledgment

We seize this opportunity to acknowledge the highly valuable and warm collaboration of all Mozambican partners met in this iterative process: the government of Mozambique, national NGOs, research centres and international organizations.

We propose this draft paper for discussion in order to nurture the on-going policy dialogue, and are willing to pursue these insightful exchanges on these first results and proposals for further policy-oriented analytical work.

Warning

This document is a work in progress to share with the different partners for discussion. All data used and assumptions are presented in the appendix. Our objective is to be transparent so that anyone can criticize the work and propose improvements. The calculations will then be improved with feedbacks from the workshop.

This work has been conducted at the national scale. As a consequence, we consider mainly large scale and not localized degradations.

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1 INTRODUCTION

1.1 Recent economic developments in Mozambique

Since 1992 and the end of the civil war Mozambique benefits from a remarkable economic growth of 8% (except for the year 2000, when it fell below 2% due to catastrophic floods), high levels of foreign direct investments and ODA, and a substantially reduced external debt, by almost 50%, through two rounds of international debt relief for Highly Indebted Poor Countries (HIPC) in 1999 and 2001.

The growth has been driven mainly by mega-project construction, investment from neighbouring countries, a high level of donor support and the post-war recovery of the agricultural sector. The mean annual growth in agricultural production between 1995 and 2003 was 5.2%, while the fishing sector practically stagnated. Growth in the agricultural sector was thus substantially lower than the overall mean GDP growth rate of 8.6%. High rates of growth (above 10%) in construction (12.8%), electricity and water (43.1%), and finance and insurance (10.4%) resulted essentially from the mega-project that generated high growth rates in manufacturing (18.9%) and mining (16.2%), and to a lesser degree from growth in the tourism industry (IPC, 2008).

The macroeconomic framework is defined in consultation with the IMF, and relies on the implementation of the second national strategy for absolute poverty reduction (PARPA II). Approved in 2006 for the period 2006-2010, this strategy aims at:
- reducing poverty from 54% of the population in 2003 to 45% of the population in 2009;
- maintaining a high growth rate (7% per year);
- increasing fiscal revenues, preserving the informal sector but increasing taxes for mega projects;
- raising external aid at 49% of public budget.

PARPA also focuses on inequalities and absolute poverty reduction, for instance in poor urban areas, on rural development and on employment. While infrastructure and social sectors were already emphasised in the previous government plans, the priority for investment in human capital reflects a major change in the policy recommendations of the principal Finance Institutions (IFIs), as compared to the 1980s structural adjustment strategies.

The vision tries to go beyond poverty reduction to encompass all dimensions of sustainable development.

The International Monetary Fund (IMF) has completed the third review of Mozambique's economic performance under a three-year Policy Support Instrument (PSI). Mozambique's economic program with the IMF remains on track and all the quantitative and structural assessment criteria to end-June 2008 were met. The PSI approved in June 2007 emphasizes that "The strategy to consolidate macroeconomic stability in the context of a continued scaling-up of aid and the acceleration of a second wave of reforms (…) should help sustain strong broad-based growth. (…) The approval of the new mining and petroleum fiscal laws, and intention to issue implementing regulations is welcome in this regard. The authorities are also encouraged to adopt new model contracts in the mining and petroleum sectors while ensuring that all new sizeable projects abide by the principles of the new fiscal regime and the core principles of the Extractive Industries Transparency Initiative."

1.2 The natural resources of Mozambique

Mozambique is a vast country of 780,000 km^2, including 620,000 km^2 covered by some vegetation, and 87,000 km^2 of protected areas, for only 21 millions inhabitants. Its climate and maritime coast, where end numerous rivers, among which the Zambeze, make Mozambique particularly vulnerable to natural disasters (floods, droughts, cyclones, etc.).

The country enjoys abundant natural resources: water, arable lands covering 10 different agro-ecological zones (only 12% being cultivated), hydropower potential (including Cahora Bassa, the second biggest dam in Africa), gas and other subsoil assets. Important fish and mineral resources have played an important role as an economic buffer. The country's forestry potential has certainly been under-utilized, although there is significant waste with current unsustainable practices.

Mozambique's biodiversity is impressive (with over 5,500 plant species, 220 mammals, 690 birds), with a large share of endemic species.

As underlined by a recent World Bank study (2005)[1], with 65% of the population living in rural areas, "the country's economy will undoubtedly continue to rely to a very large extent on its natural resource base. Even with rapid rates of urbanization, the subsistence and well being of most Mozambicans will continue to depend on their access to land, water resources, forest products, fisheries, mines, and other natural resources." Moreover, the development of commercial agriculture, key for economic growth and poverty reduction, will stress the challenge of comprehensive and sustainable natural resources management.

1.3 Objectives of the present work[2]

Step 1 - To assess the composition of the wealth of Mozambique (with a focus on natural capital)

"What constitutes wealth? Traditionally attention has been focused on produced capital such as buildings, machinery, equipment, and infrastructure. The wealth estimates introduced in this study extend these measures by accounting for exhaustible resources, renewable resources, and agricultural land. The estimates also include intangible capital, which encompasses raw labor, human capital (the stock of human skills and know-how), social capital (the quality of institutions). Economic theory tells us that there is a strong link between changes in wealth and the sustainability of development - if a country (or a household, for that matter) is running down its assets, it is not on a sustainable path. For the link to hold, however, the notion of wealth must be truly comprehensive. This is a major motivation for expanding the measure of wealth". In this study, we assess each three forms of capital: natural, physical and intangible (human and social) capital for Mozambique.

Step 2 – To assess the sustainability of the actual development path of Mozambique

Sustainable development can be defined as the process of maintaining wealth for future generations. As stated by Dasgupta and Mäler (2001), "each generation should bequeath to its successor at least as large a productive base as it inherited from its predecessor". The nation's wealth, thus understood as its productive base, include as said before not only produced (or physical) capital but also other forms of capital such as human (educational attainment,

1 Natural Resources and Growth Sustainability, Economic and Sector Work, World Bank, 2005
2 Most of this section comes or is adapted from "Where is the wealth of nations?" (World Bank, 2006)

knowledge, health, etc.), social (level of trust, institutions), and natural (soil and subsoil assets, forests, marines resources, etc). All types of capital are key inputs to sustaining economic growth.

The standard national accounts measure the change in a country's wealth by focusing solely on produced assets. A country's provision for the future is measured by its gross national saving, which represents the total amount of produced output that is not consumed. Gross National Saving, however, can say little about sustainable development, since assets depreciate over time. Net national saving equals gross national saving minus depreciation of fixed capital and is one step closer to measuring sustainability. The next step in measuring sustainability is to adjust net saving for the accumulation of other assets - human capital, the environment, and natural resources - that underpin development. In this study, we introduce the concept of *genuine* saving (formally known as adjusted net saving) first derived in Pearce and Atkinson (1993) and Hamilton (1994). Genuine saving provides a much broader indicator of sustainability by valuing changes in natural resources, environmental quality, and human capital, in addition to the traditional measure of changes in produced assets provided by net saving. Negative genuine saving rates imply that total wealth is in decline; policies leading to persistently negative genuine saving are unsustainable. In addition to serving as an indicator of sustainability, genuine saving has the advantage of presenting natural resources and environmental issues within a framework that finance and planning ministries can understand. It makes the growth-environment trade-off explicit, since those countries pursuing economic growth today, at the expense of natural resources, will be notable by their depressed rates of genuine saving.

We will first calculate the different environmental degradation costs which feed the genuine saving. These can be divided into three main categories: natural resources depletion (forests, agricultural soils, and fisheries), pollution[3] costs (mainly from water and air pollution) and the costs of water shocks (droughts and floods).

The study is organised as follows. In Section 2 we detail the methodology used to estimate Mozambican wealth (natural, physical and intangible capital stocks), the different environmental degradation costs and genuine saving. We present the results in Section 3 and then discuss those results, opportunities for further analytical work and preliminary policy implications in Section 4.

[3] We concentrate here on diffused and large scale pollutions and not local pollution for example from mega-projects

2 GENERAL METHODOLOGY OF THE STUDY

2.1 General introduction to the two steps of the study

We give below some more details on the methodology of the two steps presented in the previous section.

Step 1 - Assessment of the wealth of Mozambique

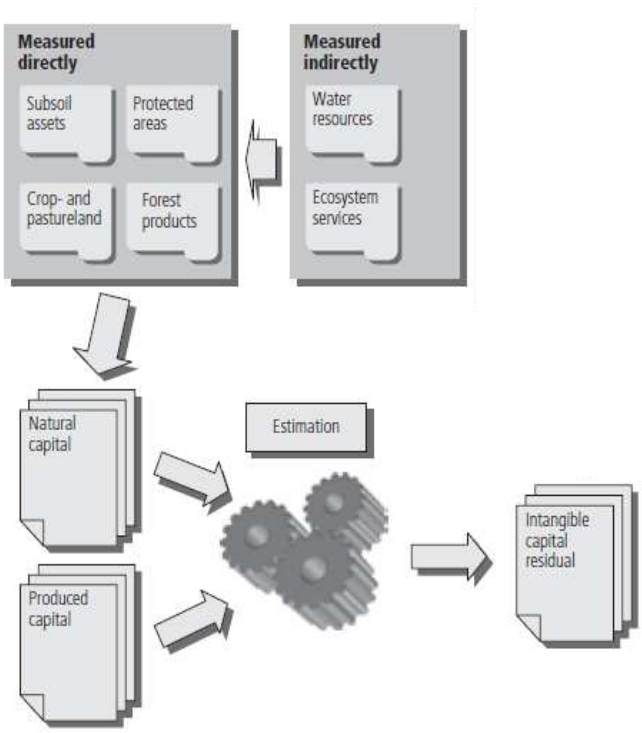


Table 1 : general framework of the wealth calculations [from (World Bank, 2006)]

Natural Capital - It includes finite resources (mineral assets), renewable ones (forests, lands) and environmental services. These different resources are valued at the present value of their rents earned over a 25-year accounting period (2005-2030). Box 1 presents some methodological elements to estimate natural capital. Much more information on the assumptions and data used is available in the Appendix.

Box 1 - Few Methodological Elements on Natural Capital calculation (more details are given in the Appendix)

Cropland - We consider the main crops of Mozambique (maize, cassava, mapira, beans, peanuts, rice, cotton, cashew nuts, potatoes and tobacco). We use current production trends to forecast future rents. Prices were taken from FAOSTAT and data on production costs were found in several studies (Gergely, 2005; Arlindo, 2007; Coughlin, 2006). We include the economic 'option value' of actually unused cultivable land which does not generate any rent to account for in present time.

Pastureland - Milk, Cattle and goat meat are the outputs we account for from pasturelands, mainly dedicated to cattle grazing in Mozambique. As for croplands, we forecast the trend of future rents on the basis of observed production trends. In the absence of comprehensive data on production costs, we rely on the rental rate of 45% inferred by the World Bank.

Timber resource - Rents from timber resources originate from industrial roundwood and fuelwood production. Legal logging estimates are based on DNTF data. Quantitative estimates on illegal logging are quite scarce. We use figures given in Mac Kenzy (2006) (for the Zambezia province, the work is being updated and expanded to other provinces). This has to be further discussed. Future rents depend on the sustainability of wood production, determined by production trends, annual regeneration and total wood stock (from Wisdom (2008) and the last National Forest Inventory). Rental rates hypothesis are 40% for industrial roundwood (USAID-CTA, 2006), and 50% for fuelwood production.

Non Timber Forest Products (NTFR) - Quantitative studies on NTFR extraction and use in Mozambique are quite scarce. Our calculations are based on two studies analyzing direct use values of fruits, wild animals, honey, raffia and bark in the central region of Mozambique: Bazaruto, Vilanculos and Chirendzene districts (Suich, 2006), and Gile district (Lizon, 2002). To extrapolate these values of NTFR average consumptions to the rest of the country, we use rural population figures, and estimate a weighted average based on the last National Forest Inventory that differentiates NTFR uses by regions. Finally, we infer a 50% rental rate from estimations made in other southern African countries (Schakleton 2002), and assume constant volumes harvested.

Protected areas - We calculate the net present value of protected areas network in Mozambique using direct use values of ecotourism and community resource use assessed by IUCN (2008). We subtract from these benefits the management costs (based on WWF (2008) estimates) and opportunity cost of the land, supposed near to zero given the availability of land in the country (this point is disputable as there are some conflicts in protected areas). Rent growth rate is set at 5% per annum (IUCN), a quite conservative hypothesis given MITUR anticipation of tourism trends. Our objective is to reveal a robust minimum value of protected area.

Marine fisheries - We consider here artisanal, semi-artisanal and industrial fisheries. For quantities and values of the production, we use data from (Wilson 2008 / IIP / IDPPE), adjusting upward artisanal fisheries figures to cover the whole coastal area. Rents accrued from fishing boats are quite volatile (mainly because of oil prices), meanwhile they are very low for artisanal fisheries: we believe realistic to take a 10% rental for the former one, and 5% for the latter. This should of course be further investigated.

Exhaustible Resources - Bucuane (2007) has conduced interesting and unique work on subsoil assets valuation for Mozambique, following the same methodology developed in World Bank. Mainly natural gas, coal and heavy sands are considered at this stage. It could be expanded if new stocks are found (oil for example). Calculations assume constant total rents and optimality of the extraction path in time. In our work we use prices from Bucuane's medium scenario, relatively conservative if we regard long-term structural trends of fossil fuel prices in last IEA (2008) study.

Physical (or reproducible) capital – Its value is estimated through the perpetual inventory method (PIM), which derives capital stocks from the stream of investments.

Intangible Capital - As in World Bank (2006), intangible capital is considered as a residual, and therefore measured as the difference between total wealth and the sum of natural and physical capital. Total wealth is calculated as the net present value of sustainable consumption overtime. More precisely, consumption is adjusted to a sustainable level by subtracting the amount of negative savings.

Step 2 – Assessment of the sustainability of the Mozambican actual development path

A. Assessment of the cost of environmental degradation

Natural capital depletion

Exhaustible and forest resources - The value of natural resource depletion is calculated as the total rents on resource extraction and harvest (where rents are estimated as the difference between the value of production and total production costs, including depreciation of fixed capital and return on capital). Thus, we have: $(P\text{-}AC)*R$ where P is the resource price, AC is average cost and R is the volume of extraction (in the case of a renewable resource, R represents harvest beyond natural regeneration). For exhaustible resources (mainly coal and gas at this stage for Mozambique), we use World Bank calculation (compiled for genuine saving calculation and available on the World Bank Website). For forest resources, we differentiate two different stocks: the roundwood stock (of commercial value) and the woody biomass stock (for fuelwood). We try to assess the dynamic of these two stocks. On one side, the stocks are being depleted because of logging (legal and illegal), slash and burn cultivation and wildfires. On the other side, there is the natural regeneration.

We also try to assess the loss of forest capital because of deforestation. We estimate the net present value of one hectare of forest and then appreciate the loss of forest capital given the deforestation rate of 219.000 hectares provided by the last National Forest Inventory. Different assumptions regarding the deforestation pattern are used and detailed in the Appendix (regarding

the productivity of forest in terms of roundwood and fuelwood, and the type of land forests are converted into).

Soil capital depreciation - Soil degradation reduces soil fertility and subsequently agricultural productivity. One common method to estimate the cost of soil degradation is to value net nutrient depletion at the price of lost nutrients. Folmer (1998) analyzed nutrient depletion at national scale in Mozambique. Some important limitations drove us to consider only the relatively small permanent crop area of around 235.000 hectares.

Impacts of pollution on health (human capital depletion)

We consider three types of pollution: Outdoor air pollution from particulate matter (PM) of small diameters: $PM_{2,5}$ is the cause of mortality through lung cancer, and PM_{10} causes various forms of morbidity (from respiratory symptoms to adult chronic bronchitis); Indoor air pollution, for instance carbon monoxide produced by fuelwood, that provokes acute respiratory illness (for children under 5 and women) and chronic obstructive pulmonary diseases (for women), both increasing mortality and morbidity of the population and water pollution or more generally impact on health because of unsafe water supply, sanitation and hygiene. We consider here mainly diarrheal diseases.

Other forms of health diseases linked to environmental management could be further investigated in a second phase such as malaria (linked to inadequate water resource management) or soil pollution by intestinal parasites or Schistosomiasis for example.

Box 2 – Methodological Elements on Pollution costs

For each pollution, we follow the same methodological principles. First, we assess the effects on health (mortality and/or morbidity), and then evaluate their costs. Based on the human capital approach, the cost of mortality is approximated the loss of an individual's future income because of premature death. As regards morbidity, we value the costs of unsubsidized health care expenditures and time lost due to illness.

Main data comes from the Demographic and Health survey (2003), the global burden disease (WHO 2002), and specific publications for dose-response parameters. Cost of medicine and heath services were assessed through comprehensive interviews with pharmacies, public and private health care providers and health authorities.

Damage costs from 'water shocks' (drought and floods)

We assess here the cost of damages from floods and droughts which are important in Mozambique. These have impacts on all forms of capitals. As stated in World Bank's Country Water Resources Assistance Strategy (2007), Mozambique economy is very sensitive to water shock, given the lack of resilient infrastructures in agriculture and other water-dependent sector. In turn, "unreliable water supply is a significant disincentive for investments in industry and services, which will slow the diversification of economic activities". Moreover, since 70% of the population relies upon subsistence agriculture, one third of the population faces food insecurity, and agricultural product trade is very limited in many countryside regions, poor rural households are particularly vulnerable to rainfall variability.

As examined in the World Bank's Country Water Resources Assistance Strategy, it is reasonable to assume that 1 in-3-or-4 year droughts are typically 50 percent as severe as the dramatic 1992 drought, and 1-in-4 year floods would be 40 percent as severe as the floods of 2000. Therefore, Mozambique experiences floods that on average cost about US$240 million[4] each 4 years and droughts that cost it about US$45 million every 3-4 years. This translates into damage costs of over US$70 million annually. Another study using regression analysis (Benito-Spinetto, 2004) found very similar results. Moreover, if no measures are taken, these costs should increase rapidly.

B. Genuine saving update

The figure below presents the main steps of the genuine saving calculation. The costs of the main environmental degradations feed the calculation of the genuine saving:

[4] We used here the assessment of the 2000 flood made by the World Bank 'A Preliminary Assessment of Damage from the flood and Cyclone Emergency of February-March 2000'

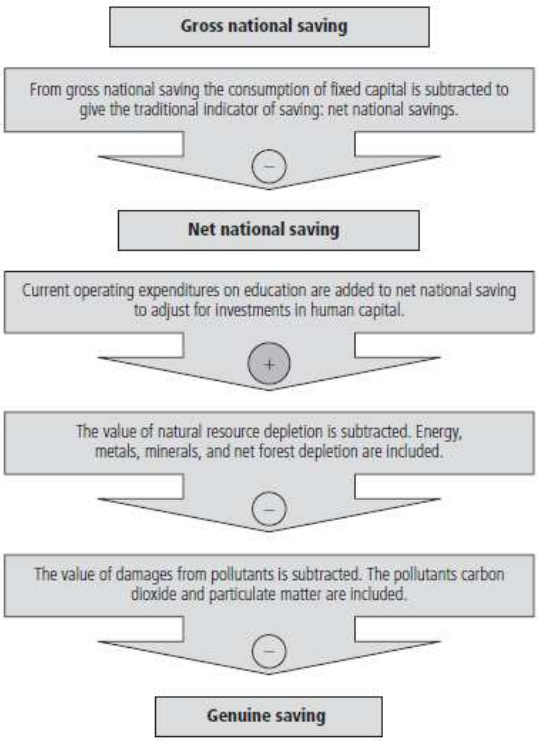


Figure 1 : steps of genuine saving calculation

More details on the general theoretical framework of the study are presented in the Appendix.

Data and sources of the study

We have collected extended datasets and numerous studies from international organisations (World Bank, European Union, Food and Agricultural Organization, United States Agency for International Development, French Agency for Development, etc.), national ministries (agriculture and fisheries, environment and forestry, national institute of statistics, etc.), non-governmental organizations (World Wide Fund for Nature) and Eduardo Mondlane University. We have discussed with experts the reliability of the data collected. This work is thus a comprehensive compilation of most existing studies and databases on Mozambican natural capital. All the sources and references are detailed in the Appendix.

3 RESULTS

3.1 Mozambican wealth composition

Natural capital

Table 2 gives the value for the different part of Mozambican natural capital. This estimate is more precise than World Bank (2005) as it refines many assumptions.

		Net present value[5]	
		This study $2005	**World Bank $2000**
Mineral resources		940	---
Forest land	Timber	347	340
	NTFR	133	392
	Protected area	30	9
Agricultural land	Cropland	694	261
	pastureland	109	57
Sea resources	fisheries	19	---
	Total	2 272	1 059

Table 2 : value of Mozambique natural capital

Physical capital (and urban land)

	Total value ($2005)	Per capita value ($2005)
2000	7 424 842 176	382
2005	17 082 399 604	880

Table 3 : value of Mozambican physical capital

One has to remember that physical capital here is only the capital owned by Mozambicans. It is important to note that foreign capital is important in Mozambique. Mozambican reproducible capital represents only around 50% of the total reproducible capital stock (and 70% in 2005). This is partly due to the important number of foreign companies in capital intensive industries such as mining.

[5] Results have to be compared carefully. Indeed, our results are for year 2005, and World Bank results are for 2000.

Intangible capital (social and human) and total wealth

	Net Present Value ($2005)
Natural capital	2 272
Produced capital	880
Intangible capital (social + human)	1 492
Total wealth	4 644

Table 4 : decomposition of Mozambican total wealth

Comments on the composition of Mozambique's wealth

Mozambique is blessed with a relatively high endowment in natural capital, representing 49% of total wealth (4.644 USD per capita), remarkably higher than the average observed in Sub-Saharan Africa (24%), showing an even higher dependence on its natural assets. Physical capital represents only a small share of total wealth, and intangible capital is an important part of total wealth. The natural capital decomposition shows that: mineral resources constitute a very important part of the Mozambican natural capital (heavy sands constitute about 50% of this capital, coal about 31% and natural gas around 19%). It could of course increase if some oil reserves were to be confirmed. Agricultural land (especially cropland) constitutes a very important share of the natural capital. Forest capital is also an important share.

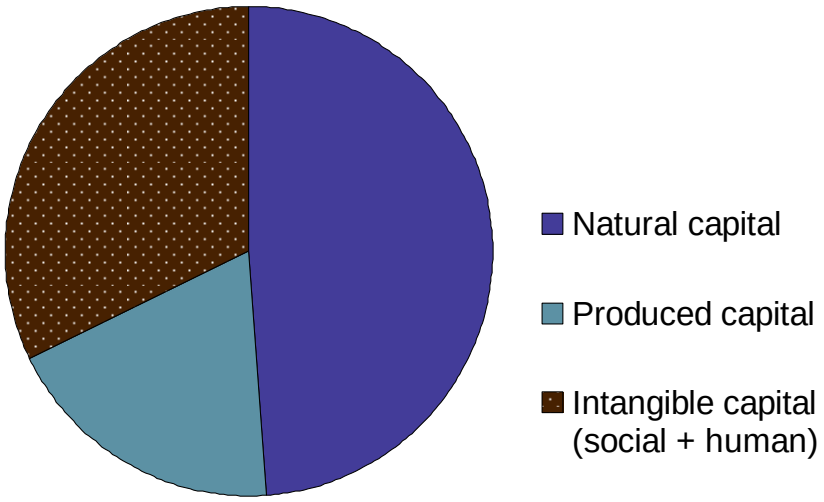


Figure 2: decomposition of the Mozambican wealth

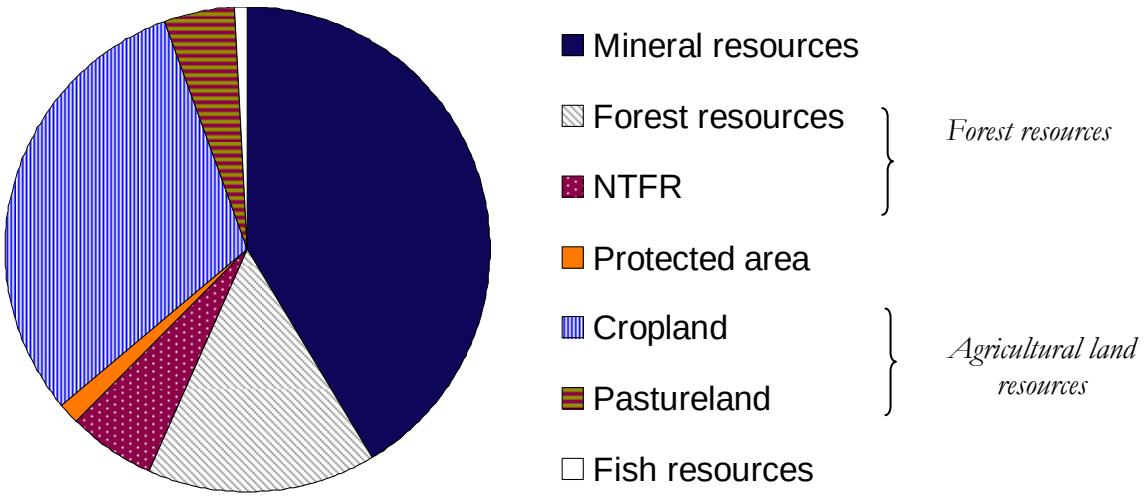


Figure 3: composition of Mozambican natural capital

As shown on the figure below, these conclusions are quite consistent with other African and low income countries which are strongly dependent on their natural asset, especially on their cropland.

	Mozambique	Sub-Saharan Africa
Natural capital	49%	24%
Physical capital	19%	13%
Intangible capital	32%	63%

Table 5: composition of wealth per capita for SSA and Mozambique (% share of total wealth)

	Sub-Saharan Africa	Mozambique
Sub-soil assets	39%	41%
Timber resources	9%	15%
NTFR	5%	5%
PA	3%	1%
Cropland	36%	30%
Pastureland	8%	5%

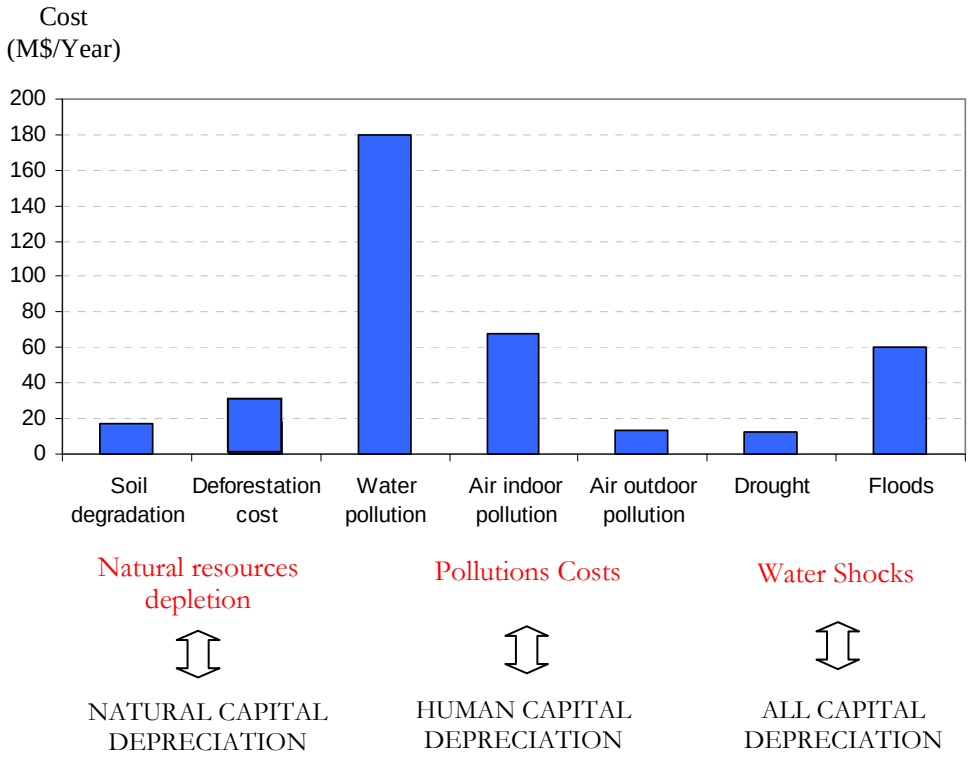
Table 6: composition of natural capital for SSA and Mozambique (% share of natural capital)

3.2 Cost of Environmental Degradation

We present on the table the main results of our calculations. Pollutions and water shocks constitute the main environmental degradation costs – climate change being left apart. However, relatively lower natural capital depletion levels still raise the question of natural resources' rent optimization.

To give an order of magnitude, estimated costs of environmental degradations, totalizing almost 370 M$, represent more than 6% of Mozambique GDP.

		M$/year	% 2008GDP
Natural capital depletion	Cropland soil depletion	17	0.2%
	Forest capital depletion	35	0.4%
Pollution costs (impact on health)	Unsafe water supply, sanitation and hygiene	180	2,8%
	Air indoor pollution	68	1,1%
	Air outdoor pollution	13	0,2%
Water shocks	Drought	12	0,2%
	Floods	60	0,9%



Comments on the costs of environmental degradation

Natural capital Depletion - Our calculations indicate quite low forest and soil capital depletions. This is consistent with a more qualitative analysis of the situation: the pressure on land remains low as there is an important quantity of land available, and the pressure on forests also (the deforestation rate remains low compared to other African countries). For forest resources, roundwood and woody biomass harvesting (even including high figures on illegal logging) appears to be below natural regeneration[6].

This has however to be balanced with several qualitative observations. First, our figures are at the national scale and the pressure can be locally important. For example, soil degradation is mainly found in intensive agriculture areas, and deforestation rates are important in some provinces (1.18% in the Nampula province for example). Second, considering forest resources, many observers indicate a degradation of the quality of the forest, so that the most valuable species stock would be depleting. This point is certainly a critical issue and has to be further investigated. It would be important to refine the work and assess the evolution of these highly valuable stocks, not the aggregate stock.

Finally, because of the lack of data at the national scale, we could not account for fish stocks, wild animal's stocks depletion or pastureland depreciation, etc. For fisheries, for example for the Sofala Bank, there has been a sharp decrease of the catch per unit effort, linked to an important increase of the effort. It remains however difficult to estimate the depletion of the biomass stock. Illegal fishing is also a critical issue on which we have very few elements (as well as local damages on habitats from bottom trawling or by-catches).

Pollution damages on health - Surprisingly, these costs appear to be pretty high, especially the cost due to unsafe water supply, sanitation and hygiene (what we call awkwardly water pollution) and indoor air pollution. In this study, we look at diffused and large-scale pollutions. But it could be interesting to look at more local pollutions such as pollution from megaprojects[7] or toxic waste in cities.

Damages from 'water shocks' - As expected, these appear to be important, especially damages from floods. Most of the damages are on physical capital (from the 2000 flood damages assessment). This estimate is certainly biased as it is easier to estimate the loss of infrastructures.

[6] We have however no data on the impact of wildfires on the roundwood stock and it is quite difficult to assess the loss of roundwood stock because of slash and burn agriculture.

[7] Some Environmental Impact Assessment will be launched and will look at these issues

3.3 Characterizing the actual development path of Mozambique: Update of genuine saving calculation

We present the different results: the decomposition of genuine saving for the year 2005 and the evolution of genuine saving since the early 90's[8].

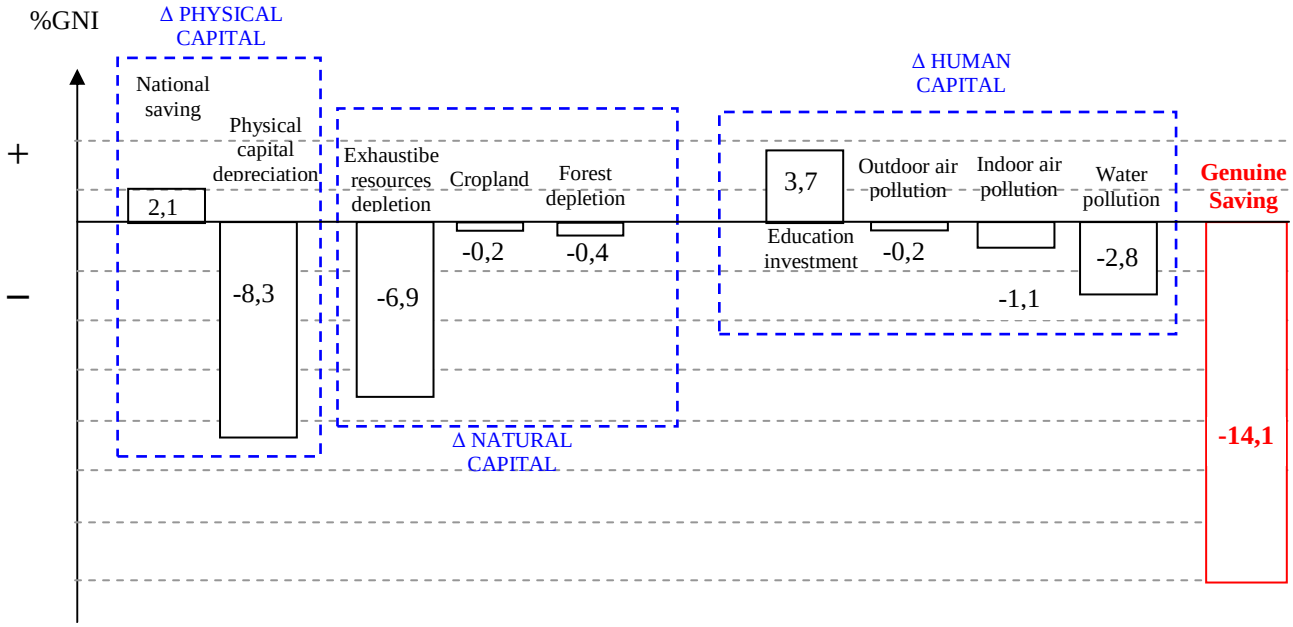


Table 7 : decomposition of genuine saving for the year 2005

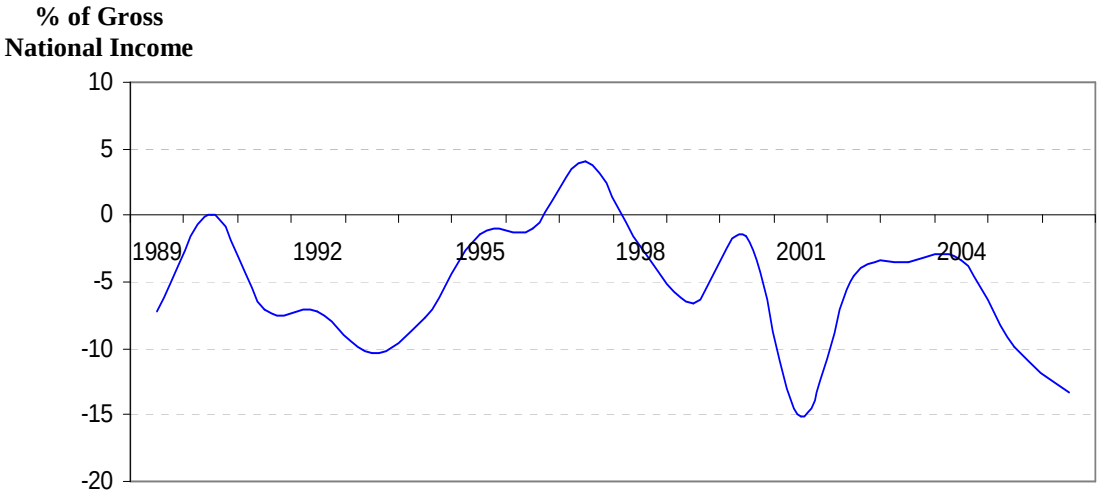


Table 8 : evolution of the Mozambican genuine saving during the last 15 years (from WB data, not readjusted as for 2005)

[8] For this figure, pollution costs are not included

Comments on genuine saving results

The genuine saving decomposition gives an idea of the evolution of the different capital assets. We present on Table 9 the main results and interpretation we can get from genuine saving for each type of capital.

Asset considered		Main results	Policies involved – How to boost investment in this asset?
Physical Capital		- low national gross saving - high depreciation	- What monetary and fiscal policies boost gross saving rates and limit produced capital depreciation?
Natural Capital		- important exhaustible resources depletion - low renewable capital depletion	- Do existing natural resource policies encourage over-exploitation? - Are extraction rates above efficient levels? - What are the most cost-effective policies to reach this level?
Human Capital	**Education**	- important investments in education	- Are enough resources reinvested into education? - Are these expenditures effective?
	Pollution	- high human capital depletion because of air pollution and unsafe water supply, sanitation and hygiene	- Are pollutant emissions beyond the socially optimal levels? (equivalent to the level where marginal damages and marginal abatement costs are equalized) - What are the most cost-effective policies to reach this level?

Table 9 : Results and main policy issues derived

Moreover, climate change will have a very important impact on all forms of capital and will increase most of the costs calculated here.

This accounting is not exhaustive. We had insufficient data to include for example: pastureland depreciation, fishes stock variations, forests and soil carbon stocks, or groundwater depletion. Most of those elements would certainly have a downward effect on genuine saving calculation. Furthermore, it would be important to refine human and social capital variation which could modify significantly our genuine saving estimate.

4 MAIN MESSAGES ON THE SUSTAINABILITY OF THE ACTUAL DEVELOPMENT PATH OF MOZAMBIQUE

On the composition of the wealth of Mozambique

Intangible capital constitutes an important part of Mozambican wealth. On the contrary, physical capital is a small share. As expected, natural capital is also very important. Exhaustible resources (mainly gas and coal) constitute an important share of this natural capital. Agriculture land, especially cropland, is also an important asset for Mozambique, so as timber. The results are in line with most Sub-Saharan countries: the country is very much dependent on its natural capital.

On the change in wealth over time / cost of environmental degradation

i) Economic growth sustainability is at risk

Genuine net saving is pretty much negative for 2005, and has been almost always negative for the last 20 years, emphasizing an economic development path not sustainable: Mozambique appears to tap in its productive base without investing enough in natural and physical capital.

Regarding physical capital, its depreciation seems very high, and national saving low and volatile. It can be questioned what monetary and fiscal policies boost gross saving rates and limit physical capital depreciation.

A weak sustainability approach would at least require that the rent derived from Mozambique's high endowment in natural capital be invested in any form of capital – what is not the case in the recent period. Meanwhile a strong sustainability stand would in turn imply to maintain the natural capital stock (or some 'critical part' of it). The question posed here is the limit of substitutability between physical, human, social and natural forms of capital, and threshold effects.

ii) High impact of pollution on health

GNS decomposition points out the relatively high investment in Mozambique in education, compared to other African countries; but these efforts to build up human capital are hindered by water and air pollutions.

Costs of air and water pollution are indeed particularly important, especially water (unsafe water supply, sanitation and hygiene) and air indoor pollution.

iii) High impact of climate shocks

As expected, Mozambique is strongly vulnerable to climatic variability. Indeed, "water shocks" (especially floods) have high costs on the Mozambican growth. And these will certainly increase because on climate change. It is important to go further and find the most effective way to handle or at least reduce the impact of these shocks.

iv) Relatively low depletion of renewable natural resources

Pressure on natural resources in Mozambique remains quite low. There does not seem to be a very high depletion of the different stocks. The resources can be overexploited locally, but at the national scale, the depletion of the stocks remains low. The problem does not seem to be to protect the resource for future use, but more to increase the productivity of the actual use and extend the use of the resource. There is a considerable productivity potential to unlock.
Considering forest resources, these figures have to be balanced with the fact that there seem to be an important degradation of the quality of forests, with highly valuable species stocks being depleted. The statistics at the national scale we have make it difficult to account for this issue.

v) The wealth depletion because of climate change should be high

The work to estimate the cost of climate change for Mozambique is still in progress (team led by S. Margulis from the World Bank). Results should be given during the year 2009, but the cost is expected to be rather high. The only policy available for Mozambique to cope with climate change is adaptation. In the same study, several adaptation strategies will be assessed through cost-benefit analysis.

vi) Question about mineral resources rent management

Depletion of gas and coal resources represents the most important share of natural capital depletion. The fact that genuine saving is negative seem to indicate that the rent derived from the

depletion of these resources is not reinvested enough in other types of capital so as to maintain the same level of wealth. Then, several issues can be tackled: Is the rent sharing between the state and the mining company optimal? And what about the efficiency of the management and allocation of this rent?

5 PRELIMINARY IDEAS OF FURTHER ANALYTICAL WORK

"Worldwide experience has shown that investing in the natural resource assets of the poor can yield impressive returns and provide for sustainable income growth, but it requires a facilitating set of stable and predictable laws, regulations and institutions responsible for their implementation. The composition of different countries' assets clearly shows that immediate action towards achieving the MDGs should focus on sustainable management and investments that could enhance scope, returns and resilience of the natural capital assets of poor countries." (Norad Report 6b 2007 Discussion)

We present below several examples of policies to tackle the different issues. This is of course not exhaustive and does not cover every sector. It is just a preliminary work introducing what the next steps of the overall study could be.

On natural capital management

Forest resources - The main issues and objectives of the actual policies are: (1) to promote forest exploitation in a concession regime instead of simple licences: simple licence remains however mostly used as it is simpler and more favourable, (2) to reduce log exports to favour local processing: a ban on exports of 1st class logs has been introduced and licence fee reduced on processed logs: national processing capacity remain weak, and it has led to a production reduction, (3) Licence fees are uniform across the national territory and therefore do not provide incentives for operators to produce timber from the more remote and less exploited forest areas; (4) Fee levels would be correct, but regulation capacity is weak.

These statements are consistent with our observations. First, the forest resource is to some extent underexploited. There is potential sustainable timber harvest of 500 thousand m^3 per year although current levels of exploitation are only 25% of that. There is a need to increase the profitability of remote forest areas and to understand the main constraints to the exploitation in these areas. It could be by reducing the licence fee for these less accessible areas. It could be also by improving infrastructures (and thus reducing transport costs). Cost-benefit analysis can be an interesting tool to test the different policy options. Second, the productivity of forests remains low (e.g. the net present value of one hectare of forest could be increased). This is partly due to the type of forests which have low regeneration and productivity. But it could be possible to

improve the productivity of forest exploitation through a better management, more long term, mixing log production with other activities. It could be interesting to test several management options through cost-benefit analysis.

Agricultural land resources - The main issues and objectives of the actual policies are: (1) only 17% of the cultivable land is used for agriculture and grazing, (2) rights on the use of land are often not clear, and conflicts are frequent, (3) land law is theoretically quite protective for local communities, but the government has very few resources to implement and enforce the law, (4) credit and poor access to markets are severe constraints to the development of new land for local people, (5) Large owners also do not develop land because of high transaction costs, poor public infrastructure, etc.

The main issue in our concern is that agricultural land remain under exploited (we do not focus here on institutional problems over land use recognition which are of course a major issue). How to increase the productivity of exploited land and how to encourage people (Mozambicans or foreigners[9]) to develop new lands? We face here classical agricultural policies problems: problem of market imperfection, lack of public infrastructures, lack of access to technology, etc. From the last Mozambican Agricultural development Strategy (World Bank, 2006), the main constraints are: a limited access to improved crop technologies, a limited access to extension service (8% income increase when access), a high cost of capital, high transaction costs (because of corruption, labour law, etc), limited rural connectivity (poor roads, very low density), etc. It is possible to compare the cost of limiting or halting the constraint with its benefits. Two important policy options to unlock this considerable potential are land reforms and investments in irrigation. Finally, foreign investors are interested by the important land resources of Mozambique. It is also an important issue for the country to get prepared so as to maximize the spillovers from these large scale agricultural projects for local populations and the country.

Sub-soil resources - In the case of extractive industries, the major issues in present policies are: for large scale projects, to increase the fiscal take (through a revision of the existing contracts, an increase of the capacity of administration to audit large companies…); for small scale projects: to finalize the reform of the FFM (Fundo de Fomento Mineiro).
Most of the debate is thus around the 'optimal' taxation of mineral companies to maximize the fiscal take. It is of course an important question. Mineral rents in Mozambique become important

[9] Africa is becoming the last continent having so much unused land, with an increasing interest from foreign investors (see the example of Daewoo in Madagascar if confirmed).

and will be even bigger in the near future. There are few discussions on what to do with the rents. There is a need for Mozambique to prepare to receive these important rents so that the country does not fall into a "resource curse" syndrome (i.e. Dutch disease, lack of skills accumulation, low linkages between the resource sector and the rest of the economy, fiscal instability linked to commodity price volatility, rent seeking and a general lack of pressure to undertake economic reforms). The results from genuine saving are not optimistic and indicate that the country does not seem to reinvest enough of the mineral rent into other forms of capital assets.

On pollution management - As we saw before, costs related to water and air pollution are particularly important. Results from other countries and international experience show that investing in water or indoor air pollution reduction can be highly socially profitable. So that there is a need to find cost-effective alternatives to cope with these problems. The table below list several possible technical alternatives.

Pollution	Possible technical solution
Indoor air pollution	- extension of access to electricity - improved cooking stoves - subsidized cleaner energies - increase of ventilation in households
Water pollution	- improve sanitation and water supply - program to sensitive people to wash their hands - water treatment / filters - extend existing waste collection systems
Outdoor air pollution	- limitation on vehicles emissions - lead-free gasoline / catalytic converters

On water shocks management - An indicative economic analysis has been conducted on the investment proposals suggested by the government through the national water development Program I strategy development process. These have not been adopted by the country but can give some elements of the potential social profitability of such investments. These were a package with different components: flood protection, reduce the impact of droughts through extended irrigated schemes, increased hydropower production. The results show that these can decrease the water shocks cost by 75% (it does not include additional benefits from improved water supply, increased agricultural output and hydropower production). Assuming a 8% discount rate, the internal rate of return is around 10%, with a Benefit/Cost ratio 1.29.

On climate change management - The undergoing study on the economics of adaptation to climate change will feed this part. Results are expected for the end of 2009. The different

adaptation strategies will be assessed through cost-benefit analysis considering economic, social and environmental perspectives.

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