Investment and Financial Flows to Address Climate Change in Namibia

UNDP Global Project: Capacity Development for Policy Makers to Address Climate

Executive Summary

Assessment of Investment and Financial Flows for Mitigation in the Energy Sector and Adaptation in the Agriculture Sector in Namibia

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Investment and Financial Flows to Address Climate Change UNDP Global Project

Climate Change poses significant challenges to development and policy makers are faced with complex tasks to respond to them and to ensure sustainable development. Particularly in Least Developed Countries decision makers have to balance poverty alleviation, economic development as well as social and environmental questions, while also questions of costs that occur with associated policies and measures play a vital role.

To better understand the magnitude of funds needed to tackle climate change now and in the long term, developing countries are undertaking assessments of investment and financial flows (I&FF) to address climate change for key sectors in a groundbreaking UNDP Environment & Energy Group project: Capacity Development for Policy Makers to Address Climate Change.

Namibia is one of 19 countries participating in this project, which was launched in May 2008 with the generous contributions of the Government of Norway, Government of Finland, Government of Switzerland as well as the UN Foundation and UNDP.

Authors:
Uazamo Kaura
Olimpio Nhuleipo
Petrus Muteyauli

Energy team:
Petrus Muteyauli
Raul Alfaro
Fransina Shihepo
Andreas Sheehama
Reagan Chunga
Martha Wilhelm
Detlof von Oertzen
Tina Andima
Luke Sweeney
Omar Fofanah

Agriculture team:
Olimpio Nhuleipo
Uazamo Kaura
Veikko Shigwedha
Pekeloye Malwa
Aina-Maria Iteta
Romie Nghiulikwa
John Ashipala
Luke Sweeney
Omar Fofanah

National coordination:
Uazamo Kaura
Olimpio Nhuleipo
Petrus Muteyauli
UNDP Namibia: Martha Mwandingi

Global coordination:
Rebecca Carman, Global Project Manager, UNDP New York
Susanne Olbrisch, Technical Specialist Climate Change – Financial Assessments, UNDP New York
AnnaLisa, Programme Associate, UNDP New York

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Contents

Acronyms

AWG	Adaptation Working Group
BAU	Business As Usual
CCP	Climate Change Policy
CO_2 eq	Carbon Dioxide equivalent
DRFN	Desert Research Foundation of Namibia
FDI	Foreign Direct Investment
FF	Financial Flow
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IECN	Integrated Environmental Consultants Namibia
IF	Investment Flow
IFF	Investment and Financial Flows
INC	Initial National Communication
IPPR	Institute for Public Policy Research
LPG	Liquid Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MME	Ministry of Mines and Energy
MoF	Ministry of Finance
MTI	Ministry of Trade and Industry
MW	Megawatt
MWh	Megawatt hour
NAD	Namibian Dollar
NPV	Net Present Value
ODA	Overseas Development Assistance
OGEMP	Off-Grid Energisation Master Plan
O&M	Operation and Maintenance
PASS	Pan-African Start Secretariat
PED	Price Elasticity of Demand
PV	Present Value
SPA	Strategic Priority on Adaptation Fund
TWh	Terawatt hour
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

Climatic constraints are one of the main factors limiting the socio-economic development of Namibia. Recent droughts have hit Namibia, combined with human activities they have led to degradation of natural resources on which the existence of the majority population depends. Therefore, in the context of the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) that Namibia had signed in June 1992 and ratified in May 1995, in addition to projects and programs, it submitted the Initial National Communication (INC) in October 2002.

The **energy** and **LULUCF/agriculture** sectors of Namibia are key to the country's economic growth and development. The First National Communication to the UNFCCC indicates that the country's Greenhouse Gas (GHG) emissions mainly result from the agriculture (180 Gg CO2-e in 2000) and energy (2200 Gg CO2-e in 2000) sectors. This indicates that carbon mitigation potentials exist in the country's energy sector. The electricity generation and transport sub-sectors were chosen for this analysis.

Whilst the impact of climate change on the Namibian agriculture sector is difficult to predict with any definitive accuracy, it is likely that the livestock and cropping activities assessed will be adversely affected by the predicted increases in temperatures and variability of rainfall. Although the climate of Namibia makes agriculture a somewhat marginal activity, subsistence agriculture is vital for a large number of rural Namibians.

1.1 Objectives

This Investment and Financial Flows Assessment has been conducted in Namibia with the aims of determining the country's current and future financial requirements to address the impact of climate change and to support long-term capacity enhancement in climate change planning and decision-making in the public sector. It is expected that the results of this work will strengthen Namibia's negotiating position at national, regional, and international climate change forums.

The sectors chosen for this analysis have been the **Energy** sector and the **LULUCF** sector, with mitigation strategies considered for the former and adaptation strategies for the latter. For energy, the inclusion of additional wind power and solar power into the energy mix, together with measures to improve energy efficiency, formed the basis of the additional mitigation measures evaluated for the electricity generation sub-sector. The partial replacement of petrol fuel by LPG was an additional measure considered for the transport sub-sector. For LULUCF, the livestock and crop subsectors have been assessed.

1.2. Choice of sectors

Namibia's **energy** sector is of key strategic importance to the country's economy, as the availability and access to reliable and affordable sources of energy is and will remain a pre-requisite to the country's ongoing development. All aspects of the Namibian economy rely either directly or indirectly on the availability of various forms of energy, hence the

deliberate development of the country's energy sector will, to a large degree, determine whether reasonable economic growth rates can be realised in the years to come.

Namibia's population of some 2 million people is spread over a land area exceeding 800,000 km², making Namibia one of the least densely populated countries in the world. According to the Namibian Labour Force Survey (MoL, 2004), the **agricultural** sector employed 27% of the country's workforce in 2004. The 2003/4 Household Income and Expenditure Survey (CBS, 2005) indicated that 48% of rural households obtain their main source of income from subsistence farming.

Climate change is a relatively new item on the national development agenda in Namibia. Many of the legal and policy instruments developed in the past do not necessarily take climate change issues into account. This assessment evaluates various mitigation and adaptation measures for the energy and agriculture sectors, and as such can be a useful tool for policy makers.

1.3 Previous analyses utilised

Energy

Several studies pertaining to the Namibian electricity sector and transport sector have been utilised in the Energy sector analyses. Where Namibia specific information was not available, findings from international sources were used.

Electricity sub-sector

The document *"Electricity Supply and Demand Management Options for Namibia - A Technical and Economic Evaluation"* prepared in 2008 identified and ranked different renewable energy technologies in Namibia in terms of benefit-cost analysis as well as other parameters like technological maturity. According to the study, the use of some renewable resources is economically efficient and within a balanced generation mix, up to 20% of demand could be met by renewable energy excluding hydro power.

Another relevant study was prepared by the Institute of Public Policy Research (IPPR), entitled *"Review of Electricity Policy in Namibia".* The 2009 study assesses the present situation in Namibia's electricity sector and develops proposals on policy and planning to overcome its energy challenges.

In addition, the government has indicated in policy documents such as the National Development Plans (NDPs), Vision 2030 and the White Paper on Energy Policy, the commitment to shift towards renewable energy. Further, a Cabinet decision signed in 2007, approved the Off-Grid Energisation Master Plan (OGEMP), which will establish Energy Shops that will bring services and solar products closer to the communities in the rural areas. The Cabinet decision also directed that the hot water supply to all Government and parastatal buildings is to be met by solar water heaters.

Transport sub-sector

The primary source for much of the data and assumptions used in the transport analysis has been the *"Namibia Energy Review for the UNFCCC",* a report prepared for the Ministry of Environment and Tourism by Capôco, Hoveka and Heita in 2007. Much of the information regarding car numbers, fuel consumption and the LPG market in this current analysis comes from this report.

In order to assess the likely growth in car ownership in Namibia, the findings from a study by Dargay, Gately and Summer (2007) were adapted for Namibian circumstances. In the study the observed relationship between Purchasing Power Parity Income per capita and the number of vehicles per person is described, using country level data. This technique is also used by the International Energy Agency (IEA) in their assessments of global future fuel demand.

Another study that was used for this analysis is Espey's (1996) work on estimating the Price Elasticity of Demand (PED) for American gasoline (petrol) usage. In that study, Espey estimates a PED for gasoline of around -0.25, which has been using in this analysis in the Namibian context to estimate the impact of predicted future fuel price changes.

Agriculture
In Namibia, several relevant climate change papers have been produced that have been of use for the I&FF assessment. However, findings and experience with the I&FF assessment show that the report, *Namibia's Vulnerability Assessment* (DRFN and CSAG, 2008), whilst useful from a qualitative point of view, did not provide substantive quantitative figures that could be used in the assessment. Therefore there is a need for more focused and specialised research studies to generate relevant data from the various agricultural subsectors, which will be used for elaborated future I&FF assessments.

Other sources with valuable data for this I&FF assessment were therefore also used. In the cases where specific information has not been available, the assessment has extrapolated information from other non-Namibian sources.

In terms of adaptation, work that is of particular relevance includes:

- LULUCF Adaptation concept paper (Zeidler, 2009)
- Namibia's V&A Assessment (DFRN and CSAG, 2008)
- Technology needs assessment (Beakat, 2005)
- Research on farming systems change to enable adaptation to Climate Change
- Africa Adaptation Programme
- Climate Change Adaptation – Strategic Priority on Adaptation Fund (SPA) pilot; various reports (coping mechanisms, baseline assessment, forecasting etc.).

1.4 Institutional arrangements and collaboration

The institutional arrangements for carrying out the assessment were designed to create strong government ownership and engagement in the assessment process. This was both to draw on specific knowledge contained within individual ministries and to build capacity within each the ministries with regards to this issue. Individual experts from different line ministries and private sector institutions were involved in the initial project definition and

training workshops, and were later invited to become active assessment team members. Two Working Groups were formed in February 2010.

Energy
Namibia's Ministry of Environment and Tourism has been the main co-ordinator of the energy assessment. Other relevant ministries such as the Ministry of Mines and Energy, the Ministry of Trade and Industry and the Ministry of Finance also have supplied representatives for meetings and have been directly involved in all steps of the analysis.

Moreover, other institutions have also been involved in the assessment process, including the UNDP country office that contributed valuable assistance throughout the formulation of the document and the Renewable Energy and Energy Efficiency Institute, which provided valuable data. VO Consulting also provided extremely valuable technical expertise throughout this exercise.

Agriculture
The Adaptation Working Group initially contained members from a wide range of sectors, to cater for expertise and input from all sectors relevant to the LULUCF context. However, after it was decided to focus the assessment more specifically on the agriculture sector (with LULUCF linkages), particularly crop and livestock production, membership was narrowed down. The Ministry of Agriculture, Water and Forestry (MAWF), the Ministry of Environment and Tourism (MET), the Ministry of Trade and Industry (MTI) and the United Nations Development Programme (UNDP) were key WG members. Additionally, a private sector expert office, Integrated Environmental Consultants Namibia (IECN), provided valuable support at the early stages of the project.

1.5 Basic methodology and key terms

Methodology
Once the scope of a sector is clearly defined, the relevant investment costs for that sector are projected for two future scenarios: 1) a **baseline scenario**, which reflects a continuation of current policies and plans, i.e., a future in which no new measures are taken to address climate change (otherwise referred to as a *"business-as-usual"* scenario), and 2) a **climate change scenario**, in which new mitigation measures are taken (a *"mitigation scenario")* or new adaptation measures are taken (an *"adaptation scenario").*

The investment costs of the baseline and mitigation (or the baseline and adaptation) scenarios are then compared to determine the changes in investments needed to mitigate emissions from the sector (or to adapt to the impacts to the sector). The assessment takes into account different investment entities: households, corporations, government, as well as the different years, in which I&FF may occur. Note that changes in investments may include not only increases in investments (new funding), but also shifts in existing investments (reallocations of existing and currently projected funding levels such that funds in one area decrease, and funds in another area increase).

The steps to carry out the I&FF assessment are:

1. Establish key parameters of the assessment

2. Compile historical data of I&FF and other input data for the scenarios
3. Define the baseline scenario
4. Calculate and project the I&FF for the base scenario
5. Define adaptation / mitigation scenarios
6. Calculate and project the I&FF for the adaptation / mitigation scenario
7. Estimated annual changes I&FF and O&M necessary for the implementation of adaptation / mitigation scenarios
8. Assess the implications in terms of public policy.

The purpose of an I&FF assessment is to determine the incremental, direct monetary costs of climate change measures, and the likely sources of those investment funds. Since the methodology is not a cost-benefit type of analysis, quantitative estimates of the direct benefits of investments are not included. The nature and scale of GHG and impacts benefits, and the size and sources of significant sales revenues, will be an important consideration when evaluating alternative investments. Therefore, the GHG reduction and adaptation benefits of climate change measures were assessed qualitatively.

Key terminology

Investment flow (IF) is the capital cost of a new physical asset with a life of more than one year, such as the capital cost of a new power plant.

Financial flow (FF) is an ongoing expenditure on programmatic measures; financial flows encompass expenditures other than those for expansion or installation of new physical assets, e.g. expenditures for an agricultural extension program for farmers.

Operation and Maintenance (O&M): the physical assets purchased with investment flows will have operation and maintenance costs associated with them i.e., ongoing fixed and variable costs such as salaries and raw materials.

Investment entity is an entity making an investment. These are the entities that decide to invest, e.g. in a wind farm. Investment entities include households, corporation and government.

Sources of I&FF funds are the origins of the funds invested by the investment entities e.g. domestic equity, foreign debt, domestic subsidies, and foreign aid.

Scenario: is an internally consistent and plausible characterization of future conditions over a specified period. For each sectoral assessment, a baseline scenario and mitigation/adaptation scenario was developed.

Baseline scenario is a reflection of the business-as-usual conditions, i.e. it is a description of what is likely to occur in the absence of new policies to address climate change.

Mitigation/adaptation scenario incorporates new measures to mitigate GHG emissions / to adapt to climate change.

Base Year: is the first year of the assessment period. It should be a recent year for which I&FF and O&M information is available. Under the project, 2005 was recommended as the reference year.

The assessment period: is the time horizon in years that are covered by the scenarios and associated I&FF and O&M flows expected during that time. The assessment period should cover 25 years (2005-2030).

2. Summary of sectoral assessments

2.1 Energy sector

2.1.1 Description of sectoral scope

The energy (mitigation) sector group concentrated on two energy sub-sectors: electricity generation and transport. Under the electricity generation sub-sector, it was agreed to consider solar, wind, and energy efficiency as mitigation measures. These measures were chosen because the expected direct impacts of climate change on them will be minimal when compared to other measures, such as hydropower; and because they are measures that the Government may consider to support to strengthen Namibia's future energy mix.

Under the transport sub-sector, the working group agreed to focus on the liquid fuels sector, and in particular on petrol-powered passenger vehicles. Liquid fuel consumption constituted over 70 percent of Namibia's total energy demand in 2006 (Capoco et al., 2007), and although diesel fuel consumption was much greater than petrol fuel consumption in 2006, the broad range of vehicle types using diesel fuel would have made the assessment very difficult to undertake. In contrast, the petrol-fuel car market is relatively homogenous, allowing assessment of particular technologies that are widely applicable. Here the main mitigation measure assessed was the introduction and use of Liquid Petroleum Gas (LPG) as an additional fuel source. The rationale for this choice was motivated by the realisation that LPG already has a small footprint in Namibia, and is a proven technology that has been adopted with success in other parts of the world.

2.1.2 Base year and assessment period

The baseline year used for the assessment is 2005, and the assessment period selected was 2005-2030, thus providing a unique opportunity to assess the implications under Namibia's Vision 2030 development plan. Where input data was unavailable for 2005, the most recent year for which such information was available was used.

In line with UNDP recommendations, all costs displayed are expressed in 2005 US$. The discount rate used to compute the Present Value (PV) was taken to be 8%, which reflects Government's long-term borrowing costs. The currency conversion between Namibian dollars (NAD) and 2005 US$ was carried out by deflating current (or otherwise as available) prices and converting these to US$. Here, the Consumer Price Index data from Bank of Namibia[1] was used, while exchange rate information was taken from the 2009 Preliminary National Accounts (MoF) where N$1 = US$6.41 in 2005.

2.1.3 Description of mitigation measures

Under the mitigation scenario, where additional mitigation measures are undertaken, the energy mix incorporates significant investments in solar power and wind power, together with energy demand reductions as part of an energy efficiency programme. These

[1] See www.bon.com.na/

investments in turn displace some of the investments expected under the baseline scenario. Solar power is expected to replace the electricity provision by local diesel generators under the mitigation scenario, the installed capacity of wind power investments are expected to be 42 MW by 2030, and energy efficiency measures are expected to decrease energy demand by 20% of the baseline figure by 2030. In addition to the benefits from reduced GHG emissions under the mitigation scenario, a reduction of energy imports from 50% to 30% of energy consumed was modeled, to provide greater self-sufficiency.

The transport sub-sector incorporates a greater market penetration of LPG into the sedan car market, with associated impacts on fuel infratrstucture.

2.1.4 Summary of results

Overall, the incremental costs of the mitigation scenarios for the electricity generation and transport sub-sectors (factoring in the baseline costs) are estimated to be **US$1.2 billion** over the time period of analysis. The costs per ton of CO_2 eq. emissions reduced are estimated to be US$102 per ton.

More specifically, the incremental costs were as follows:

- Hydro ($0 mil.)
- Diesel (-$1,123.9 mil., n.b a saving)
- Coal (-$288.3 mil., n.b. a saving)
- Solar power ($1103.1 mil.)
- Wind power ($75.9 mil.)
- Energy efficiency ($1363.2 mil.)
- Increased use of LPG ($42.37 mil.)

For the electricity generation sub-sector, three key mitigation measures have been assessed: solar power, wind power and energy efficiency (hydropower is already part of the Namibian current and future energy mix). The increased costs for solar power, wind power and energy efficiency are partially offset by the savings in diesel and coal. This is a reflection of the replacement of diesel and coal generation under the mitigation scenario by solar power and wind, together with the reduction in overall energy demand through energy efficiency measures. Per ton of CO_2 eq. reduced by these measures, this implies a cost of US$101 per ton.

Solar power. Namibian conditions are very suitable for the use of solar power, both in terms of large-scale generation and localised generation. The technology is costly however, requiring large levels of up-front capital financing. In contrast, O&M costs are very low, as is the GHG reduction potential (including the life-cycle costs of assembly and disposal).

The analysis focused on localised generation solutions for off-grid households, representing an effective generation of 1.5 TWh per annum in 2030. The costs of providing electricity to those off-grid households is estimated at US$1.1 billion over the 25 year time period until 2030, which is substantial. The alternative, considered under the baseline scenario, would be for localised diesel generation, which would cost around US$1.12 billion, greater than 90 percent of which would be in running costs. The difference in GHG emissions over the 25-

year time period would be approximately 8.7 million tons. It is important to note that alternative baseline scenario solutions for household electricity provision have not been considered, which may indeed be cheaper than small scale diesel generation.

Wind power. With its long and windswept coastline, Namibia also has significant wind power potential. As with solar power, the costs of wind power are mainly in terms of large capital costs, although O&M costs are not insignificant.

Investment in wind power in the analysis was assessed in terms of the replacement of other power generation technologies in the energy mix and in terms of reducing Namibia's reliance on foreign energy supplies (to 30 percent of total supply, as opposed to the current 50 percent of total supply). Investment in wind farms with an installed capacity of 72 MW (effective generation 0.16 TWh) under the mitigation scenario are estimated to cost US$70 million, with associated O&M costs of US$6 million. If this energy generation replaced the equivalent generation by a coal powered plant, this would represent a saving of 2.8 million tons of GHG over the 2010-2030 wind farm lifecycle.

Energy efficiency. Improving energy efficiency can be seen as the most cost-effective option available to reduce global GHG emissions; indeed many energy efficiency measures are themselves cost reducing (win-win solutions) (see, for example, Stern, 2006). Based on a basket of energy efficiency measures that reduce energy consumption by households by 20 percent and by government and businesses by 10 percent, the costs are estimated to be US$1.4 billion, US$24 million of which occurs in O&M costs. From a start date of 2010 until 2030, this implies a saving of 13.2 TWh. Based on the baseline energy mix in 2030, this implies a saving of 4 million tons of GHG. It should be noted that this measure also reduces the need for investment in additional energy sources, a benefit captured in the current analysis through the costs relating to other technologies.

For the transport sub-sector cost figure, this includes a saving of US$26 million in terms of O&M costs over the time period of analysis due to the difference in car running costs. Financial flows are estimated to be US$35 million for subsidisation of car conversion to use LPG fuel, with investment costs being US$34 million over the period of analysis.

It is expected that the passenger vehicle population would increase with the growth in GDP and human population. In practical terms, this growth is likely to lead to significant increases in GHG emissions. In order to mitigate the GHGs from the transport subsector, less carbon intensive fuels could replace conventional petrol and diesel. GHG emissions from a litre of LPG consumed are estimated to be around 35 percent less than the emissions from petrol consumption, although due to the difference in energy content of the two fuels, the emissions per km travelled is around 20 percent less for LPG travel. Additionally, the impact of cheaper fuel prices for LPG on fuel demand means that drivers would be expected to travel further on switching to LPG powered vehicles. As such, the overall saving in emissions as part of a programme to increase LPG usage is estimated to be around 1.2 million tons of GHG over the time period of analysis.

The incremental costs of a programme to increase LPG usage are estimated to be around US$42 million, which includes the costs of car conversion to LPG use, petrol station infrastructure, Government subsidisation of conversion costs and costs of O&M[2].

Based on the analysis performed, the incremental costs imply an average cost per kg of CO_2 eq of US$28 per ton (of US$56 per ton, if the O&M savings are excluded).

2.1.5 Policy implications

Please refer to section 2.2.5

2.1.6 Uncertainties and limitations of the methodology

Electricity Generation
The major limitation of the model is the reliability of data, and uncertainty regarding the projections. Given the continuous improvements in technology, there is also a real possibility that the unit costs of different technologies will change overtime, affecting the funding requirements derived from the model.

Another challenge is the unavailability of information on the funding sources of the various mitigation options considered. Companies (even State Owned Enterprises) are reluctant to provide detailed information on projected funding requirements and sources.

The need to equate the share of people with access to electricity (the electrification rate) in both scenarios had a severe methodological complication. Namibia's low population density renders 100% on grid-electrification unfeasible. In the business as usual scenario, this would have meant that a share of the population would have remained without access to electricity. However, since in the mitigation scenario 100% electrification via solar technology was targeted, also it was necessary to also assume 100% electrification in the business as usual scenario. In this case, the only theoretical option was diesel generators, whose operation and maintenance costs cause them to be unworkable in practical terms. By having to include as a mere theoretical alternative such costly generators, the costs in the business as usual scenario are artificially inflated, consequently artificially reducing the additional incremental funds needed by the country to attain the mitigation scenario. However, it is interesting to note that the costs of providing 100% electrification are very similar under both scenarios: if this is not a policy that is followed, the overall incremental costs would not be substantially different.

Transport
The model is an attempt to depict changes in the sedan car market in Namibia, and the potential costs of policy changes to incentivise LPG market penetration due to the mitigation potential of the technology. In predicting future market situations, especially when

[2] Note that the incremental O&M costs are estimated to be negative (minus US$26 million), based on the price of fuel. Essentially this saving (a benefit to consumers) can be seen as a cost to Government in terms of reduced taxation revenue (effectively a transfer from Government to car users, assuming the price differential reflects differing taxation regimes). Should the price differential between the fuels not be maintained, this saving to car users would not be present.

concerning a technology that still has little market penetration in Namibia, it is somewhat inevitable that there are uncertainties inherent to the model.

In other areas of the model, consistency has been assumed throughout time. For example, the difference in running costs between LPG and petrol cars is consistent, irrespective of the price of fuel. Likewise the price elasticity of demand for car usage is assumed to be consistent, as is the share of cost born by debt and equity by each of the three actors (government, business and actors) considered.

Aside from investigating some of the assumptions further, the scope of the model itself is perhaps a limiting factor in reflecting the cost of climate change within the transport sector in the future. Whilst focusing on the expansion of LPG to the exclusion of all other measures provides a clear estimate of the costs of the policy options related to LPG, this narrow scope perhaps does not reflect the reality of the various policy solutions available for reducing emissions in the sector. In particular, further model developments could focus on the costs related to expansion of public transport, with the interactions between the policies measures providing valuable further insight into the costs of mitigation.

2.2 LULUCF sector

2.2.1 Description of sectoral scope

The following subsectors or elements thereof are interpreted to be part of the LULUCF sector:

- Agriculture, incl. crops & livestock
- Forestry
- Fisheries (inland)
- Tourism
- Wildlife
- Ecosystem services

It is clear that various production systems are considered part of a broader picture in Namibia. In fact the important inter-linkages of the traditional sectors are recognized in all development planning that has taken place in Namibia (e.g. in Vision 2030 and Namibia's 3rd National Development Plan). However, due to time constraints, only the crop and livestock subsectors were selected for assessment following the consultation with PASS, the regional centre providing technical backstopping to the national team. This decision was mainly taken to narrow the scope of the work, and to use the first two subsectors assessment as a learning opportunity. Additional sector assessments could and should be conducted at a later stage. The livestock sub-sector focused and concentrated on cattle, small stock and game, while the crop sub-sector concentrated on four crops: wheat, maize, mahangu, and sorghum.

2.2.2 Base year and assessment period

The overall I&FF adaptation assessment period is from 2005 to 2030. It was agreed to use the end of the Second National Development Plan (NDP2), which has 2005 as the baseline cut-off. Therefore, 2005 is used as the starting point for adaptation scenario, which coincides

with the start of NDP3. The overall planning horizon of the scenario is in line with Namibia's long term Vision 2030, running up to 2030. Historical data has been mapped out prior to 2005, as far as possible.

In line with the UNDP methodology, costs are displayed in 2005 US$. The discount rate used for the Net Present Value (NPV) calculations was 8 percent, based on cost of government bonds/borrowing in Namibia.

The discount rate was used to reflect government's long term borrowing costs, which was proxied as the secondary market trading cost of the bond with the longest maturity (the GC24 at the time of selecting the discount rate).

The currency conversion to 2005 US$ was done by deflating current (or otherwise) prices in Namibian dollars and then converting these 2005 prices to US$. For deflation we used CPI data from Bank of Namibia[3]; for the exchange rate we used information from the 2009 Preliminary National Accounts with N$1 = US$6.41 in 2005.

2.2.3 Description of adaptation measures

The adaptation measures assessed for the livestock sector include:

- Increasing the level of support provided to subsistence farmers, to share best practices and increase market availability
- Reducing cattle numbers in communal areas to sustainable levels to increase the off-take of cattle
- Encouraging commercial farmers to switch to game production from cattle and small stock production, given the resilience of ingenious wildlife to climactic variability in comparison to domesticated livestock.
- Encouraging farmers in both communal and commercial areas to switch to indigenous breeds of livestock, given the potential for these breeds, as with game, to withstand natural climactic variability.
- A programme of debushing, to increase the effective area of rangeland available for farming purposes.

For crops, the adaptation measures considered are:

- Increasing the area of land for irrigation
- Partial mechanisation of communal farms
- Training of commercial farmers to improve irrigation possibilities

2.2.4 Summary of results

For the measures considered for the livestock sub-sector, the incremental costs over the time period considered are estimated to be around US$2.45 billion. Just over half these incremental costs relate to investment costs associated with the measures, with just under half relating to increases in O&M costs. Although the benefits associated with these measures for the livestock sub-sector have not been estimated, the expected impact of

[3] See www.bon.com.na/

these activities would be to increase the tonnage of meat produced per annum by 40,000 tonnes by 2030. This difference in productive output between the baseline and adaptation scenarios is equivalent to around 35 percent of the tonnes of meat produced in 2005.

The incremental costs relating to the crop sector measures are expected to be around US$590 million, US$430 million of which is in the form of investments over the 2005-2030 time period considered and US$160 million of which is in the form of increased O&M costs. The impact of these measures would be to increase crop yield in 2030 by 118,000 tonnes. This difference in productive output between the two scenarios is equivalent to 82 percent of 2005 crop production yields.

Taking the two agriculture subsectors together, the overall incremental costs of the measures are US$3.04 billion.

More specifically, the costs were as follows:
Livestock:

- Extension services ($1.72 mil.)
- Additional extensions services ($103.11 mil.)
- Destocking ($-10.53 mil. – this means a net saving)
- Choice of breeds ($835.28 mil.)
- Game switching ($601.44 mil.)
- Debushing ($914.3 mil.)

Crops:

- Rain fed subsistence ($-37.5 mil. – this means a net saving)
- Rain fed mechanisation ($195.1 mil.)
- Rain fed commercial ($-8.7 mil. – this means a net saving)
- Irrigation commercial ($441.6 mil.)

2.2.5 Policy implications

Currently the Namibian government is in the final stages of developing a national Climate Change Policy. The main purpose of this policy is to provide the legal framework and overarching national strategy for the development, implementation, monitoring and evaluation of climate change mitigation and adaptation activities. The policy will promote the enhancement of synergies amongst sectors, policies and stakeholders for effective and efficient action on climate change mitigation and adaptation. The outcomes of the I&FF assessment could provide guidance on needed adaptation and mitigation actions for the policy.

2.2.6 Uncertainties and limitations of the methodology

Livestock Model
Data and time constraints have meant that the model developed for assessing the I&FF relating to the livestock sector has a relatively narrow scope of analysis. Likewise, the various adaptation measures that have been assessed are not exhaustive and further work could expand on the current analysis to evaluate the costs and efficacy of further measures.

In common with all models relying on future projections, there is an inherent uncertainty about the model outputs. In this case, uncertainties are compounded by the relative lack of data on climate change in Namibia, itself a highly uncertain prospect.

A key limitation of the model concerns the important impact of water availability on the agricultural sector. Again data constraints limit the potential of this analysis: for example, the impact of high use of groundwater supplies by livestock farmers has received less attention than perhaps the significance that this issue demands.

Another major stumbling block regarding data is the lack of information on the funding sources of the measures. There is no historical data available on the sources of funding of any of the investment entities, in which case it is almost impossible to know with certainty the origin of financing beyond a one year span.

Crop Model

The crop model is also not exhaustive. It only considers the crops wheat; maize; and mahangu and sorghum and three adaptation measures (training for farmers that use irrigation, increase of land under irrigation, and mechanisation of rainfed subsistence land), leaving room for more exhaustive research on the impact of climate change on the overall agricultural sector.

Also for this model, future projections are prone to some uncertainties due to an inevitable level of uncertainty regarding future trends, as well as the unavailability of information on the funding sources of the measures.

Problems with the data aside, the major limitations of the model relate to productivity and the availability of water. With regards to productivity, due to data unavailability we are assuming that all land has the same yield potential regardless of its geographical location (albeit each crop has a different yield). This could be a significant drawback if productivity varied significantly among the different regions of the country.

3. Summary tables of incremental investment costs

Table 1: Incremental Cumulative Discounted IF & FF for All Investments in Each Sector, by Investment Entity and Funding Source

Category of Investment Entity	Source of I&FF Funds		Incremental Cumulative (2005-2030) Discounted Sectoral Investments (million 2005US$)					
			Mitigation			Adaptation		
			Energy Sector			LULUCF Sector		
			∆IF	∆FF	∆O&M	∆IF	∆FF	∆O&M
Households	Domestic	Equity and debt	1633.46	0.00	-1025.69	13.96	0.00	240.5
	Total Household Funds (all domestic)		1633.46	0.00	-1025.69	13.96	0.00	240.5
Corporations	Domestic	Domestic equity (including internal cash flow)	288.79	0.00	15.11	278.39	0.00	1030.56
		Domestic borrowing (bonds and loans)	224.68	0.00	-5.51	223.44	0.00	0.00
		Total Domestic Sources	513.51	0.00	9.61	501.78	0.00	1030.56
	Foreign	Foreign direct investment (FDI)	0.00	0.00	0.00	58.4	0.00	0.00
		Foreign borrowing (loans)	212.8	0.00	0.00	223.39	0.00	0.00
		Foreign aid (ODA)	0.00	0.00	0.00	0.00	0.00	0.00
		Total Foreign Sources	212.8	0.00	0.00	281.74	0.00	0.00
	Total Corporation Funds		726.30	0.00	9.61	783.57	0.00	1030.56
Government	Domestic	Domestic funds (budgetary)	-103.09	24.25	-58.09	496.30	9.41	98.52
	Foreign	Foreign borrowing (loans)	0.00	0.00	0.00	58.4	0.00	0.00
		Bilateral foreign aid (bilateral ODA)	-44.18	10.39	-0.63	246.07	0.00	0.00
		Multilateral foreign aid (multilateral ODA)	0.00	0.00	0.00	58.4	0.00	0.00
		Total Foreign Sources	44.18	10.39	-0.63	362.86	0.00	0.00
	Total Government Funds		-147.27	34.64	-58.72	859.17	9.41	98.52
Total (all investment entities and all sources)			2212.49	34.64	-1074.81	1656.69	9.41	1369.58

Source: Prepared by the study

Table 2: Incremental Annual IF & FF for All Investments in Each Sector

Year	Incremental Annual Sectoral Investments (million 2005US$)					
	Mitigation			Adaptation		
	Energy Sector			LULUCF Sector		
	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M
2005	163.39	0.00	0.00	0.00	0.00	0.00
2006	156.23	0.00	0.00	0.00	0.00	-0.05
2007	149.11	0.00	0.00	0.00	0.00	-0.08
2008	142.08	0.00	0.00	0.00	0.00	-0.11
2009	135.16	0.00	0.00	0.00	0.00	-0.14
2010	289.18	5.25	-7.31	81.7	0.01	18.45
2011	245.17	0.93	-8.31	79.36	0.01	30.73
2012	231.6	1.11	-9.55	76.84	0.30	39.6
2013	219.09	1.31	-11.05	74.84	0.19	48.38
2014	219.76	1.56	-12.85	72.76	0.90	54.91
2015	49.45	1.85	-20.29	69.44	0.84	62.75
2016	203.09	2.13	-22.41	67.11	0.77	67.79
2017	196.01	2.45	-24.99	64.68	0.72	69.40
2018	189.58	2.82	-28.11	62.41	0.66	72.39
2019	181.6	7.79	-31.84	60.21	0.61	74.63
2020	179.32	4.51	-36.44	58.08	0.57	76.22
2021	175.96	5.18	-41.65	56.03	0.53	77.24
2022	173.83	5.94	-47.77	54.05	0.49	77.77
2023	179.13	6.80	-54.95	52.15	0.45	77.87
2024	180.89	7.79	-63.36	50.32	0.42	77.62
2025	183.85	8.91	-73.18	48.57	0.39	77.06
2026	188.11	10.19	84.65	46.9	0.36	76.23
2027	194.33	11.62	-98.01	45.31	0.33	75.19
2028	201.26	16.21	-113.58	43.8	0.31	73.98
2029	213.71	15.54	-131.71	42.36	0.28	72.62
2030	227.84	17.61	-152.8	40.99	0.26	71.14

Source: Prepared by the study

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