CLIMATE CHANGE VULNERABILITY AND ADAPTATION ASSESSMENT FOR NAMIBIA'S BIODIVERSITY AND PROTECTED AREA SYSTEM

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LIST OF ABBREVIATIONS

AAU	Assigned Amount Unit
AIDS	Acquired Immunodeficiency Syndrome
AFOLU	Agriculture, forestry and other land uses
AR	Aforestation / Reforestation
AR4	Fourth Assessment Report (of IPCC)
BCLME	Benguela current and large marine ecosystem
CBD	United Nations Convention on Biological Diversity
CBM	Community Based Management
CBNRM	Community Based Natural Resource Management
CCF	Cheetah Conservation Foundation
CCU	Conservation Credit Units
CDM	Clean Development Mechanism
CER	Certified Emissions Reductions
CLRA	Communal Land Reform Act
CLRA	Communal Land Reform Act
CPP	Country Pilot Partnership
DAPP	Development Aid from People to People
DART	Directorate of Agricultural Research and Training, MAWF
DEA	Directorate of Environmental Affairs
DEES	Directorate of Engineering and Extension Services, MAWF
DoF	Directorate of Forestry, MAWF
DPWM	Directorate of Parks and Wildlife Management
DRWS	Directorate of Rural Water Supply
DVS	Directorate of Veterinary Services, MAWF
DWA	Department of Water Affairs, MAWF
EAF	Ecosystems Approach to Fisheries Management
EC	European Commission
ECFSP	Emerging Commercial Farmers Support Programme
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMU	Emergency Management Unit
FIRM	Forum for Integrated Resource Management
FSRE	Farming Systems Research and Extension
GCM	General Circulation Model
GCS	Global Conservation Standard
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GRN	Government of the Republic of Namibia
HADCM3	
HWCM	Human Wildlife Conflict Management
HIV	Human Immunodeficiency Virus

ICM	Integrated Coastal Management
ICZMP	Integrated Coastal Zone Management Plan
IMSCLUP	Inter-ministerial Standing Committee on Land Use Planning
IPCC	Intergovernmental Panel on Climate Change
ISLM	Integrated Sustainable Land Management
LA	Local Authority
LFCC	Low Forest Cover Country
LLM	Local Level Monitoring
LRAC	Land Reform Advisory Commission
LUEB	Land Use and Environmental Board
LUP	Land Use Planning
M&E	monitoring and evaluation
MAWF	Ministry or Agriculture, Water and Forestry
MDG	Millennium Development Goal
MET	Ministry of Environment and Tourism
MLRR	Ministry of Lands and Resettlement
MFMR	Ministry of Fisheries and Marine Resources (Namibia)
MoH	Ministry of Health
MOHSS	(former) Ministry of Health and Social Services
MPA	Marine Protected Area
MRLGHRD	Ministry of Regional and Local Government and Housing and Rural Development
MRA	Marine Resources Act
MTI	Ministry of Trade and Industry
MWTC	Ministry of Woks, Transport and Communications
NACOMA	Namibia Coastal Management Project
NACSO	Namibian Association of CBNRM Support Organisations
NAPCOD	Namibia's Programme to Combat Desertification
NAU	Namibia Agricultural Union
NCA	Northern Communal Area
NCSA	National Capacity Self-Assessment
NDP	National Development Plan
NGO	Non-Governmental Organisation
NMS	Namibia Meteorological Service
NNF	Namibia Nature Foundation
NNFU	Namibia National Farmers Union
NPAB	Namibia Planning Advisory Board
NPC	National Planning Commission
NTB	Namibia Tourism Board
PA	Protected Area
PAN	Protected Area Network
PP	Primary Production
PU	Planning Unit
NWR	Namibia Wildlife Resorts
PS	Permanent Secretary
RCM	Regional Circulation Model

RDCC	Regional Development Coordination Committee
REDD	Reduced Emissions from Deforestation and Degradation
REMU	Regional Emergency Management Unit
RPRP	Rural Poverty Reduction Programme
SACU	Southern African Customs Union
SADC	Southern African Development Community
SAIEA	Southern African Institute for Environmental Assessment
SDAC	Sustainable Development Advisory Council
SLM	Sustainable Land Management
SME	Small and Medium-sized Enterprise
SPAN	Supporting the Protected Area Network Project
SST	Sea Surface Temperatures
TA	Traditional Authority
TAR	Third Assessment Report (from IPCC)
TEV	Total Economic Value
Tralac	Trade Law Centre of Southern Africa
UN	United Nations
UNCCD	United Nations Convention on Combating Desertification
UNFCCC	United Nations Framework Convention on Climate Change
WASSP	Water Supply and Sanitation Policy
WPA	Water Point Association
WPC	Water Point Committee
WTTC	World Travel and Tourism Council
VER	Verified / Voluntary Emissions Reductions
y	Year

EXECUTIVE SUMMARY

Introduction

The main objectives of this study were to assess the vulnerability of Namibia's biodiversity and ecosystems to climate change, to assess the economic implications of climate change-ascribed wildlife and biodiversity changes, and to investigate feasible adaptation options, such as improving the effectiveness of the current protected area network in safeguarding wildlife populations and biodiversity under climate change, so that these areas continue to function optimally and be central to socio-economic growth and development in the country.

The study was initially intended to focus on three or four representative parts of Namibia at a local scale. However, because of the course scale and uncertainty of climate change models, the study was conducted at a national scale.

Geography, climate and biodiversity

Namibia falls within Africa's South West Arid Zone, and is the most arid country in Africa south of the Sahara. Rainfall ranges from about 600 mm in the extreme north-east to less than 50 mm in the extreme south and along the coast. About 22% of Namibia's 823 680 km^2 land area is desert, 70% is arid to semi-arid and the remaining 8% is dry sub-humid. Primary production is low throughout the country, and highly dependent upon annual rainfall. There are four terrestrial biomes: the Tree and shrub savanna, Nama Karoo, Namib Desert and Succulent Karoo. Terrestrial diversity of plants and animals is highest in the north-eastern parts of Namibia, because of the higher rainfall and presence of wetlands and forest habitats that are not found elsewhere in the country. Endemism is highest in the central and north-west parts of the country. Perennial rivers only occur on the country's borders and floodplain wetlands are concentrated in the north-east. Pans such as Etosha Pan are important for biodiversity. Several coastal wetlands support impressive numbers of waterbirds, with three being Ramsar sites. The marine ecosystems off Namibia's coast are influenced by the cold Benguela current system, and tend to be species poor and low in endemism, but highly productive. Several islands off the coast of Namibia support important breeding populations of seabirds.

Land use and conservation

The protected areas network covers some 16.6% of the terrestrial area of Namibia. The proclamation of most protected areas in Namibia pre-dated the emergence of biodiversity conservation science. Parks were established in areas that were perceived to have little other value, such as deserts that were unsuitable for farming, as buffer zones between settler farmers and indigenous people, and for the protection of game animals. Of Namibia's 29 vegetation types, 13 have less than 10% of their respective areas protected in national parks. Marine resources are heavily utilised and the first marine protected area was established in 2009, stretching 400km along the coast and 30km offshore, incorporating 10 islands. This will soon be expanded to the entire coastline.

Outside of protected areas, land use is dominated by livestock, and agriculture to a lesser extent. Crop production is limited to the northern and eastern parts of the country where it is marginal to

low, and livestock production ranges from marginal in the south and west to moderate in the north and east. In the north, where 60% of the population resides, agriculture comprises small scale mixed livestock and crop farming, and a high proportion of households are also dependent on natural resources for their livelihoods. Agriculture in these areas is marginal. Cattle are farmed mainly in the central-northern areas. Only 40 000 ha in Namibia area is under intensive commercial cropping. This is mainly in the high rainfall Grootfontein-Tsumeb-Otavi triangle, where irrigation is also widely practiced.

The state has created a policy and legislative framework for freehold farms, communal conservancies and community forests to acquire rights over wildlife, trees and non-timber products, and tourism. This policy framework has led to ever increasing areas of land being converted to indigenous biodiversity production systems, including wildlife, tourism and forestry, a significant increase in wildlife numbers and diversity across the country through effective local management and reintroduction. Land adjacent to protected areas is often more profitable under wildlife and tourism than under conventional farming. This has led to a significant reduction in park-neighbour boundary conflicts as neighbours begin to practice compatible land uses. Including private and communal conservation areas, the broader conservation network covers 45% of the country or approximately 37 million ha, although the 60% under private or communal tenure cannot be assumed to be as efficient as protected areas in their conservation outcome.

In 2005, a "Parks Vision" was developed, which was to effectively expand, manage and develop the park network of Namibia in order to adequately protect the biodiversity and landscapes of the country. This included improving the connectivity of the parks system through establishing new conservancies. The Ministry of Environment and Tourism, which has the mandate for the management of the protected areas system, has recently developed a strategy which is largely aligned with this vision. However it is important to note that the Parks Vision did not take the potential impacts of climate change into account.

The value of land and natural resources

While the focus of this study is on biodiversity protection and the protected area system, in order to understand the potential implications of climate change and adaptation measures it was necessary to have a broad understanding of land uses and their values both within and outside of the protected area system. Values of land and natural resources include those generated by direct uses such as agricultural production, natural resource harvesting and tourism, indirect uses, being derived from the services provided by ecosystem functions, and non-use values, being the welfare value associated with people's appreciation of the existence of biodiversity.

Agricultural production generates some N$3.23 billion in terms of value added to national income. Some 77% of this is attributable to livestock. Commercial land contributes 74% of total agricultural land use production value, and 79% of livestock production value.

Tourism is a rapidly growing sector in Namibia and the leisure tourism component of this, which makes up some 40% of value, is dominated by nature-based pursuits. The nature-based component is attributable mainly to scenery and wildlife. Nature-based tourism generates some N$2.45 billion

in expenditure (leading to an estimated direct contribution of N$1113 million or 2.1% of GNP), of which about N$433 million is spent in state protected areas.

Tourism, wildlife, and natural resource uses were estimated to be worth some N$3.8 billion in 2009. This is dominated by two main components; tourism (47%) and natural plant use (44%). Currently 70% of tourism value is generated on freehold land. There remains significant potential for tourism development within parks and communal areas.

Climate change predictions

It is predicted with a high degree of certainty that Namibia (and the rest of southern Africa) can expect an increase in temperature and evapo-transpiration at all localities, with the maximum increase (2 - 6°C) in the interior. Warming is likely to be less along the coast than along the escarpment and inland regions (though the levels of uncertainty are high regarding currents, winds, sea temperatures and fog). Most global circulation models and the median of these models project that Namibia will become drier, rainfall variability is likely to increase and extreme events such as droughts and floods are likely to become more frequent and intense. Soil moisture levels are projected to decline, with the cumulative impacts of higher temperature, lower rainfall, higher run-off, lower humidity, higher evaporation and lower plant cover probably creating a compounding impact on soil moisture and on primary production that is greater than the sum of their individual contributions. There are currently no credible projections of changes to Namibia's coastal fog system, which is known to be vital for most endemic and many other plant and animal species in the Namib.

For this analysis it was assumed that a 10% decrease in rainfall will be experienced in the northern and southern regions of Namibia, and a 20% decrease in the central regions, by 2050, and that these figures will worsen to 20% and 30% respectively by 2080.

Direct Impacts on ecosystems and biodiversity

Coastal areas are likely to see increased incidence of flooding and inundation, affecting low-lying urban areas. Marine species most sensitive to climate change will be those that have been heavily exploited.

Wetlands (including coastal lagoons and seasonal oshanas), and their associated fauna and flora, are among Namibia's most threatened ecosystems. Most are underprotected and highly vulnerable to increasing pollution, water abstraction and devegetation. The impacts of climate change on wetland systems are difficult to predict as insufficient work has been done to derive any clear projections. The Orange River is heavily regulated and future flows in this system are likely to be determined primarily by the socio-economic needs of South Africa rather than climate change. Namibia's northern rivers may experience an increase in water volumes and flooding may be more frequent and of greater magnitude. While this will have initial negative consequences for people it will have positive ecological impacts. It will favour resident wetland and floodplain species such as Hippopotamus, Sitatunga, Lechwe, Reedbuck, Puku, otters, Crocodile, wetland birds such as Fish Eagle, Wattled Crane, ducks, storks and many others, as well as fish, mollusks and other aquatic

invertebrates. It will have positive impacts on fish recruitment and production, for both subsistence and tourism.

Namibia's ephemeral wetland systems have their catchments within Namibia and will be subject to decreasing rainfall and increasing temperatures and rates of evaporation, which will probably result in less frequent and lower magnitude flooding. This will reduce aquifer recharge and result in a lowering of the water table. The implications for biodiversity could be severe as large trees in riverbeds provide essential fodder and habitat to many species of wildlife.

There are five Ramsar wetlands in Namibia and it is likely that the inland sites will receive less water inflow. Reduced inflows into the Etosha pan may impact on the natural springs around the southern parts of the pan and on the breeding of Greater and Lesser Flamingos. The only other breeding area for these flagship species in southern Africa is the Makgadikgadi Pan in Botswana, which will probably experience similar drying conditions to those in Etosha.

Terrestrial areas that are particularly vulnerable to climate change include the western escarpment (which separates the arid desert from the semi-arid savannas), and the south-western Succulent Karoo – both important centres of endemism. The latter is considered to be one of the world's 25 top 'global biodiversity hotspots' and is likely to suffer considerable numbers of local extinctions by 2050. Namibia's vegetation is likely to shift in spatial dominance from Grassy Savanna to Desert and Arid Shrubland by 2080 and ground cover will decline throughout much of the country. A sustained increase in ambient temperature is capable of causing significant changes in species distribution, composition and migration. The south and south west parts of the country are predicted to see the greatest increase in total plant species numbers as well as the lowest proportion of species loss, whereas much greater losses are expected to be experienced in the central, northern and eastern areas. Some 7% of plant species have been estimated to shift their distribution range out of Namibia entirely with 52% of species showing range contractions and 41% showing range expansions.

The semi-arid to arid plains game of Namibia are largely climate tolerant, with small expansions of range expected in some species towards the north-east in response to an expected shift of the savanna biome, and small declines expected in the ranges of some species in the extreme west and south as the hyper arid Namib expands. Springbok and Gemsbok will likely expand their ranges to the BwaBwata National Park but none of the ranges of plains game species are likely to retreat out of any of the national parks. If parks are managed as isolated units and fenced, then the numbers of plains game will decline because the overall carrying capacity will decline. This will be particularly severe in the most arid regions, e.g. Namib-Naukluft Park and Sperrgebiet National Park, where wildlife numbers may crash to very low levels following periods of prolonged drought. The most important adaptation by plains game to arid savanna systems is their mobility – migratory and nomadic responses to variable and unpredictable rainfall, both temporally and spatially. It is thus essential to maintain open systems and manage across large landscapes. This can be achieved by implementing park-neighbour initiatives that create co-managed open landscapes.

Woodland ungulates are sensitive to climate change and will likely retreat to the north-east. They are not expected to prosper in the Etosha and Waterberg Parks, and MET should focus its

conservation efforts for these species on the Khaudum, BwaBwata and Mudumu Parks. Open systems should be maintained with neighbouring areas which are under compatible forms of land use, both within Namibia and across international borders, particularly with Botswana. Where populations of these species are held below about 400 mm mean annual rainfall, supplementary feeding will be required in dry times. Because of their high value, this may be a viable economic option for wildlife production systems, but inappropriate for national parks.

Namibia's two subspecies of impala (Common and Black-faced) are important production animals as they reproduce rapidly, provide excellent meat and are attractive for tourism and trophy hunting. They are also fairly resilient to climate variability because of their broad diet. Their ranges are not expected to change significantly as a result of climate change, perhaps retreating slightly to the east in both cases. An opportunity may exist for expanding the range of Black-faced Impala into the Otavi Mountains, but all Common Impala must be removed from the area prior to reintroductions to avoid hybridization.

Flagship species such as Elephant, Rhino, Giraffe, Hartmann's Mountain Zebra, predators, cranes and vultures are highlighted in this study because of their importance for, inter alia, conservation, their representation of cohorts under pressure (e.g. species with high value by-products, scavenging species, wetland species) and tourism.

Elephants are able to survive in a wide range of habitats, even extending along dry river courses into the Namib Desert. However, declining rainfall and carrying capacity will lead to Elephants exerting extra pressure on these habitats. Active Elephant management is needed to prevent habitat damage, biodiversity loss and human-wildlife conflicts. Elephants currently occupy a very small part of their former range because of high human density and conflicting land uses. However, as more land is placed under wildlife management and as co-managed landscape approaches are adopted over large areas, so will Elephant range and numbers increase, because they make an economically significant contribution to wildlife production systems, through various forms of utilization, particularly tourism.

Giraffe also survive in a wide range of habitats across Namibia and into the edge of the Namib Desert where ephemeral rivers and drainage lines provide suitable habitat. Their range is not expected to change significantly, though their density may decrease in some areas with declining woody vegetation, their overall numbers may increase because of growth in the wildlife sector and more land coming into wildlife production.

Black Rhino are browsers able to tolerate more arid conditions than the White Rhino, which is a grazer. The range of the Black Rhino is not expected to change, though a decline in carrying capacity may result in Etosha National Park and parts of the Kunene Region, which may be overpopulated. Animals should be removed from these high density areas and used to start new populations in areas that have the potential to support significant meta-populations, e.g. in Khaudum and Ai-Ais National Parks, Nyae-Nyae and N≠a_Jaqna conservancies. By contrast, the range of White Rhino in Namibia is expected to retreat from the west and south and to expand to the north-east, where the Khaudum and BwaBwata National Parks will likely provide suitable habitat by 2050. The prediction

that grasslands will prosper at the expense of woodlands in north-eastern Namibia would further favour White Rhino. The establishment of new White Rhino populations west of Windhoek and south of Mariental should be discouraged.

Hartmann's Mountain Zebra is a near endemic subspecies. It is highly nomadic, showing clear west-east movements patterns. Being arid adapted its range is not expected to change significantly as a result of climate change, though populations may adjust to declining carrying capacity. It is important that a park-neighbour and co-managed landscape approach is implemented to allow this species to move over large areas. If this is achieved, its populations will be secure despite the impacts of climate change. It is also worth exploring the introduction of this species to the Otavi mountain range as conditions there get drier.

Predators and scavengers are largely climate tolerant. If their food source is secure their distribution and abundance will be little affected. Protected areas and land under wildlife and tourism are vital for their long-term survival because these animals are heavily persecuted in livestock production areas. A shift towards small-stock will increase the risk to predators and scavengers. An ongoing shift towards wildlife-based land uses, especially tourism, and the establishment of large open co-managed systems will, however, lead to the recovery of predators and scavengers.

Namibia's endemic plants and animals occur mainly along the western escarpment with the belt of greatest endemic diversity being east of the coastal national parks and west of Etosha National Park; and south of eastern Etosha via Windhoek to the Naukluft Mountains and into the Sperrgebiet. This belt does not extend significantly into the national parks network, but occurs on communal lands mainly in the Kunene and Erongo regions, and on freehold land in mainly the Otjozondjupa, Khomas and Erongo regions. Much of this land falls within communal and freehold conservancies, which highlights the importance of creating appropriate incentives and encouraging the custodians of these areas to manage them in appropriate ways.

It is expected that climate change impacts on ground living endemic animals on the escarpment belt and central highlands is likely to be limited. Numbers may decline slightly and the ranges of some species may expand somewhat to the east for those species whose eastern limits are determined by rainfall. The western limits of these escarpment species are unlikely to change. The abundance of arboreal species may decline with the predicted decline in woody plants of less than 2 m tall. The status of Namib endemics not dependent on coastal fog is also unlikely to change significantly. However, the status of endemics and other species that do rely on coastal fog may be at significant risk. There are currently no credible projections on likely changes in coastal fog as a result of climate change. If fog were to decline in frequency, moisture levels and eastward extent, very significant changes in the status of endemic and other species would occur. Such changes would put many species at risk of extinction. It is therefore a priority to try and understand what impacts climate change may have on coastal fog and associated biodiversity.

Changes in land and resource use and the socioeconomic and biodiversity implications

Namibia's farming systems are on the arid margins of viability. The impacts of projected climate change on these production systems are expected to be severe. This in turn will have significant

impact of the livelihoods of rural households as well as on the economy of farming-related businesses. The resulting anthropogenic impact on Namibia's indigenous biodiversity is expected to exceed the direct impacts of climate change on biodiversity.

By 2050 it is likely that only the eastern Kavango and Caprivi will be able to produce crops under rain-fed conditions.Even the food growing Grootfontein-Tsumeb-Otavi triangle is on the very margins of economically viable rain-fed crop production, and it is predicted that the failure rate of crops will increase, resulting in a shift to small-scale irrigation that requires significant abstraction of ground water. In terms of commercial crop irrigation, it is expected that:-

- Inter-annual variability of net irrigation water requirements will increase;
- Virtually all irrigated lands will require at least 10% more water applications per annum. Irrigated land in Lesotho may require up to 30% more irrigation applications per year – impacting considerably on the downstream end of the Orange river;
- The leaching of pesticides and fertilizers from irrigated land will cause an increase in water pollution – threatening freshwater ecosystems and human health;
- The growing season of maize may shift to an earlier date and, as a result of increased temperatures, shorter growing seasons and reduced yield quality are likely; and
- Weeds and crop pests will increase.

These trends will also lead to a greater focus on livestock. However, livestock production will also suffer. In terms of livestock farming, Namibia's long-term carrying capacity is already exceeded in many places. The productive area for large stock in Namibia will shrink towards the east and north and cattle will decline significantly and probably be replaced by small stock and more profitably by wildlife and tourism in many areas. The amount of land that will remain viable for farming in general will decline from the present 64 million ha to 57 million ha in 2050 and 53 million ha in 2080; a decline of 11% and 18% respectively. The situation for small stock farming is similar to that of cattle farming, and the same carrying capacity principles apply. The productive area for small stock in Namibia will retreat from the west and expand towards the north and east into former cattle farming areas. Despite an overall increase in productive range the numbers of small stock are predicted to decline by 16% and 25% by 2050 and 2080 respectively. By comparison, cattle numbers are predicted to decline by 24% and 49% respectively. A mean loss of 28% of livestock revenue can be expected by 2050. Cattle will probably be replaced by small stock and more profitably by wildlife and tourism.

Impacts on wildlife are expected to be less severe than on agricultural production. Changes in carrying capacity are predicted to lead to declines in wildlife in protected areas of about 12% by 2050 and 25% by 2080. Similar declines of 11% and 22% are predicted for communal areas, and 13% and 24% for freehold areas. At the national level, a decline of 13% by 2005 and 24% by 2080 are predicted. This is likely to encourage further shifts in land use from agriculture to wildlife.

Unless concerted, innovative and effective interventions are pro-actively applied, the socio-economic implications of climate change on the farming sector, on the rural population and on the supporting businesses and services are likely to be severe. In the worst affected communal land

areas, the predicted changes will lead to increases in poverty and vulnerability, debt and lawlessness, as well as to an increase in dependence on natural resources and government assistance. These in turn will have significant implications for the environment, for biodiversity and for Namibia's protected areas. The indirect impacts on Namibia's environment, resulting from climate change impacts on farming systems, holds a far greater threat to Namibia's indigenous biodiversity and its protected areas than do the direct impacts of climate change.

Impacts on tourism demand

A survey was conducted to determine factors affecting the demand for wildlife tourism by assessing their response to various climate change scenarios. Holiday makers were interviewed in Namibian National Parks and at Hosea Kutako International Airport in Windhoek, during June – July 2009. The study showed that tourism would be relatively resilient to losses in biodiversity because of the high contribution of landscapes to the visitor experience, and the fact that these would not be significantly impacted by climate change. Without any change in tourism strategy, predicted changes in biodiversity could reduce nature-based tourism demand by up to 15%.

Impacts on economic output

Estimated economic losses were highest for the livestock sector (N$2 035m), and in particular for commercial fenced ranching. This is a result of the fragile financial and economic viability of this system, where a small drop in income results in a devastating loss in net income. In terms of long term adaptation it means that medium to large scale livestock farming systems will tend towards becoming lower input in nature, with systems closer to the cattle posts of the communal lands rather than ranches. Dryland cropping will be almost eliminated but this will be compensated by irrigated crop production in which a lot of resources will be expended despite scarcity of water and poor financial viability. Losses in this sector are predicted to be in the order of N$137m. Income from natural resources use is expected to be more resilient in the face of climate change, given the generally lower reliance of these activities on primary production and rangeland carrying capacity, with total losses of about N$327m. In total climate change is estimated to reduce land-based economic outputs by a total of just under N$2.5 billion per annum (in 2009 values) by 2080. This does not include other costs such as those associated with deterioration in social systems and health.

Adaptation options and their economic feasibility

Adaptations options were examined in terms of addressing both direct and indirect impacts on biodiversity as a result of climate change. Among options to address direct impacts, the most important is addressing the coverage of the conservation network (including state, private and communal conservation areas). As a proportion of the country, Namibia probably has one of the largest conservation networks of any country globally. Only 2% of biodiversity features targeted are not represented within the conservation network at all, and a total of 5% fall short of their target. Thus, the Namibian conservation network is currently representative of the majority of the country's biodiversity, but there are some notable gaps:

- The Cuvelai drainage ecosystem has been almost entirely transformed and is the only "critically endangered" landscape in Namibia.

- The south of the country especially the SE (Nama Karoo and Orange River valley) is the most poorly represented in the conservation network and consequently the area where most outstanding targets are still to be met.

A conservation planning analysis was conducted, in which conservation targets were set at an area equivalent to 10% of the *future* predicted range of each species. The current conservation network is also effective at achieving future targets for plant species (99%). Mopping-up outstanding future species targets would require a 20-30% expansion of the conservation network. Maintaining current populations would require an estimated 35-43% increase in the size of the current conservation network. Most of this expansion could be achieved by expanding and consolidating existing PAs with notable exceptions in the south of the country particularly the southern Kalahari where there are currently no protected areas, and where there is opportunity to extend the Kgalagadi Transfrontier Conservation Area.

The following conservation measures are recommended:

- Addressing gaps in the conservation network by
    - Expansion and consolidation of conservation areas particularly in the north.
    - Creation of conservation areas particularly in the SE Kalahari, Nama Karoo and eastern Orange River valley regions.
- Promote persistent populations by removing fencing to create larger contiguous management areas that meet viable animal population size requirements and facilitate species movement in response to seasonal variation.
- Conservation efforts for woodland ungulate species which will no longer prosper in Etosha should be focused on the Khaudum, BwaBwata and Mudumu Parks.
- Facilitate species movement through building a landscape-level biodiversity corridor network that will allow biodiversity to respond to changing climates. Consolidating the existing conservation network into 3 major bioregional corridors would contribute significantly to the maintenance of macro-ecological climatic gradient corridors. These corridors are the:
    - North-south escarpment/Namib corridor (existing)
    - West-east Kaokoveld-Caprivi corridor (existing)
    - West-east southern Namib-Kalahari corridor (not existing)
- Cooperate with neighbouring states when planning and implementing landscape-scale corridors to align conservation management efforts across political boundaries.
- Adopt integrated river basin management and develop a national policy and action plan that safeguards wetland ecosystems. The Eastern Zambezi-Chobe River and floodplains, the Kwandu-Linyanti system, the lower Kavango River in Namibia and the Nyae-Nyae Pan system should be considered as potential Ramsar sites.
- Maintain an ecosystem approach to fisheries management.

In terrestrial areas, increased conservation can be achieved through voluntary actions by landowners, which can be stimulated by focussed CBNRM support, active promotion of nature based

tourism and general preparation for major shift in land use to wildlife tourism. Preserving species in artificial environments (e.g. zoos) should be regarded as a last resort.

Bush encroachment will have to be addressed through encouragement of production of charcoal and fuel wood, and possibly small-scale power generation.

A properly-designed monitoring program will allow biodiversity trends and status within the protected area network to be assessed. The rational for monitoring is that it allows a clear trend to be established which can be correlated with climate data to give an understanding of the impacts of climate change. Key requirements of a monitoring program would be to establish an inventory of flora and fauna within the protected are network.

Options for reducing indirect impacts of climate change on parks and wildlife involve reducing impacts on agriculture and livelihoods. One of the most important needs for adaptation will be within the water sector. This should involve the adoption of Integrated Water Resource Management, including measures to increase water supply and reduce demand. Measures to improve water supply could include inter-basin transfers, rehabilitating water basins, artificial recharge, desalination and appropriate water harvesting systems. Water demand should be addressed through water saving technologies, drought resistant crops, and indigenous technologies.

Pressures arising as a result of reduced agricultural productivity should be addressed through measures such as diversifying livelihoods, including building capacity in this regard. Unpredictability in agricultural systems will need to be addressed though a move to more robust practices. Natural resource shortages will need to be addressed with improved natural resource management. The new human Wildlife Conflict Management Policy and the Policy on Parks, Neighbours and Resident People will help to deal with the park-neighbour conflicts that are expected to arise. Health impacts can be addressed both by improving public health infrastructure, and by maintaining biodiversity and predator-prey interactions, and avoiding monoculture.

The high levels of climate variability and current lack of reliable data result in a very restricted predictive capacity of the climate models creates difficulties in attempting economic analysis of climate change adaptation required for the protected area network. The climate-change impacts described in this report would take place over seventy years, and would be mitigated to some extent by autonomous adaptation. In other words, some of the measures we envisage would take place gradually without any intervention. Nevertheless, losses will be felt, particularly in the agricultural sector, and active intervention would need to be made to accelerate and better direct the required adaptation measures. This means increasing the focus on rangeland and natural resource management, and shifts into conservation-oriented business, and would involve building on existing programmes such as CBNRM. Given the relative advantage of wildlife in marginal agricultural areas, these interventions are likely to have a positive return, with a base case economic rate of return (ERR) of some 20%, even though the full climate change impacts may not be felt for many years to come. The results of this analysis suggest that adaptation can be carried out in an economically efficient manner. In the case of the CBNRM activities, the benefits are anticipated to be greater than just the offsetting of potential losses due to climate change.

Opportunities for income from carbon projects

Financing will need to be found for some of these measures. While Namibia is unlikely to be able to generate significant revenue from afforestation/reforestation-type carbon projects, opportunities for other types of carbon projects, such as concentrated solar power and small-scale biomass energy production, are worth exploring. Meanwhile, Namibia should also apply for adaptation funding in order to meet some of the challenges that lie ahead.

Policy recommendations

Environmental institutions and policies focused on the agriculture, water, forestry and wildlife, environmental planning, coastal management and fisheries will need to be strengthened in order to make them more resilient to climate change. These will need to be robust, promoting best practise and preparedness across all sectors.

Namibia already has to deal with severe environmental conditions of poor soils, low and highly variable rainfall, high temperatures, high rates of evaporation and meagre amounts of fresh water. Addressing the challenges of climate change through appropriate adaptation will automatically improve current management practices, enhance sustainability and promote socio-economic development. The converse is also true – that is, better management of the current situation is a pre-adaptation for coping with climate change. Many of the elements required for both improved current management and climate change adaptation are already contained in Namibia's Vision 2030, but have not been put into full effect. The first is to recognise Namibia's strategic comparative and competitive advantages. The second is to strengthen the policy environment to create incentives for the growth of businesses and enterprises around these. The third is the create and nurture strong and full partnerships between government and civil society (business sector, community sector, NGOs and academic institution) with none curtailing the other, with minimal bureaucracy, with maximum collaboration and working to optimize outcomes. And the fourth is to work to identify key bottlenecks and to remove these, so that sustainable socio-economic development is effectively unleashed.

Thus, Namibia's ability to adapt requires appropriate policies and laws, functioning institutions and partnerships, consistency in decision making, educated and competent citizens, access to technology and the appropriate allocation of resources, all of which combined with ensure wealth creation. In the future as in the past, the success of adaptation to climate will require choosing the right development options, so that those who are vulnerable (inevitably the poor) are not exposed to greater climate risk, and so that environmental integrity is maintained.